UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic Atmospheric Administration
National Marine Fisheries Service
P.O. Box 21668
Juneau Alaska 99802-1668

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

Issuance of Incidental Harassment Authorization under Section 101(a)(5)(D) of the Marine Mammal Protection Act to Fairweather LLC (Fairweather) for Anchor Retrieval Activities in the U.S. Chukchi and Beaufort Seas, Alaska, during the 2016 Open Water Season

NMFS Consultation Number: *AKR-2016-9526*

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
Fin Whale (*Balaneoptera physalus*)	Endangered	Yes	No	N/A
Humpback Whale DPS (*Megaptera novaeangliae*)	Endangered	Yes	No	N/A
North Pacific Right Whale (*Eubalaena japonica*)	Endangered	No	No	No
Gray Whale, Western North Pacific DPS (*Eschrichtius robustus*)	Endangered	No	No	N/A
Sperm Whale (*Physeter macrocephalus*)	Endangered	No	No	N/A
Ringed Seal, Arctic Subspecies (*Phoca hispida hispida*)	Threatened[1]	Yes	No	No
Bearded Seal, Beringia DPS (*Erignathus barbatus nauticus*)	Threatened[1]	Yes	No	N/A
Steller Sea Lion, Western DPS (*Eumatopias jubatus*)	Endangered	No	No	No

Consultation Conducted By: National Marine Fisheries Service, Alaska Region

Issued By:

for James W. Balsiger, Ph.D.
Administrator, Alaska Region

Date: 6/17/2016

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TERMS AND ABBREVIATIONS

µPa	Micro Pascal
2D	Two-Dimensional
3D	Three-Dimensional
AHTSV	Anchor Handling Towing Supply Vessel
BIA	Biologically Important Area
BSAI	Bering Sea/Aleutian Island
BWASP	Bowhead Whale Feeding Ecology Study
CAA	Conflict Avoidance Agreement
CI	Confidence Interval
CPUE	Catch Per Unit Effort
cui	Cubic Inches
CWA	Clean Water Act
dB	Decibels
DDT	Dichloro-Diphenyltrichloroethane
Discoverer	M/V *Noble Discoverer*
DP	Dynamic Positioning
DPS	Distinct Population Segment
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ESW	Effective Strip Width
Fairweather	Fairweather LLC
ft	Feet
gal	Gallons
Hz	Hertz
IHA	Incidental Harassment Authorization
IPCC	Intergovernmental Panel on Climate Change
ITS	Incidental Take Statement
IWC	International Whaling Commission
km	Kilometers
km^2	Square Kilometers
L	Liters
Mi	Miles
MMPA	Marine Mammal Protection Act
NMFS	National Marine Fisheries Service
NPDES	National Pollution Discharge Elimination System
NPRW	North Pacific right whale
OC	organochlorine
opinion	Biological Opinion
PAH	Polycyclic Aromatic Hydrocarbons
PAM	Passive Acoustic Monitoring
PBDE	Polybrominated Diphenyl
PBF	Physical Biological Feature
PBR	Potential Biological Removal

PCB	Polychlorinated Biphenyls
PCE	Primary Constituent Element
PR1	Office of Protected Resources- Permits and Conservation Division
PSO	Protected Species Observer
PTS	Permanent Threshold Shift
RMS	Root Mean Square
RPA	Reasonable Prudent Alternative
SAE	SAExploration, Inc.
SONAR	Sound Navigation and Ranging
t	Ton
TTS	Temporary Threshold Shift
UME	Unusual Mortality Event
USFWS	United States Fish and Wildlife Service
VGP	Vessel General Permit

1. INTRODUCTION

Section 7(a)(2) of the Endangered Species Act of 1973, as amended (ESA; 16 U.S.C. 1536(a)(2)) requires each Federal agency to insure that any action it authorizes, funds, or carries 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 (USFWS), 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 are exempt from this general requirement 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 USFWS concurs with that conclusion (50 CFR §402.14(b)).

Section 7(b)(3) of the ESA requires that at the conclusion of consultation, NMFS and/or USFWS provide an opinion stating how the Federal agencies' actions will affect ESA-listed species and their critical habitat under their jurisdiction. If incidental take is expected, section 7(b)(4) requires the consulting agency to provide an Incidental Take Statement (ITS) that specifies the impact of any incidental taking, specifies those reasonable and prudent measures necessary to minimize such impact, and sets forth terms and conditions that must be complied with to implement those measures.

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 anchor retrieval operations in U.S. State and Federal waters of the Chukchi and Beaufort Seas by Fairweather LLC (Fairweather) between July 1, 2016 and October 31, 2016. The consulting agency 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 and designated critical habitat for those 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 and ITS are in compliance with the Data Quality Act (44 U.S.C. 3504(d)(1) et seq.), and underwent pre-dissemination review.

1.1 Background

This opinion considers the effects of the issuance of an IHA to take marine mammals by harassment under the MMPA incidental to anchor retrieval operations by Fairweather in the U.S. Beaufort and Chukchi Sea from June 22 to October 31, 2016. These actions have the potential to affect the endangered bowhead whale (*Balaena mysticetus*), endangered fin whale (*Balaenoptera physalus*), endangered humpback whale (*Megaptera novaeangliae*), endangered North Pacific right whale (*Eubalaena japonica*), endangered western Steller sea lion (*Eumatopias jubatus*) distinct population segment (DPS), threatened Arctic subspecies of ringed seal (*Phoca hispida hispida*), and threatened Beringia DPS of bearded seal (*Erignathus barbatus nauticus*), as well as the designated critical habitats for North Pacific right whale and Steller sea lion.[1]

This biological opinion is based on information provided by Fairweather in the April 2016, Revised Incidental Harassment Authorization Application; February 2016, Draft Environmental Assessment; March 2016, Proposed Incidental Harassment Authorization Federal Register Notice (81 FR 31594), 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 1, 2016, Fairweather submitted an IHA application to NMFS for the non-lethal taking of cetaceans and seals in conjunction with its proposed anchor retrieval activities in the Kotzebue Sound, Chukchi Sea and Beaufort Sea, Alaska during the summer of 2016. On February 3, 2016, Fairweather submitted a revised IHA application. On February 10, 2016, NMFS PR1 submitted a request to initiate section 7 consultation to the NMFS Alaska Region. On February 24, 2016, NMFS AKR reviewed the initiation packaged and submitted comments concerning exposure estimates and density. PR1 responded on February 29, 2016. On April 6, 2016, Fairweather submitted a revised IHA application. On May 3, 2016, NMFS Alaska Region submitted an additional information request. PR1 responded on May 6 and 12, 2016.

[1] NMFS listed the Arctic subspecies of ringed seals and the Beringia DPS of bearded seals as threatened under the ESA on December 28, 2012 (77 FR 76706 and 77 FR 76740 respectively). On July 25, 2014, the U.S. District Court for the District of Alaska issued a decision vacating the Beringia DPS bearded seal listing (Alaska Oil and Gas Association v. Pritzker, Case No. 4:13-cv-00018-RPB). Subsequently on March 17, 2016, the District Court vacated the Arctic subspecies of ringed seal listing (Alaska Oil and Gas Association v. NMFS, Case No. 4:14-cv-00029-RRB). NMFS has appealed the bearded seal and ringed seal decisions. We include ringed and bearded seals here so that the action agency has the benefit of our analysis of the consequences of the proposed action on these species, even though the listings are not in effect.

2. DESCRIPTION OF THE PROPOSED ACTION

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 Fairweather's anchor retrieval activities in the U.S. Chukchi and Beaufort Seas between June 22, 2016 and October 31, 2016.

The purpose of the proposed action is to retrieve large anchors that were deployed as part of Shell's exploratory drilling program in 2012 and 2015. The anchors were deployed at five locations: 1) Good Hope Bay in Kotzebue Sound for barge moorings, 2) Burger A site in the Chukchi Sea for the Arctic containment system moorings, 3) Burger V site in the Chukchi Sea for the M/V *Noble Discoverer* (Discoverer) drilling rig moorings, 4) Kakapo in the Chukchi Sea for a contingency location for the Discoverer drilling rig, and 5) Sivulliq site in the Beaufort Seas for the mobile offshore drilling unit *Kulluk* (Kulluk) drilling rig moorings (Figure 1). The mooring systems at each site include anchors, chain, wire rope, clump weights, connecting gear, and float ropes. The anchors and all associated gear are scheduled for retrieval. The retrieval program will be funded by Shell but all aspects of the program will be operated by Fairweather (Fairweather 2016).

2.1.1 Fairweather's Proposed Activities

Fairweather proposes to retrieve approximately 55 anchors from five locations in the Chukchi and Beaufort Seas with the use of four specialized Anchor Handling Towing Supply Vessels (AHTSV) and sonar survey vessel (see Figure 1).

The Kotzebue location is approximately 20 kilometers (km, 12 miles [mi]) offshore of the village of Kotzebue, on the northwest coast of Alaska. The average depth in the Kotzebue project area is approximately 9 meters (m, 29 feet [ft]). The Burger A and Burger V locations are approximately 100 km (64 mi) offshore and approximately 126 km (78 mi) northwest of the closest village of Wainwright. Water depths in the Burger prospect area average 40-48 m (130-157 ft). The Kakapo location is approximately 110 km (68 mi) offshore to the northwest of the village of Point Lay, also on the northwest coast of Alaska. Water depths in the Kakapo area are similar to Burger, averaging 40 m (130 ft). The Sivulliq location is approximately 25 km (15 mi) offshore of the North Slope of Alaska in between Prudhoe Bay to the west and Kaktovik to the east. The average water depth at the Sivulliq project area is approximately 30-35 m (98-115 ft).

The components of the project include: transiting to anchor locations, anchor handling and dynamic positioning of vessels, retrieving mooring systems (chain, wire rope, synthetic fiber rope, connectors, and anchoring points), sidescan sonar and ice management. There will also be additional vessel activity associated with crew and fuel transfer, and resupply, and additional monitoring for marine mammals.

Fairweather plans to remove anchors between July 1 and October 31, 2016. Anchor retrieval is expected to take approximately 7 days per site or 35 days total, depending on weather. Sidescan sonar activities are anticipated to take 30 days to conduct. The Conflict Avoidance Agreement (CAA) states that operations will cease during the fall bowhead whale hunt to avoid interference with the Cross Island (Nuiqsut residents), Kaktovik, or Barrow-based hunts if required by those communities. Typically this requires vessels to be out of the Beaufort prior to August 25th (Fairweather 2016).

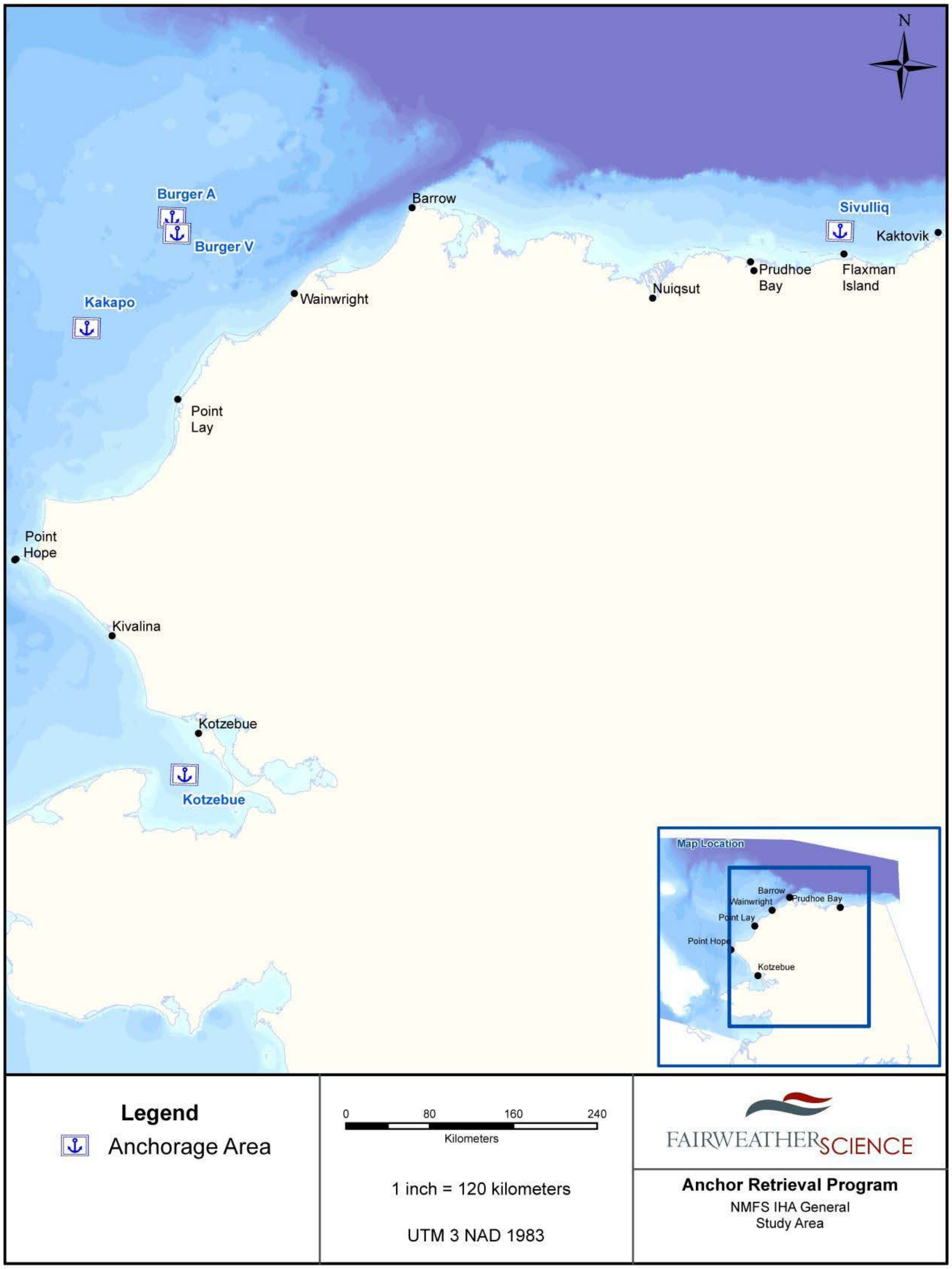

Figure 1. **Anchor retrieval locations associated with the proposed action (Fairweather 2016).**

2.1.1.1 Fairweather's Vessel Operations

Fairweather will employ four AHTSVs for anchor retrieval (M/V Aiviq, M/V *Ross* Chouest, M/V *Nanuq*, and M/V *Dino Chouest*). The R/V *Norseman II* will conduct sidescan sonar surveys at anchor retrieval locations, and three, small, flat-bottom vessels, will be available for crew changes in Kotzebue, Wainwright or Prudhoe Bay if necessary. The AHTSVs will mobilize from Dutch Harbor in late June and arrive in Kotzebue area by early July. Additional information on project vessels can be found in Table 1.

Table 1. Fairweather's Proposed Vessels (Fairweather 2016).

Vessel	Specification	Size (feet)	Max Speed	Available Fuel Storage
M/V *Aiviq*	Anchor Handling Ice Classed Refueling Support	360 x 80	15 knots	527,073 gallons
M/V *Ross Chouest*	Anchor Handling	256 x 54	12 knots	149,157 gallons
M/V *Nanuq*	Anchor Handling Ice Classed Refueling Support	301 x 60	15 knots	323,065 gallons
M/V *Dino Chouest*	Anchor Handling ROV	348 x 72	15 knots	508,337 gallons
R/V *Norseman II*	Sidescan Sonar Surveys	115 x 28	10 knots	44,000 gallons
(3) Support Vessels	Crew support Resupply Refueling	-	-	-

Timing and movement of the vessels is a complex planning exercise. It is likely that one or two vessels will need to transit to Dutch Harbor to offload anchors. The goal is to arrive at Kotzebue Sound and retrieve these systems in early July. Fairweather will work closely with the communities in Kotzebue Sound (Kotzebue, Kivalina, and Shishmaref) to ensure there are no conflicts with the beluga whale harvest. If subsistence harvest activities are taking place, Fairweather will not retrieve anchors until cleared by the communities to do so. The vessels will move into the Chukchi Sea to retrieve the Burger and Kakapo anchors, depending on ice presence. As soon as the passage to Barrow around Point Barrow is ice free and safe for passage to the Beaufort Sea, two of the four AHTSVs will immediately transit to the Sivulliq site. Typically, this occurs in late July/early August. Retrieval operations will be completed and vessels will be out of the Beaufort prior to the August 25th commencement for the Nuiqsut/Kaktovik bowhead whale harvest. Once the Sivulliq anchors are retrieved, the two vessels will return to the Chukchi Sea to complete any remaining operations. According to the Fairweather anchor retrieval scenario, a total of 12 transits may occur within North Pacific right whale critical habitat (Fairweather 2016).

The *Norseman II* will be in the Bering Strait region starting in early June conducting scientific research for other organizations. As soon as the ice allows, the *Norseman II* will transit to Kotzebue Sound to collect the imagery and then up to the Chukchi Sea. As with the anchor handling vessels, the timing of transiting to the Beaufort Sea will depend on ice around Point Barrow.

2.1.1.2 Fairweather's Anchor Retrieval

Anchor Handling

Once on site, the retrieval of each anchor and associated mooring system typically takes approximately four hours to complete. There is typically one to two vessels onsite, only one of which will be retrieving an anchor. Depending on weather and number of the mooring lines/anchors, one site is expected be completed within two to seven days. Anchors will be retrieved in one of two ways. The first is by locating the float rope connected to each of the mooring systems with the ROV and retrieving the anchor from the opposite side of the anchor, working towards the anchor itself. The second method will be employed if the float rope cannot be located, or the vessel retrieving does not have an ROV. A grappling hook will be deployed and to grasp the mooring chain along the anchoring system. From that point, the anchor system will be pulled on the back deck with retrieval on the non-anchor side first, then the anchor side, and all the way to the anchor.

Over this period, the anchor winch and thrusters will pull, unseat and retrieve anchors from the seafloor. Depending on water and anchor depth, this typically takes 15-20 minutes per anchor. Thruster usage while maintaining station using Dynamic Positioning (DP) will vary depending on weather and sea conditions. Thruster percentages are automatically increased and decreased based on the sea state and weather. If weather conditions are poor, the thrusters will need to work harder to maintain position. Anchors at Burger A and Kakapo locations are wet stored (they were not seated deeply in place) and will not require unseating.
During the 2012 exploratory program for Shell, detailed sound level measurements were performed for all the various activities and vessels, including anchor handling.

JASCO (2014) measured sound levels produced by the *Tor Viking* during activities associated with anchor handling in the Chukchi Sea during Shell's 2012 exploration drilling program at Burger. Distance to the 120 dB re 1 μPa rms during these activities was estimated to be approximately 14 km (Fairweather 2016).

Detailed descriptions of the sound measurements and analysis methods are provided in the Shell 2012 90-day report (Austin et al. 2013) and in the Comprehensive Joint Monitoring Report (LGL et al. 2014). Anchor handling activities were found to be the loudest of the activities due to the thrusters working at their highest power during the seating of the anchors.

Received levels were measured at 143 dB at 860 m. Fairweather assumes the unseating of the anchors will be similar in power needed from the vessel, so this source is suitable to estimate the area ensonified for the anchor unseating. Thrusters will only be used during anchor retrieval operations (Fairweather 2016).

Sidescan Sonar

The deployed locations of each anchor are known, but the mooring lines may have shifted over time and there may be significant marine vegetation growth. The ROV used to manipulate the float ropes is equipped with a camera to give the operators a visual of the equipment once onsite. However, to facilitate the efficiency and safety of the retrieval process, Fairweather may obtain high resolution geo-referenced imagery using an interferometric sidescan sonar or multi-beam sidescan sonar prior to the beginning of retrieval operations at each site. This imagery will provide the anchor handlers with an accurate picture of exactly where equipment is located to allow safe and efficient retrieval. Fairweather may also survey each site after retrieval is complete to confirm all anchors and associated gear are removed.

The sonar survey will be conducted from the R/V *Norseman II*, operated by Olgoonik Fairweather, LLC. The *Norseman II* has operated in the Arctic for industry and research organizations since 2007. This vessel will operate independently from the AHTSVs. The sonar will be towed over the anchor site array in a grid pattern sufficient to produce a mosaic of the entire site. Each survey is expected to last a period of one to three days. In the event that interferometric sonar is used, it will be pole mounted on the side of the survey vessel. The imagery will be provided immediately to the vessel operators so they will be able to develop a detailed plan for the retrieval based on actual conditions of the equipment.

Sidescan sonar is a sideward-looking, narrow-beam instrument that emits a sound pulse and “listens” for its return. The sidescan sonar can be a two or multichannel system with single frequency monotonic or multiple frequency. The frequency of individual sidescan sonars can range from 100 to 1600 kHz with source levels between 194 and 249 dB re 1 μPa at 1 m (rms). Depending on the operating frequencies, sidescan sonars may be outside the hearing range (7 Hz to 100 kHz) of species considered in this opinion (see Table 2).

Echosounders measure the time it takes for sound to travel from a transducer to the seafloor and back to a receiver. The travel time is converted to a depth value by multiplying it by the sound velocity of the water column. Single beam echosounders measure the distance of a vertical beam below the transducer. For the proposed action, a single-beam echosounder is anticipated to have an operating frequency of 210 kHz with a source level of approximately 220 dB re 1 μPa at 1 m (rms). The beam width is anticipated to be approximately 3 degrees (Fairweather 2016). Multibeam echosounders emit a swath of sound to both sides of the transducer with an operating frequency of 240 kHz and source level 220 dB re 1 μPa at 1 m (rms). The beam width of emitted sound along-track direction is 1.5 degrees, while across track beam width is 1.8 degrees (HydroSurveys 2010, Konsberg 2014). A dual frequency sonar system will operate at 400 kHz and 900 kHz with a source level of 215 dB dB re 1 μPa at 1 m. The beam width is 0.45 degrees for the 400 kHz and 0.25 degrees at 900 kHz with a vertical beam width of 50 degrees (Fairweather 2016).

Table 2. Active Acoustic Sources Associated with the Proposed Action (Fairweather 2016).

Source	Broadband Source Level (dB re 1 µPa at 1 m)	Operating Frequencies	Within Hearing Range	
			Low-Freq Cetaceans (7Hz-30 kHz)	Phocids (75 Hz-100 kHz)
Anchor Removal	231	10-2,000 Hz (most energy at <200 Hz)	Yes	Yes
Side scan Sonar (dual frequency)	215	400 kHz 900 kHz	No	No
Multibeam Echosounder	220	240 kHz	No	No
Single-beam Echosounder	220	210 kHz	No	No

2.1.1.3 Ice Management

Although highly unlikely, it may be necessary for ice management near Point Barrow while transiting to the Sivulliq site. During exploration drilling operations on the Burger Prospect in 2012, encroachment of sea ice required the *Discoverer* to temporarily depart the drill site. While it was standing by to the south, ice management vessels remained at the drill site to protect buoys that were attached to the anchors. Sounds produced by vessels managing the ice were recorded and the distance to the 120 dB re 1 µPa rms threshold was calculated to occur at 9.6 km (JASCO 2014). The total calculated ensonified area would be 290 km^2.

2.1.2 Mitigation Measures Proposed by NMFS's IHA Stipulations

The mitigation measures described below are required per the NMFS's IHA stipulations, and will be implemented by Fairweather to reduce potential impacts to marine mammals from anchor removal, sidescan sonar, and vessel movements. Unless otherwise noted, these measures apply to all marine mammal species.

Establishing and Monitoring Safety Zone for Anchor Retrieval

Each vessel will be staffed with two Protected Species Observers (PSOs) for a total of up to 10 PSOs. For anchor retrieval activities, PSOs will not implement shutdown procedures as these are neither safe nor feasible. PSOs cannot feasibly monitor out to the 120 dB isopleth (14 km) during anchor handling due to the distance. However, they will establish and monitor a safety zone of 500 m (larger than the modeled safety zone of 121 m) for anchor retrieval activity. When the AHTSV is positioned on-site, the PSOs will 'clear' the area by observing the 500m safety zone for 30 minutes; if no marine mammals are observed within those 30 minutes, anchor retrieval will commence. If a marine mammal(s) is observed within 500 m of the anchor retrieval safety zone during the clearing, the PSOs will continue to watch until the animal(s) is gone and has not returned for 15 minutes if the sighting was a pinniped, or 30 minutes if it was a cetacean. Once the PSOs have cleared the area, anchor retrieval operations may commence. Should a marine mammal(s) be observed within, or about to enter, the 500 m safety zone during the retrieval operations in the opinion of the PSO, the PSO will monitor and carefully record any reactions observed.

Establishing and Monitoring Exclusion Zone for Sonar Activity

Although NMFS does not expect marine mammals would be taken by high-frequency sonar used for locating anchors because the frequency is outside the hearing range of cetaceans and pinnipeds except at very close range, Fairweather will implement the following mitigation and monitoring measures as a precautionary measure related to sonar operations be implemented: (1) PSOs would establish and monitor an exclusion zone of 500 m for sonar activity (larger than the modeled 180 dB exclusion zone of 100 meters); (2) Prior to starting the sonar activity, the PSOs will 'clear' the area by observing the 500 m exclusion zone for 30 minutes; if no marine mammals are observed within those 30 minutes, sonar activity will commence; (3) If a marine mammal(s) is observed within the 500 m exclusion zone during the clearing, the PSOs will continue to watch until the animal(s) is gone and has not returned for 15 minutes if the sighting was a pinniped, or 30 minutes if it was a cetacean; and (4) Once the PSOs have cleared the area, sonar activity may commence.

Establishing and Monitoring Exclusion Zone for Ice Management

Although NMFS does not anticipate ice management activities will be needed, Fairweather will implement the following mitigation and monitoring measures related to ice management operations if needed: (1) PSOs would establish and monitor a safety zone of 500 m for ice management activity (larger than the modeled 160 dB exclusion zone of 60 meters); (2) Prior to starting the ice management, the PSOs will 'clear' the area by observing the 500 m exclusion zone for 30 minutes; if no marine mammals are observed within those 30 minutes, ice management activity will commence; (3) If a marine mammal(s) is observed within the 500 m safety zone during the clearing, the PSOs will continue to watch until the animal(s) is gone and has not returned for 15 minutes if the sighting was a pinniped, or 30 minutes if it was a cetacean; and (4) Once the PSOs have cleared the area, ice management activity may commence. Should a marine mammal(s) be observed within, or in the opinion of the PSO about to enter, the 500 m safety zone during the ice management operations, the PSOs will monitor and carefully record any reactions observed.

Establishing Zones of Influence (ZOIs)

PSOs would establish and monitor ZOIs where the received level is 120 dB during Fairweather's anchor retrieval and ice management operations and where the received level is 160 dB during sonar activity see Table 3.

Table 3. Anticipated distances to Exclusion Zones (180 dB for cetaceans, and 190 dB for pinnipeds) and Harassment Zone (160 dB for impulsive and 120 dB for Continuous Noise Sources) (Fairweather 2016).

		Exclusion Zone (Pinnipeds)	Exclusion Zone (Cetaceans)	Harassment Zone (Impulsive Source)	Harassment Zone (Continuous Source)
Source	**Source Level**	**190 dB**	**180 dB**	**160 dB**	**120 dB**
Anchor Handling	195 dB re 1 μPa (rms)	4 m	12 m	121 m	14 km
Sidescan Sonar	220 dB re 1 μPa (rms)	32 m	100 m	1 km	N/A
Ice Management	192 dB re 1 μPa (rms)	3 m	10 m	60 m	9.6 km

Visual-Based PSOs

PSOs will be required onboard AHTSV and sidescan vessels to meet the following criteria:

- 2 PSOs will be stationed on each AHTSV, 1-2 PSOs will be stationed on the smaller sonar source vessel;
- 100% monitoring coverage of exclusion zones during all anchor handling, ice management, and sidescan operations in daylight;
- PSOs will be aboard both AHTSV and sonar vessels to document the occurrence of marine mammals, implement mitigation requirements, and record the reactions of marine mammals to operations;
- Maximum of 4 consecutive hours on watch per PSO; and
- Maximum of ~12 hours of watch time per day per PSO.
- PSO teams shall consist of Inupiat observers and experienced field biologists. An experienced field crew leader will supervise the PSO team. New PSOs will be paired with experienced PSO or experienced field biologist so that the quality of marine mammal observations and data recording is kept consistent;
- Biologist-observers will have previous marine mammal observation experience, and field crew leaders will be highly experienced with previous vessel-based marine mammal monitoring and mitigation projects;
- Inupiat observers will be experienced in the region and familiar with marine mammals of the area;
- PSOs shall be trained using visual aids (e.g., videos, photos) to help them identify the species in the conditions that they are likely to encounter;
- Within safe limits, the PSOs should be stationed where they have the best possible viewing. Viewing may not always be best from the ship bridge, and in some cases may be best from higher positions with less visual obstructions (e.g., flying bridge);
- PSOs should be instructed to identify animals as unknown where appropriate rather than strive to identify a species if there is significant uncertainty;

- PSOs should maximize their time with eyes on the water. This may require new means of recording data (e.g., audio recorder) or the presence of a data recorder so that the observers can simply relay information to them;
- The PSOs shall be provided with Fujinon 7 x 50 or equivalent binoculars for visual based monitoring onboard all vessels.
- Laser range finders (Leica LRF 1200 laser rangefinder or equivalent) shall be available to assist with distance estimation.

Shutdown Measures for Sidescan Sonar

If any marine mammal enters the 500 m exclusion zone, or based on the discretion of the PSO is likely to enter the exclusion zone, sonar activities will be shut down immediately. Sonar operations may not resume until the PSO has confirmed the marine mammal(s) has left the exclusion zone, or the if the marine mammal has not been spotted for 15 minutes if the sighting was a pinniped, or 30 minutes if it was a cetacean. PSOs will also collect behavioral information on marine mammals beyond the exclusion zone.

Vessel Related Mitigation Measures

These mitigation measures apply to all vessels that are part of Fairweather's Kotzebue Sound, Chukchi Sea and Beaufort Sea anchor removal, ice management, and sidescan sonar vessel activities. They apply when mobilizing to the project area, when demobilizing from the project area, and in the performance of any other operations in support of the anchor removal program:

- For sonar activities, if a marine mammal appears likely to enter the 500 m exclusion zone based on the discretion of the PSO, the vessel's speed and/or course direction may be altered when practical and safe to do so.
  - Marine mammal movements shall be closely monitored to ensure that the animal does not enter the exclusion zone. Further mitigation action will be taken (i.e., either further course alteration or shut down of sonar activities) if the marine mammal continues to approach the exclusion zone.
- Avoid concentrations of 5 or more whales. Operators of vessels should, at all times, conduct their activities at the maximum distance possible from such concentrations or groups of whales.
- If any vessel approaches within 1.6 km (1 mi) of observed whales, except when providing emergency assistance to whalers or in other emergency situations, the vessel operator will take reasonable precautions to avoid potential interaction with the whales by taking one or more of the following actions, as appropriate:
  - Reducing vessel speed to less than 5 knots within 300 yards (274 m) of the marine mammal;
  - Steering around the whale(s) if possible;
  - Operating the vessel(s) in such a way as to avoid separating members of a group of whales from other members of the group;
  - Operating the vessel(s) to avoid causing a whale to make multiple changes in direction; and
  - Checking the waters immediately adjacent to the vessel(s) to ensure that no whales will be injured when the propellers are engaged.

North Pacific Right Whale Critical Habitat Mitigation Measures

All vessels associated with Fairweather's operations will avoid transits within designated North Pacific right whale critical habitat. If transit within North Pacific right whale critical habitat cannot be avoided, vessel operators are requested to exercise extreme caution and observe a 10 knot (18.52 km/h) vessel speed restriction within North Pacific right whale critical habitat. Within the North Pacific right whale critical habitat, all vessels shall keep 2,625 ft (800 m) away from any observed North Pacific right whales and avoid approaching whales head-on consistent with vessel safety.

Reporting Measures

The results of Fairweather's anchor retrieval program monitoring reports would be presented in weekly, monthly, and 90-day reports, as required by NMFS under the proposed IHA.

Weekly Reports

Fairweather will submit weekly reports to NMFS no later than the close of business (Alaska Time) each Thursday during the weeks when anchor removal or sonar activities take place. The weekly reports will summarize species detected, in-water activity occurring at the time of the sighting, behavioral reactions to in-water activities, the number of marine mammals exposed to harassment level noise (i.e., ≥ 120 dB rms for continuous noise sources and ≥160 dB rms for impulsive sources), the distance marine mammals were spotted from operations, and the associated noise isopleth for active sound sources.

Monthly Reports

Fairweather will submit monthly reports to NMFS for all months during which anchor handling or sonar activities take place. The monthly reports will contain and summarize the following information:

- Dates, times, locations, heading, speed, weather, sea conditions (including Beaufort Sea state and wind force), and associated activities during the seismic survey and marine mammal sightings.
- Species, number, location, distance from the vessel, and behavior of any sighted marine mammals, as well as associated surveys (number of shutdowns), observed throughout all monitoring activities.

90-Day Reports

Within 90-days of the expiration of the IHA (if issued), a 90-day report will be provided to NMFS that includes:

- 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);
- Summaries that represent an initial level of interpretation of the efficacy, measurements, and observations, rather than raw data, fully processed analyses, or a summary of operations and important observations;
- Analyses of the effects of various factors influencing detectability of marine mammals (e.g., sea state, number of observers, and fog/glare);
- Species composition, occurrence, and distribution of marine mammal sightings, including date, water depth, numbers, age/size/gender categories (if determinable), group sizes, and ice cover;

- Estimates of uncertainty in all take estimates, with uncertainty expressed by the presentation of confidence limits, a minimum-maximum, posterior probability distribution, or another applicable method, with the exact approach to be selected based on the sampling method and data available;
- A clear comparison of authorized takes and the level of actual estimated takes.

The 90-day reports will be subject to review and comment by NMFS. Any recommendations made by NMFS must be addressed in the final report prior to acceptance by NMFS.

Notification of Injured or Dead Marine Mammals

In the unanticipated event that the specified activity clearly causes the take of a marine mammal in a manner not authorized by the IHA, such as a serious injury, or mortality (e.g., ship-strike, gear interaction, and/or entanglement), Fairweather would immediately cease the specified activities and immediately report the incident to the NMFS Permits and Conservation Division, Office of Protected Resources, Shane Guan (301-427-8418), the Alaska Region Protected Resources Division, Alicia Bishop (907-586-7224) or Alicia.Bishop@noaa.gov, and the Alaska Regional Stranding Coordinator, Mandy Migura (907-271-1332) or Mandy.Migura@noaa.gov). 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).

Activities would not resume until NMFS is able to review the circumstances of the prohibited take. NMFS would work with Fairweather to determine what is necessary to minimize the likelihood of further prohibited take and ensure ESA/MMPA compliance. Fairweather would not be able to resume its activities until notified by NMFS via letter, email, or telephone.

In the event that Fairweather discovers a dead marine mammal, and the lead PSO determines that the cause of the 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), Fairweather would immediately report the incident to the Chief of the NMFS Permits and Conservation Division, Office of Protected Resources, the NMFS Alaska Stranding Hotline (877-925-7773), and/or by email to the Alaska Regional Stranding Coordinator. 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 Fairweather to determine whether modifications of the activities are appropriate.

In the event that Fairweather discovers a dead marine mammal, and the lead PSO determines that the 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), Fairweather would report the incident to the NMFS Chief of the Permits and Conservation Division, Office of Protected Resources, the NMFS Alaska Stranding Hotline (877-925-7773), and/or by email to the Alaska Regional Stranding Coordinator, within 24 hours of the discovery. Fairweather would provide photographs or video footage (if available) or other documentation of the stranded animal sighting to NMFS. Fairweather can continue its operations under such circumstances.

Vessel Disturbance Study

Fairweather proposes to collect information on responses of marine mammals, particularly walruses and seals, to vessel disturbance associated with transit during the proposed action. Observers will record the initial and subsequent behaviors of marine mammals, a methodology we refer to as 'focal following.' Marine mammals will be monitored and observed until they disappear from the PSO's view (PSOs may have to follow the marine mammals by moving to new locations in order to keep the marine mammals in constant view). Observers will also record any perceived reactions that marine mammals may have in response to the vessel. When following the animal, PSOs will use either a notebook or voice recorder to note any changes in behavior and the time when these changes occur. Time of first observation, time of changes in behavior, and time last seen will be recorded. Behaviors and changes in behaviors of marine mammals will be recorded as long as they are in view of the boat. After the animal is out of sight, PSOs will summarize the observation in the notes field of the electronic data collection platform. It may be difficult to find the animal being followed after it dives and if this happens, the PSO will stop focal follow observation.

For groups of marine mammals that are too large to monitor each animal, one or more focal animals, e.g., cow/calf pair, subadult female, adult male, etc., will be chosen to monitor until no longer observable. For a sighting with more than one animal, the most common behavior of the group will be recorded. Focal animals will be chosen without bias in relation to age and sex, but as observations accumulate and specific age/sex categories are underrepresented, focal animals may be chosen from those underrepresented categories if possible. A separate section in the 90-day report will be provided with a summary of results of vessel disturbance, with the ultimate goal of a peer-reviewed publication.

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) the five anchor retrieval sites in Kotzebue Sound, the Chukchi Sea, and the Beaufort Sea; (2) the ensonfied area associated with anchor handling and sidescan sonar; and (3) transit areas from Dutch Harbor through the Bering Strait, into Kotzebue Sound, Chukchi Sea, and Beaufort Sea, and from anchor retrieval sites to coastal communities that provide refueling and resupply (Kotzebue, Wainwright or Prudhoe Bay if necessary) (see Figure 2).

PR1 is proposing to authorize Fairweather to take marine mammal species in connection with Fairthweather's anchor retrieval activities within five locations in Kotzebue Sound, the Chukchi Sea, and the Beaufort Sea. In total, the action area covers 208,617 square kilometers of water in depths ranging from 9-69 meters. Within this area, the loudest sound source with the greatest propagation distance is anticipated to be associated with anchor handling activities. Received levels from anchor handling with a nominal source level of 231 dB, may be expected on average to decline to 120 dB re 1 μPa (rms) within 14 km of the anchor retrieval site assuming a mixed sound speed profile and medium reflectivity geoacoustics (Austin et al. 2015, Fairweather 2016). The 120 dB isopleth was chosen as the level at which we anticipate seismic survey noise levels would approach ambient noise levels (i.e. the point where no measurable effect from the project would occur). While project noise may attenuate beyond the 120 dB isopleth, we do not anticipate that marine mammals would respond in a biologically significant manner at these low levels and great distance from the source. Mobilization and demobilization of vessels are anticipated to occur from Dutch Harbor[2] with resupply and support activities potentially occurring out of Kotzebue, Wainwright, or Prudhoe Bay.

[2] NMFS reviewed all of the previous IHA applications and 90-day monitoring reports from previous seismic and exploratory drilling operations in the Chukchi and Beaufort Seas from 2006-2013. ION Geophysical (2012) and Beland and Ireland (2010) both started their projects in Canadian Arctic waters; however, both projects ended in Dutch Harbor.

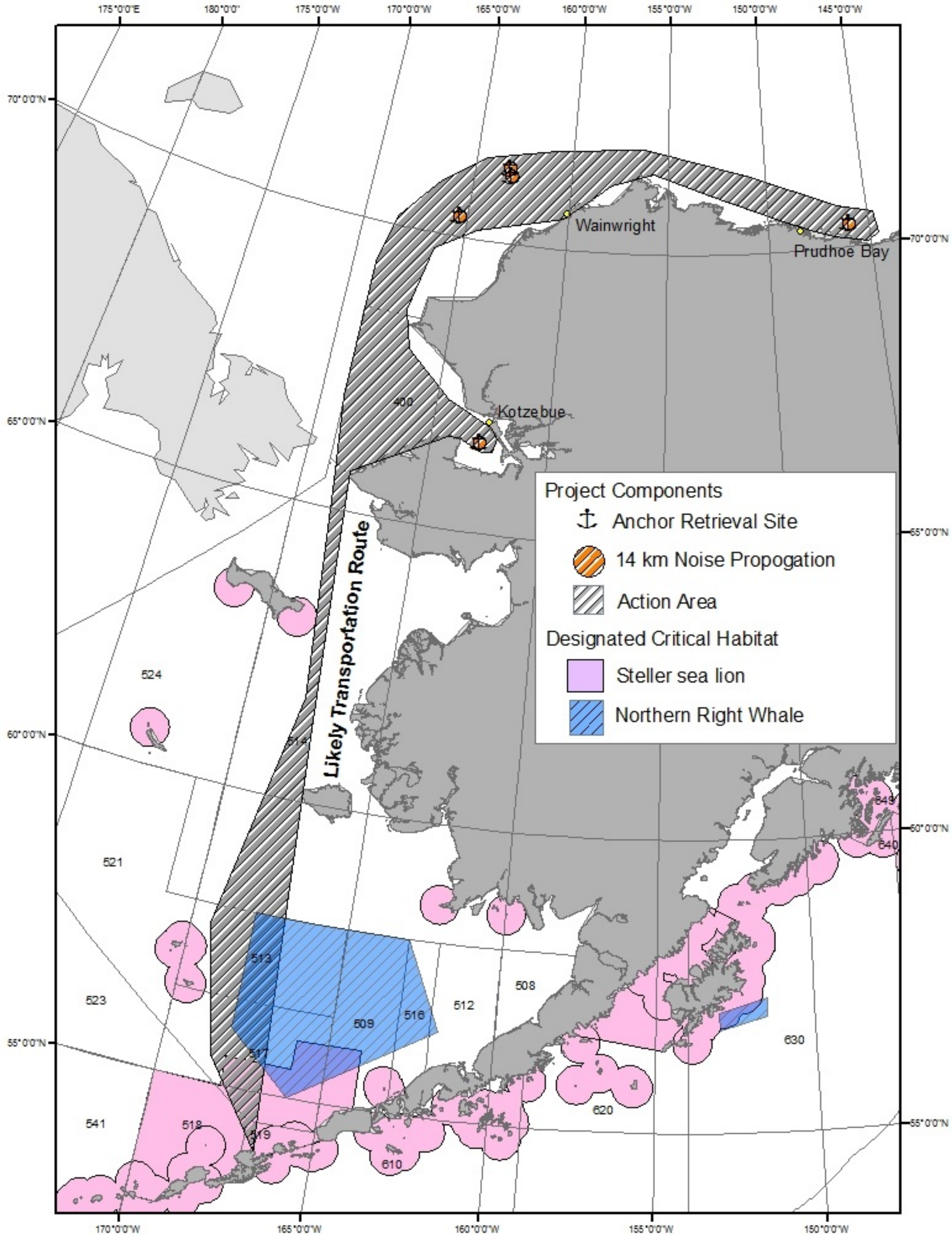

Figure 2. **Action area map for Fairweather's proposed anchor retrieval operations in Kotzebue Sound, Chukchi Sea, and Beaufort Sea. Transit to anchor retrieval areas will occur from Dutch Harbor with resupply occurring out of Kotzebue, Wainwright, or Prudhoe Bay.**

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. The adverse modification analysis considers the impacts to the conservation value of the designated critical habitat.

"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 the survival or 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, a setback to recovery alone may result in a jeopardy biological opinion (51 FR 19926, 19934; June 2, 1986).

For purposes of this opinion, NMFS interprets this definition consistent with the court's opinion in *National Wildlife Federation v. NMFS*, 524 F.3d 917 (9th Cir. 2008). NMFS's jeopardy analysis considers how the proposed action may affect the likelihood of survival of the species and how it may affect the likelihood of recovery of the species.

Under NMFS's regulations, the destruction or adverse modification of critical habitat "means a direct or indirect alteration that appreciably diminishes the value of critical habitat for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features" (50 CFR 402.02). endeavors wer

3.1.1 Approach to the Assessment

We use the following approach to determine whether the proposed action described in Section 2 is likely to jeopardize listed species or destroy or adversely modify critical habitat:

- Identify those aspects (or stressors) of the 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 and temporal extent of these direct and indirect effects.
- Identify the rangewide status of the species and critical habitat 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 including: past and present impacts of Federal, state, or private actions and other human activities *in the action area;* 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 stressors and the populations or subpopulations those individuals represent. NMFS also evaluates the proposed action's effects on critical habitat features. The effects of the action are described in Section 6 of this opinion with the exposure analysis described in Section 6.3 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 6.4 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: (1) appreciably reduce the likelihood of both survival and recovery of the species in the wild by reducing its numbers, reproduction, or distribution; or (2) reduce the value of designated or proposed critical habitat for the conservation of the species. These assessments are made in full consideration of the status of the species and critical habitat (Section 4). 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 in 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 Exposure Analyses

Exposure analyses are designed to identify the listed resources that are likely to co-occur with the action's 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. When it is impossible or impracticable to estimate the number of individuals likely to be exposed, we try to estimate the proportion of a population that is likely to be exposed. If we cannot estimate this proportion, we will rely on a surrogate or index.

Given the many uncertainties in predicting the quantity and types of impacts of sound on marine mammals, it is common practice to estimate how many animals would be present within a particular distance of human activities and/or exposed to a particular level of anthropogenic sound. In most cases, this approach likely overestimates the numbers of marine mammals that would be affected in some biologically important manner. One of the reasons for this is that the selected distances/isopleths are based on limited studies indicating that some animals exhibited short-term reactions at this distance or sound level, whereas the calculation assumes that all animals exposed to this level would react in a biologically significant manner.

Another scenario we considered but did not use assumed marine mammals would try to avoid exposure to seismic transmissions (See *Response Analysis* Section 6.1.4). However, the data necessary on the rate at which cetacean and pinniped densities would change in response to initial or continued seismic exposure were not available for this consultation so we could not reach conclusions based on this scenario. As a result, although we considered an alternative exposure scenario for this consultation, we only report the results of one exposure scenario.

3.1.3 Response Analyses

Once we identify which listed resources are likely to be exposed to stressors associated with the proposed action, and the nature of that exposure, we examine the scientific and commercial data available to determine whether and how (1) endangered or threatened species are likely to respond following exposure and the set of physical, physiological, behavioral, or social responses that are likely and (2) the action is likely to affect the quantity, quality, or availability of one or more of the physical or biological features of critical habitat.

Conceptual Model for Response Analyses

To guide our response analyses, we use a conceptual model of responses to noise (which is the principal stressor included in the proposed action). The model is based on animal behavior and behavioral decision-making (Figure 2) although we continue to recognize the risks presented by physical trauma and noise-induced losses in hearing sensitivity (threshold shift). This model is also based on a conception of "hearing" that includes cognitive processing of auditory cues, rather than focusing solely on the mechanical processes of the ear and auditory nerve. Our model incorporates the primary mechanisms by which behavioral responses affect the longevity and reproductive success of animals: changing an animal's energy budget, changing an animal's time budget (which is related to changes in an animal's energy budget), forcing animals to make life history trade-offs (for example, engaging in evasive behavior such as deep dives that involve short-term risks while promoting long-term survival), or changes in social interactions among groups of animals (for example, interactions between a cow and her calf). This conceptual model begins with the specific acoustic stimuli that we focus on in an assessment (Box 1 in Figure 2). Although we generally consider different acoustic stimuli separately, we consider a single source of multiple acoustic stimuli as a complex "acoustic object" that has several acoustic properties. For example, we treat pulses produced by seismic sound sources and sounds produced by the source vessel as a single "acoustic object" that produce continuous sounds (engine- noise, propeller cavitation, hull displacement, etc.) and periodic impulsive pulses. Because animals would be exposed to this complex of sounds produced by a single, albeit moving, source over time, we assum they would generally respond to the acoustic stream associated with this single acoustic object moving through their environment. Multiple ships associated with a particular type of survey, for instance 3D seismic surveys, are expected to also represent a single acoustic object as all vessels are moving in formation at the same speeds while alternating shots. Multiple ships associated with drilling operations, such as support ships that move independently of the survey formation would represent different acoustic objects in the acoustic environment of endangered and threatened marine animals.

Acoustic stimuli can represent two different kinds of stressors: *processive stressors*, which require high-level cognitive processing of sensory information, and *systemic stressors*, which usually elicit direct physical or physiological responses and, therefore, do not require high-level cognitive processing of sensory information (Herman and Cullinan 1997, Anisman and Merali 1999, de Kloet et al. 2005, Wright et al. 2007). Disturbance from surface vessels and airguns would be examples of processive stressors while ship strikes would be an example of a systemic stressor. The proposed action may result in two general classes of responses:

1. responses that are influenced by an animal's assessment of whether a potential stressor poses a threat or risk (see Figure 2: Behavioral Response).

2. responses that are not influenced by the animal's assessment of whether a potential stressor poses a threat or risk (see Figure 2: Physical Response).

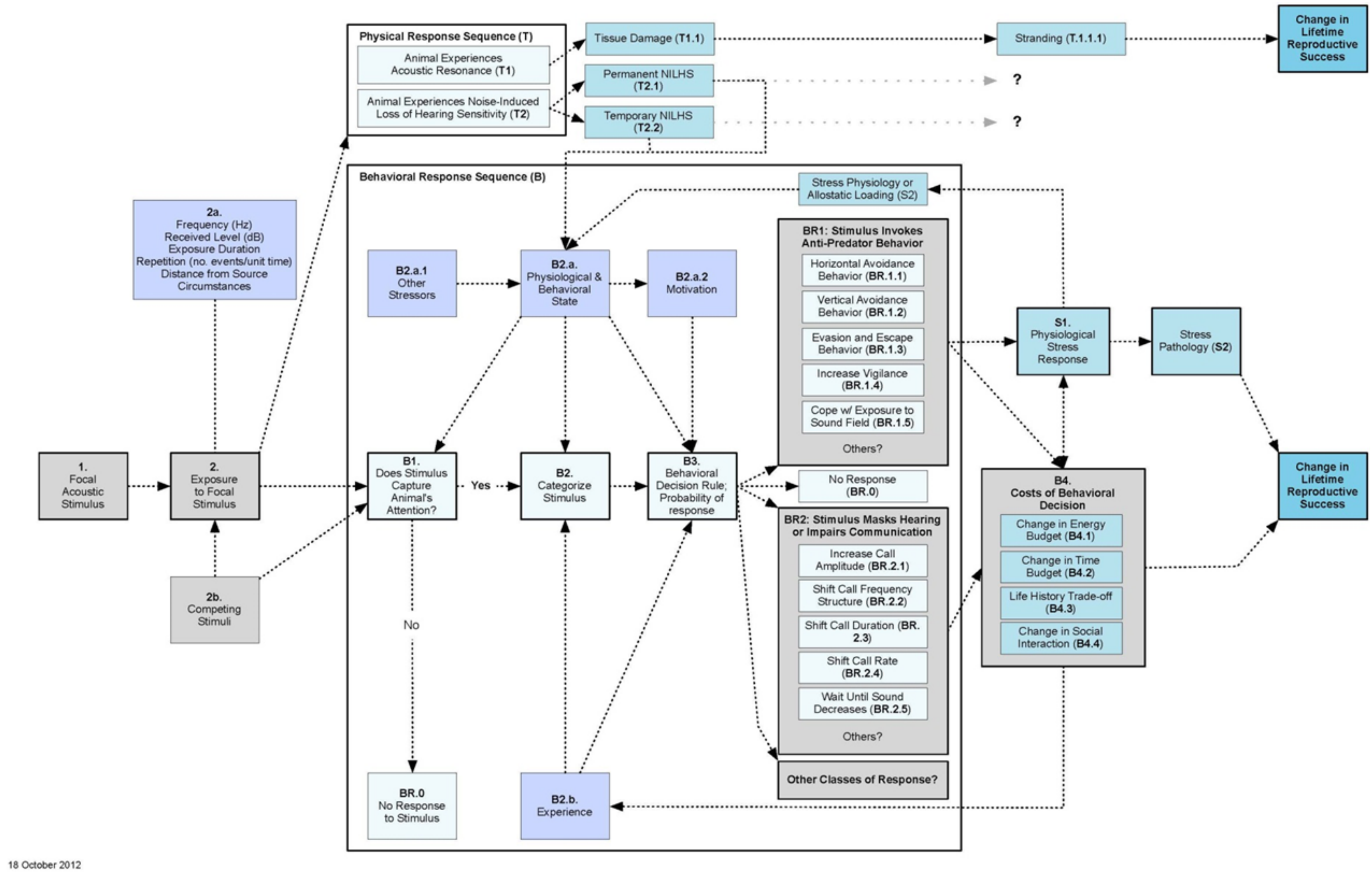

Figure 2. **Conceptual model of the potential responses of listed species upon exposure to active acoustic sources, and the pathways by which those responses might affect the fitness of individual animals that have been exposed (NMFS 2012).**

Our conceptual model explicitly recognizes that other acoustic and non-acoustic stimuli that occur in an animal's environment might determine whether a focal stimulus is salient to a focal animal (the line connecting Box 2b to Box 2 in Figure 2). The salience of an acoustic signal will depend, in part, on its signal-to-noise ratio and, given that signal-to-noise ratio, whether an animal will devote attentional resources to the signal or other acoustic stimuli (or ambient sounds) that might compete for the animal's attention (the line connecting Box 2b to Box B1 in Figure 2).[3] That is, an acoustic signal might not be salient (1) because of a signal-to-noise ratio or (2) because an animal does not devote attentional resources to the signal, despite its signal-to-noise ratio. Absent information to the contrary, we generally assume that an acoustic stimulus that is "close" to an animal (within 10 – 15 kilometers) would remain salient regardless of competing stimuli and would compete for an animal's attentional resources. By extension, we also assume that any behavioral change we might observe in an animal would have been caused by a focal stimulus (the stimulus most immediately confronting the animal) rather than competing stimuli. However, as the distance between the source of a specific acoustic signal and a receiving animal increases, we assume that the receiving animal is less likely to devote attentional resources to the signal.

If we assume that an acoustic stimulus, such as a seismic or drilling source, was salient to an animal or population of animals, we would then ask how an animal might classify the stimulus as a cue about its environment (Box B2 in Figure 2) because an animal's response to a stimulus in its environment depends upon whether and how the animal converts the stimulus into information about its environment (Blumstein and Bouskila 1996, Yost 2007). For example, if an animal classifies a stimulus as a "predatory cue," that classification will invoke a suite of candidate physical, physiological, or behavioral responses that are appropriate to being confronted by a predator (this would occur regardless of whether a predator is, in fact, present).

By incorporating a more expansive concept of "hearing," our conceptual model departs from earlier models which have focused on the mechanical processes of "hearing" associated with structures in the ear that transduce sound pressure waves into vibrations and vibrations to electro-chemical impulses. That conception of hearing resulted in assessments that focus almost exclusively on active acoustic sources while discounting other acoustic stimuli associated with activities that marine animals might also perceive as relevant. That earlier conception of hearing also led to an almost singular focus on the intensity of the sound (its received level in decibels) as an assessment metric and noise-induced hearing loss as an assessment endpoint.

[3] See Blumstein and Bouskila (1996) for more of a review of the literature on how animals process and filter sensory information, which affects the subjective salience of sensory stimuli. See Clark and Dukas (2003), Dukas (2002), and Roitblat (1989) for more extensive reviews of the literature on attentional processes and the consequences of limited attentional resources in animals.

Among other considerations, the earlier focus on received level and losses in hearing sensitivity failed to recognize several other variables that affect how animals are likely to respond to acoustic stimuli:

- "Hearing" includes the cognitive processes an animal employs when it analyzes acoustic impulses (see (see Bregman 1990, Blumstein and Bouskila 1996, Hudspeth 1997, Yost 2007), which includes the processes animals employ to integrate and segregate sounds and auditory streams and the circumstances under which they are likely to devote attentional resources to an acoustic stimulus.
- Animals can "decide" which acoustic cues they will focus on and their decision will reflect the salience of a cue, its spectral qualities, and the animal's physiological and behavioral state when exposed to the cue.
- Animals not only perceive the received level (in dB) of a sound source, they also perceive their distance from a sound source. Further, animals are more likely to devote attentional resources to sounds that are close than sounds that are distant.
- Both received levels and the spectral qualities of sounds degrade over distance so the sound perceived by a distant receiver is not the same sound at the source.

As a result of this shift in focus, we have to consider more than the received level of a particular low- or mid-frequency wave form and its effects on the sensitivity of an animal's ear structure. We also have to distinguish between different auditory scenes; for example, animals will distinguish between sounds from a source that is moving away, sounds from a source that is approaching them, sounds from multiple sources that are all approaching, sounds from multiple sources that appear to be moving at random, etc.

Animals would then combine their perception of the acoustic stimulus with their assessment of the auditory scene (which include other acoustic stimuli), their awareness of their behavioral state, physiological state, reproductive condition, and social circumstances to assess whether the acoustic stimulus poses a risk and the degree of risk it might pose, whether it is impairing their ability to communicate with conspecifics, whether it is impairing their ability to detect predators or prey, etc. We assume that animals would categorize an acoustic source differently if the source is moving towards its current position (or projected position), moving away from its current position, moving tangential to its current position, if the source is stationary, or if there are multiple acoustic sources it its auditory field.

This process of "categorizing a stimulus" (Box B2 in Figure 2) lends meaning to a stimulus and places the animal in a position to decide whether and how to respond to the stimulus (Blumstein and Bouskila 1996). How an animal categorizes a stimulus will determine the set of candidate responses that are appropriate in the circumstances. That is, we assume that animals that categorize a stimulus as a "predatory cue" would invoke candidate responses that consist of anti-predator behavior rather than foraging behavior (Blumstein and Bouskila 1996, Bejder et al. 2009).

We then assume that animals apply one or more behavioral decision rules to the set of candidate responses that are appropriate to the acoustic stimulus as it has been classified (Box B3 in Figure 2). Our use of the term "behavioral decision rule" follows Blumstein and Bouskila (1996), and Lima and Dill (1990), and is synonymous with the term "behavioral policy" of McNamara and Houston (1986a): the process an animal applies to determine which specific behavior it will select from the set of behaviors that are appropriate to the auditory scene, given its physiological and behavioral state when exposed and its experience. Because we would never know the behavioral policy of an individual, free- ranging animal, we treat this policy as a probability distribution function that matches a particular response in the suite of candidate behavioral responses.

Once an animal selects a behavioral response from a set of candidate behaviors, we assume that any change in behavioral state would represent a shift from an optimal behavioral state (or behavioral act) to a sub-optimal behavioral state (or behavioral act) as the animal responds to a stimulus such as acoustic sound sources. That selection of the sub-optimal behavioral state or act could be accompanied by *canonical costs*, which are reductions in the animal's expected future reproductive success that would occur when an animal engages in suboptimal behavioral acts (McNamara and Houston 1986a).

Specifically, canonical costs represent a reduction in current and expected future reproductive success (which integrates survival and longevity with current and future reproductive success) that would occur when an animal engages in a sub-optimal rather than an optimal sequence of behavioral acts; given the pre-existing physiological state of the animal in a finite time interval (McFarland and Sibly 1975, McNamara and Houston 1982, McNamara and Houston 1986b, Houston et al. 1993, McNamara 1993, McNamara and Houston 1996, Nonacs 2001, Crone et al. 2013). Canonical costs would generally result from changes in animals' energy budgets (Sapolsky 1997, Moberg 2000, McEwen and Wingfield 2003, Wingfield and Sapolsky 2003, Romero 2004), time budgets (Sutherland 1996, Frid and Dill 2002a), life history trade-offs (Cole 1954, Stearns 1992b), changes in social interactions (Sutherland 1996), or combinations of these phenomena (see Box B4 in Figure 4). We assume that an animal would not incur a canonical cost if they adopted an optimal behavioral sequence (see McNamara and Houston 1986a for further treatment and discussion).

This conceptual model does not require us to assume that animals exist in pristine environments. In those circumstances in which animals are regularly or chronically confronted with stress regimes that animals would adapt to by engaging in sub-optimal behavior, we assume that a change in behavior that resulted from exposure to a particular stressor or stress regime would either contribute to sub-optimal behavior or would cause animals to engage in behavior that is even further from optimal.

3.1.4 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 posed to listed individuals that are likely to be exposed to an action's effects. Our analyses then integrate those 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.

The effects analyses of biological opinions consider the impacts on listed species and designated critical habitat that result from the incremental impact of an action by identifying natural and anthropogenic stressors that affect endangered and threatened species throughout their range (the *Status of the Species*) and within an action area (the *Environmental Baseline*, which articulates the pre-existing *impacts* of activities that occur in an action area, including the past, contemporaneous, and future *impacts* of those activities). We assess the effects of a proposed action by adding the direct and indirect effects to the *impacts* of the activities we identify in an *Environmental Baseline* (50 CFR 402.02), in light of the impacts of the status of the listed species and designated critical habitat throughout their range. As a result, our effects analyses are similar to those contained in the "cumulative impact" sections of NEPA documents.

3.1.5 Brief Background on Sound

Sound is a wave of pressure variations propagating through a medium (for this consultation, the sounds generated by seismic and electromechanical equipment propagates through marine water as its medium). Pressure variations are created by compressing and relaxing the medium. Sound measurements can be expressed in two forms: *intensity* and *pressure*. Acoustic intensity is the average rate of energy transmitted through a unit area in a specified direction and is expressed in watts per square meter. Acoustic intensity is rarely measured directly, it is derived from ratios of *pressures*; the standard reference pressure for underwater sound is 1 µPa; for airborne sound, the standard reference pressure is 20 µPa (Richardson et al. 1995).

Acousticians have adopted a logarithmic scale for sound intensities, which is denoted in decibels (dB). Decibel measurements represent the ratio between a measured pressure value and a reference pressure value (in this case 1 µPa or, for airborne sound, 20 µPa.). The logarithmic nature of the scale means that each 10 dB increase is a ten-fold increase in power (e.g., 20 dB is a 100-fold increase, 30 dB is a 1,000- fold increase). The term "sound pressure level" implies a decibel measure and a reference pressure that is used as the denominator of the ratio. Throughout this opinion, we use 1 µPa as a standard reference pressure unless noted otherwise.

It is important to note that decibels underwater and decibels in air are not the same and cannot be directly compared. Because of the different densities of air and water and the different decibel standards in water and air, a sound with the same intensity (i.e., power) in air and in water would be approximately 63 dB quieter in air.

Sound frequency is measured in cycles per second, or Hz, and is analogous to musical pitch; high-pitched sounds contain high frequencies and low-pitched sounds contain low frequencies. Natural sounds in the ocean span a huge range of frequencies: from earthquake noise at 5 Hz to harbor porpoise clicks at 150,000 Hz. These sounds are so low or so high in pitch that humans cannot hear them; acousticians call these infrasonic and ultrasonic sounds, respectively. A single sound may be made up of many different frequencies together. Sounds made up of only a small range of frequencies are called "narrowband," and sounds with a broad range of frequencies are called "broadband;" airguns are an example of a broadband sound source and sonars are an example of a narrowband sound source.

When considering the influence of various kinds of noise on the marine environment, it is necessary to understand that different kinds of marine life are sensitive to different frequencies of sound. Most dolphins, for instance, have excellent hearing at very high frequencies between 10,000 and 100,000 Hz. Their sensitivity at lower frequencies below 1000 Hz, however, is quite poor. On the other hand, the hearing sensitivity of most baleen whales appears to be best at frequencies between about between 20 Hz-5 kHz, with maximum sensitivity between 100-500 Hz (Erbe 2002). As a result, baleen whales might be expected to suffer more harmful effects from low frequency noise than would dolphins.

When sound travels away from its source, its loudness decreases as the distance traveled by the sound increases. Thus, the loudness of a sound at its source is higher than the loudness of that same sound a kilometer distant. Acousticians often refer to the loudness of a sound at its source as the *source level* and the loudness of sound elsewhere as the *received level*. For example, a humpback whale 9 kilometers from an airgun that has a source level of 230 dB may only be exposed to sound that is 160 dB loud. As a result, is important not to confuse source levels and received levels when discussing the loudness of sound in the ocean.

As sound moves away from a source, its propagation in water is influenced by various physical characteristics, including water temperature, depth, salinity, and surface and bottom properties that cause refraction, reflection, absorption, and scattering of sound waves. Oceans are not homogeneous and the contribution of each of these individual factors is extremely complex and interrelated. Sound speed in seawater is generally about 1,500 meters per second (5,000 feet per second) although this speed varies with water density, which is affected by water temperature, salinity (the amount of salt in the water), and depth (pressure). The speed of sound increases as temperature and depth (pressure), and to a lesser extent, salinity, increase. The variation of sound speed with depth of the water is generally presented by a "sound speed profile," which varies with geographic latitude, season, and time of day.

Sound tends to follow many paths through the ocean, so that a listener may hear multiple, delayed copies of transmitted signals (Richardson et al. 1995). Echoes are a familiar example of this phenomenon in air. In order to determine what the paths of sound transmission are, one rule is to seek paths that deliver the sound to the receiver the fastest. If the speed of sound were constant throughout the ocean, acoustic rays would consist of straight-line segments, with reflections off the surface and the bottom. However, because the speed of sound varies in the ocean, most acoustic rays do not follow a straight path.

As sound travels through the ocean, the intensity associated with the wave front diminishes, or attenuates. In shallow waters of coastal regions and on continental shelves, sound speed profiles become influenced by surface heating and cooling, salinity changes, and water currents. As a result, these profiles tend to be irregular and unpredictable, and contain numerous gradients that last over short time and space scales. This decrease in intensity is referred to as propagation loss, also commonly called transmission loss. In general, in a homogeneous lossless medium, sound intensity decreases as the square of the range due to simple spherical spreading. In other words, a source level of 235 dB will have decreased in intensity to a received level of 175 dB after about 914 meters (1,000 yards).

4. RANGEWIDE STATUS OF THE SPECIES AND CRITICAL HABITAT

Nine species of marine mammals listed under the ESA under NMFS's jurisdiction may occur in the action area.[4] The action area also includes designated critical habitat for two species (see Table 4).

Table 4. 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
Balaneoptera physalus (Fin Whale)	Endangered	NMFS 1970, 35 FR 18319	Not designated
Megaptera novaeangliae (Humpback Whale)	Endangered	NMFS 1970, 35 FR 18319	Not designated
Eubalanea japonica (North Pacific Right Whale)	Endangered	NMFS 2008, 73 FR 12024	NMFS 2008, 73 FR 19000
Eschrichtius robustus (Western DPS North Pacific Gray Whale)	Endangered	NMFS 1970, 35 FR 18319	Not designated
Physeter macroephalus (Sperm Whale)	Endangered	NMFS 1970, 35 FR 18319	Not designated
Phoca hispida hispida (Arctic Ringed Seal)	Threatened	NMFS 2012, 77 FR 76706	Not designated
Erignathus barbatus nauticus (Beringia DPS Bearded Seal)	Threatened	NMFS 2012, 77 FR 76739	Not designated
Eumetopias jubatus (Western DPS Steller Sea Lion)	Endangered	NMFS 1997, 62 FR 24345	NMFS 1993, 58 FR 45269

[4] On July 25, 2014, the U.S. District Court for the District of Alaska issued a decision vacating the Beringia DPS bearded seal listing (Alaska Oil and Gas Association v. Pritzker, Case No. 4:13-cv-00018-RPB). Subsequently on March 17, 2016, the District Court vacated the Arctic subspecies of ringed seal listing (Alaska Oil and Gas Association v. NMFS, Case No. 4:14-cv-00029-RRB). NMFS is appealing the bearded and ringed seal decisions. We include ringed and bearded seals here so that the action agency has the benefit of our analysis of the consequences of the proposed action on these species, even though the listings are not in effect.

4.1 Species and Critical Habitat Not Considered Further in this Opinion

As described in the Approach to the Assessment section of this opinion, NMFS uses two criteria to identify those endangered or threatened species or critical habitat that are likely to be adversely affected. The first criterion is exposure or some reasonable expectation of a co-occurrence between one or more potential stressors associated with Fairweather's activities and a listed species or designated critical habitat. The second criterion is the probability of a response given exposure. For endangered or threatened species, we consider the susceptibility of the species that may be exposed; for example, species that are exposed to sound fields produced by active seismic activities, but are not likely to exhibit physical, physiological, or behavioral responses given that exposure (at the combination of sound pressure levels and distances associated with an exposure), are not likely to be adversely affected by the seismic activity. For designated critical habitat, we consider the susceptibility of the constituent elements or the physical, chemical, or biotic resources whose quantity, quality, or availability make the designated critical habitat valuable for an endangered or threatened species. If we conclude that the quantity, quality, or availability of the constituent elements or other physical, chemical, or biotic resources is not likely to decline as a result of being exposed to a stressor and a stressor is not likely to exclude listed individuals from designated critical habitat, we would conclude that the stressor may affect, but is not likely to adversely affect, the designated critical habitat.

The designations of critical habitat for species that occur in the project's action area use the term primary constituent element (PCE) or essential features. Recent revisions to our critical habitat regulations at 50 CFR §402 (81 FR 7414) replace this term with physical or biological features (PBFs). The shift in terminology does not change the approach used in conducting a ''destruction or adverse modification'' analysis, which is the same regardless of whether the original designation identified primary constituent elements, physical or biological features, or essential features. In this opinion, we use the term PBF to mean PCE or essential feature, as appropriate for the specific critical habitat.

We applied these criteria to the species and critical habitats listed above and determined that the following species and designated critical habitats are not likely to be adversely affected by the proposed action: North Pacific right whales, western DPS gray whales, sperm whales, western DPS Steller sea lions, and the designated critical habitats of North Pacific right whales and Steller sea lions.

4.1.1 Cetaceans

Vessels transiting to and from anchor handling locations in Kotzebue Sound, the Chukchi Sea, and the Beaufort Sea overlap with the ranges of North Pacific right whales, western gray whales, and sperm whales as well as the designated critical habitat of North Pacific right whales in the eastern Bering Sea. A maximum of eight vessels associated with the proposed action would be transiting to and from the anchor handling sites (Fairweather 2016).

As part of the proposed action, PR1 has included vessel strike avoidance measures including: maintaining a vigilant watch for listed cetaceans and pinnipeds and slowing down or stopping vessels to avoid striking protected species by observing the 5 kn (9.26 km/h) speed restriction when within 900ft of cetaceans or pinnipeds. In addition, the applicant will avoid transits within designated North Pacific right whale critical habitat. If transit within North Pacific right whale critical habitat cannot be avoided, vessel operators are requested to exercise extreme caution and observe the 10 kn (18.52 km/h) vessel speed restriction within North Pacific right whale critical habitat. Fairweather vessels transiting through North Pacific right whale critical habitat will have PSOs actively engaged in sighting marine mammals. PSOs would increase vigilance and allow for reasonable and practicable actions to avoid collisions with North Pacific right whales. Fairweather vessels will maneuver vessels to keep 800 m away from any observed North Pacific right whales within their designated critical habitat and avoid approaching whales head-on consistent with vessel safety. Vessels should take reasonable steps to alert other vessels in the vicinity of whale(s), and report of any dead or injured listed cetaceans or pinnipeds.

Based on the extremely small number of observations of North Pacific right, western gray, and sperm whales in the Bering Sea, Kotzebue Sound, Chukchi Sea, and Beaufort Sea, the limited number of vessels potentially being mobilized out of Dutch Harbor associated with the proposed action, the transitory nature of vessels heading to and from project sites, the lack of spatial overlap between North Pacific right, western gray, and sperm whales known distribution and the sonar and anchor retrieval areas in the Kotzebue Sound, Chukchi Sea, and Beaufort Sea, mitigation measures to avoid cetaceans and North Pacific right whale critical habitat while vessels are transiting, and the decades of vessels transiting in the Bering, Chukchi, and Beaufort Seas without a known vessel strike of these species, NMFS concludes that these cetaceans have a sufficiently small probability of being exposed to stressors associated with Fairweather's proposed activities such that the potential for these species being exposed to the proposed project stressors is extremely unlikely to occur, and the risks posed by the proposed action to North Pacific right, western gray, and sperm whales are discountable.

Any noise or visual disturbance from vessels transiting would be brief and so small in scale as to be immeasurable. The resulting effects on cetaceans would be insignificant and would not result in take. Therefore, we conclude that the proposed action is not likely to adversely affect these cetaceans and do not consider them further in this opinion.

Critical habitat for the North Pacific right whale was designated in the eastern Bering Sea and in the Gulf of Alaska on April 8, 2008 (73 FR 19000). Only the eastern Bering Sea critical habitat overlaps with the action area (see Figure 3). The PBF deemed necessary for the conservation of North Pacific right whales include the presence of specific copepods (*Calanus marshallae*, *Neocalanus cristatus*, and *N. plumchris*), and euphausiids (*Thysanoessa Raschii*) that act as primary prey items for the species.

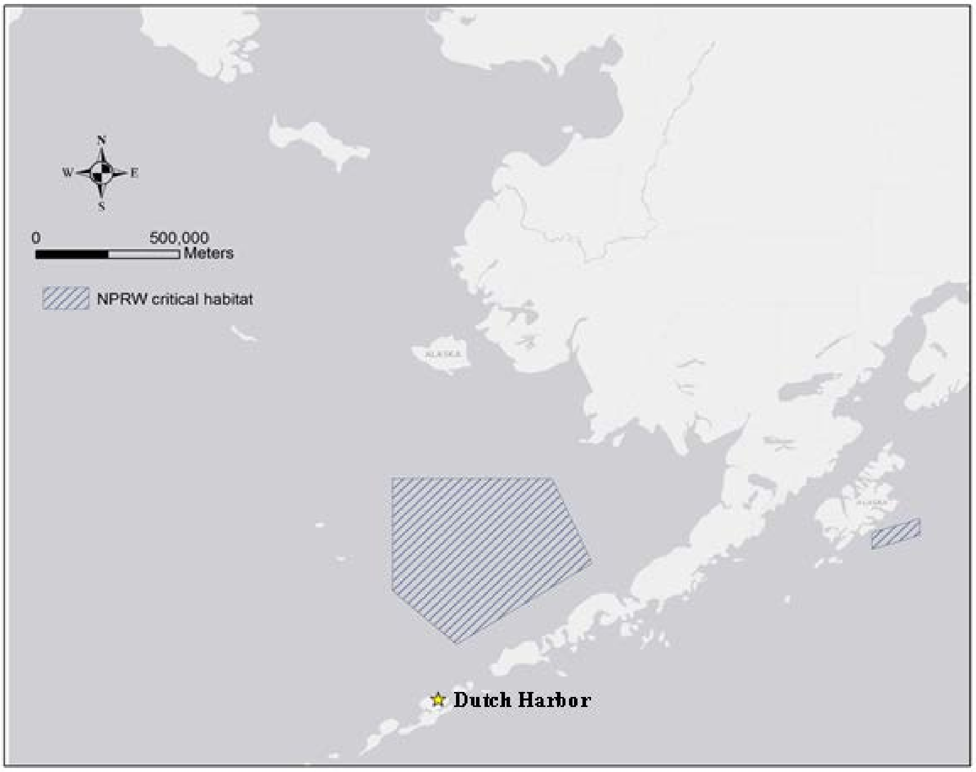

Figure 3. North Pacific right whale critical habitat shown in both the Bering Sea and Gulf of Alaska. The pentagon area in the Bering Sea is the only section of critical habitat that occurs within the action area.

Vessels transiting to and from Dutch Harbor may enter the Bering Sea critical habitat for North Pacific right whale. According to the Fairweather anchor retrieval scenario, a total of 12 transits may occur within North Pacific right whale critical habitat (Fairweather 2016). However, vessel traffic is not anticipated to affect aggregations of copepods or euphausiids, and therefore will not affect the PBFs associated with North Pacific right whale critical habitat. In addition, the critical habitat in the Bering Sea would not be exposed to acoustic signals associated with geohazard surveys or anchor removal because those activities would only be authorized to occur within Kotzebue Sound, the Chukchi Sea, and the Beaufort Sea, all of which are far enough away from the critical habitat area that received sound levels within the habitat will not exceed thresholds of sound pressure levels from broad band sounds that cause behavioral disturbance (160 dB rms re: 1µPa for impulse sound and 120 dB rms re: 1µPa for continuous sound). For these reasons, we do not expect critical habitat for the North Pacific right whale to be adversely affected by acoustic signals or vessel traffic associated with Fairweather's authorized activities, therefore, we will not consider this critical habitat further in this opinion. In summary, the proposed action is not likely to adversely affect North Pacific right, western gray, or sperm whales, or the designated critical habitat for North Pacific right whales.

4.1.2 Pinnipeds

Vessels transiting to and from Dutch Harbor in association with Fairweather's authorized activities are within the range of the western DPS of Steller sea lions, and overlap with designated critical habitat. Dutch Harbor sits within the Bogoslof designated foraging area and is within the 20 nm aquatic zone associated with rookery and haulout locations (see Figure 4). In addition, depending on the routes vessels take to transit through the Bering Strait, they may also overlap with critical habitat designated on the Pribilof Islands, St. Matthew Island, or St. Lawrence Island. Steller sea lions are anticipated to be within the Bering Sea section of the action area, and may overlap with Fairweather's vessels.

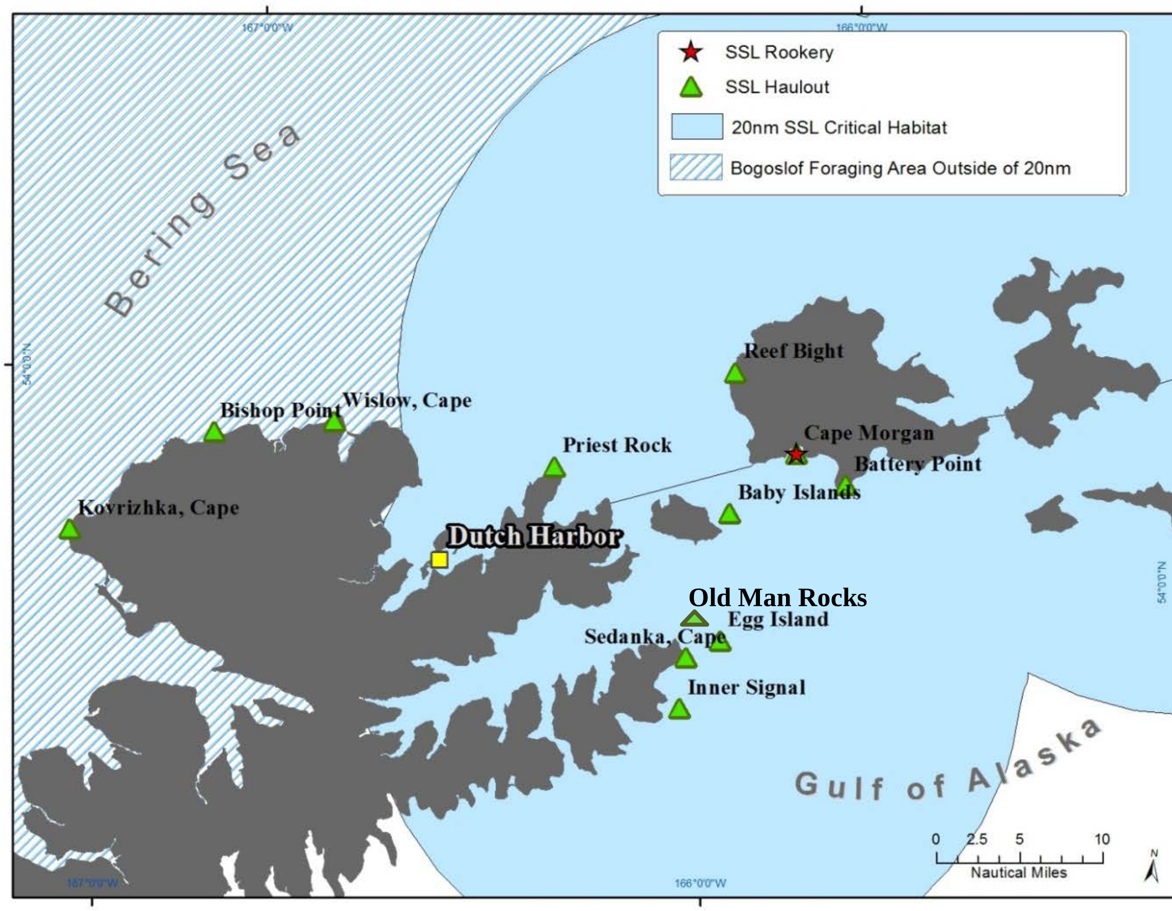

Figure 4. Haulout and rookery locations for the western DPS of Steller sea lion near Dutch Harbor, the nearby designated Bogoslof foraging area, and the location of Dutch Harbor to and from which vessels will be transiting.

Designated critical habitat for Steller sea lions includes terrestrial, air, and aquatic habitats that support reproduction, foraging, rest and refuge. These designations were based on the location of terrestrial rookery and haulout sites where breeding, pupping, refuge and resting occurs; aquatic areas surrounding rookeries and haulouts, the spatial extent of foraging trips, and availability of prey items, and rafting sites. Air zones around terrestrial and aquatic habitats are also designated as critical habitat to reduce disturbance in these essential areas. Within the action area, vessels have the potential to transit through the 20nm aquatic zone around rookeries and haulouts, and the Bogoslof foraging area.

The 3-mile no transit zones are established and enforced around rookeries in the area for further protection, and NMFS's guidelines for approaching marine mammals discourage vessels approaching within 100 yards of haulout locations. The Bogoslof foraging area historically supported large aggregations of spawning pollock (Fiscus and Baines 1966, Kajimura and Loughlin 1988). While vessels transiting to and from anchor retrieval sites may enter Bogoslof foraging area, noise associated with vessel operations is not anticipated to affect PBFs or impact foraging.

Despite all of the traffic in and around rookery and haulout locations near Dutch Harbor, there have been no reported incidents of ship strike with Steller sea lions in Alaska. In addition, the Steller sea lion population in and around Dutch Harbor has been increasing at about 3% per year, despite ongoing vessel traffic (Fritz 2012).

Vessels are expected to have a short-term presence in the Bering Sea as they transit to anchor retrieval locations. NMFS is not able to quantify existing traffic conditions across the entire Bering Sea to provide context for the addition of approximately eight Fairweather vessels for four months. However, Dutch Harbor has thousands of vessel transits per year. The addition of eight vessels per four months would be very small compared to the total number of vessels in the area. In addition, the absence of collisions involving any vessels and Steller sea lions in the Bering Sea despite decades of spatial and temporal overlap suggest that the probability of collision is low.

Based on the small number of vessels associated with the proposed action in comparison to the thousands of vessels known to transit the Bering Sea, the continued growth of the sea lion population near Dutch Harbor despite heavy traffic, mitigation measures in place to avoid marine mammals and designated critical habitat, and the history of spatial and temporal overlap that have not resulted in a known collision, we conclude that some individuals may be exposed to vessel traffic noise but the exposure would be brief and the resulting effects on Steller sea lions would be insignificant and not result in take. In addition, we do not anticipate any adverse effects to designated critical habitat or impacts to foraging, therefore we will not consider Steller sea lions or their designated critical habitat further in this opinion.

4.2 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.

The timeframe for the proposed action is June 2016 through October 2016 which is a relatively short duration. However, the Arctic is experiencing rapid climate change with further decreases in ice cover and extensions of the open-water season. In March 2016, the National Snow and Ice Data Center reported that the maximum extent of Arctic sea ice this past winter was at a record low for the second straight year (NSIDC 2016).

There is widespread consensus within the scientific community that atmospheric temperatures on earth are increasing 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 its 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). 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). Climate change would result in increases in atmospheric temperatures, changes in sea surface temperatures, increased ocean acidity, changes in patterns of precipitation, and changes in sea level (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). Climate change would result in increases in atmospheric temperatures, changes in sea surface temperatures, changes in patterns of precipitation, and changes in sea level (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). Changes in snowfall over the 21st century were projected to reduce ringed seal habitat for lairs by 70% (Hezel et al. 2012). 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.

4.3 Status of Listed Species

The remainder of this section consists of narratives for each of the endangered and threatened species that occur in the action area and may be adversely affected by the proposed action. 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 as a starting point for our analysis of whether 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 determine how certain activities may impact each species, and help 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 to inform our assessment of how the 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 (2015). Cameron et al. (2010) and Kelly et al. (2010b) provided status reviews of bearded and ringed seals.

4.3.1 Bowhead Whale

Population Structure

The International Whaling Commission (IWC) recognizes four stocks of bowhead whale for management purposes (Allen and Angliss 2015). 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 2015). 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 range from 54º to 85º N 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 action area, bowhead whales are distributed in the seasonally ice-covered waters of the Arctic and near-Arctic, generally occurring north of 60°N and south of 75°N in the western Arctic Basin (Braham 1984, Rugh et al. 2003a). 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 eastern Beaufort Sea where they spend much of the summer (June through early to mid-October) before returning again to the Bering Sea in fall (September through December) to overwinter (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.

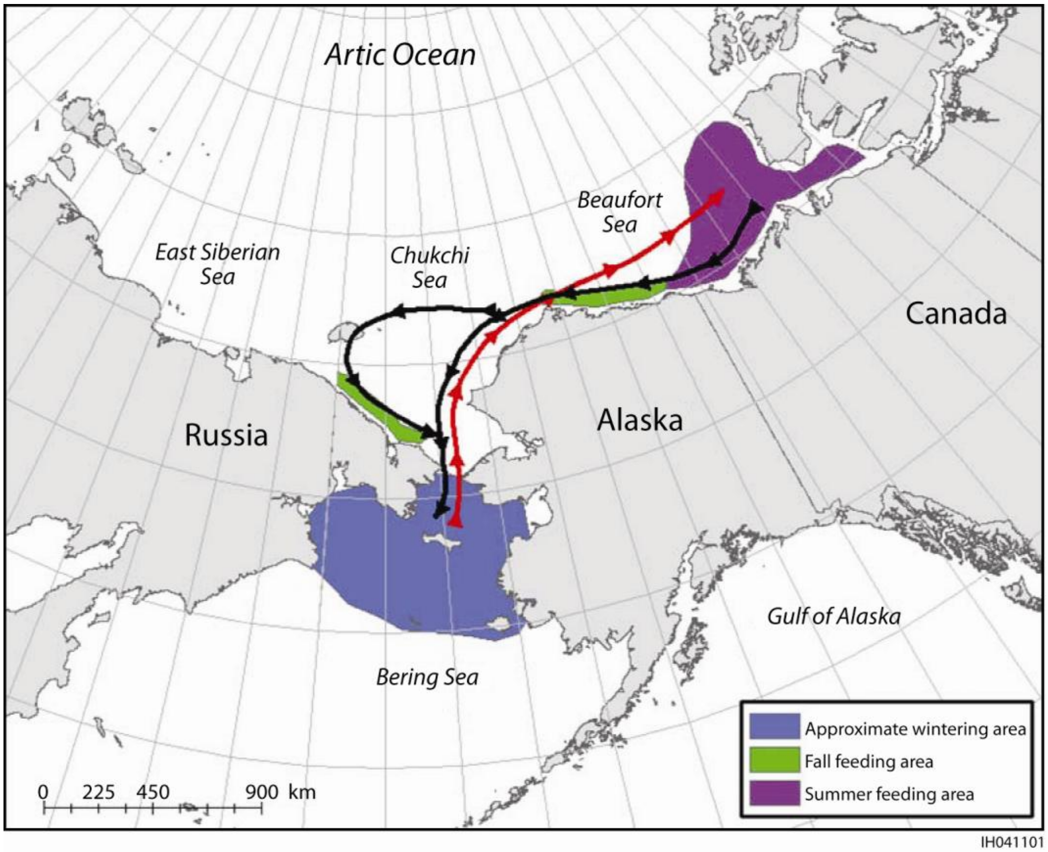

Figure 5. Generalized Migration Route, Feeding Areas, and Wintering Area for Western Arctic Bowhead Whale

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

Threats to bowhead whales are described in detail in the species stock assessment report (Allen and Angliss 2015), and are briefly summarized below. Details about individual threats in the action area will also be discussed in the *Environmental Baseline* section.

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 eight 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, Suydam et al. 2011).

Canadian and Russian Natives also take whales from this stock. Hunters from the western Canadian Arctic community of Aklavik harvested one whale in 1991 and one in 1996. Twelve whales were harvested by Russian subsistence hunters between 1999-2005 (Allen et al. 2014). No catches for Western Arctic bowheads were reported by either Canadian or Russian hunters for 2006-2007 or by Russia in 2009, but two bowheads were taken in Russia in 2008, and in 2010 (IWC 2012, Allen and Angliss 2015). The annual average subsistence take (by Natives of Alaska, Russia, and Canada) during the 5-year period from 2008 to 2012 was 42 bowhead whales (Allen and Angliss 2015).

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 2015). 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. 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 2008-2012 is 0.4; however, the overall rate is currently unknown (Allen and Angliss 2015).

Bowhead whales are among the slowest moving of whales. This 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. This increase in vessel presence could result in an increased number of vessel collisions with bowhead whales. Increasing oil and gas development in the Arctic has led to an increased risk of various forms of pollution in bowhead whale habitat, including oil spills and contaminants. Noise produced by the increased number of seismic surveys and increased vessel traffic resulting from shipping and offshore energy exploration is also a concern (Allen and Angliss 2015). 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 may 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 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 2015).

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. (2010a) 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). Using the 2011 population estimate of 16,892 and its associated CV= 0.2442, the minimum population estimate for the Western Arctic stock of bowhead whales is 13,796 (Allen and Angliss 2015). The population may be approaching carrying capacity despite showing no sign of a slowing in the population growth rate (Brandon and Wade 2006a).

The current estimate for the annual rate of increase for this stock of bowhead whales is 3.2-3.4% (George et al. 2004a, Schweder et al. 2010a). (Wade and Angliss 1997) recommend using the cetacean maximum theoretical net productivity rate (R_{max}) of 4% for the Western Arctic stock of bowhead.[5]

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.

[5] The estimate for the current rate of increase for this stock (3.2-3.4%) should not be used as an estimate of R_{max} 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 2015).

The potential biological removal (PBR) for this stock is 138 animals (13,796 x 0.02 x 0.5) (see Allen and Angliss 2015). 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 306 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.

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

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 1993). Most mating occurs in late winter and spring in the Bering Sea, although some mating occurs as late as September and early October (Koski et al. 1993, Reese et al. 2001a). 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).

Given the life history of bowhead whales and gestational constraints on minimum calving intervals (e.g., Reese et al. 2001), and assuming that adult survival rates based on aerial photo-ID data (Zeh et al. 2002; Schweder et al. 2010) and age-at-maturity have remained stable, the trend in abundance implies that the population has been experiencing relatively high annual calf and juvenile survival rates. This is consistent with documented observations of native whalers around St. Lawrence Island, who have reported not only catching more pregnant females but also seeing more young whales than during earlier decades (Noongwook et al. 2007). While the sample size was small, that the pregnancy rate from the 2012 Alaskan harvest data indicate that 2013 calf production could be higher than average (George et al. 2004b; George et al. 2011; Suydam et al. 2013).

A change in either calf production or survival rates (or age-at-sexual maturation) of young whales in the future could be indicative of a population level response to anthropogenic stressors, or alternatively, a signal of the seemingly inevitable event that this population approaches the carrying capacity of its environment (Eberhardt 1977). Since the late 1970s and the initiation of surveys for abundance, the estimates of population size do not indicate that either anthropogenic (e.g., offshore oil and gas activities, subsistence whaling catch quotas, etc.) or natural factors (e.g., prey availability) have resulted in any negative influence on the BCB bowhead whale trend in abundance (LGL Alaska Research Associates Inc. et al. 2013).

Feeding and Prey Selection

Bowheads are filter feeders, filtering prey from the water through baleen (Lowry 1993a). 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 1993b). It is estimated that a 60 ton 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).

Western Arctic bowhead whales feed in the OCS of the Chukchi and Beaufort Seas and 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 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 (1993b) reported that the stomachs of 13 out of 36 spring-migrating bowheads harvested near Point Barrow between 1979 through 1988 contained food. Lowry (1993b) 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 Aerial Surveys of Arctic Marine Mammals (ASAMM) surveys have not noted such behavior in Camden Bay. While data indicate that bowhead whales might feed almost anywhere in the Alaskan Beaufort Sea within the 50-m isobath, feeding in areas outside of the area noted between Smith Bay and Point Barrow and/or in Barrow Canyon are ephemeral and less predictable (J. Clarke, pers. comm. 2013).

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. 2003b). 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 (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 in 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, and 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). It appears that bowhead whale singing behavior differs from that of other mysticetes in that multiple songs are sung each year (Johnson et al. 2014). 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 2002). 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 2002). While there is no direct data on hearing in low-frequency cetaceans, the functional hearing range is anticipated to be between 7 Hz to 25 kHz (NOAA 2015).

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. 2007b). 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 Fin Whale

Population Structure

Fin whales have two recognized subspecies: *B. p. physalus* occurs in the North Atlantic Ocean (Gambell 1985), while *B. p. quoyi* occurs in the Southern Ocean (Fischer 1829). Most experts consider the North Pacific fin whales a separate unnamed subspecies.

In the North Atlantic Ocean, the IWC recognizes seven management units or “stocks” of fin whales: (1) Nova Scotia, (2) Newfoundland-Labrador, (3) West Greenland, (4) East Greenland-Iceland, (5) North Norway, (6) West Norway-Faroe Islands, and (7) British Isles-Spain-Portugal. In addition, the population of fin whales that resides in the Ligurian Sea, in the northwestern Mediterranean Sea is believed to be genetically distinct from other fin whales populations (as used in this opinion, “populations” are isolated demographically, meaning, they are driven more by internal dynamics — birth and death processes — than by the geographic redistribution of individuals through immigration or emigration. Some usages of the term “stock” are synonymous with this definition of “population” while other usages of “stock” do not).

In U.S. Pacific waters, the IWC recognizes three “stocks”: (1) Alaska (Northeast Pacific), (2) California/Washington/Oregon, and (3) Hawaii (Allen and Angliss 2015). However, Mizroch et al. (2009) suggests that this structure should be reviewed and updated, if appropriate, to reflect current data which suggests there may be at least six populations of fin whales.

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

Distribution

Fin whales are distributed widely in every ocean except the Arctic Ocean (where they have only recently begun to appear). In the North Pacific Ocean, fin whales occur in summer foraging areas in the Chukchi Sea, the Sea of Okhotsk, around the Aleutian Islands, and the

Gulf of Alaska; in the eastern Pacific, they occur south to California; in the western Pacific, they occur south to Japan. Fin whales in the eastern Pacific winter from California south; in the western Pacific, they winter from the Sea of Japan, the East China and Yellow Seas, and the Philippine Sea (Gambell 1985).

In the North Atlantic Ocean, fin whales occur in summer foraging areas from the coast of North America to the Arctic, around Greenland, Iceland, northern Norway, Jan Meyers, Spitzbergen, and the Barents Sea. In the western Atlantic, they winter from the edge of sea ice south to the Gulf of Mexico and the West Indies. In the eastern Atlantic, they winter from southern Norway, the Bay of Biscay, and Spain with some whales migrating into the Mediterranean Sea (Gambell 1985).

In the Southern Hemisphere, fin whales are distributed broadly south of 50° S in the summer and migrate into the Atlantic, Indian, and Pacific Oceans in the winter, along the coast of South America (as far north as Peru and Brazil), Africa, and the islands in Oceania north of Australia and New Zealand (Gambell 1985).

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

Recent information on seasonal fin whale distribution has been gleaned from the reception of fin whale calls by bottom-mounted, offshore hydrophone arrays along the U.S. Pacific coast, in the central North Pacific, and in the western Aleutian Islands (Moore et al. 1998, Watkins et al. 2000, Moore et al. 2006, Stafford et al. 2007, Širović et al. 2013, Soule and Wilcock 2013). Moore et al. (1998, 2006), Watkins et al. (2000), and Stafford et al. (2007) all documented high levels of fin whale call rates along the U.S. Pacific coast beginning in August/September and lasting through February, suggesting that these may be important feeding areas during the winter. In addition, fin whale calls were detected in the northeastern Chukchi Sea using instruments moored there in July through October from 2007 through 2010 (Delarue et al. 2013). Call data collected from the Bering Sea suggests that several fin whale stocks may feed in the Bering Sea, but call data collected in the northeast Chukchi Sea suggests that only one of the putative Bering Sea stocks appears to migrate this far north to feed (Delarue et al. 2013).

Fin whales were seen regularly and sometimes caught by Soviet whalers in the Chukchi Sea until the 1940s (Allen and Angliss 2014). Fin whales are again being seen increasingly during sighting surveys in the Chukchi Sea in summer (Funk et al. 2010a, Aerts et al. 2013b, Clarke et al. 2013b), and have been recorded each year from 2007-2010 in August and September on bottom-mounted hydrophones in the Chukchi (Delarue et al. 2013) suggesting they may be re-occupying habitat used prior to large-scale commercial whaling (Allen and Angliss 2015).

Threats to the Species

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

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

Whaling reduced fin whales to a fraction of their historic population size and, as a result, makes it easier for other human activities to push fin whales closer to extinction. Otherwise, whaling currently does not threaten the fin whale species, although it may threaten specific populations. There is no authorized subsistence take of fin whales in the Northeast Pacific stock (Allen and Angliss 2015). In the Antarctic Ocean, Japanese whalers were allowed to kill up to 10 fin whales each year for the 2005-2006 and 2006-2007 seasons under an Antarctic Special Permit.

Fin whales are also hunted in subsistence fisheries off West Greenland. In 2004, 5 males and 6 females were killed and landed; 2 other fin whales were struck and lost in the same year. In 2003 2 males and 4 females were landed and 2 other fin whales were struck and lost (IWC 2005). Between 2003 and 2007, the IWC set a catch limit of up to 19 fin whales in this subsistence fishery (2005); however, the IWC's Scientific Committee recommended limiting the number of fin whale killed in this fishery to 1 to 4 individuals until accurate population estimates are produced.

Despite anecdotal observations from fishermen which suggest that large whales swim through their nets rather than get caught in them, fin whales have been entangled by fishing gear off Newfoundland and Labrador in small numbers: a total of 14 fin whales are reported to have been captured in coastal fisheries in those two provinces between 1969 and 1990 (Perkins and Beamish 1979, Lien 1994). Of these 14 fin whales, 7 are known to have died as a result of that capture, although most of the animals that died were less than 15 meters in length (Lien 1994). Between 1999 and 2005, there were 10 confirmed reports of fin whales being entangled in fishing gear along the Atlantic Coast of the U.S. and the Maritime Provinces of Canada (Cole et al. 2005, Nelson et al. 2007). Of these reports, fin whales were injured in one and killed in three of the entanglements. Between 2009 and 2013, there was one observed incidental mortality of a fin whale in the ground tackle of a commercial mechanical jig fishing vessel in Alaska waters (Allen et al. 2014), resulting in a mean annual mortality rate of 0.2. These data suggest that, despite their size and strength, fin whales are likely to be entangled and, in some cases, killed by gear used in modern fisheries.

Fin whales are also killed and injured in collisions with vessels more frequently than any other whale. Of 92 fin whales that stranded along the Atlantic Coast of the U.S. between 1975 and 1996, 31 (33%) showed evidence of collisions with ships (Laist et al. 2001). Between 1999 and 2005, there were 15 reports of fin whales being struck by vessels along the U.S. Atlantic coast and the maritime provinces of Canada (Cole et al. 2005, Nelson et al. 2007). Of these reports, 13 were confirmed as ship strikes which resulted in the death of 11 fin whales.

Jensen and Silber's (2004b) review of the NMFS ship strike database revealed fin whales as the most frequently confirmed victims of ship strikes (26% of the recorded ship strikes [n = 75/292 records]), with most collisions occurring off the east coast, followed by the west coast of the U.S. and Alaska/Hawaii. Five of seven fin whales stranded along Washington State and Oregon showed evidence of ship strike with incidence increasing since 2002 (Douglas et al. 2008a). From 1994-1998, two fin whales were presumed killed by ship strikes. More recently, in 2002, three fin whales were struck and killed by vessels in the eastern North Pacific (Jensen and Silber 2003).

Two fin whale deaths due to ship strikes (one in 2009 and one in 2010) in Alaska waters were reported to the NMFS Alaska Region stranding database between 2009 and 2013 (Allen et al. 2014), resulting in a mean annual mortality rate of 0.4 fin whales due to ship strikes.

The total estimated annual rate of mortality and serious injury for the Northeast Pacific stock is 0.6 based on takes incidental to U.S. commercial fisheries (0.2) and ship strikes (0.4). Because the PBR is unknown, the level of annual U.S. commercial fishery-related mortality that can be considered insignificant and approaching zero mortality and serious injury rate is unknown (Allen and Angliss 2014).

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

Increased noise in the ocean stemming from shipping seems to alter the acoustic patterns of singing fin whales, possibly hampering reproductive parameters across wide regions (Castellote et al. 2012).

Status

Fin whales were listed as endangered in 1970 (35 FR 18319) and that listing was carried over after Congress enacted the ESA (39 FR 41367). In 1976, the IWC protected fin whales from commercial whaling (Allen 1980). Fin whales are listed as endangered on the IUCN Red List of Threatened Animals (IUCN 2012). They are also protected by the Convention on International Trade in Endangered Species of wild flora and fauna and the MMPA. Critical habitat has not been designated for fin whales. A Final Recovery Plan for the Fin Whale (*Balaenoptera physalus*) was published on July 30, 2010 (NMFS 2010d).

It is difficult to assess the current status of fin whales because (1) there is no general agreement on the size of the fin whale population prior to whaling and (2) estimates of the current size of the different fin whale populations vary widely. Prior to exploitation by commercial whalers, fin whales are thought to have numbered greater than 464,000 worldwide, and are now thought to number approximately 119,000 worldwide (Braham 1991).

Ohsumi and Wada (1974) estimated that the North Pacific fin whale population ranged from 42,000-45,000 before whaling began. Of this, the "American population" (i.e., the component centered in waters east of 180º W longitude), was estimated to be 25,000-27,000. Based on visual surveys, Moore *et al.* (2002) estimated 3,368 (CV=0.29) and 683 (CV=0.32) fin whales in the central eastern Bering Sea and southeastern Bering Sea, respectively, during summer surveys in 1999 and 2000. However, these estimates are considered provisional because they were never corrected for animals missed on the track line or that may have been submerged when the ship passed. Dedicated line transect cruises were conducted in coastal waters of western Alaska and the eastern and central Aleutian Islands in July-August 2001-2003 (Zerbini et al. 2009). Fin whale sightings (n = 276) were observed from east of Kodiak Island to Samalga Pass, with high aggregations recorded near the Semidi Islands. Zerbini et al. (2006) estimated that 1,652 (95% CI: 1,142-2,389) whales occurred in the area. An annual increase of 4.8% (95% CI: 4.1-5.4%) was estimated for the period of 1987-2003 (Allen and Angliss 2015).

Results of surveys on the eastern Bering Sea shelf in 2002, 2008, and 2010 provided provisional estimates of 419, 1,368, and 1,061 whales respectively (Friday et al. 2013). These estimates are considered provisional because they have not been corrected for animals missed on the trackline, animals submerged when the ship passed, or responsive movement.

The minimum estimate for the California/Oregon/Washington stock, as defined in the 2008 U.S. Pacific Marine Mammal Stock Assessments is about 2,316 (Carretta et al. 2009). An increasing trend between1979/80 and 1993 was suggested by the available survey data, but it was not statistically significant (Barlow et al. 1997).

Similarly, estimates of the current size of the different fin whale populations and estimates of their global abundance also vary widely. The final recovery plan for fin whales accepts a minimum population estimate of 2,269 fin whales for the Western North Atlantic stock (NMFS 2010d). However, based on data produced by surveys conducted between 1978-1982 and other data gathered between 1966 and 1989, Hain et al. (1992) estimated that the population of fin whales in the western North Atlantic Ocean (specifically, between Cape Hatteras, North Carolina, and Nova Scotia) numbered about 1,500 whales in the winter and 5,000 whales in the spring and summer. Because authors do not always reconcile "new" estimates with earlier estimates, it is not clear whether the current "best" estimate represents a refinement of the estimate that was based on older data or whether the fin whale population in the North Atlantic has declined by about 50% since the early 1980s.

The East Greenland-Iceland fin whale population was estimated at 10,000 animals (95 % confidence interval = 7,600- 14,200), based on surveys conducted in 1987 and 1989 (Buckland et al. 1992). The number of eastern Atlantic fin whales, which includes the British Isles-Spain-Portugal population, has been estimated at 17,000 animals (95% confidence interval = 10,400 - 28,900; (Buckland et al. 1992)). These estimates are both more than 15 years old and the data available do not allow us to determine if they remain valid.

Forcada *et al.* (1996) estimated the fin whale population in the western Mediterranean numbered 3,583 individuals (standard error = 967; 95% confidence interval = 2,130-6,027). This is similar to a more recent estimate published by Notarbartolo-di-Sciara *et al.* (2003). Within the Ligurian Sea, which includes the Pelagos Sanctuary for Marine Mammals and the Gulf of Lions, the fin whale population was estimated to number 901 (standard error = 196.1) whales (Forcada et al. 1995).

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

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

Feeding and Prey Selection

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

Fin whales killed off central California in the early twentieth century were described as having either “plankton” (assumed to have been mainly or entirely euphausiids) or “sardines” (assumed to have been anchovies, *Engraulis mordax*) in their stomachs (Clapham et al. 1997). A larger sample of fin whales taken off California in the 1950s and 1960s were feeding mainly on krill, mostly *Euphausia pacifica*, with only about 10% of the individuals having anchovies in their stomachs (Rice 1963). Fin whales in the Gulf of California prey mainly on zooplankton such as *Nyctiphanes simplex* (Tershy 1992).

Feeding may occur in waters as shallow as 10 m when prey are at the surface, but most foraging is observed in high-productivity, upwelling, or thermal front marine waters (Gaskin 1972, Sergeant 1977, Nature Conservancy Council 1979 as cited in ONR 2001, Panigada et al. 2008).

Diving and Social Behavior

The percentage of time fin whales spend at the surface varies. Some authors have reported that fin whales make 5-20 shallow dives with each of these dive lasting 13-20 seconds followed by a deep dive lasting between 1.5 and 15 minutes (Gambell 1985, Stone et al. 1992, Lafortuna et al. 2003). Other authors have reported that the fin whale's most common dives last between 2 and 6 minutes, with 2 to 8 blows between dives (Watkins 1981, Hain et al. 1992). The most recent data support average dives of 98 m and 6.3 min for foraging fin whales, while non-foraging dives are 59 m and 4.2 min (Croll et al. 2001). However, Lafortuna *et al.* (1999) found that foraging fin whales have a higher blow rate than when traveling. Foraging dives in excess of 150 m are known (Panigada et al. 1999). In waters off the U.S. Atlantic Coast, individuals or duos represented about 75 percent of sightings during the Cetacean and Turtle Assessment Program (Hain et al. 1992). Barlow (2003) reported mean group sizes of 1.1–4.0 during surveys off California, Oregon, and Washington.

There is considerable variation in grouping frequency by region. In general, fin whales, like all baleen whales, are not very socially organized, and most fin whales are observed as singles. Fin whales are also sometimes seen in social groups that can number 2 to 7 individuals. However, up to 50, and occasionally as many as 300, can travel together on migrations (NMFS 2010d).

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

Vocalizations and Hearing

The sounds fin whales produce underwater are one of the most studied *Balaenoptera* sounds. Fin whales produce a variety of low-frequency sounds in the 10-200 Hz band (Watkins 1981, Watkins et al. 1987, Edds 1988, Thompson et al. 1992). The most typical signals are long, patterned sequences of short duration (0.5-2s) infrasonic pulses in the 18-35 Hz range (Patterson and Hamilton 1964). Estimated source levels for fin whales are 140-200 dB re 1 µPa m (Patterson and Hamilton 1964, Watkins et al. 1987, Thompson et al. 1992, McDonald et al. 1995, Clark and Gagnon 2004). In temperate waters intense bouts of long patterned sounds are very common from fall through spring, but also occur to a lesser extent during the summer in high latitude feeding areas (Clark and Charif 1998). Short sequences of rapid pulses in the 20-70 Hz band are associated with animals in social groups (McDonald et al. 1995), Clark personal communication, McDonald personal communication). Each pulse lasts on the order of one second and contains twenty cycles (Tyack 1999).

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

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

While there is no direct data on hearing in low-frequency cetaceans, the functional hearing range is anticipated to be between 7 Hz to 30 kHz (Watkins 1986, Au et al. 2006, Southall et al. 2007, Ciminello et al. 2012, NOAA 2013).

Baleen whales have inner ears that appear to be specialized for low-frequency hearing. In a study of the morphology of the mysticete auditory apparatus, Ketten (1997) hypothesized that large mysticetes have acute infrasonic hearing. Synthetic audiograms produced by applying models to X-ray computed tomography scans of a fin whale calf skull indicate the range of best hearing for fin whale calves to range from approximately 0.02 to 10 kHz, with maximum sensitivities between 1 to 2 kHz (Cranford and Krysl 2015).

4.3.3 Humpback Whale

Population Structure

A variety of population and stock structures have been proposed for humpback whales. Humpback whale populations can be generally sub-divided into four major groups:

- North Atlantic
- North Pacific
- Arabian Sea
- Southern Hemisphere

Populations within these groups are relatively well defined. Under the MMPA, NMFS currently recognizes five stocks of humpback whales in the Atlantic and Pacific Oceans:

- Atlantic
    - Gulf of Maine stock

- Pacific
    - Western North Pacific stock
    - Central North Pacific stock
    - California/Oregon/Washington stock
    - American Samoa stock

The IWC recognizes seven stocks in the Southern Hemisphere.

NMFS recently conducted a global status review and proposed changing the status of humpback whales under the ESA (80 FR 22304; April 21, 2015). Under this proposal, 14 DPSs of humpback whales would be recognized worldwide:

- North Atlantic
    - West Indies
    - Cape Verde Islands/Northwest Africa
- North Pacific
    - Western North Pacific
    - Hawaii
    - Mexico
    - Central America
- Northern Indian Ocean
    - Arabian Sea
- Southern Hemisphere
    - Brazil
    - Gabon/Southwest Africa
    - Southeast Africa/Madagascar
    - West Australia
    - East Australia
    - Oceania
    - Southeastern Pacific

Under the existing stock structure, humpback whales in the action area belong to either the western or central North Pacific stocks. Under the proposed rule to change the status of humpbacks under the ESA, humpback whales in the action area would belong to the western North Pacific, Hawaii, or Mexico DPSs. Most of the animals in the action area would be from the Hawaii DPS, which would not be listed under the ESA.

Distribution

Humpback whales migrate seasonally between warmer, tropical or sub-tropical waters in winter months (where they reproduce and give birth to calves) and cooler, temperate or sub-Arctic waters in summer months (where they feed). In their summer foraging areas and winter calving areas, humpback whales tend to occupy shallower, coastal waters, while during their seasonal migrations they disperse widely in deep, pelagic waters and tend to avoid shallower coastal waters (Winn and Reichley 1985).

In the North Pacific Ocean, the summer range of humpback whales includes coastal and inland waters from Point Conception, California, north to the Gulf of Alaska and the Bering Sea, and west along the Aleutian Islands to the Kamchatka Peninsula and into the Sea of Okhotsk and north of the Bering Strait ((Nemoto 1957, Johnson and Wolman 1984a) as cited in (Allen and Angliss 2013)). Humpback whales have also been observed during the summer in the Chukchi and Beaufort Seas (Allen and Angliss 2015). Humpback whale sightings in the Bering Sea have been recorded southwest of St. Lawrence Island, the southeastern Bering Sea, and north of the central Aleutian Islands (Moore et al. 2002).

In August 2007, a mother-calf pair was sighted from a barge approximately 87 km (54.1 mi) east of Barrow in the Beaufort Sea (Hashagen et al. 2009). Additionally, Ireland et al. (2008) reported three humpback sightings in 2007 and one in 2008 during surveys of the eastern Chukchi Sea.

Hartin et al.(2013) reported four humpback whales during vessel-based surveys in the Chukchi Sea in 2007, two in 2008, and one in 2010. Five instances of humpback sightings (11 individuals) occurred during the CSESP vessel-based surveys in 2009 and 2010 (Aerts et al. 2012), and a single humpback was observed several kilometers west of Barrow during the 2012 CSESP vessel-based survey (Aerts et al. 2013a).

The Aerial Surveys of Arctic Marine Mammals (ASAMM) reported four humpback whale sightings near the coast between Icy Cape and Pt. Barrow in July and August of 2012, as well as 24 individual humpback whales on 11 September south and east of Pt. Hope (Clarke et al. 2013b). Prior to 2012 only a single humpback had been sighted during the COMIDA (Clarke et al. 2011d).

Humpback whales have been seen and heard with some regularity in recent years (2009-2012) in the southern Chukchi Sea (see Figure 6), often feeding and in very close association with feeding gray whales. Sightings have occurred mostly in September, but effort in the southern Chukchi has not been consistent and it is possible that humpback whales are present earlier than September (Hashagen et al. 2009, Clarke et al. 2011d, Crance et al. 2011). Additional sightings of four humpback whales occurred in 2009 south of Point Hope, while transiting to Nome (Brueggeman 2010). The approximate distribution of humpback whales in Alaskan waters is provided in Figure 6 below.

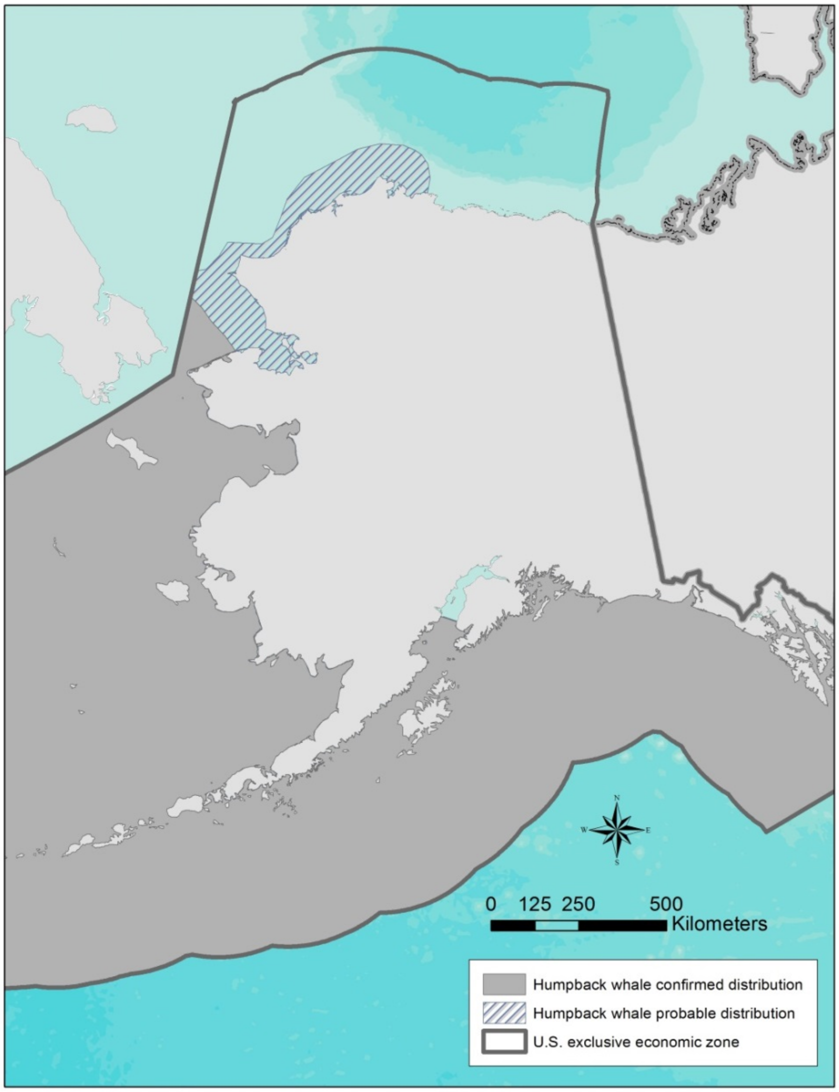

Figure 6. Approximate distribution of humpback whales in the Alaskan waters (shaded area). Area within the hash lines is a probable distribution based on recent sightings in the Beaufort Sea (Hashagen et al. 2009) (Source: Allen and Angliss 2015).

Threats to the Species

NATURAL THREATS. There is limited information on natural phenomena that kill or injure humpback whales. Humpback whales are killed by orcas (Whitehead and Glass 1985, Dolphin 1987b, Florezgonzalez et al. 1994, Naessig and Lanyon 2004), and are probably killed by false killer whales and sharks. Calves remain protected near mothers or within a group, and lone calves have been known to be protected by presumably unrelated adults when confronted with attack (Ford and Reeves 2008).

A recent study examining levels of harmful algal bloom toxins (HABs) in 13 species of marine mammals in Alaska detected domoic acid in all species, with humpback whales showing 38% prevalence for the toxin. Saxitoxin was detected in 10 of the 13 species, with the highest prevalence in humpback whales (50%) and bowhead whales (32%) (Lefebvre et al. 2016). The occurrence of the nematode *Crassicauda boopis* appears to increase the potential for kidney failure in humpback whales and may be preventing some populations from recovering (Lambertsen 1992a).

Entrapments in ice have been documented in the spring ice pack in Newfoundland (Merdsoy et al. 1979), and up to 25 humpback whales have been entrapped in the same event (Lien and Stenson 1986), with some mortalities reported. No humpback ice entrapments have been reported in the Chukchi Sea.

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

Humpback whales are also killed or injured during interactions with commercial fishing gear, although the evidence available suggests that these interactions do not have significant, adverse consequence for humpback whale populations. From 1979-2008, 1,209 whales were recorded entangled in Newfoundland and Labrador, 80% of which were humpback whales (Benjamins et al. 2012). Along the Pacific coast of Canada, 40 humpback whales have been reported as entangled since 1980, four of which are known to have died (Ford et al. 2009, COSEWIC 2011).

Brownell et al. (2000) compiled records of bycatch in Japanese and Korean commercial fisheries between 1993 and 2000. During the period 1995-99, there were six humpback whales indicated as “bycatch”. In addition, two strandings in this region were reported during this period. These data indicate a minimum mortality level of 1.1/year (using bycatch data only) to 2.4/year (using bycatch, stranding, and market data) in the waters of Japan and Korea. Because many mortalities pass unreported, the actual rate in these areas is likely much higher. An analysis of entanglement rates from photographs collected for Structure of Populations, Levels of Abundance and Status of Humpback Whales (SPLASH) found a minimum entanglement rate of 31% for humpback whales from the Asia breeding grounds (Cascadia Research 2003).

A photography study of humpback whales in southeastern Alaska in 2003 and 2004 found at least 53% of individuals showed some kind of scarring from fishing gear entanglement (Neilson et al. 2005). Between 2008 and 2012, there were two mortalities of Western North Pacific humpback whales in the Bering Sea/Aleutian Islands pollock trawl fishery, and one mortality in the Bering Sea/Aleutian Islands flatfish trawl (Allen and Angliss 2015). Average minimum annual mortality from observed fisheries was 0.60 humpbacks from this DPS (Allen and Angliss 2015).

The mean annual human-caused mortality and serious injury rate for 2008-2012 based on fishery and gear entanglements reported in the NMFS Alaska Regional Office stranding database is 0.3 (Allen and Angliss 2015). The estimated annual mortality rate due to interactions with all fisheries is 0.9 (0.6 + 0.3).

Other sources of human-caused mortality and serious injury include reported collisions with vessels and entanglement in marine debris. The mean minimum annual human-caused mortality and serious injury rate for 2008-2012 for the WNP DPS based on vessel collisions (0.45) and entanglement in unknown marine debris/ gear (0.8) reported in the NMFS Alaska Regional Office stranding database is 1.25 (Allen and Angliss 2015).

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

Status

Humpback whales were listed as endangered in 1970 (35 FR 18319) and that listing was carried over after Congress enacted the ESA (39 FR 41367). Humpback whales are listed as endangered on the IUCN Red List of Threatened Animals (Baillie and Groombridge 1996). They are also protected by the Convention on International Trade in Endangered Species of wild flora and fauna and the MMPA. Critical habitat has not been designated for humpback whales. A final recovery plan for the humpback whale was completed in November of 1991 (NMFS 1991).

NMFS recently conducted a global status review and proposed changing the status of humpback whales under the ESA. Under this proposal, the globally-listed species would be divided into 14 DPS, two of which would remain endangered, two of which would be listed as threated, and the remaining 10 DPSs would not be listed under the ESA (80 FR 22304; April 21, 2015). As described under *Population Structure*, humpback whales in the action area may belong to the proposed western North Pacific, Hawaii, or Mexico DPSs. Under the proposed rule, the western North Pacific DPS would be listed as threatened and the Hawaii and Mexico DPSs would not be listed.

NORTH PACIFIC OCEAN. Estimates of the number of humpback whales occurring in the different populations that inhabit the Northern Pacific have risen over time. In the 1980s, estimates ranged from 1,407 to 2,100 (Baker 1985, Darling and Morowitz 1986, Baker and Herman 1987), while recent estimates place the population size at about 6,000 whales (standard error = 474) in the North Pacific (Calambokidis et al. 1997, Cerchio 1998, Mobley et al. 1999). Based on data collected between 1980 and 1983, Baker and Herman (1987) used a capture-recapture methodology to produce a population estimate of 1,407 whales (95% confidence interval = 1,113 - 1,701). More recently, (Calambokidis et al. 1997) relied on resightings estimated from photographic records of individuals to produce an estimate of 6,010 humpback whales occurring in the North Pacific Ocean. Because the estimates produced by the different methodologies are not directly comparable, it is not clear which of these estimates is more accurate or if the change from 1,407 to 6,000 individuals results from a real increase in the size of the population, sampling bias in one or both studies, or assumptions in the methods used to produce estimates from the individuals that were sampled. Since the last of these estimates was published almost 20 years ago, we do not know if the estimates represent current population sizes.

Between 2004 and 2006, an international group of whale researchers coordinated their surveys to conduct a comprehensive assessment of the population structure, levels of abundance, and status of humpback whales in the North Pacific (Calambokidis et al. 2008). The SPLASH effort identified a total of 7,971 unique individuals from photographs taken during close approaches. Based on the results of that effort, Calambokidis et al. (2008) estimated that the current population of humpback whales in the North Pacific Ocean consisted of about 18,300 whales, not counting calves.

The most recent minimum population estimate of the western North Pacific stock is 865 whales with an estimated growth rate of 6.7 percent, though the growth rate is likely biased high to an unknown degree. The most recent minimum population estimate of the central North Pacific stock is 7,890 whales with an estimated growth rate of 5.5 to 6.0 percent (Allen and Angliss 2015).

In the proposed rule to change the status of humpback whales under the ESA (80 FR 22304; April 21, 2015), the abundances of the proposed western North Pacific, Hawaii, and Mexico DPSs were estimated to be 1,000, 12,000, and 6,000 to 7,000 whales, respectively. The growth rate for the proposed western North Pacific DPS was estimated to be 6.9 percent, though it was noted that humpback whales of this population remain rare in some parts of their former range. The growth rate of the proposed Hawaii DPS was estimated to be between 5.5 and 6.0 percent. The growth rate of the proposed Mexico DPS was reported to be unknown, though unlikely to be in decline.

Based on ecological theory and demographic patterns derived from several hundred imperiled species and populations, humpback whales appear to exist at population sizes that are large enough to avoid demographic phenomena that are known to increase the extinction probability of species that exist as “small” populations (that is, “small” populations experience phenomena such as demographic stochasticity, inbreeding depression, Allee effects, etc, that cause their population size to become a threat in and of itself).

Reproduction and Growth

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

Although long-term relationships do not appear to exist between males and females, mature females do pair with other females; those individuals with the longest standing relationships also have the highest reproductive output, possibly as a result of improved feeding cooperation (Ramp et al. 2010).

Feeding and Prey Selection

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

Humpback whales are relatively generalized in their feeding compared to some other baleen whales. In the Northern Hemisphere, known prey includes: euphausiids (krill); copepods; herring; juvenile salmonids; Arctic cod; walleye pollock; pollock; pteropods; and cephalopods (Johnson and Wolman 1984b, Perry et al. 1999). Foraging is confined primarily to higher latitudes (Stimpert et al. 2007), including areas as far north as the action area.

Diving and Social Behavior

In Hawaiian waters, humpback whales remain almost exclusively within the 1800 m isobath and usually within waters depths less than 182 meters. Maximum diving depths are approximately 170 m (558 ft) (but usually <60 m [197 ft]), with a very deep dive (240 m [787 ft]) recorded off Bermuda (Hamilton et al. 1997). They may remain submerged for up to 21 min (Dolphin 1987a). Dives on feeding grounds ranged from 2.1-5.1 min in the north Atlantic (Goodyear unpublished manuscript). In southeast Alaska average dive times were 2.8 min for feeding whales, 3.0 min for non-feeding whales, and 4.3 min for resting whales, with the deepest dives to 148m (Dolphin 1987a), while whales observed feeding on Stellwagon Bank in the North Atlantic dove <40m (Hain et al. 1992). Because most humpback prey is likely found above 300 m depths most humpback dives are probably relatively shallow. Hamilton et al. (1997) tracked one possibly feeding whale near Bermuda to 240 m depth.

In a review of the social behavior of humpback whales, Clapham (1996) reported that they form small, unstable social groups during the breeding season. During the feeding season they form small groups that occasionally aggregate on concentrations of food. Feeding groups are sometimes stable for long-periods of time. There is good evidence of some territoriality on feeding (Clapham 1994, 1996) and calving areas (Tyack 1981). In calving areas, males sing long complex songs directed towards females, other males or both. The breeding season can best be described as a floating lek or male dominance polygyny (Clapham 1996). Inter-male competition for proximity to females can be intense as expected by the sex ratio on the breeding grounds, which may be as high as 2.4:1.

Average group size near Kodiak Island is 2-4 individuals, although larger groups are seen near Shuyak and Sitkalidak islands and groups of 20 or more have been documented (Wynne et al. 2005). Humpback whales observed in the Alaska Chukchi Sea have been single animals and one cow calf pair was observed in the U.S. Beaufort Sea (Hashagen et al. 2009).

Vocalization and Hearing

While there is no direct data on hearing in low-frequency cetaceans, the functional hearing range is anticipated to be between 7 Hz to 30 kHz (Watkins 1986, Au et al. 2006, Southall et al. 2007, Ciminello et al. 2012, NOAA 2013). Baleen whales have inner ears that appear to be specialized for low-frequency hearing. In a study of the morphology of the mysticete auditory apparatus, Ketten (1997) hypothesized that large mysticetes have acute infrasonic hearing.

Humpback whales produce a wide variety of sounds. During the breeding season males sing long, complex songs, with frequencies in the 20-5000 Hz range and intensities as high as 181 dB (Payne 1970, Winn et al. 1970, Thompson et al. 1986). Source levels average 155 dB and range from 144 to 174 dB (Thompson et al. 1979). The songs appear to have an effective range of approximately 10 to 20 km. Animals in mating groups produce a variety of sounds (Tyack 1981, Silber 1986b).

Social sounds in breeding areas associated with aggressive behavior in male humpback whales are very different than songs and extend from 50 Hz to 10 kHz (or higher), with most energy in components below 3 kHz (Tyack and Whitehead 1983, Silber 1986a). These sounds appear to have an effective range of up to 9 km (Tyack and Whitehead 1983).

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

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

1. Complex songs with components ranging from at least 20 Hz–5 kHz with estimated source levels from 144– 174 dB; these are mostly sung by males on the breeding grounds (Winn et al. 1970, Richardson et al. 1995, Au et al. 2000, Frazer and Mercado 2000, Au et al. 2006);

2. Social sounds in the breeding areas that extend from 50Hz – more than 10 kHz with most energy below 3kHz (Tyack and Whitehead 1983, Richardson et al. 1995); and

3. Feeding area vocalizations that are less frequent, but tend to be 20 Hz–2 kHz with estimated sources levels in excess of 175 dB re 1 Pa at 1m (Thompson et al. 1986, Richardson et al. 1995).

4.3.4 Arctic Ringed Seal

Population Structure

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

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 (snow caves) 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

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).

UNUSUAL MORTALITY EVENT (UME) Since July 2011, more than 60 dead and 75 diseased seals, mostly ringed seals, have been reported in Alaska as an UME. The underlying cause of the UME remains unknown. 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 are the greatest challenges to the persistence of Arctic ringed seals. Within this century, snow cover is 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. The decreased availability or 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 Alaska Natives in 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 was 9,567 (Allen and Angliss 2015). Comprehensive data on community subsistence harvests are not collected at present, and no new annual state-wide harvest monitoring efforts have been funded. Five Alaska communities in the Northwest Arctic region of Alaska voluntarily reported a total of 40 ringed seals harvested during 2012 (Allen and Angliss 2015). 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 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 2008 and 2012, there have been an average of 4.1 (CV=0.06) mortalities of ringed seals incidental to commercial fishing operations per year (Allen and Angliss 2015).

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 may pose 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, since they are closely associated with ice throughout the year. Icebreakers pose special risks to ringed seals because they are capable of operating year-round in all but the heaviest ice conditions.

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 and in State waters. 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.

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. However, to date no mortalities have been documented from research to ringed seals (Allen and Angliss 2014).

The large range and population size of the Arctic subspecies make it less vulnerable to other perturbations, such as hunting, fisheries interactions, and research takes. Therefore, at the time of listing, ESA Section 4(d) protective regulations and Section 9 prohibitions were deemed unnecessary for the conservation of the species (77 FR 76706).

Status

NMFS listed the Arctic ringed seals as threatened under the ESA on December 28, 2012 (77 FR 76706). NMFS proposed designation of critical habitat for the Arctic ringed seal on December 9, 2014 (79 FR 73010). On March 17, 2016, the District Court vacated the Arctic subspecies of ringed seal listing (Alaska Oil and Gas Association v. NMFS, Case No. 4:14-cv-00029-RRB). NMFS appealed the decision.

There are no precise 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 stock's range (Allen and Angliss 2014). 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. During April-May in 2012 and 2013, U.S. and Russian researchers conducted comprehensive and synoptic aerial abundance and distribution surveys of ice-associated seals in the Bering and Okhotsk Seas (Moreland et al. 2013). Preliminary analysis of the U.S. surveys, which included only a small subset of the 2012 data, produced an estimate of about 170,000 ringed seals in the U.S. Exclusive Economic Zone (EEZ) of the Bering Sea in late April (Conn et al. 2014).

Current and precise data on trends in abundance for the Alaska stock of ringed seals are considered unavailable. PBR for this stock is also unknown at this time (Allen and Angliss 2015).

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

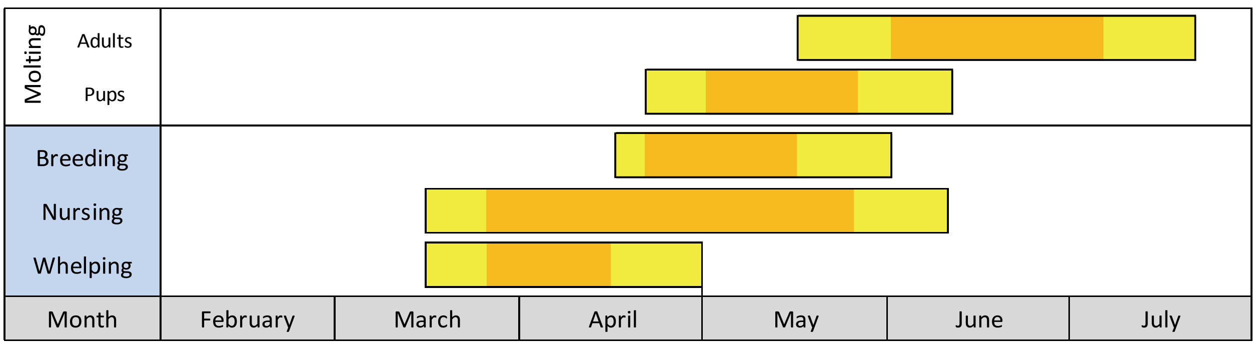

Figure 7. **Approximate annual timing of reproduction and molting for Arctic ringed seals. Yellow bars indicate the "normal" range over which each event is reported to occur and orange bars indicated the "peak" timing of each event (Kelly et al. 2010b).**

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 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 function hearing range phocids should be considered to be 75 Hz to 100 kHz (Hemila et al. 2006, Kastelein et al. 2009, NOAA 2013). The proposed anchor retrieval for this action is anticipated to be below 2 kHz, and should be well within the auditory bandwidth for the Arctic ringed seal. Depending on the operating frequencies, sidescan sonars may be outside the hearing range of ringed seals.

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 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).

In addition, noise exposure may affect the vestibular and neurosensory systems. Unlike cetaceans, pinnipeds have a well-developed more conventional vestibular apparatus that likely provides multiple sensory cues similar to those of most land mammals. There is a direct coupling through the vestibule of the vestibular and auditory systems; therefore, it is possible that marine mammals may be subject to noise-induced effects on vestibular function as has been shown in land mammals and humans (Southall et al. 2007). Noise-induced effects on vestibular function may be even more pronounced than in land mammals considering a single vibrissa on a ringed seal contains ten times the number of nerve fibers typically found in one vibrissa of a land mammal (Hyvärinen 1989). Responses to underwater sound exposures in human divers and other immersed land mammals suggest that vestibular effects are produced from intense underwater sound at some lower frequencies (Steevens et al. 1997). However, more data are needed to more fully assess potential impacts of underwater sound exposure on non-auditory systems in pinnipeds.

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

4.3.5 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, made up of the 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

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

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.

PREDATION. 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).

UNUSUAL MORTALITY EVENT. 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 as a UME. The cause of the Arctic seal disease remains unknown. 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 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 that bearded seals can communicate under quiet conditions, will increase the potential for masking when man-made noise is present.

HARVEST. 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 (2015) 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. Data on community subsistence harvests are no longer being collected and no new annual harvest estimates exist (Allen and Angliss 2015). 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).

COMMERCIAL FISHERIES INTERACTIONS. Commercial fisheries may impact bearded seals through direct interactions (i.e., incidental take or bycatch) and indirectly through competition for prey resources and other impacts on prey populations. Estimates of bearded seal bycatch could only be found for commercial fisheries that operate in Alaska waters. Between 2008 and 2012, 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 1.83 (CV= 0.05) bearded seals per year, based exclusively on observer data (Allen and Angliss 2015). For indirect impacts, Cameron et al. (2010) noted that commercial fisheries target a number of known bearded seal prey species, such as walleye pollock and cod. Bottom trawl fisheries also have the potential to indirectly affect bearded seals through destruction or modification of benthic prey and/or their habitat.
SHIPPING. Current shipping activities in the Arctic may pose 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, since they are closely associated with ice throughout the year. Icebreakers pose special risks to bearded seals because they are capable of operating year-round in all but the heaviest ice conditions.

RESEARCH. 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 2007 and 2011, there was one mortality resulting from research on the Alaska stock of bearded seals (2007), which results in an average of 0.2 mortalities per year from this stock (Tammy Adams, Permits, and Conservation Division, Office of Protected Resources, pers comm. as cited in (Allen and Angliss 2015).

CONTAMINATION. 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 currently 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 a large oil spill.

In the United States, oil and gas activities have been conducted off the coast of Arctic Alaska since the 1970s, with most of the activity occurring in the Beaufort Sea. 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). On July 25, 2014, the U.S. District Court for the District of Alaska issued a decision vacating this listing (Alaska Oil and Gas Association v. Pritzker, Case No. 4:13-cv-00018-RPB). NMFS is appealing the decision.

The present population of the Beringia DPS is highly uncertain, it has been estimated to be about 155,000 individuals (Cameron et al. 2010). Based on extrapolation from existing aerial survey data, Cameron et al. (2010) considered the current population of bearded seals in the Bering Sea to be about double the 63,200 estimate reported by Ver Hoef et al. (2010) (corrected for seals in the water) for U.S. waters, or approximately 125,000 individuals. In addition, Cameron et al. (2010) derived crude estimates of: 3,150 bearded seals for the Beaufort Sea (uncorrected for seals in the water), which was noted as likely a substantial underestimate given the known subsistence harvest of bearded seals in this region; and about 27,000 seals for the Chukchi Sea based on extrapolation from limited aerial surveys (also uncorrected for seals in the water).

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, and the PBR for this stock is unknown (Allen and Angliss 2015).

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.

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. 1994b).
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.[6]

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. 1994b, Lydersen et al. 1996, Watanabe et al. 2009). The time spent in water during the nursing period is remarkable when compared to most other sympatric phocids, such as harp (*Pagophilus groenlandica)*; (71%:0%), grey (*Halichoerus grypus)*; (28%:0%), and hooded seals (0%:0%); however, it is similar to that of ringed seals (*Phoca hispida)*; (mothers 82% : pups 50%) (Lydersen and Hammill 1993, Lydersen et al. 1994b, a, Lydersen 1995, Lydersen and Kovacs 1999, Krafft et al. 2000). In addition to acquiring resources for lactation, time spent in the water may function to minimize exposure to surface predators (Lydersen and Kovacs 1999, Krafft et al. 2000). Mothers traveled an average 48 km per day and alternated time in the water with one to four short bouts on the ice to nurse their pups usually between 0900 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.

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

Vocalizations and Hearing

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

The facial whisker pads of bearded seals have 1300 nerve endings associated with each whisker, making them among the most sensitive in the animal kingdom (Marshall et al. 2006), as reported in (Burns 2009). Schusterman (1981) speculated sightless seals use sound localization and other non-visual, perhaps tactile, cues to locate food. Harbor seals have the known ability to detect and follow hydrodynamic trails out to 180 meters away (Dehnhardt et al. 2001) and research data supports the position that pinniped vibrissae are sensitive active-touch receptor systems enabling seals to distinguish between different types of trail generators (i.e. prey items, currents) (Supin et al. 2001, Marshall et al. 2006, Wieskotten et al. 2010). Mills and Renouf (1986) determined harbor seal vibrissae are least sensitive at lower frequencies (100, 250, and 500 Hz), and more sensitive at higher frequencies (750+ Hz) where the smallest detectable vibration occurred at 1000 Hz. Bearded seal vibrissae may prove to be sensitive at similar frequencies as harbor seals.

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). A more recent review suggests that the function hearing range phocids should be considered to be 75 Hz to 100 kHz (Hemila et al. 2006, Kastelein et al. 2009, NOAA 2013).

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 populations, although the effects of these reductions likely persist today. Other human activities are ongoing and may continue to affect populations of endangered whales and 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.

5.1.1 Targeted Hunts

<u>Historical Commercial Hunting</u>

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 the 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.

Fin Whale

Between 1911 and 1985, 49,936 fin whales were reported killed throughout the North Pacific (Mizroch et al. 2009), although newly revealed information about illegal Soviet catches indicates that the Soviets over-reported catches of about 1,200 fin whales, presumably to hide catches of other protected species (Doroshenko 2000).

Humpback Whale

Rice (1978) estimated that the number of humpback whales in the North Pacific may have been approximately 15,000 individuals prior to exploitation; however, this was based upon incomplete data and, given the level of known catches (legal and illegal) since World War II, may be an underestimate. Intensive commercial whaling removed more than 28,000 animals from the North Pacific during the 20th century (Rice 1978). On the feeding grounds, substantial catches occurred around the Commander Islands and western Aleutian Islands, as well as in the Gulf of Anadyr (Springer et al. 2006).

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

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.

<u>Subsistence Harvest</u>

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 11 Alaska communities (Philo et al. 1993). Under this quota, the number of kills has ranged between 14 and 72 per year, the number depending in part on changes in management strategy and in part on higher abundance estimates in recent years (Stoker and Krupnik 1993). Suydam and George (2011, 2012) summarized Alaskan subsistence harvests of bowheads from 1974 to 2011 reporting a total of 1,149 whales landed by hunters from 12 villages with Barrow landing the most whales (n = 590) while 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), 31 in 2009 (Suydam et al. 2010), 45 in 2010 (Suydam et al. 2011), and 38 in 2011 (Suydam et al. 2012). 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), and in 2011 it was 76% (Suydam et al. 2012).

For 2013-2018, the IWC established a block quota of 306 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 2015). This quota includes an allowance of five animals to be taken by Chukotka Natives in Russia. The annual average subsistence take (by Natives of Alaska, Russia, and Canada) during the 5-year period from 2008 to 2012 was 42 bowhead whales (Allen and Angliss 2015).

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 2015). 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 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). Five Alaska Native communities in the Northwest Arctic region of Alaska voluntarily reported a total of 258 bearded seals were harvested during 2012 (Ice Seal Committee 2013).

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 2015). 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 2014).

5.1.2 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 significant 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).

Year-round recordings of background ambient sound levels collected through the CSESP from 2006 to 2013 confirm that the background ambient levels are well below the levels that might affect the acoustic effects zones modeled in this analysis. The CSESP data showed seasonal variation in ambient sound levels, but minimal spatial variability across the Chukchi Sea Lease Area. Additionally, long-term data from one recorder that was in the center of the Chukchi Sea revealed little inter-annual variation (mean broadband level: 99.7 dB re 1µPa; standard deviation: 1 dB). This supports the conclusion from the multi-station analysis that there is a significant difference between seasonal ambient levels (median broadband levels: 104.6 dB re 1 µPa and 94.5 dB re 1µPa for summer and winter, respectively) (Austin et al. 2015).

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. 1969, 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 sound can vary dramatically depending on the season, type of activity, and local conditions. These noise sources include transportation, dredging, and 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 Sea, 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 Hz-3 kHz) noise levels of 5-10 dB are caused by propeller cavitation (Greene and Moore 1995, Austin et al. 2015). Broadband source levels for icebreaking operations are anticipated to be ~198 dB re 1 µPa at 1m (Austin et al. 2015). Icebreaking activities are anticipated to be the loudest noise sources associated with the proposed action and noise may reach the 120 dB re 1 µPa rms isopleth at 45 km (Austin et al. 2015).

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/3D seismic survey with multiple guns would emit sound at frequencies at about 10 Hz-3 kHz (Austin et al. 2015). 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). 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.

NMFS issued an IHA to Conoco Phillips Alaska to take eight species of marine mammals by Level B behavioral harassment incidental to conducting geophysical surveys in the Chukchi Sea on May 23, 2008 (73 FR 30064). From 2008-2010, NMFS issued Shell three IHAs to take a small number of marine mammals incidental to marine seismic, shallow hazard, and sites clearance survey activities in the Chukchi and Beaufort Seas (73 FR 66106, 74 FR 55368, and 75 FR 49710). In 2010 and 2011, NMFS issued Statoil two IHAs to take small numbers of marine mammals by harassment incidental to marine seismic and shallow hazard surveys in the

Chukchi Sea (75 FR 32379, 76 FR 30110). No seismic surveys were conducted in the Beaufort Sea in 2011. In 2012, NMFS issued IHAs to Shell, BP Exploration Alaska (BPXA), and ION Geophysical, and to take small numbers of marine mammals by harassment incidental to conducting an exploratory drilling program in the Chukchi Sea (77 FR 27322), an open-water 3D OBC seismic survey in Beaufort Sea (77 FR 40007), and an in-ice 2D seismic surveys in the Beaufort and Chukchi Seas (77 FR 65060) respectively.

The Arctic Regional Biological Opinion (ARBO) issued in 2013 was a programmatic incremental step consultation with BOEM/BSEE that covered oil and gas leasing and exploration activities in the Beaufort and Chukchi Sea Planning Areas over a 14-year period. ARBO covered on and off lease deep penetration marine seismic and geohazard surveys as well exploration drilling in the Chukchi and Beaufort Sea Planning Areas. Under ARBO (NMFS 2013a), annual takes by harassment associated with marine seismic and geohazard surveys in the Beaufort Sea is anticipated to be (368) bowhead whales, (3,740) ringed seals, and (1,516) bearded seals, and annual takes in the Chukchi Sea is anticipated to be (124) bowhead whales, (64) fin whales, (64) humpback whales, (2,152) ringed seals, and (4,320) bearded seals.

In 2013, NMFS issued an IHA to Shell and TGS to take small numbers of marine mammals by harassment incidental to site clearance and shallow hazard surveys and equipment recovery and maintenance activities in the Chukchi Sea (78 FR 47495), and marine seismic surveys in the Chukchi (78 FR 51147) respectively. The site specific consultations that were done for these IHAs fall under the umbrella of the take issued by ARBO.

NMFS issued two IHAs to BPXA for 3D seismic operations in Prudhoe Bay (79 FR 36730) and 2D seismic geohazard surveys in Foggy Island Bay in the Beaufort Sea (79 FR 36769) in 2014. The Prudhoe Bay IHA allowed for up to six instances of seismic exposure to bowhead whales, 87 instances of seismic exposure to bearded seals, and 324 instances of seismic exposure to ringed seals associated with 3D seismic surveys. The Foggy Island Bay IHA allowed for up to one instance of exposure to bowhead whales, 19 instances of exposure to bearded seals, and 71 instances of exposure to ringed seals associated with 2D seismic geohazard surveys. In addition in 2014, NMFS issued an IHA to SAE for 3D seismic operations in the Coleville River delta (79 FR 51963). The Coleville River IHA allowed for up to 131 instances of seismic exposure to bowhead whales, 32 instances of seismic exposure to bearded seals, and 638 instances of seismic exposure to ringed seals associated with 3D seismic surveys. These sites specific consultations also fell under the ARBO.

In 2015, NMFS issued the Lease Sale 193 Biological Opinion (LS 193), which was another programmatic incremental step consultation with BOEM/BSEE that covered oil and gas leasing and exploration activities in the Chukchi Sea Planning Areas over a 9-year period. LS 193 covered on lease marine seismic, geohazard and geotechnical surveys as well exploration drilling in the Chukchi Sea Lease Area. Under LS 193(NMFS 2015a), annual takes by harassment associated with oil and gas exploration activities in the Chukchi Sea Lease Area is anticipated to be on average (760) bowhead whales, (101,406) ringed seals, and (80,708) bearded seals, (13) fin whales, and (13) humpback whales.

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 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 2013b).

During the 2012 exploration drilling activities, measurements of sounds produced by the drillship *Discoverer* were made on the Burger prospect in the Chukchi Sea. Broadband source levels of the *Discoverer* ranged from 177 to 185 dB re 1 μPa rms (Austin and Warner 2010). Most of the acoustic energy was contained in the 100-1000 Hz and 1-10 kHz frequency bands, both of which typically were at levels just below 120 dB re 1 μPa rms. When no other vessels were present near the *Discoverer* and drilling was occurring, broadband sound levels fell below 120 dB re 1 μPa rms at 1.5 km (Austin et al. 2013).

Distance to the 120 dB re 1 μPa rms during anchor handling by the *Tor Viking* was estimated to be 14 km during Shell's exploration drilling program at Burger (Fairweather 2016). Sounds produced by vessels managing the ice were recorded and the distance to the 120 dB re 1 μPa rms isopleth was calculated to occur at 9.6 km (JASCO Applied Sciences 2013).

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 transien sounds that vary widely in intensity and frequency (BOEM 2011).

5.1.3 Vessel Interactions

The general Arctic maritime season lasts only from June through October, and unaided navigation occurs within a more limited time frame. However, this pattern appears to be rapidly changing, as ice-diminished conditions become more extensive during the summer months. Between 2008 and 2012, vessel activity in the U.S. Arctic went from 120 vessels to 250, an increase of 108 percent (ICCT 2015). This includes only the northern Bering Sea, the Bering Strait, Chukchi Sea and Beaufort Sea to the Canadian border. The increase in vessel traffic on the outer continental shelf of the Chukchi Sea and the near-shore Prudhoe Bay from oil and gas exploration activity is particularly pronounced (ICCT 2015) (see Figure 8).

On September 16, 2012, Arctic sea ice reached its lowest coverage extent ever recorded (Biello 2012), paving the way for the longest Arctic navigation season on record. To better understand vessel distribution and density as activity increases, satellite automatic identification system (AIS) data were analyzed for the U.S Arctic above the Aleutian Islands. Vessel projections for the Arctic assume: 1) there will not be a U.S. Arctic deep-water port available in the next decade; 2) no increase in military presence or Coast Guard assets to the region, and 3) number of research vessels, cruise ships and adventure tourism will remain consistent with 2013 levels.

A direct comparison was made of July through November vessel locations for 2011 and 2012. The most apparent pattern between years is the shift from coastal traffic to more offshore traffic. During this time, Shell was involved in offshore drilling, and much of this shift could be attributable to offshore supply and support for oil and gas exploration and drilling on the outer continental shelf of the Chukchi Sea (ICCT 2015). In addition, some of this nearshore traffic in the Beaufort is likely attributable to the ongoing construction by Exxon at Point Thompson for a gas condensate facility, which required barge deliveries from Prudhoe Bay (ICCT 2015).

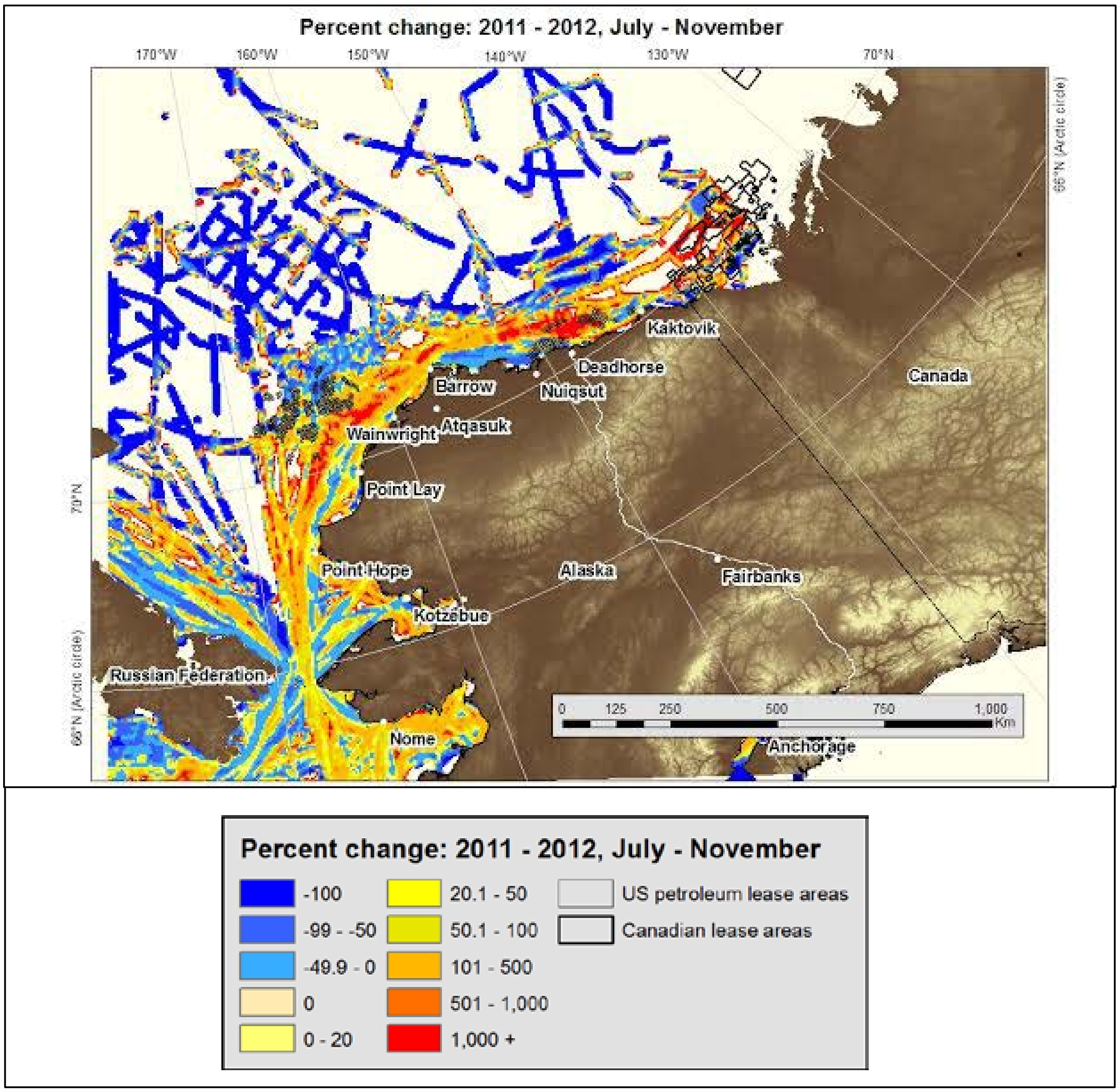

Figure 8. Percent difference in vessel activity from 2011 to 2012 using 5 km grid cells (ICCT 2015).

Vessel traffic can pose a threat to marine mammals because of the risk of ship strikes and the disturbance associated with noise from 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){Neilson, 2012 #1599}. 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.

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. Two fin whale deaths due to ship strikes (one in 2009 and one in 2010) in Alaska waters were reported to the NMFS Alaska Region stranding database between 2009 and 2013 (Allen et al. 2014), resulting in a mean annual mortality rate of 0.4 fin whales due to ship strikes. In addition, the mean minimum annual human-caused mortality and serious injury rate for 2008-2012 for humpback whales based on vessel collisions (0.45) and entanglement in unknown marine debris/ gear (0.8) reported in the NMFS Alaska Regional Office stranding database is 1.25 (Allen and Angliss 2015). However, no strikes of cetaceans have been reported in the Arctic.

Current shipping activities in the Arctic may pose 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 1983b). To date, no bearded or ringed seal carcasses have been found with propeller marks. However, Sternfeld (2004) documented a single 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. Reeves (1998) noted that some ringed seals have been killed by ice-breakers moving through fast-ice breeding areas.

5.1.4 Commercial Fishing Interaction

While currently no commercial fishing is authorized in the Chukchi Sea or 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 Chukchi and Beaufort sites.

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 2015).

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. 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. One dead whale was found floating in Kotzebue Sound in early July 2010 entangled in crab pot gear similar to that used by commercial crabbers in the Bering Sea (Suydam et al. 2011). During the 2011 spring aerial photographic survey of bowhead whales near Point Barrow, one entangled bowhead was photographed (Mocklin et al. 2012). The minimum average annual entanglement rate in U.S. commercial fisheries for the 5-year period from 2008-2012 is 0.4 (Allen and Angliss 2015). However, the overall rate is currently unknown.

Fin Whale

Between 2008 and 2012, there was one observed incidental mortality of a fin whale due to entanglement in the ground tackle of a commercial mechanical jig fishing vessel (Helker et al. 2015).

Humpback Whale

Between 2008 and 2012, there were two mortalities of humpback whales in the Bering Sea/Aleutian Islands pollock trawl fishery and one in the Bering Sea/Aleutian Islands flatfish trawl fishery. Because these incidents occurred in areas where the ranges of the western North Pacific and central North Pacific stocks overlap, it is not known to which stock(s) the affected whales belonged. One central North Pacific humpback whale was injured in the Hawaii shallow set longline fishery during this same time period. The estimated annual mortality rate due to interactions with all U.S. fisheries is 0.9 whales per year from the western North Pacific stock and the overall minimum estimate of mortality and serious injury rate due to fisheries for the central North Pacific stock is 8.4 whales per year. A minimum mortality rate of 1.1 to 2.4 western North Pacific humpback whales per year is estimated in the waters of Japan and Korea (Allen and Angliss 2015).

Ringed Seal

Between 2008 and 2012, there were incidental serious injuries and mortalities of ringed seals in the Bering Sea/Aleutian Islands flatfish trawl fishery, the BSAI pollock trawl, BSAI cod trawl, and BSAI cod longline. Based on this data, there has been an average of 4.12 (CV = 0.06) mortalities of ringed seals incidental to commercial fishing operations (Allen and Angliss 2015).

Bearded Seal

Between 2008 and 2012, there were incidental serious injuries and mortalities of bearded seals in the BSAI pollock trawl and the BSAI flatfish trawl. The estimated minimum mortality rate incidental to commercial fisheries is 1.83 (CV = 0.05) bearded seals per year, based exclusively on observer data (Allen and Angliss 2015).

Lethal take of seals resulting from capture in the Bering Sea/Aleutian Island pollock fishery is limited to 18 Beringia DPS bearded seals and 36 Arctic ringed seals over a period of three consecutive years (NMFS 2014).

5.1.5 Pollutants and Contaminants

Authorized Discharges

Existing development in the action area provides multiple sources of contaminants that may be bioavailable (NMFS 2013c). 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. Small oil spills have occurred with routine frequency and are considered likely to occur into the future (BOEM 2015b). Small spills during exploration activities are expected to consist of refined oils because crude and condensate oil would not be produced during exploration (BOEM 2015a).

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

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

Fin Whale

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

Humpback Whale

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

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

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.

Heavy metals such as mercury, cadmium, lead, selenium, arsenic, and nickel accumulate in ringed seal vital organs, including liver and kidneys, as well as in the central nervous system (Kelly et al. 2010b). Gaden et al. (2009) suggested that during ice-free periods the seals eat more Arctic cod (and mercury). They also found that mercury levels increased with age for both sexes. Dehn et al.'s (2005) finding near Barrow also supports this. 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 Artic (Tynan and DeMaster 1997).

5.1.6 Research

The NMFS Permits Division has issued scientific research permits for activities that adversely affect ringed and bearded seals in the action area. Permit No. 15142 authorizes the capture of four bearded seals (Beringia DPS); up to two of the captured seals would be placed into permanent captivity for non-invasive sensory research (Permit No. 14535). Permit No. 18537 authorizes the incidental disturbance (i.e., harassment during aerial surveys) of ringed (N = 200) and bearded seals (N = 200), during scientific research targeting the Steller sea lion (Western DPS). Permit No. 14610 authorizes the incidental disturbance (i.e., harassment during vessel surveys) of ringed (N = 10) and bearded seals (N = 10), during scientific research targeting beluga and bowhead whales. Permit No. 15324 authorizes the incidental disturbance (i.e., harassment during aerial and vessel surveys, and incidental to capture) of ringed (N = 300,050) and bearded seals (N = 150,050), the capture, drug, and tagging of ringed (N=200), and bearded seals (N= 200), and the unintentional mortality of ringed (N=5) and bearded seals (N=5).While these authorized numbers of directed takes may seem high, the actual number of take that results from these permits is often low. As an example, between 2003-2011, there was one mortality resulting from research of the Alaska stock of bearded seals (2007), which results in an average of 0.2 mortalities per year from this stock.

5.1.7 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 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 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 sea ice extent is often taken as an index, the recent reductions of the area of multi-year sea ice and the reduction of sea ice thickness are 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 soon return to previous climatological conditions. Continued loss of sea ice will be a major driver of changes across the Arctic over the next decades, especially in late summer and autumn.

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 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). According to climate model projections, snow cover is forecasted to be inadequate for the formation and occupation of birth lairs for ringed seals within this century over the Alaska stock's entire range (Kelly et al. 2010b).

The ringed seal's broad distribution, ability to undertake long movements, diverse diet, and association with widely varying ice conditions suggest resilience in the face of environmental variability. Bearded seals, on the other hand, are restricted to areas where seasonal sea ice occurs over relatively shallow waters where they may forage on the bottom (Fedoseev 2000), and although bearded seals usually associate with sea ice, young seals may be found in ice-free areas such as bays and estuaries.

As temperatures in Arctic waters are warming and sea ice is diminishing, there is an increased potential for harmful algal blooms (HABs) that produce toxins that affect marine life (see Figure 9). Biotoxins like domoic acid and saxitoxin may pose a risk to Arctic marine mammals, and, increased temperatures can cause increases in Brucella infections. In a recent study, 905 marine mammals from 13 species across Alaska were sampled (humpback whales, bowhead whales, beluga whales, harbor porpoises, northern fur seals, Steller sea lions, harbor seals, ringed seals, bearded seals, spotted seals, ribbon seals, Pacific walruses, and northern sea otters) and domoic acid was detected at low levels in all species examined. This HABs toxin had the greatest prevalence in bowhead whales (68%) and harbor seals (67%). Another HABs toxin, saxitoxin, was also detected at low levels in 10 of the 13 species, with the highest prevalence in humpback whales (50%) and bowhead whales (32%) (Lefebvre et al. 2016).

In 2015, an unusually high level of large whale mortalities occurred in the Western Gulf of Alaska, encompassing the areas around Kodiak, Afognak, Chirikof, and Simidi Islands, and the southern shoreline of the Alaska Peninsula. NMFS declared this event a UME. Though a cause of death has not been determined for any of the mortalities, it's possible that elevated water temperatures could play a factor.

Figure 9. Algal toxins detected in 13 species of marine mammals from southeast Alaska to the Arctic from 2004 to 2013 (Lefebvre et al. 2016).

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 prey availability for the Western Arctic stock of bowhead whales.

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 Potentially Affecting Listed Species in the Action Area

We considered several potential stressors in the *Environmental Baseline* that may adversely affect listed marine mammals that occur in the action area:

- Commercial whaling in the 19th and early 20th centuries reduced large whale populations in the North Pacific down to a fraction of historic population sizes. However, the Western Arctic stock of the bowhead whale is showing marked recovery with numbers approaching the low end of the historic population estimates.

- 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 substantial in some regions but is not considered a threat at the population or species 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, ferries, recreational cruisers, whale watching catamarans, fishing vessels, and skiffs. Shipping and vessel traffic are expected to increase in the Arctic if warming trends continue.
- Shipping activities in the U.S. Arctic may 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 can 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 estimations 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 2015). The feeding range of fin whales is larger than that of other species and consequently, as feeding generalists, it is likely that the fin whale may be more resilient to climate change, should it affect prey, than feeding specialists. Recent observations of fin and humpback whales in the Chukchi Sea may be indicative of seasonal habitat expansion in response to receding sea ice or increases in prey availability, which these whales now exploit.
- Ringed seals' 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, long generation time and ability to produce only a single pup each year may limit ringed seals' 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.

Bowhead, fin, and humpback whales in the action area appear to be increasing in population size – or, at least, their population sizes do not appear to be declining – despite their continued exposure to the direct and indirect effects of the activities discussed in the Environmental Baseline. While we do not have current abundance estimates for ringed and bearded seals, they also do not appear to be declining as a result of the current stress regime.

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 Fairweather'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.

6.1 Project Stressors

During our assessment, we considered several potential stressors associated with the proposed action. Based on our review of the data available, anchor handling, ice management, sidescan sonar surveys, and vessel activities may cause these primary stressors:

1. sound fields produced by continuous noise sources such as: AHTSVs, ice management, sonar source vessel, and support vessels;
2. pulsed sounds from sidescan sonar surveys; and
3. risk of collisions associated with proximity to the vessels involved in those anchor handling activities.

6.2 Acoustic Thresholds and Definitions of Harassment

Since 1997, NMFS has used generic sound exposure thresholds to determine whether an activity produces underwater and in-air sounds that might result in impacts to marine mammals (70 FR 1871). NMFS is currently developing comprehensive guidance on sound levels likely to cause injury and behavioral disruption to marine mammals (NOAA 2013). However, until formal guidance is available, NMFS uses conservative thresholds of sound pressure levels from broad band sounds that cause behavioral disturbance (160 dB rms re: 1μPa for impulse sound and 120 dB rms re: 1μPa for continuous sound) and injury (180 dB rms re: 1μPa for whales and 190 dB rms re: 1μPa for pinnipeds). These "disturbance" and "injury" thresholds correlate with the "Level A" harassment and "Level B" harassment thresholds as those terms are defined pursuant to the MMPA (16 U.S.C. § 1362(18)(A)(i) and (ii)).

The MMPA defines "harassment" as: any act of pursuit, torment, or annoyance which (i) has the potential to injure a marine mammal or marine mammal stock in the wild [Level A harassment]; or (ii) 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 [Level B harassment].

As described below, we anticipate that exposures to listed marine mammals from noise associated with the proposed action may result in disturbance and potential injury. However, no mortalities or permanent impairment to hearing are anticipated.

6.3 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.

6.3.1 Exposure to Active Anchor Handling

Noise sources from the proposed action include: anchor handling, sonar survey equipment (sidescan, multi-beam or single beam echosounder), ice management, and support vessels associated with these operations (see Table 2 for full list). All of the source types operated in the action area as part of Shell's exploratory drilling program in 2012 and 2015. These projects operated under IHAs that required acoustic measurements of underwater noise sources, and the results are cataloged in reports submitted to NMFS (Bisson et al. 2013). The reports dating back to 2006 are publicly available on NMFS' ITA website: http://www.nmfs.noaa.gov/pr/permits/incidental/oilgas.htm.

Mitigation Measures to Minimize the Likelihood of Exposure to Anchor Handling

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

1. Two PSOs are required on all AHTSVs engaged in activities that may result in an incidental take through acoustic exposure

2. When the vessel is positioned on-site, the PSO will 'clear' the area within 500 meters of the AHTSV for 30 minutes prior to starting anchor retrieval; if no marine mammals are observed within those 30 minutes, anchor retrieval can commence.

Approach to Estimating Exposures during Anchor Retrieval

We relied on exposure estimates provided by Fairweather in its revised IHA application (Fairweather 2016). Fairweather's estimates assume: (1) marine mammals would not try to avoid being exposed to the stressor (loud noise); (2) maximum densities of marine mammals would be constant over time within the action area; (3) ASAMM data from 2014 are representative, despite including high nearshore bowhead densities in comparison to previous years, and a relatively small survey block; (4) duration of anchor handling is likely worst-case, and (5) source levels are based on anchor seating which is anticipated to be louder than anchor removal. Overall, this approach is very conservative and likely results in an overestimate of exposure.

The narratives that follow present the approach NMFS PR1 used to estimate the number of marine mammals that may reasonably be expected to be "taken" during anchor handling activities.

The instances of exposure for each species to received levels of continuous sound ≥120, 160, 180, and 190 dB rms were estimated by multiplying:

- the maximum bowhead whale, humpback whale, fin whale, ringed seal, and bearded seal densities during the summer, by
- the daily ensonified area out to the 120, 160, 180, and 190 dB isopleths, by
- the number of activity days per season.

Anticipated Densities of Listed Species

Bowhead Whales

To estimate bowhead whale densities, NMFS PR1 used data from the 2008 and 2014 ASAMM aerial surveys flown in the Beaufort and Chukchi Seas. (Ferguson, pers. comm., 2015); www.afsc.noaa.gov/nmml/). Only "on-transect" sighting and effort data were used. The analysis was further restricted to sightings made by primary observers, and did not include repeat sightings or sightings of dead animals. The ASAMM density data were separated by depth, month, year, and location.

The temporal variability in animal density was incorporated by computing separate density estimates for each month (July-October). The maximum density estimate represents the greatest density estimate per depth stratum per month in a single year. The year chosen could vary across months for a given depth stratum (Ferguson, pers. comm., 2015). We did this to be conservative and account for the potential of large pulses of migrating bowhead whales (see Figure 10).

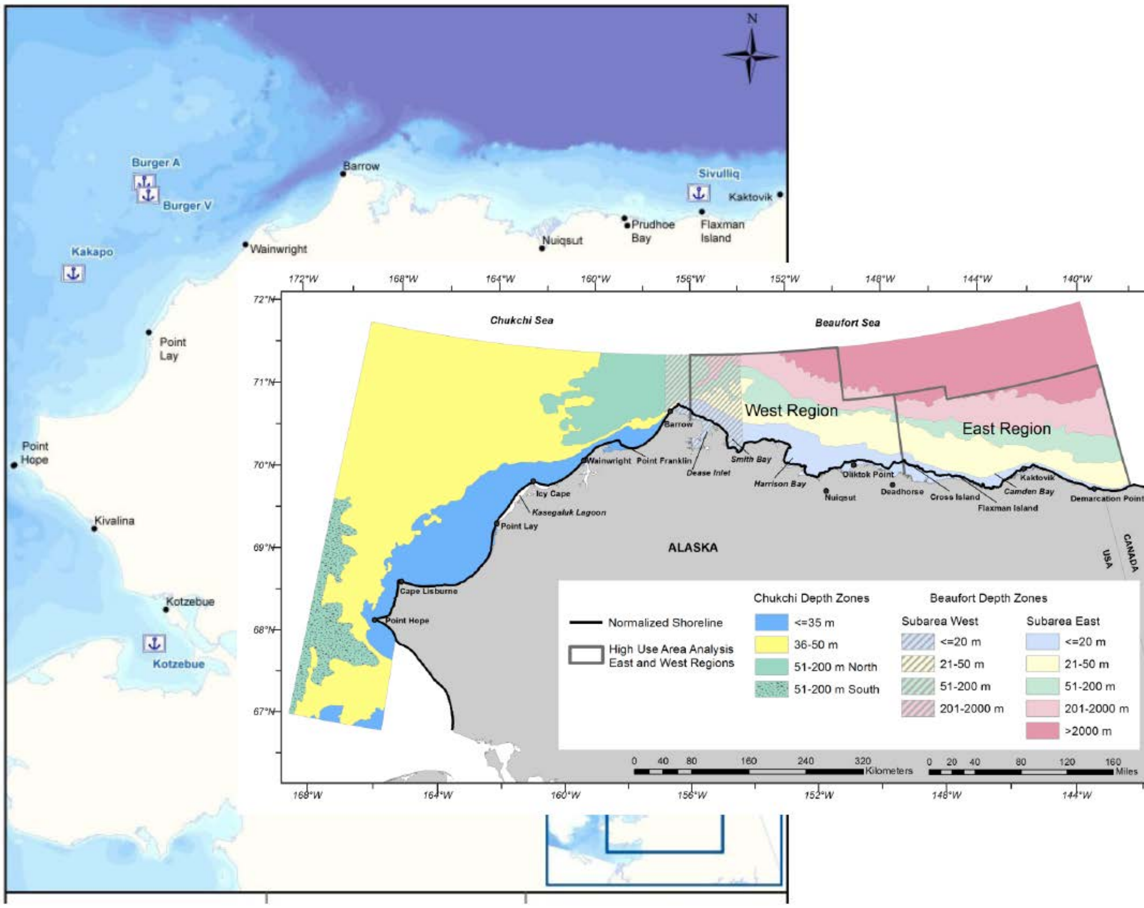

Figure 10. Anchor retrieval locations and depth contours associated with density estimates (Fairweather 2016).

The Kotzebue site is located within the 0-35 m south depth stratum, the Kakapo site is located within the 0-35 m north depth stratum, the Burger sites are located within the 35-50 m depth stratum, and the ice management activity would occur near Point Barrow in the 50-200 m north depth stratum in the Chukchi Sea. The Sivulliq site is located within the east 21-50 m depth stratum in the Beaufort Sea (see Figure 10).

Values for *f(0)* were taken from Ferguson and Clarke (2013). Because there currently are no estimates of trackline detection probability for the ASAMM sighting data, values for *g(0)* were taken from Thomas et al. (2002).[7] Resulting density estimates are shown in Table 8 for the project area.

Other Cetaceans

Although there is evidence of the occasional occurrence of fin and humpback whales in the Chukchi Sea, it is unlikely that more than a few individuals will be encountered during the proposed activities. Clarke et al. (2011d, 2013c) and Hartin et al. (2013) reported humpback

[7] *f(0)*= sighting probability density at zero perpendicular distance, or equivalently, 1/effective strip width, *g(0)*= probability of sighting an object located directly on the trackline.

and fin whale sightings. NMFS (2013c) recently concluded that these whales may be regular visitors to the Chukchi Sea but occur in low numbers there. In addition, at least one humpback whale mother-calf pair was sighted from a barge approximately 87 km (54.1 mi) east of Barrow in the Beaufort Sea (Hashagen et al. 2009). In the absence of more definitive data regarding humpback and fin whale densities in the Chukchi Sea, and humpback whales densities in the Beaufort Sea, we used minimum reported densities for these species (0.0004 whales/km^2) across season and depth contours (see Table 8). Fin whales are not anticipated in the Beaufort Sea.

Table 5. Maximum anticipated density (#/km^2) for cetaceans in the project area by season and depth contour (Fairweather 2016).

Depth Stratum	Bowhead whale		Fin whale		Humpback whale	
	Summer	Fall	Summer	Fall	Summer	Fall
Chukchi Sea						
0-35 m south (Kotzebue site)	0.000	0.000	0.0004	0.0004	0.0004	0.0004
0-35 m north (Kikapo site)	0.008	0.015	0.0004	0.0004	0.0004	0.0004
35-50 m (Burger sites)	0.003	0.051	0.0004	0.0004	0.0004	0.0004
50-200 m north (Point Barrow)	0.015	0.181	0.0004	0.0004	0.0004	0.0004
Beaufort Sea						
50-200 m east (Sivulliq site)	0.288	0.131	0.000	0.000	0.0004	0.0004

Ringed and Bearded Seals

Ringed seal and bearded seals maximum summer ice-margin densities were available in Bengtson et al. (2005) from spring surveys in the offshore pack ice zone of the northern Chukchi Sea. However, corrections for bearded seal availability, *g(0)*, based on haulout and diving patterns were not available. Densities of ringed and bearded seals in open water are expected to be somewhat lower in the summer when preferred pack ice habitat may still be present in the Chukchi Sea. Maximum open-water densities have been estimated as 3/4 of the ice margin densities during both seasons for both species. The fall density of ringed seals in the offshore Chukchi Sea has been estimated as 2/3 the summer densities because ringed seals begin to reoccupy nearshore fast ice areas as it forms in the fall (Table 9). Bearded seals may also begin to leave the Chukchi Sea in the fall, but less is known about their movement patterns so fall densities were left unchanged from summer densities.

Table 6. Maximum densities (#/km^2) of listed pinnipeds in the Chukchi and Beaufort Seas for the summer (July-Aug) and fall (Sept-Oct) activity period (Fairweather 2016).

Species	Summer Max Density	Fall Max Density
Ringed Seal	0.6075	0.4070
Bearded Seal	0.0203	0.0203

Daily Area Ensonified

Anchor handling is considered a continuous noise source. During Shell's 2012 exploration drilling program, JASCO (2014) measured sound levels produced by the *Tor Viking* during activities associated with anchor handling in the Chukchi Sea at Burger. The measured level was 143 dB re 1 µPa at 860 m. The extrapolated distance to the 120 dB re 1 µPa rms threshold to approximately 14 km (JASCO 2014, Fairweather 2016). Fairweather assumes the unseating of anchors will be similar in power needed from the vessel for anchor retrieval (Table 10).

Table 7. Distance (in meters) to various received rms SPLs (in dB re 1 µPa) for anchor retrieval activities (Fairweather 2016).

Sound Source		190 dB	180 dB	160 dB	120 dB
Anchor Retrieval	Radius (m)	4 m	12 m	121 m	14 km

The area ensonified was then calculated (πr^2), for a total ensonified area of 615 km^2 (see Table 11).

Table 8. Ensonified area estimates associated with anchor retrieval activities (provided in km^2) (Fairweather 2016) .

Sound Source		190 dB	180 dB	160 dB	120 dB
Vessel Noise	Ensonified Area (km^2)	n/a	n/a	0.046	615

Number of Anchor Retrieval Days

Each anchor site has different configurations and numbers of anchors, but Fairweather assumes it will take up to seven days per site to remove all anchors. Vessels are only anticipated to be operating at full power during half of the time on each anchor site (3.5 days). This would result in 14 days anticipated for the Kotzebue and Chukchi sites, and an additional 3.5 days for the Beaufort Sivulliq site for a total of 17.5 days of anchor handling activity that may result in acoustic disturbance. For this reason the estimated instances of exposures result from multiplying seasonal density by daily ensonified area per season by number of survey days per season (see Table 12).

Results of Exposure Analysis (Anchor Retrieval)

The estimated instances of exposure (see Table 12) are likely overestimates for the following reasons:

- The estimates assume that marine mammals would not avoid anchor handling noise, yet some degree of avoidance is likely;
- Anchor removal is anticipated to take up to seven days at each site with vessels anticipated to be at full power retrieving anchors for 3.5 days at each site when it may only take two days to retrieve anchors or one day at full power at each site;
- Anchor retrieval sound propagation estimates are based on measured levels for anchor handling which will likely be louder and take more time than anchor retrieval; and
- Mitigation measures will be employed to detect listed species prior to initiating anchor retrieval, further reducing instances of exposure (see Sections 2.1.2).

Fairweather and NMFS PR1 estimated the number of bowhead whales, ringed seals, and bearded seals might be exposed to received levels ≥120, 160, 180, and 190 dB (rms) from anchor retrieval operations during the 2016 open water season (Table 12). Estimates multiply daily ensonified area, animal density, number of activity days, and season.

Table 9. Potential instances of exposure of listed marine mammals to received sound levels ≥120 dB 1 μPa (rms) from anchor retrieval activities during Fairweather's proposed action.

	Kotzebue and Chukchi Sites					Beaufort Site			**Total Summer exposure**
Species	Ensonified area (km^2)	Days	Density (km^{-1})	Chukchi Summer exposure	Ensonified area (km^2)	Days	Density (km^{-1})	Beaufort Summer exposure	
Bowhead whale	615	14	0-0.008	29	615	3.5	0.2883	621	**650**
Humpback whale	615	14	0.0004	4	615	3.5	0.0004	1	**5**
Fin whale	615	14	0.0004	4	615	3.5	0.0000	0	**4**
Ringed seal	615	14	0.6075	5,234	615	3.5	0.6075	1,309	**6,543**
Bearded seal	615	14	0.0203	175	615	3.5	0.0203	44	**219**

In the *Response Analysis* (Section 6.4.1) we apply the best scientific and commercial data available to describe the species' expected responses to these exposures.

6.3.2 Exposure to Ice Management Activities

Mitigation Measures to Minimize the Likelihood of Exposure to Ice Management

Mitigation measures are described in detail in Section 2.1.2. 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 ice management activities.

1. Two PSOs are required on all AHTSVs engaged in activities that may result in an incidental take through acoustic exposure;
2. Prior to ice management commencing, the PSO will observe the area within 500 meters of the AHTSV for 30 minutes prior to starting ice managment; if no marine mammals are observed within those 30 minutes, ice management may begin.
3. Vessels in transit shall be operated at speeds necessary to ensure no physical contact with whales occurs.

a) Transiting vessels will avoid approaching within 1 mile (1.6 km) of observed whales

b) Vessel speed will be reduced to less than 5 knots when within 300 yards of whales

c) Avoid groups of five whales or more by all vessels under the direction of Fairweather.

Approach to Estimating Exposures to Ice Management

The proposed anchor handling fleet consists of two ice classed vessels, the *M/V Aiviq* and *M/V Nanuq*. Fairweather does not anticipate needing to conduct ice management, and if they do, they only anticipate using one vessel near Barrow during the summer.

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 maximum bowhead whale, humpback whale, fin whale, ringed seal, and bearded seal densities during the summer, by
- the daily ensonified area out to the 120, 160, 180, and 190 dB isopleths, by
- the number of activity days per season.

Anticipated Area Ensonified to Specified Levels from Ice Management

The noise associated with vessel operation is considered a continuous noise source. Sounds produced by vessels managing the ice were recorded in the Chukchi Sea and the distance to the 120 dB re 1 μPa rms threshold was calculated to occur at 9.6 km (JASCO 2014) (see Table 3). The total calculated ensonified area would be 290 km^2. (Table 13).

Table 10. Ensonified area estimates associated with various received sound levels for ice management activities (ensonified area provided in km^2) (Fairweather 2016).

Sound Source		190	180	160	120
Ice Management	Ensonified Area (km^2)	n/a	n/a	0.011	290

Expected Densities of Listed Species near Barrow (Summer)

The anticipated densities of listed species are the same as those listed in Tables 8-9 above (see Section 6.3.1). If ice management activities occur, they are anticipated near Point Barrow in the 50-200 m north region in the Chukchi Sea in the summer (Fairweather 2016).

Results of Exposure Analyses (Ice Management)

We anticipate that noise associated with ice management would drop to 120 dB within 9.6 km (or less) of the vessel (JASCO 2014), operations would only involve one vessel, and occur near Barrow in the summer. Estimates multiply daily ensonified area, animal density by season and location, and number of activity days (see Table 14).

Table 11. Potential instances of exposure of listed marine mammals to received sound levels ≥120 dB 1 μPa (rms) to ice management activities during Fairweather's proposed action in the Chukchi Sea during the summer (Fairweather 2016).

	Barrow Location			
Species	Ensonified area (km^2)	Days	Density (km^{-1})	**Chukchi Summer exposure**
Bowhead whale	290	2	0.0145	**8**
Humpback whale	290	2	0.0004	**0**
Fin whale	290	2	0.0004	**0**
Ringed seal	290	2	0.6075	**352**
Bearded seal	290	2	0.0203	**12**

6.3.3 Exposure to Sidescan Sonar Noise

Mitigation Measures to Minimize the Likelihood of Exposure to Sidescan Sonar Noise

Mitigation measures are described in detail in Section 2.1.2. The following mitigation measure will be implemented through the MMPA permitting process to reduce the adverse effects of other acoustic sources on marine mammals from the sidescan sonar activities.

1. PSOs are required on sonar source vessel that may result in an incidental take through acoustic exposures.
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.

Approach to Estimating Exposures to Sidescan Sonar Noise

We relied on exposure estimates provided by Fairweather and NMFS PR1 (Fairweather 2016). For the proposed action, manufacturer specifications for single and multi-beam sidescan sonar provide a source level of 220 dB re 1 μPa at 1 m and have a frequency range from 100 to 500 kHz (HydroSurveys 2008, 2010, Konsberg 2014). Section 2.1.1.2 describes each of these sound sources, with source levels and frequency ranges, in more detail.

Fairweather anticipates sidescan sonar's underwater sound propagation would drop to 160 dB rms within 1,000 m (or less) of the source vessel. The ensonified area is anticipated to be 3.14 km^2 (Fairweather 2016) (see Table 15).

Similar to the approach Fairweather used to estimate the potential instances of exposure to marine mammals associated with anchor handling, the instances of exposure for each listed species to received levels of impulsive sound associated with sidescan sonar ≥160 dB rms were estimated by multiplying: the anticipated area to be ensonified to ≥160 dB rms by maximum species density per season per area, by the anticipated number of survey days.

Expected Densities of Listed Species in Kotzebue Sound, Chukchi Sea, and Beaufort Sea (Summer and Fall Seasons)

The anticipated densities of listed species are the same as those listed in Tables 8-9 above (see Section 6.3.1).

Number of Sidescan Sonar Days

Each side scan sonar survey is expected to take up to three days at each site and Fairweather assumes the sonar will be operated 24 hours during that time (although it is unlikely it will be operating full time or that it will take three full days). Each anchor site will be surveyed in the summer prior to anchor handling for a total of 15 days in summer. Each anchor site may also be surveyed in the fall after retrieval activities for a total of 15 days in fall (Fairweather 2016).

Results of Exposure Analysis (Sidescan Sonar)

Table 12. Potential instances of exposure of listed marine mammals to received sound levels ≥160 dB 1 µPa (rms) to sidescan sonar activities during Fairweather's proposed action in the Kotzebue Sound, Chukchi Sea and Beaufort Seas during the summer (July-Aug) and fall (Sept-Oct) (Fairweather 2016).

Kotzebue Sound and Chukchi Sea Sites									
	Summer				Fall				**Total Chukchi Exposures**
Species	ZOI (km^2)	Days	Density (km^{-1})	Summer exposure	ZOI (km^2)	Days	Density (km^{-1})	Fall exposure	
Bowhead whale	3.14	12	0-0.008	0	3.14	12	0-0.0514	1	**1**
Humpback whale	3.14	12	0.0004	0	3.14	12	0.0004	0	**0**
Fin whale	3.14	12	0.0004	0	3.14	12	0.0004	0	**0**
Ringed seal	3.14	12	0.6075	23	3.14	12	0.4070	15	**38**
Bearded seal	3.14	12	0.0203	1	3.14	12	0.0203	1	**2**
Beaufort Sea Site									
	Summer				Fall				**Total Beaufort Exposures**
Species	ZOI (km^2)	Days	Density (km^{-1})	Summer exposure	ZOI (km^2)	Days	Density (km^{-1})	Fall exposure	
Bowhead whale	3.14	3	0.2883	3	3.14	3	0.1310	1	**4**
Humpback whale	3.14	3	0.0004	0	3.14	3	0.0004	0	**0**
Fin whale	3.14	3	0.0004	0	3.14	3	0.0004	0	**0**
Ringed seal	3.14	3	0.6075	6	3.14	3	0.4070	4	**10**
Bearded seal	3.14	3	0.0203	0	3.14	3	0.0203	0	**0**

Marine mammals are unlikely to be subjected to repeated pings because of the narrow fore-aft width of the beam and will receive only limited amounts of energy because of the short pings. The beam is narrowest closest to the source, further reducing the likelihood of exposure to marine mammals (NMFS 2015b).

Given the directionality, short pulse duration, and small beam widths for sidescan sonar, only a few exposures at low received levels are anticipated for listed species. If exposed, whales and seals would not be anticipated to be in the direct sound field for more than one to two pulses (NMFS 2013c). 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. We do not anticipate these sources to be operating in isolation, and expect co-occurrence with other acoustic sources such as vessel operations. Many whales and seals would move away in response to the approaching vessel noise before they would be in close enough range for there to be exposure to the sidescan sonar sources. 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 sonar sources (see Section 2.1.2) would further reduce or eliminate any potential effect from sidescan sonar.

Based on the small ensonified area estimates (Table 15), a few exposures to marine mammals are anticipated to occur at received levels ≥160 dB. If marine mammals are exposed, they are not likely to respond to that exposure as described in Section 6.4.2 (*Responses to Sidescan Sonar*).

6.3.4 Exposure to Vessel Strike

Mitigation Measures to Minimize the Likelihood of Exposure to Vessel Strike

Mitigation measures are described in detail in Section 2.1.2. 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 AHTSV and sonar vessels;

2. Vessels in transit shall be operated at speeds necessary to ensure no physical contact with whales occurs;

   a) Transiting vessels will avoid approaching within 1 mile of observed whales

   b) Vessel speed will be reduced to less than 5 knots when within 300 yards of whales

   c) Avoid concentrations or groups of whales by all vessels under the direction of Fairweather.

3. Vessel speed will be reduced during inclement weather conditions in order to avoid collisions with marine mammals; and

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

5. Fairweather operators will avoid transits within designated North Pacific right whale critical habitat. If transit within North Pacific right whale critical habitat cannot be avoided, vessel operators are requested to exercise extreme caution and observe a 10 knot vessel speed restriction while within North Pacific right whale critical habitat, and maintain an avoidance distance of 800m from any observed North Pacific right whale while within their designated critical habitat consistent with vessel safety.

Approach to Estimating Exposures to Vessel Strike

As discussed in the *Proposed Action* section of this opinion, the activities NMFS PR1 proposes to authorize for Fairweather's anchor retrieval activities would increase the number of vessels transiting the area. Additional vessel traffic could increase the risk of exposure between vessels and marine mammals.

Assumptions of increased vessel traffic related to the proposed action are as follows:

- Vessels will mobilize from Dutch Harbor in late June to arrive in Kotzebue by early July
- The maximum number of vessels associated with the proposed action is anticipated to be eight vessels.
- Retrieval operations would commence on or after approximately July 1 and end by early October 31, 2015.
- At the end of a program, vessels will return to Dutch Harbor where they will demobilize.

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 2004a, 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 retrieval operations occur at relatively low speeds, large vessels are capable of transiting up to 15 knots and operate in periods of darkness and poor visibility (Fairweather 2016). In addition, large vessels when traveling cannot perform abrupt turns and cannot slow speeds over short distances to react to encounters with marine mammals. All of these factors increase the risk of collisions with marine mammals (BOEM 2015a). However, standard mitigation measures discussed above are designed to help avoid potential vessel strikes to marine mammals.

Cetacean Exposure (bowhead, humpback, and fin whale)
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 transit during open-water periods (late June through October) when bowhead, fin, and humpback whales are known to migrate and feed in the action area. Vessels transiting to the Chukchi Sea and Beaufort Sea from Dutch Harbor at the start of the open water season, or returning at the end of the season, transiting between sites, or for resupply in and out of coastal communities have the highest chance of encountering migrating bowheads or aggregations feeding in more coastal regions of the northeast Chukchi (Clarke et al. 2011d, Clarke et al. 2012, 2013b).

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 2013c). 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.

Around the world, fin whales are killed and injured in collisions with vessels more frequently than any other whale (Laist et al. 2001, Jensen and Silber 2004a, Douglas et al. 2008b). Differences in frequency of injury types among species may be related to morphology. The long, sleek, fin whale tends to be caught on the bows of ships and carried into port where they are reported to stranding networks for assessment and response (Laist et al. 2001). There were 108 reports of whale-vessel collisions in Alaska waters between 1978 and 2011. Of these, 3 involved fin whale (Neilson et al. 2012). None of the reported fin whale ship strikes occurred in Arctic waters. Even if vessel-related deaths of fin whales in the waters south of the action area where strike of fin whales has been known to occur were several times greater than observed levels, it would still be a small fraction of the total fin whale population (Laist et al. 2001).

Some of the unique feeding habits of fin whales may also put them at a higher risk of collision with vessels than other baleen whales. Fin whales lunge feed instead of skim feeding (BOEM 2011). These lunges are quick movements which may put them in the path of an oncoming vessel, and give the captain of a vessel little time to react. In addition, despite their large body size, fin whales appear to be limited to short dive durations (Goldbogen et al. 2007) which may make them more susceptible to ship strikes when they are near the surface. Based on ship-strike records, immature fin whales appear to be particularly susceptible to strike (Douglas et al. 2008b).

The number of humpback whales killed worldwide by ship strikes is exceeded only by fin whales (Jensen and Silber 2004a). On the Pacific coast, a humpback whale is killed about every other year by ship strikes (Barlow et al. 1997). Of the 108 Alaska whale-vessel collisions reported between 1978 and 2011, 93 involved humpback whales (Neilson et al. 2012). Between 2008 and 2012 the mean minimum annual human-caused mortality and serious injury rate for humpback whales based on vessel collisions in Alaska was (0.45) according to reports from the NMFS Alaska Regional Office stranding database (Allen and Angliss 2015). However, even if vessel-related deaths of humpback whales in the waters south of the action area where strike of humpback whales has been known to occur were several times greater than observed levels, it would still be a small fraction of the total humpback whale population (Laist et al. 2001). No vessel collisions or prop strikes involving humpback whales have been documented in the Beaufort Sea, Chukchi Sea or Bering Sea.

The high proportion of calves and juveniles among stranded ship-struck right whales and humpback whales indicates that young animals may be more vulnerable to being hit by ships (Laist et al. 2001). This could be caused by the relatively large amount of time that calves and juveniles spend at the surface or in shallow coastal areas where they are vulnerable to being hit (Laist et al. 2001). Considering that at least one humpback cow/calf pair has been sighted in the action area, we can assume that this life stage may be present and susceptible to ship strike.

Vessels would have a transitory presence in any specific location. NMFS is not able to quantify existing traffic conditions across the action area to provide context for the addition of eight vessels. 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 small number of vessels associated with the proposed activities, the limited number of sightings of fin and humpback whales during the anchor retrieval time, the slow vessel speeds while retrieving anchors, mitigation measures to minimize exposure to vessel activities, and the decades of spatial and temporal overlap that have not resulted in a known mortality from vessel strike in the Beaufort Sea, Chukchi Sea, Bering Sea or Kotzebue Sound, we conclude that the probability of a Fairweather vessel striking a cetacean in the action area is extremely small and any effects from vessel strike are 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 vessels (Reiser et al. 2011, Aerts et al. 2012, Funk et al. 2013, Reider et al. 2013, Cate et al. 2014). These data indicate that seals tend to avoid on-coming vessels (NMFS 2013c). Available information indicates that the rate of 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 Chukchi Sea and Beaufort Seas, and are anticipated to be in the action area during any time anchor retrieval activities may occur. During the open water foraging period ringed seals are making short and long distance foraging trips and may encounter vessels (Kelly et al. 2010a, ADFG 2014).

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 anchor retrieval activities and vessel operations associated with the proposed action but in lower numbers than ringed seals.

Seals that closely approach larger vessels also have some potential to be drawn into bow-thrusters or ducted propellers (BOEM 2015a). 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 2015a). To date, few incidents such as these have been documented in Alaska, though Sternfeld (2004) documented a single spotted seal stranding in Bristol Bay, Alaska that may have resulted from a propeller strike (BOEM 2015a). There have been no incidents of ship strike with bearded or ringed seals documented in Alaska (BOEM 2015a) despite the fact that PSOs routinely sight bearded and ringed seals during oil and gas exploration activities.

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 during the early transit and anchor retrieval periods. During the open-water period ringed seals are anticipated to be more widely distributed. This dispersed distribution may help mitigate the risks of localized shipping disturbance since the impacts from such events would be less likely to affect a large number of seals (Kelly et al. 2010a). However, ringed seals may be at the greatest risk from shipping threats in areas of the Arctic where geographic constriction concentrates seals and vessel activity into confined areas, such as the Bering Strait (Arctic Council 2009).

From mid-April to June as the ice recedes, some of the bearded seals that overwintered in the Bering Sea migrate northward through the Bering Strait. During the summer they are found near the widely fragmented margin of sea ice covering the continental shelf of the Chukchi Sea and in nearshore areas of the central and western Beaufort Sea. Since bearded seals are benthic feeders, they generally associate with seasonal sea ice over shallow water of less than 200m (656 ft) (Burns 1981). However, they can also feed on ice-associated organisms when they are present, which allows a few bearded seals to live in areas where water depth is considerably greater than 200m (Cameron and Boveng 2009). Bearded seals are likely to be encountered during anchor retrieval activities, and greater numbers are likely to be encountered if the ice edge occurs nearby.

Vessels would have a transitory presence in any specific location. NMFS is not able to quantify existing traffic conditions across the action area to provide context for the addition of eight vessels. 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.

Timing restrictions would likely avoid adverse effects to newborn ringed seal pups, particularly when nursing and molting (NMFS 2013c). In addition, standard mitigation measures require vessel speed and course alternations if a marine mammal is detected within 300 yards of a vessel.

Based on the small number of vessels associated with the proposed activities, the history of spatial and temporal overlap that have not resulted in a known vessel strike or mortality from vessel strike in the Beaufort Sea, Chukchi Sea or Bering Sea for ice seals, and the mitigation measures in place to minimize exposure of pinnipeds to vessel activities, we conclude that the probability of a Fairweather vessel striking a ringed or bearded seal in the action area is extremely small and any effects from vessel strike are discountable.

6.4 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. 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.

6.4.1 Responses to Vessel Noise (Anchor Retrieval, Transit, and Ice Management)

As described in the Sections 6.3.1 and 6.3.2, bowhead, humpback, and fin whales and ringed and bearded seals are anticipated to overlap with noise associated with vessel transit, anchor retrieval, and ice management activities from the proposed action, and some individuals are likely to be exposed and respond to these continuous noise sources.

Baleen Whales (bowhead, fin, and humpback whales)

While cetaceans are a diverse group with varied life histories and migratory patterns (see Section 4.3), they share many important traits and exhibit similar physiological and behavioral responses. In this section whales' responses are analyzed collectively where appropriate, as the species share many similar characteristics. The majority of the information provided below focuses on bowhead whales as they are the most commonly occurring listed baleen whale in the action area, and a large amount of research has been done on this species. We anticipate responses from fin and humpback whales to be similar to the bowhead whale.

Transiting Vessels

Reactions of marine mammals to vessels often include changes in general activity (e.g. from resting or feeding to active avoidance), changes in surfacing-respiration-dive cycles, and changes in speed and direction of movement (NMFS 2013c). Past experiences of the animals with vessels are important in determining the degree and type of response elicited from an animal-vessel encounter. Whale reactions to slow-moving vessels are less dramatic than their reactions to faster and/or erratic vessel movements. Some species have been noted to tolerate slow-moving vessels within several hundred meters, especially when the vessel is not directed toward the animal and when there are no sudden changes in direction or engine speed (Wartzok et al. 1989, Richardson et al. 1995, Heide-Jorgensen et al. 2003).

Bowhead whales react to approaching vessels at greater distances than they react to most other activities. Vessel-disturbance experiments in the Canadian Beaufort Sea by Richardson and Malme (1993) showed that most bowheads begin to swim rapidly away when fast moving vessels approach directly. Avoidance usually begins when a rapidly approaching vessel is 1 to 4 km (0.62 to 2.5 mi) away. Whales move away more quickly when approached closer than 2 km (1.2 mi) (Richardson and Malme 1993). A few whales reacted at distances of 5 to 7 km (3.1 to 4.3 mi), while others did not react until the vessel was <1 km (<0.62 mi) away. Received noise levels as low as 84 dB re 1 μPa, or 6 dB above ambient, elicited strong avoidance reactions from bowhead from an approaching vessel 4 km (2.5 mi) away. During the experiments, vessel disturbance temporarily disrupted activities, and socializing whales moved apart from one another. Fleeing from a vessel usually stopped soon after the vessel passed, but scattering lasted for a longer time period. Some bowheads returned to their original locations after the vessel disturbance (Richardson and Malme 1993). However, it is not known whether they would return after repeated disturbance (Richardson et al. 1995). Boat disturbance also tended to cause unusually brief surfacing with few respirations per surfacing (Richardson et al. 1985). Bowheads showed clear reactions to approaching vessels as much as 4 km away, based on measurements of whale headings, speeds, surface times, and number of respirations per surfacing (Richardson and Malme 1993). Bowheads react less dramatically to and appear more tolerant of slow-moving vessels, especially if they do not approach directly.

Confirming assertions made by native bowhead hunters, low levels of underwater noise can elicit flight reactions in bowhead whales (Richardson and Malme 1993). In one test, received noise levels from an approaching fishing boat were only ~6-13 dB above the background noise and cause flight reactions in bowhead (Miles et al. 1987a, Richardson and Malme 1993). Mothers traveling with calves can be particularly sensitive to vessel traffic, and showed strong evasive behaviors when vessels were over 15 km away (Richardson and Malme 1993). In contrast, animals that are actively feeding may be less responsive to boats (Wartzok et al. 1989).

Humpback whale reactions to approaching boats are variable, ranging from approach to avoidance (Payne 1978, Salden 1993). On rare occasions humpbacks "charge" towards a boat and "scream" underwater, apparently as a threat (Payne 1978). Baker et al. (1983) reported that humpbacks in Hawai'i responded to vessels at distances of 2 to 4 km. Bauer and Herman (1986) concluded that reactions to vessels are probably stressful to humpbacks, but that the biological significance of that stress is unknown. Similar to bowhead whales, humpbacks seem less likely to react to vessels when actively feeding than when resting or engaged in other activities (Krieger and Wing 1984). Mothers with newborn calves seem most sensitive to vessel disturbance (Clapham and Mattila 1993). Marine mammals that have been disturbed by anthropogenic noise and vessel approaches are commonly reported to shift from resting behavioral states to active behavioral states, which would imply that they incur an energy cost. Morete et al. (2007) reported that undisturbed humpback whale cows that were accompanied by their calves were frequently observed resting while their calves circled them (milling) and rolling interspersed with dives. When vessels approached, the amount of time cows and calves spent resting and milling respectively declined significantly. Considering that one cow calf pair was observed in the Beaufort Sea (Hashagen et al. 2009), there is the potential for interactions between vessels and cow calf pairs in the Arctic.

Fin whales responded to vessels at distances of about 1 km (Edds and Macfarlane 1987). Watkins (1981) found that fin and humpback whales appeared startled and increased their swimming speed to avoid approaching vessels. Jahoda et al. (2003) studied responses of fin whales in feeding areas when they were closely approached by inflatable vessels. The study concluded that close vessel approaches caused the fin whales to swim away from the approaching vessel and to stop feeding. These animals also had increases in blow rates and spent less time at the surface (Jahoda et al. 2003). This suggests increases in metabolic rates, which may indicate a stress response. All these responses can manifest as a stress response in which the mammal undergoes physiological changes with chronic exposure to stressors, it can interrupt essential behavioral and physiological events, alter time budget, or a combination of all these stressors (Sapolsky 2000, Frid and Dill 2002b).

In general, baleen whales react strongly and rather consistently to approaching vessels of a wide variety of types and sizes. Whales are anticipated to interrupt their normal behavior and swim rapidly away if approached by a vessel. Surfacing, respiration, and diving cycles can be affected. The flight response often subsides by the time the vessel has moved a few kilometers away. After single disturbance incidents, at least some whales are expected to return to their original locations. Vessels moving slowly and in directions not toward the whales usually do not elicit such strong reactions (Richardson and Malme 1993). Anchor retrieval activities will involve extremely slow speeds, but AHTSV and other vessels may transit at speeds up to 15 knots (Fairweather 2016).

We anticipate that noise associated with transiting vessels would drop to 120 dB within 7 km (or less) of most vessels associated with anchor retrieval activities (O'Neill and McCrodan 2012b, a). At these distances, a whale that perceived the vessel noise is likely to ignore such a signal and devote its attentional resources to stimuli in its local environment. If animals do respond, they may exhibit slight deflection from the noise source, engage in low-level avoidance behavior, short-term vigilance behavior, or short-term masking behavior, but these behaviors are not likely to result in adverse consequences for the animals.

In addition, with mitigation measures in place which specify procedures for changing vessel speed and/or direction to avoid groups of whales, avoid potential for collision, and PSOs on board to spot nearby whales, the impact of vessel transit on bowhead, humpback, and fin whales is not anticipated to reach the level of take, and is considered insignificant.

Anchor Retrieval and Ice Management

For this action, we estimated 658 instances (650 from anchor retrieval, and 8 from ice management) where bowhead whales might be exposed to continuous noise sources at received levels between 120 dB and 179 dB in the action area. An additional 4 fin and 5 humpback whales may be exposed to continuous noise sources at received levels between 120 dB and 179 dB (see Section 6.3.1 and 6.3.2, Tables 12 and 14).

These instances of exposure assume a uniform distribution of animals and do not account for avoidance. We used the maximum predicted density in estimating instances of exposure in order to account for variability and to be conservative.

The primary sources of sounds from all vessel classes are propeller cavitation, propeller singing, and propulsion or other machinery. Propeller cavitation is usually the dominant noise source for vessels (Ross 1976). Propeller cavitation and singing are produced outside the hull, whereas propulsion or other machinery noise originates inside the hull. There are additional sounds produced by vessel activity, such as pumps, generators, flow noise from water passing over the hull, and bubbles breaking in the wake. Considering that anchor retrieval activities are anticipated to produce the loudest sounds in comparison to the other vessel activities, we will focus on potential responses of marine mammals to this stressor. Anchor handling activities were found to be the loudest of the activities due to the thrusters working at their highest power during the seating of the anchors during Shell's 2012 operations (Fairweather 2016).

Most spring-migrating bowhead whales would likely pass through the Chukchi Sea prior to the start of the planned anchor handling activities. However, a few whales that may remain in the Chukchi Sea during the summer could be encountered during the anchor handling activities or by transiting vessels (Fairweather 2016).

Baleen whale response distances to anchor retrieval and ice management activities are expected to vary, depending on sound-propagation conditions and whether or not the animals are actively feeding. There is limited information on cetacean responses to these sources. However, there is information available on responses to ice breaking which is significantly louder than the continuous noise sources associated with the proposed action. Miles, Malme, and Richardson (1987b) modeled icebreaker noise and predicted that roughly half of the bowhead whales would show an avoidance response to an icebreaker underway in open water at a range of 5–34 km (3–21 mi) when the noise associated with the source is at least 30 dB greater than ambient noise levels.

Reactions of baleen whales to icebreaking activities are largely unknown. In the Beaufort Sea, migrating bowheads apparently avoided an icebreaker-supported drill site by 25+ km during the autumn of 1992 where there was intensive icebreaking around the drill site almost daily (Brewer et al. 1993). However, migrating bowheads also avoided a nearby drill site in another autumn with little icebreaking (LGL and Greenridge Sciences Inc 1987). Thus, the relative roles of icebreaker noise, drilling noise, and the ice itself in diverting bowheads around these drill sites are uncertain (Richardson et al. 1995). An icebreaker playback study in the spring lead system indicated the predicted response distances for bowhead whales around an actual icebreaker would be highly variable; however, for typical traveling bowhead whales, detectable effects on movements and behavior are predicted to extend commonly out to radii of 10–30 km (6.2–18.6 mi).

Since anchor retrieval and ice management will be continuous noise sources, it is not anticipated that marine mammals would enter into an area where they would suffer from TTS or PTS. In addition, vessel mitigation measures will also avoid separation of whales within groups, slow down during periods of low visibility, and avoid close approaches.

Of the whales that might be exposed to received levels ≥120 dB during the maximum annual 440 exposure events associated with anchor retrieval and ice management, some whales are likely to reduce the amount of time they spend at the ocean's surface, increase their swimming speed, change their swimming direction to avoid vessel operations, change their respiration rates, increase dive times, reduce feeding behavior, or 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 multiple vessels are operating in the surrounding area.

Some whales may be less likely to respond because they are feeding. Also, some whales that are exposed to these sounds probably would have prior experience with similar vessel stressors during previous years considering that oil and gas operations have been occurring in the Arctic since the 1960s and baleen whales are long lived animals; that experience will make some whales more likely to avoid the anchor retrieval 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 vessel and encounter another vessel while they are engaged in avoidance behavior.

Prey Resources

Anthropogenic noises may have indirect, adverse effects on prey availability through lethal or sub-lethal damage, stress responses, or alterations in their behavior or distribution. Effects from exposure to high-intensity sound sources have been documented in fish and invertebrates, including stress (Santulli et al. 1999), injury (McCauley et al. 2003), TTS (Popper et al. 2005), and changes in balance (Dalen and Knutsen 1986). In general, we expect fish will be capable of moving away from project activities if they experience discomfort. We expect the area in which stress, injury, TTS, or changes in balance, of prey species may occur (if at all) will be limited to a few meters directly around the thrusters and acoustic sources proposed for use in this project. Prey species may startle and disperse when exposed to sounds from project activities, but we expect any disruptions will be temporary. We do not expect effects to prey species will be sufficient to affect ESA-listed whales and seals.

Anchor retrieval activities may impact prey species of ESA-listed whales and pinnipeds by crushing, dislodging, smothering (i.e., clogging of the gills or other feeding structures) with displaced sediment. Fairweather estimated each anchor would impact a seafloor area of up to approximately 233m^2, for a total area of disturbance from anchor retrieval activities of approximately 12,815 m^2 in Kotzebue Sound, Chukchi Sea, and Beaufort Sea. We do not expect that impacts to prey species in this comparatively small area will be sufficient to affect ESA-listed whales and seals.

Pinnipeds (ringed and bearded seals)

Vessel Transit

Few authors have specifically described the responses of pinnipeds to boats, and most of the available information on reactions to boats concerns pinnipeds hauled out on land or ice. However, the mere presence and movements of ships in the vicinity of seals can cause disturbance to their normal behaviors (Henry and Hammill 2001, Ferland and Decker 2005, Shaughnessy et al. 2008, Jansen et al. 2010), and could potentially cause ringed seals and bearded seals to abandon their preferred breeding habitats in areas with high traffic (Smiley and Milne 1979, Mansfield 1983a, Reeves 1998). Surveys and studies in the Arctic have observed mixed reactions of seals to vessels at different times of the year. Disturbances from vessels may motivate seals to leave haulout locations and enter the water (Richardson et al. 1995). Due to the relationship between ice seals and sea ice, the reactions of seals to vessel activity is likely to vary seasonally with seals hauled out on ice reacting more strongly to vessels than seals during the open water conditions (BOEM 2015a).

Ringed seals hauled out on ice pans often showed short-term escape reactions when a ship came within 250-500m (Brueggeman et al. 1992). Jansen et al. (2006) reported that harbor seals approached by vessels to 100m (0.06 mi) were 25 times more likely to enter the water than were seals approached at 500m (0.3 mi). However, in places where boat traffic is heavy, there have been cases where seals have tolerated vessel disturbance (e.g. (Bonner 1982, Jansen et al. 2006).

During the open water season in the Chukchi Sea, bearded and ringed seals are commonly observed close to vessels where received sound levels are low (e.g., (Harris et al. 2001, Moulton and Lawson 2002, Blees et al. 2010, Funk et al. 2010b). Funk et al. (2010a) noted among vessels operating in the Chukchi Sea where received sound levels were <120 dB, 40% of observed seals showed no response to a vessel's presence, slightly more than 40% swam away from the vessel, 5% swam towards the vessel, and the movements of 13% of the seals were unidentifiable. More recently, Bisson et al. (2013) reported a total of 938 seals observed during vessel-based monitoring of exploratory drilling activities by Shell in the Chukchi Sea during the 2012 open-water season. This total includes animals sighted outside of the leased area during transits to and from the drill site. The majority of seals (42%) responded to moving vessels by looking at the vessel, while the second most noted behavior was no observable reaction (38%). The majority of seals (58%) showed no reaction to stationary vessels, while looking at the vessel was the second most common behavioral response (38%). Other common reactions to both moving and stationary vessels included splashing and changing direction.

Adult ringed and bearded seals are agile and easily avoid vessels in open water conditions. Pups have a greater potential for heat loss than adults and so would be more prone to incur energetic costs of increased time in the water if vessel disturbance became a more frequent event (Cameron et al. 2010). If a vessel disturbs young ice seals, some might become energetically and behaviorally stressed, leading to lower overall fitness of those individuals. The potential for ship traffic to cause a mother to abandon her pup may be lower in bearded seals than in ringed seals (Smiley and Milne 1979), as bearded seal mothers appear to exhibit a high degree of tolerance when approached by small boats.

We anticipate that noise associated with transiting vessels would drop to 120 dB within 7 km (or less) of most vessels associated with anchor retrieval activities (O'Neill and McCrodan 2012b, a). At these distances we would not anticipate that ice seals would devote attention to these stressors. If animals do respond, they may exhibit slight deflection from the noise source, engage in low-level avoidance behavior, short-term vigilance behavior, or short-term masking behavior, but these behaviors are not likely to result in adverse consequences for the animals. Overall, vessel noise does not seem to strongly affect pinnipeds that are in the water (Richardson et al. 1995), which is where ringed and bearded seals are anticipated to be during the open-water season.

In addition, with mitigation measures in place restricting vessel speed and approach, and PSOs on board to spot nearby seals, the impact of vessel transit on ringed and bearded seals is anticipated to be insignificant.

Anchor Handling and Ice Management

The maximum annual instances of exposure to anchor handling and ice management activities was predicted to be 6,895 for ringed seals and 231 for bearded seals (see Section 6.3.1 and 6.3.2, Tables 12 and 14). These instances of exposure combine major vessel noise (e.g. anchor handling and ice management) to received levels between 120 dB and 189 dB in the action area between July and October 2016.

These instances of exposure are likely to be overestimates because they assume a uniform distribution of animals and do not account for avoidance. In addition, these exposure estimates are significantly higher than what has previously been reported in 90 day reports from previous drilling operations in the Arctic (e.g., during Shell's 2012 drilling operations only seven ringed and seven bearded seals were directly observed to be taken due to anchor handling activities, and 466 ringed seals and 16 bearded seals were estimated to be taken based on density; see Bisson et al. 2013). We used maximum predicted densities in estimating a range of instances of exposure in order to account for variability and to be conservative.

There is limited information on pinniped responses to anchor handling and ice management. However, information is available on responses to ice breaking which is significantly louder than the continuous noise sources associated with the proposed action. Considering that icebreaking activities are anticipated to produce the loudest ensonified area in comparison to the other vessel activities, we will focus on potential responses of ice seals to this stressor. Icebreakers contribute greater sound levels during ice-breaking activities than ships of similar size during normal operation in open water (Richardson et al. 1995). This higher sound production results from the greater amount of power and propeller cavitation required when operating in thick ice.

All vessels produce sounds during operation, which when propagated at certain frequencies and intensities can alter the normal behavior of marine mammals, mask their underwater communications and other uses of sound, and cause them to avoid noisy areas (Arctic Council 2009, Götz and Janik 2011). All ice-breeding pinniped species are known to produce underwater vocalizations (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. Effects of vessel noise on bearded seal vocalizations have not been studied, though the frequency range of the predominant "trill" and "moan" calls (130-10590 Hz and 130-1280 Hz, respectively) that are broadcast during the mating season partially overlaps the range (20-300 Hz) over which ship noise dominates ambient noise in the oceans (Urick 1983, Cleator et al. 1989, Ross 1993, Risch et al. 2007, Tyack 2008). Vocalizations of the sympatric harp seal were shown to be completely masked by stationary ship noise at a distance of 2 km (Terhune et al. 1979), a finding supported by communication-range models for this species which predicted call masking and a significant loss of communication distances in noisy environments (Rossong and Terhune. 2009).

Studies show that animals adapt their acoustic signals to compensate for environmental modifications to sound (Wilczynski and Ryan 1999). Indeed, background noise has been suggested to account for geographical differences in the range and quality of bearded seal calls (Rogers 2003, Risch et al. 2007). However, compensating for sound degradation – such as by delaying calling, shifting frequencies, moving to a quieter area, or calling louder, longer, and more frequently – incurs a cost (Tyack 2008). The cost of these adaptations, or that of missing signals, is inherently difficult to study in free-ranging seals and to date has not been measured in any phocid seal. Because bearded seals broadcast over distances of at least 30-45 km (Cleator et al. 1989), perhaps over 100s of kilometers (Stirling 1983, Rossong and Terhune. 2009), their calls are increasingly susceptible to background interference. Though in some areas male bearded seals may "practice" calling throughout the year, the period of peak vocalization is during the breeding season (April to mid-June). While ice-breaking vessels have the potential of disrupting bearded seal communication and thus mating because they produce louder (174-200 dB), higher frequency (> 5000 Hz), and more variable sounds (Arctic Council 2009), these activities are not anticipated to overlap with the breeding season, minimizing the effects of masking. Overall, the noise generated from ice breaking could have a similar masking effect on seals as ambient noise such as proximity to a vocalizing marine mammal or noise from strong wind and rain or ice movement (Gales 1982).

The proposed anchor handling activities in the action area are not anticipated to start until late June to early July, and ice management is not anticipated until late July through August, minimizing the potential overlap with the bearded seal breeding season. The extent to which these louder vessel operations are localized near areas where bearded seals are mating, and the acoustic characteristics of the area, will determine the level that communication is disrupted. Considering that the vessels will avoid areas of pack ice, where communication and mating occurs, or transit these areas outside the breeding season, effects are not expected to be significant.

Vessel sounds from the ice-breaking cargo vessel MV *Arctic* were estimated to be detectable by seals under fast ice at distances up to 20-35 km (Davis and Malme 1997). Mansfield (1983) reasoned that an icebreaker approaching a ringed seal at full power while breaking ice could be heard by ringed seals from 40 km (about 25 mi) away in Lancaster Sound, Canada. For the ice breaking operation in the Chukchi, JASCO estimated that noise associated with icebreaking may reach the 120 isopleth at a distance of ~45 km in reflective environments (Austin et al. 2015).

Data on how close seals allow icebreakers to approach are limited, but ringed and bearded seals on pack ice typically dove into the water within 0.93 km (0.58 mi) of the vessel (Brueggeman et al. 1992), and remained on the ice when the icebreaker was 1-2 km away (Kanik et al. 1980). Because of their habitat preferences in polynyas, and the ice front, icebreakers could elicit startle or escape reactions by a proportion of bearded seals encountered on ice.

Icebreakers are unlikely to be a threat to bearded seals because of their habitat preferences and the fast growth and development of their pups. Unlike ringed seals, bearded seals rest on top of the ice where they would be visible to approaching icebreakers and less likely to be crushed (BOEM 2015a). Recent research suggests that bearded seals may exhibit fidelity to distinct areas and habitats during the March to June breeding season (Van Parijs and Clark 2006). Vessel traffic that occurs during this period could disturb bearded seals in the pack ice; however, vessels without icebreaker support are expected to avoid these areas by a large margin due to the risks associated with navigating large amounts of sea ice.

Ice seals are adapted to moving frequently to accommodate changing ice conditions so displacement due to a passing icebreaker or ice management is likely to be temporary and well within the normal range of ability for ice seals at this time of year.
Of the seals that might be exposed to received levels ≥120 dB during the maximum 7,126 exposure events, some may change their behavior, alter their vocalizations, mask received noises, increase vigilance, and avoid noisy areas (Richardson and Malme 1993, Richardson et al. 1995, Rogers 2003, Blackwell et al. 2004, Rossong and Terhune. 2009). We assume that these responses are more likely to occur when seals are aware of multiple vessels in their surrounding area.

Since anchor handling and ice management will be continuous noise sources, it is not anticipated that marine mammals would enter into an area where they would suffer from TTS or PTS. Mitigation measures restricting vessel speed and approach, and requiring PSOs on board to spot nearby seals will minimize the impacts of the potential exposures, while timing of operations will minimize potential masking effects on bearded seals during the breeding season. Thus, despite the fact that there may be many instances of exposure to continuous sounds ≥120 dB, the impact of anchor handling and ice management on ringed and bearded seals is anticipated to be minor.

6.4.2 Responses to Sidescan Sonar

During the operation of sidescan sonars, some instances of exposure (55 total) may occur to bowhead whales, ringed seals, and bearded seals at received levels ≥160 dB re 1 μPa m (rms) (see Section 6.3.3, *Exposure to Sidescan Sonar Noise*). However, out of these total exposures during the open water season, NMFS would classify 0 instances of exposure as "take" considering the operating frequencies of this equipment (210 kHz-900kHz) are well outside the hearing range of listed low frequency cetaceans (7 Hz-30 kHz) and phocids (75 Hz-100 kHz)

As we discussed in the *Approach to the Assessment* section of this opinion, endangered or threatened animals that are not likely to respond to that exposure, are not likely to 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 animals represent (that is, we would not expect reductions in the reproduction, numbers, or distribution of those populations). We expect any effects on ESA-listed whales or seals from side-scan sonar to be minor and not measurable. Therefore, we conclude the effects of this stressor are insignificant and will not consider this stressor further in our analysis.

6.4.3 Responses to Vessel Strike

As we indicated in *Section 6.3.4 Exposure to Vessel Strike*, the likelihood of effects from a vessel strike occurring as part of the proposed action to a listed baleen whale or pinniped is 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 action area, 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 ESA.

NMFS reviewed recent environmental reports, NEPA compliance documents, 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 2016). We did not find any information about non-Federal actions other than what has already been described in the *Environmental Baseline* (see Section 5). We expect climate change, fisheries, harvest, noise, oil and gas activities, pollutants and discharges, scientific research, and ship strike will continue into the future. We expect moratoria on commercial whaling and bans on commercial sealing will remain in place, aiding in the recovery of ESA-listed whales and seals.

8. INTEGRATION AND SYNTHESIS

The Integration and Synthesis section is the final step of NMFS's 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 individuals of the 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 1992a, Anderson 2000). Therefore, if we conclude that individuals of the listed species are not likely to experience reductions in their fitness, we would conclude our assessment because we would not expect the action to affect the performance of the populations those individuals represent or the species those population comprise. If, however, we conclude that individuals of the 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 (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 Cetacean Risk Analysis

Based on the results of the *Exposure Analysis*, we expect bowhead, fin, and humpback whales to be exposed and respond to anchor retrieval and ice management noise. Exposure to vessel strike is extremely unlikely to occur and therefore associated effects are considered discountable. While exposure to sidescan sonar noise may occur, listed species are not anticipated to respond to exposure and the effects of this stressor are considered insignificant.

Our consideration of probable exposures and responses of bowhead whales to noise sources associated with the proposed action is designed to help us assess whether those activities are likely to increase the extinction risks, impede recovery, 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). 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 listed whales. As a result, the whales' probable responses to close approaches by AHTSVs, sonar vessel, or ice management (i.e., reduce the amount of time they spend at the ocean's surface, increase their swimming speed, change their swimming direction to avoid anchor retrieval operations, change their respiration rates, increase dive times, reduce feeding behavior, or alter vocalizations and social interactions) and their probable exposure to noise sources are not likely to reduce the fitness or current or expected future reproductive success of listed 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.

In total, the proposed action is anticipated to result in 658 instances of exposure to bowhead whales, 4 instances of exposure to fin whales, and 5 instances of exposure to humpback whales at received sound levels ≥120 dB re 1 μPa rms for continuous noise sources (see Table 16). No cetaceans are anticipated to be exposed to sound levels that could result in TTS or PTS.

These estimates represent the total number of takes that could potentially occur, not necessarily the number of individuals taken, as a single individual may be taken multiple times over the course of the proposed action. These exposure estimates are likely to be overestimates because they assume a uniform distribution of animals, do not account for avoidance, and assume maximum density.

Although the anchor retrieval, sonar, and ice management activities are likely to cause individual whales to experience changes in their behavioral states that might have adverse consequences (Frid and Dill 2002b), 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 anchor retrieval activities or migrating through the action area.

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

These exposures may cause some 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, or 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.

In addition, our *Exposure Analysis* concluded that bowhead, fin, and humpback whales are not likely to be exposed to vessel noise or the potential for vessel strike because only eight vessels are 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 limited number of vessels and small ensonified area reduce the probability of exposure to whales to very small levels, and thus we would consider any effects to whales to be discountable. The implementation of mitigation measures will further reduce the instances of exposure and minimize the effects on listed whales. As a result, the activities NMFS PR1 plans to authorize are not likely to appreciably reduce the listed whales likelihood of surviving or recovering in the wild.

The strongest evidence supporting the conclusion that anchor retrieval, ice management, vessel noise, and sidescan sonar noise will likely have minimal impact on bowhead, fin, and humpback whales is the estimated growth rate of the whale populations in the Arctic and sub-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). The maximum theoretical net productivity rate is 4% for the Western Arctic stock of bowhead (Wade and Angliss 1997). The time series of abundance estimates indicates an approximate 50% increase in total abundance of bowhead whales during the last ten years, and a doubling in abundance since the early 1990s (LGL Alaska Research Associates Inc. et al. 2014). The Northeast Pacific fin whale stock has been increasing at approximately 4% (Wade and Angliss 1997). Zerbini et al.(2006) estimated the rate of increase for fin whales in coastal waters south of the Alaska Peninsula to be around 4.8% (95% CI: 4.1-5.4%) for the period 1987-2003. The maximum productivity rate for humpback whales is assumed to be 7% (Wade and Angliss 1997, Allen and Angliss 2015). Recent passive acoustic detections (Delarue et al. 2010, Crance et al. 2011, Hannay et al. 2011, Delarue et al. 2013) and direct observations from monitoring and research projects of fin and humpback whales from industry (Ireland et al. 2008, Hashagen et al. 2009, Ireland et al. 2009, Funk et al. 2010b, Aerts et al. 2012, Aerts et al. 2013a, Bisson et al. 2013, Funk et al. 2013, Hartin et al. 2013) and government (Clarke et al. 2011c, Clarke et al. 2013a, Clarke et al. 2013b) indicate that fin and humpback whales are considered to be in low densities, but regular visitors to the Alaska Chukchi Sea. Despite exposure to oil and gas exploration activities in the Beaufort and Chukchi Seas since the late 1960s (BOEM 2015a), a small number of humpback and fin whale entanglements in fishing gear, and a single subsistence take of one humpback whale in 2006, this increase in the number of fin and humpback whales suggests that the stress regime these whales are exposed to in the action area has not prevented them from increasing their numbers and expanding their range in the action area.

Given the life history of bowhead whales and gestational constraints on minimum calving intervals (e.g., Reese et al. 2001b), and assuming that adult survival rates based on aerial photo-ID data (Zeh et al. 2002, Schweder et al. 2010b) and age-at-maturity have remained stable, the trend in abundance implies that the population has been experiencing relatively high annual calf and juvenile survival rates. This is consistent with documented observations of native whalers around St. Lawrence Island, who have reported not only catching more pregnant females but also seeing more young whales than during earlier decades (Noongwook et al. 2007a). While the sample size was small, the pregnancy rate from the 2012 Alaskan harvest data indicate that 2013 calf production could be higher than average (George et al. 2004b, George et al. 2011, Suydam et al. 2013).

A change in either bowhead whale calf production or survival rates (or age-at-sexual maturation) of young whales in the future could be indicative of a population level response to anthropogenic stressors, or alternatively, a signal of the seemingly inevitable event that this population approaches the carrying capacity of its environment (Eberhardt 1977). Since the late 1970s and the initiation of surveys for abundance, however, the estimates of population size do not indicate that either anthropogenic (e.g., offshore oil and gas activities, subsistence whaling catch quotas, etc.) or natural factors (e.g., prey availability) have resulted in any negative influence on the bowhead whale trend in abundance (LGL Alaska Research Associates Inc. et al. 2014).

As discussed in the *Environmental Baseline* section of this opinion, bowhead, fin, and humpback whales have been exposed to oil and gas activities in the Arctic, including associated vessel, seismic, sonar, and aircraft traffic, for generations. Although we do not know if more listed whales might have used the action area or the reproductive success of listed whales in the Arctic would be higher absent their exposure to these activities, the rate at which listed whales occur in the Arctic suggests that bowhead, fin, and humpback whale numbers have increased substantially in these important migration and feeding areas despite exposure to earlier oil and gas operations. The activities NMFS PR1 proposes to authorize are significantly smaller in magnitude as compared to previous or contemporaneous activities in the area, and these activities are not likely to affect the rate at which bowhead, fin, or humpback whale counts in the action area 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 and respond to anchor retrieval and ice management noise. Exposure to vessel strike is extremely unlikely to occur and therefore associated effects are considered discountable. While exposure to sidescan sonar noise may occur, listed species are not anticipated to respond to exposure and the effects of this stressor are considered insignificant.

As we discussed in the narratives for cetaceans listed above, our consideration of probable exposures and responses of pinnipeds to noise stressors associated with anchor retrieval activities in the action area are designed to help us assess whether those activities are likely to increase the extinction risks facing listed pinnipeds, impede recovery, or jeopardize their continued existence.

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). This early fall foraging period overlaps with fall anchor retrieval activities NMFS PR1 plans to permit. However, 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 (i.e., tolerance, avoidance, short-term masking, and short-term vigilance behavior) to close approaches by anchor retrieval vessels and their probable exposure to sonar pulses are not likely to reduce their 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.

We estimated 6,895 instances of ringed seal exposure to anchor retrieval and ice management activities from the proposed action (see Sections 6.3.1 and 6.3.2) at received levels sufficiently high (or distances sufficiently close) that might result in behavioral harassment (see Section 6.4, *Responses Analysis*). No ringed or bearded seals are anticipated to be exposed to sound levels that could result in TTS or PTS.

These estimates represent the total number of takes that could potentially occur, not necessarily the number of individuals taken, as a single individual may be taken multiple times over the course of the proposed action. These exposure estimates are likely to be overestimates because they assume a uniform distribution of animals, do not account for avoidance, and assume maximum density of listed species.

For anchor retrieval and ice management, PSOs are required. However, the AHTSV does not have the ability to power- or shut-down if marine mammals enter harassment zone. While this will not mitigate the potential impacts associated with anchor retrieval noise, PSOs will keep track of the potential take (if any) that could occur. Considering that this will be a continuous source of underwater noise, it is not anticipated that marine mammals would enter into an area where they would suffer from acoustic harassment.

Although these anchor retrieval activities are likely to cause some individual ringed and bearded 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, or social dynamics of individual ringed seals in ways or to a degree that would reduce their fitness because the seals are actively foraging in waters around the proposed activities, have their heads above water, or hauled out. In most circumstances, ringed and bearded seals are likely to avoid ensonified areas that may cause TTS. 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 ringed and bearded seals seem rather tolerant of low frequency noise. Southall et al. (2007) reviewed literature describing responses of pinnipeds to continuous sound and reported that the limited data suggest exposures between ~90 and 140 dB re 1 μPa generally do not appear to induce strong behavioral responses in pinnipeds exposed to continuous sounds in water.

In addition, our *Exposure Analysis* concluded that ringed seals are not likely to be exposed to vessel noise or the potential for vessel strike because only eight vessels are associated with the proposed action and noise associated with the vessel operations is anticipated to drop to 120 dB within 176 m (or less). The limited number of vessels and small ensonified area reduce the probability of exposure to ringed seals to very low levels and thus we would consider the effects to be discountable. The implementation of mitigation measures will further reduce the instances of exposure and minimize the effects on the species.

As we discussed in the *Approach to the Assessment* section of this opinion, an action that is not likely to reduce the fitness of individual seals would not be likely to reduce the viability of the populations those individual seals represent (that is, we would not expect reductions in the reproduction, numbers, or distribution of such populations). For the same reasons, an action that is not likely to reduce the viability of those populations is not likely to increase the extinction probability of the species those populations comprise; in this case, the ringed and bearded seal. As a result, the anchor retrieval activities PR1 plans to authorize are not likely to appreciably reduce the ringed or bearded seals' 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's biological opinion that the proposed action is not likely to jeopardize the continued existence of the endangered bowhead whale (*Balaena mysticetus*), endangered fin whale (*Balaenoptera physalus*), endangered humpback whale (*Megaptera novaeangliae*), Arctic subspecies of ringed seal (*Phoca hispida hispida*), or Beringia DPS of bearded seal (*Erignathus barbatus nauticus*).

In addition, the proposed action is not likely to adversely affect the endangered North Pacific right whale (*Eubalaena japonica*), the endangered Western DPS of gray whale (*Eschrichtius robustus*), the endangered sperm whale (*Physeter macroephalus*), the endangered Western DPS of Steller sea lion (*Eumetopias jubatus*), or designated critical habitats for North Pacific right whales or Steller sea lions.

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. The MMPA defines “harassment” as: any act of pursuit, torment, or annoyance which (i) has the potential to injure a marine mammal or marine mammal stock in the wild [Level A harassment]; or (ii) 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 [Level B harassment] (16 U.S.C. §1362(18)(A)(i) and (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 16). 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, we estimate potential instances of exposure and assume these exposures constitute takes. 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 any measurable adverse effect. 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 (which does not apply to ringed seals or bearded seals) become effective only upon the issuance of MMPA authorization to take the marine mammals identified here**. The applicant will need MMPA authorization for this take statement to become effective. Absent such authorization, this statement is inoperative.

The terms and conditions described below are nondiscretionary. NMFS PR1 has a continuing duty to regulate the activities covered by this incidental take statement. In order to monitor the impact of incidental take, NMFS 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 NMFS PR1 (1) fails to require the authorization holder to adhere to the terms and conditions of the Incidental Take Statement through enforceable terms that are added to the authorization, 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)).

The Beaufort Sea portion of this consultation falls within the scope of the programmatic Arctic Regional Biological Opinion that NMFS issued to BOEM/BSEE in April 2013. The Chukchi Sea portion falls within the scope of the Lease Sale 193 programmatic opinion NMFS issued to BOEM/BSEE in June 2015. 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 (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 anchor retrieval and ice management operations that are likely to result in behavioral changes that we would classify as "harassment." This incidental take statement does not exempt take resulting from vessel strikes. No whales or pinnipeds are likely to die or be wounded as a result of their exposure to the proposed action. The results of our incidental take estimates are presented in Table 16.

For bowhead, fin, and humpback whales and ringed and bearded seals, based on the best scientific and commercial information available, we would not anticipate responses to continuous noise at received levels < 120 dB re 1 μPa rms 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 ≥ 120 dB re 1 μPa rms.

For purposes of this opinion, the endangered bowhead, fin, and humpback whale are 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 are relevant to when re-initiation is required.

Table 13. Summary of incidental take associated with anchor retrieval and ice management, activities on bowhead, fin, and humpback whales and ringed and bearded seals.

Species	Estimated Exposure to ≥120 dB at Kotzebue and Chukchi Sites	Estimated Exposure to ≥120 dB at Beaufort Sites	TOTAL Take	Anticipated Temporal Extent of Take
Bowhead whale	37	621	**658**	**July 1, 2016 Through October 31, 2016**
Fin whale	4	0	**4**	
Humpback whale	4	1	**5**	
Ringed seal	5,586	1,309	**6,895**	
Bearded seal	187	44	**231**	

The instances of harassment identified in Table 16 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 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 anchor retrieval, sounds produced by the engine of the ice management vessels, and other sounds associated with the proposed activities.

10.2 Effect of the Take

Studies of marine mammals and responses to low-frequency noise such as anchor retrieval and ice management have shown that bowhead whales as well as ringed and bearded seals are likely to respond behaviorally. Although the biological significance of those behavioral responses remains unknown, this consultation has assumed that exposure to vessel 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 anchor retrieval or ice management and any associated disruptions are not expected to affect the reproduction, survival, or recovery of these species.

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, fin, and humpback whales and ringed and bearded seals resulting from the proposed action.

- 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.
- The taking of bowhead, fin, and humpback 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.

- NMFS PR1 must implement measures to reduce the probability of exposing bowhead whales, humpback whales, fin whales, ringed seals, and bearded seals to anchor retrieval or ice management noise that will occur during the proposed activities.
- NMFS PR1 must 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.
- NMFS PR1 must submit reports to NMFS AKR that evaluate its mitigation measures and report 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, NMFS PR1 must comply with the following terms and conditions, which implement the reasonable and prudent measures described above, the mitigation measures set forth in Section 2.1.2 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, NMFS PR1 or its authorization holder must undertake the following:

A. At all times when conducting anchor retrieval, ice management, or sidescan sonar activities, NMFS PR1 must require the authorization holder to possess on board the 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, NMFS PR1 or its 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 within 24 hours to NMFS AKR, Protected Resources Division at 907-586-7638.

B. In the unanticipated event that the specified activity clearly causes the take of a marine mammal in a manner prohibited by the IHA, such as a serious injury or mortality (e.g., ship-strike, gear interaction, and/or entanglement), Fairweather must immediately cease the specified activities and immediately report the incident to the NMFS Permits and Conservation Division, Office of Protected Resources, Shane Guan 301-427-8418, and the Alaska Region Protected Resources Division 907-586-7224 and/or by email to Alicia.Bishop@noaa.gov, and the Alaska Regional Stranding Coordinator at 907-271-1332 and/or by email to Mandy.Migura@noaa.gov. The report must include the following information: (i) Time, date, and location (latitude/longitude) of the incident; (ii) the name and type of vessel involved; (iii) the vessel's speed during and leading up to the incident; (iv) description of the incident; (v) status of all sound source use in the 24 hours preceding the incident; (vi) water depth; (vii) environmental conditions (*e.g.*, wind speed and direction, Beaufort sea state, cloud cover, and visibility); (viii) description of marine mammal observations in the 24 hours preceding the incident; (ix) species identification or description of the animal(s) involved; (x) the fate of the animal(s); (xi) and photographs or video footage of the animal (if equipment is available).

Activities must not resume until NMFS is able to review the circumstances of the prohibited take. NMFS will work with Fairweather to determine what is necessary to minimize the likelihood of further prohibited take. Fairweather may not resume their activities until notified by NMFS via letter, email, or telephone.

To carry out RPM #3 and #4, NMFS PR1 must undertake the following:

A. All mitigation measures as outlined in Section 2.1.2 of this biological opinion, or or equivalent or more protective measures, must be implemented.

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

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

B. In addition to the final 90-day report provided by Fairweather and detailed in the IHA, monthly PSO reports and completed marine mammal observation record form (developed by Fairweather) will also be required. Items 1 through 4, below, provide details about what must be included in the reports.

1. The reporting period for each monthly PSO report will be the entire calendar month, and reports will be submitted by close of business on the 5th business day of the month following the end of the reporting period (e.g., the monthly report covering July 1 through 31, 2016, will be submitted to NMFS Alaska Region by close of business [i.e., 5:00 pm, AKDT] on August 5, 2016).
    1.1. Completed marine mammal observation record forms, in electronic format, will be provided to NMFS Alaska Region in monthly reports.
    1.2. Observer report data will include the following for each listed marine mammal observation (or “sighting event” if repeated sightings are made of the same animal[s]):
        1.2.1. Species, date, and time for each sighting event
        1.2.2. Number of animals per sighting event and number of adults/juveniles/calves/pups per sighting event
        1.2.3. Primary, and, if observed, secondary behaviors of the listed marine mammals in each sighting event
        1.2.4. Geographic coordinates for the observed animals, with the position recorded by using the most precise coordinates practicable (coordinates must be recorded in decimal degrees, or similar standard, and defined coordinate system)

1.2.5. Time and description of most recent project activity prior to marine mammal observation
1.2.6. Environmental conditions as they existed during each sighting event, including, but not limited to:
1.2.6.1. Beaufort Sea State
1.2.6.2. Weather conditions
1.2.6.3. Visibility (km/mi)
1.2.6.4. Lighting conditions
1.2.6.5. Percentage of ice cover

1.3. Observer report data will also include the following for each take of a marine mammal that occurs in the manner and extent as described in Section 10.1 of this opinion:
1.3.1. All information listed under Item 1.2, above
1.3.2. The distance marine mammals were spotted from operations and associated noise isopleth for active sound source, and cause of take (e.g. bowhead within the Level B 160 dB isopleth approximately 100 meter from *Aiviq* during anchor retrieval)
1.3.3. Time the animal(s) entered the zone, and, if known, the time it exited the zone
1.3.4. Any mitigation measures implemented prior to and after the animal entered the zone
1.3.5. An estimate of the number (by species) of: (i) pinnipeds that have been exposed to the anchor retrieval or ice management (extrapolated from visual observation) at received levels greater than or equal to 120 dB re 1 µPa (rms) with a discussion of any specific behaviors those individuals exhibited; and (ii) cetaceans that have been exposed to the anchor retrieval or ice management (extrapolated from visual observation) at received levels greater than or equal to 120 dB re 1 µPa (rms) with a discussion of any specific behaviors those individuals exhibited.

2. A final technical report will be submitted to NMFS Alaska Region within 90 days after all anchors have been retrieved and all vessels have left the action area. The report will summarize all project activities and results of marine mammal monitoring conducted during project activities. The final technical report will include all elements from Item 1, above, as well as:
2.1. Summaries that include monitoring effort (e.g., total hours, total distances, and marine mammal distribution through the study period, accounting for sea state and other factors that affect visibility and detectability of marine mammals)
2.2. Analyses on the effects from various factors that influences detectability of marine mammals (e.g., sea state, number of observers, fog, glare, etc.)
2.3. Species composition, occurrence, and distribution of marine mammal sightings, including date, water depth, numbers, age/size/sex categories (if determinable), group sizes, and ice cover
2.4. Species composition, occurrence, and distribution of marine mammal takes, including date, water depth, numbers, age/size/sex categories (if determinable), group sizes, and ice cover
2.5. Analyses of effects of project activities on listed marine mammals

- 2.6. Number of marine mammals observed and taken (by species) during periods with and without project activities (and other variables that could affect detectability), such as:
  - 2.6.1. Initial sighting distances versus project activity at time of sighting
  - 2.6.2. Observed behaviors and movement types versus project activity at time of sighting
  - 2.6.3. Numbers of sightings/individuals seen versus project activity at time of sighting
  - 2.6.4. Distribution around the action area versus project activity at time of sighting

3. If unauthorized take occurs, (i.e., Level A take of ESA-listed species in Table 16 or any take of ESA-listed species not included in the same table), it must be reported to NMFS Alaska Region within one business day to the contact listed in Item 4, below. Observation records for ESA-listed marine mammals taken in a manner or to the extent other than described in Section 10.1 of this opinion must include:
   - 3.1. All information listed under Item 1, above
   - 3.2. Number of listed animals taken
   - 3.3. Date and time of each take
   - 3.4. Cause of the take (e.g., sperm whale observed within Level B zone or ship-strike of a humpback whale)
   - 3.5. Time the animal(s) entered the zone, and, if known, the time it exited the zone, if applicable
   - 3.6. Mitigation measures implemented prior to and after the animal entered the zone, if applicable
4. 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.
5. NMFS Contact:

   Monthly and final reports and reports of unauthorized take will be submitted to:
   NMFS Alaska Region, Protected Resources Division
   Alicia Bishop
   alicia.bishop@noaa.gov
   907-586-7224

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. To the maximum extent practicable, NMFS PR1 should encourage operators to schedule anchor retrieval operations during daylight hours and good visibility conditions when marine mammals can more easily be sighted.

2. NMFS PR1 should request Fairweather to monitor ambient sound levels within the action area as well as elevated sound levels due to anchor retrieval, ice management, and side scan sonar to gain insight into the incremental impact of increasing sound levels on listed species.

3. 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 cetaceans and pinnipeds. This analysis includes the cumulative impacts on the distribution, abundance, and the physiological, behavioral and social ecology of these species.

4. NMFS PR1 should require Fairweather PSOs to complete a protected species observer training course that includes the requirements described in the NOAA Fisheries Service 2013 National Standards for Protected Species Observer and Data Management Program (Baker et al. 2013). This two or three-day training session on marine mammal monitoring should be conducted shortly before the anticipated start of the proposed action. The training session(s) should be conducted by qualified marine mammalogists with extensive crew-leader experience during previous vessel-based monitoring programs. A marine mammal observers' handbook, adapted for the specifics of the planned program, should be reviewed as part of the training.

5. Fairweather should collaborate with other industrial operators in the area (i.e., SAE and Quintillion) to integrate and synthesize monitoring results as much as possible (such as submitting sightings from their monitoring projects to an online data archive like OBIS-SEAMAP), and archiving and making the complete database available upon request.

In order to keep NMFS AKR informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, NMFS PR1 should notify NMFS AKR of any conservation recommendations implemented in the 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 the federal government 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/pr/biological-opinions/. 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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