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

Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion
Office of Naval Research (ONR) Arctic Activities

NMFS Consultation Number: AKRO-2021-01926

Action Agencies: U.S. Navy ONR and Office of Protected Resources, Permits and Conservation Division

Affected Species and Determinations:

ESA-Listed Species and Distinct Population Segments (DPS) or Evolutionarily Significant Units (ESU)	Status	Is the Action Likely to Adversely Affect Species?	Is the Action Likely to Adversely Affect Critical Habitat?	Is the Action Likely To Jeopardize the Species?	Is the Action Likely To Destroy or Adversely Modify Critical Habitat?
Bowhead whale (*Balaena mysticetus*)	Endangered	No	N/A	No	N/A
Fin whale (*Balaenoptera physalus*)	Endangered	No	N/A	No	N/A
North Pacific right whale (*Eubalaena japonica*)	Endangered	No	No	No	No
Gray whale, Western North Pacific DPS (*Eschrichtius robustus*)	Endangered	No	N/A	No	N/A
Humpback whale, Western North Pacific DPS (*Megaptera novaeangliae*)	Endangered	No	No	No	No
Humpback whale, Mexico DPS (*Megaptera novaeangliae*)	Threatened	No	No	No	No
Ringed seal, Arctic subspecies (*Phoca hispida hispida*)	Threatened	Yes	N/A	No	N/A
Bearded seal, Beringia DPS (*Erignathus barbatus nauticus*)	Threatened	No	N/A	No	N/A

Consultation Conducted By: National Marine Fisheries Service, Alaska Region (AKR)

Issued By:

Robert D Mecum
for
James W. Balsiger, Ph.D.
Regional Administrator

Date: September 29, 2021

ALASKA REGION - https://www.fisheries.noaa.gov/region/alaska

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Terms and Abbreviations

ADEC	Alaska Department of Environmental Conservation
ADFG	Alaska Department of Fish and Game
ADNR	Alaska Department of Natural Resources
AEWC	Alaska Eskimo Whaling Commission
AIS	Automatic Identification System
AKR	(NMFS) Alaska Regional Office
ASAMM	Aerial Surveys of Arctic Marine Mammals
BA	Biological Assessment
BSAI	Bering Sea/Aleutian Islands
CFR	Code of Federal Regulations
CO_2	Carbon dioxide
CV	Coefficient of variation
CWA	Clean Water Act of 1972
dB re 1μPa	Decibel referenced 1 microPascal
dB	Decibel
DPS	Distinct Population Segment
EEZ	(U.S.) Exclusive Economic Zone
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ESCA	Endangered Species Conservation Act
°F	Fahrenheit
FR	*Federal Register*
ft	Feet
GOA	Gulf of Alaska
GPS	Global Positioning System
HF	High-frequency (cetacean hearing group)
hr	Hour(s)
Hz	Hertz
IHA	Incidental Harassment Authorization
IPCC	Intergovernmental Panel on Climate Change
ITS	Incidental Take Statement
IWC	International Whaling Commission
kHz	kiloHertz
km	kilometer

kn	Knots
L_E	Cumulative sound exposure at reference value of 1μPa^{2}s
L_{pk}	Peak sound pressure at 1 μPa
LF	Low frequency (cetacean hearing group)
μPa	Micro Pascal
m	meter
MF	Mid-frequency (cetacean hearing group)
mi	mile
MLLW	Mean lower low water
MMPA	Marine Mammal Protection Act
mph	Miles per hour
nm	Nautical mile
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
OW	Otariid pinniped underwater (hearing group)
PBF	Physical or Biological Feature
PCB	polychlorinated biphenyls
PCE	Primary Constituent Element
PK	Peak sound level
PSO	Protected Species Observer
PTS	Permanent threshold shift
PW	Phocid pinniped underwater (hearing group)
rms	Root mean square
RPA	Reasonable and prudent alternative
SD	Standard deviation
SEL	Sound exposure level
SPL	Sound pressure level
SSV	Sound source verification
TTS	Temporary threshold shift
UME	Unusual Mortality Event
U.S.C.	United States Code
USFWS	U.S. Fish and Wildlife Service

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 ensure 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 may fulfill this general requirement informally if they conclude that an action may affect, but "is not likely to adversely affect" endangered species, threatened species, or designated critical habitat, and NMFS or the 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 agency's action is likely to affect ESA-listed species and their critical habitat. If incidental take is reasonably certain to occur, 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 or appropriate to minimize such impact, and sets forth terms and conditions to implement those measures.

In this document, the action agencies are the U.S. Navy's Office of Naval Research (ONR) which proposes to conduct Arctic Research Activities (ARA), and the NMFS Office of Protected Resources, Permits and Conservation Division (hereafter referred to as "the Permits Division"). The Permits Division plans to issue an incidental harassment authorization (IHA) pursuant to section 101(a)(5)(D) of the Marine Mammal Protection Act of 1972, as amended (MMPA) (16 U.S.C. §1361 et seq.), to ONR for harassment of marine mammals incidental to the proposed research (86 FR 47065). When issued, the IHA will be valid from early October 2021 through early October 2022 and will authorize the incidental harassment of the threatened Arctic ringed seal. This opinion represents NMFS's biological opinion on the effects of this proposal on endangered and threatened species and designated critical habitat that might be affected by the proposed action.

The opinion and ITS were prepared by NMFS in accordance with section 7(b) of the ESA (16 U.S.C. §1536(b)) and implementing regulations at 50 CFR part 402. The opinion is 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 is based on information provided in the August IHA application (ONR 2021), the proposed IHA (86 FR 47065), the 2017 Biological Assessment and the Supplemental Overseas Environmental Assessment for ONR's Arctic Research Activities in the Beaufort Sea October 2021 – October 2022, and the 2018 Biological Evaluation that was submitted to cover ONR's Arctic Research Activities from 2018-2021. Other sources of information include emails, recent biological opinions completed in the same region, and Arctic marine mammal surveys. A complete record of the consultation is on file at NMFS's Anchorage, Alaska office.

The proposed IHA for this project would cover the fourth year of a larger project for which ONR obtained prior IHAs (83 FR 48799, September 27, 2018; 84 FR 50007, September 24, 2019; 85 FR 53333, August 28, 2020) and may request take authorization for subsequent facets of the overall project. The IHA would be valid for a period of one year from the date of issuance (early October 2021 to early October 2022). The larger project involves several scientific objectives that support the Arctic and Global Prediction Program, as well as the Ocean Acoustic Program and the Naval Research Laboratory, for which ONR is the parent command. ONR has complied with the requirements (e.g., mitigation, monitoring, and reporting) of the previous IHAs (83 FR 48799, September 27, 2018; 84 FR 50007, September 24, 2019; 85 FR 53333, August 28, 2020).

The consulting agency for this proposal is NMFS's Alaska Region (AKR). AKR completed a biological opinion in 2018 (AKR-2018-9725) for the overarching research activities that were to be conducted from 2018-2021. In that consultation we acknowledged that ONR research activities might continue after 2021, but that the nature of the platforms and the locations of future deployments were unknown, and that such future activities would be covered under future environmental planning documents. Modifications to research activities were submitted by ONR in 2019 and we completed another biological opinion (AKRO-2019-00688), to cover those modifications and the time frame from 2019-2021. This opinion considers the effects of activities associated with ONR's proposed Arctic Research Activities (ARA), from early October 2021 to early October 2022 and the associated proposed issuance of an IHA for these activities.

The ARA include one vessel that will deploy various towed and moored active acoustic sources and sensors (in October 2021 and again in October 2022), manned and unmanned aircraft, deployment of on-ice measurement systems, underwater rovers, and deployment of weather balloons. The research vessel will deploy from Nome, Alaska and travel across the northeastern portion of the Bering Sea, across the southeastern portion of the Chukchi Sea, and into the Beaufort Sea (Figure 5). Because ONR indicated that ice breaking operations are not part of the proposed action, no effects associated with ice breaking are considered in this opinion. The ARA will take place primarily in the Beaufort Sea. However, drifting buoys could float into the eastern Chukchi Sea (white box, Figure 1). These actions have the potential to affect the endangered bowhead whale (*Balaena mysticetus*), endangered fin whale (*Balaenoptera physalus*), endangered Western North Pacific distinct population segment (DPS) humpback whale (*Megaptera novaeangliae*), threatened Mexico DPS humpback whale (*Megaptera novaeangliae*), endangered North Pacific right whale (*Eubalaena japonica*), endangered western North Pacific DPS gray whales (*Eschrichtius robustus*), threatened Arctic subspecies of ringed seal (*Phoca hispida hispida*), and threatened Beringia DPS bearded seal (*Erignathus barbatus nauticus*).

1.2. Consultation History

- June 22, 2021: An initiation letter and IHA application were received from ONR.
- After obtaining clarification from ONR and providing guidance, a second initiation letter was received on July 1, 2021.
- July 16, 2021. ONR gave a PowerPoint presentation on their proposed activities to the NMFS Alaska Region (AKR) staff and the Permits Division.
- July 20, 2021. An Early Review Team meeting was held between AKR and the Permits

Division staff.

- July 21, 2021. A list of clarifying questions was sent to ONR.
- July 27, 2021. ONR responded to a portion of the questions.
- July 29, 2021. Final Overseas Environmental Assessment and a revised IHA application were received.
- July 29 to August 4, 2021. Multiple emails were exchanged between AKR and ONR to clear up details concerning project activities.
- August 4, 2021. The Draft Supplemental Overseas Environmental Assessment for ONR Research Arctic Research Activities in the Beaufort Sea October 2021 – October 2022 was received.
- August 5, 2021. Final revised IHA application received.
- August 9, 2021. Consultation initiated.
- August 19, 2021. The Permits Division requested consultation initiation.
- August 23, 2021. The proposed IHA was published in the Federal Register (86 FR 47065).

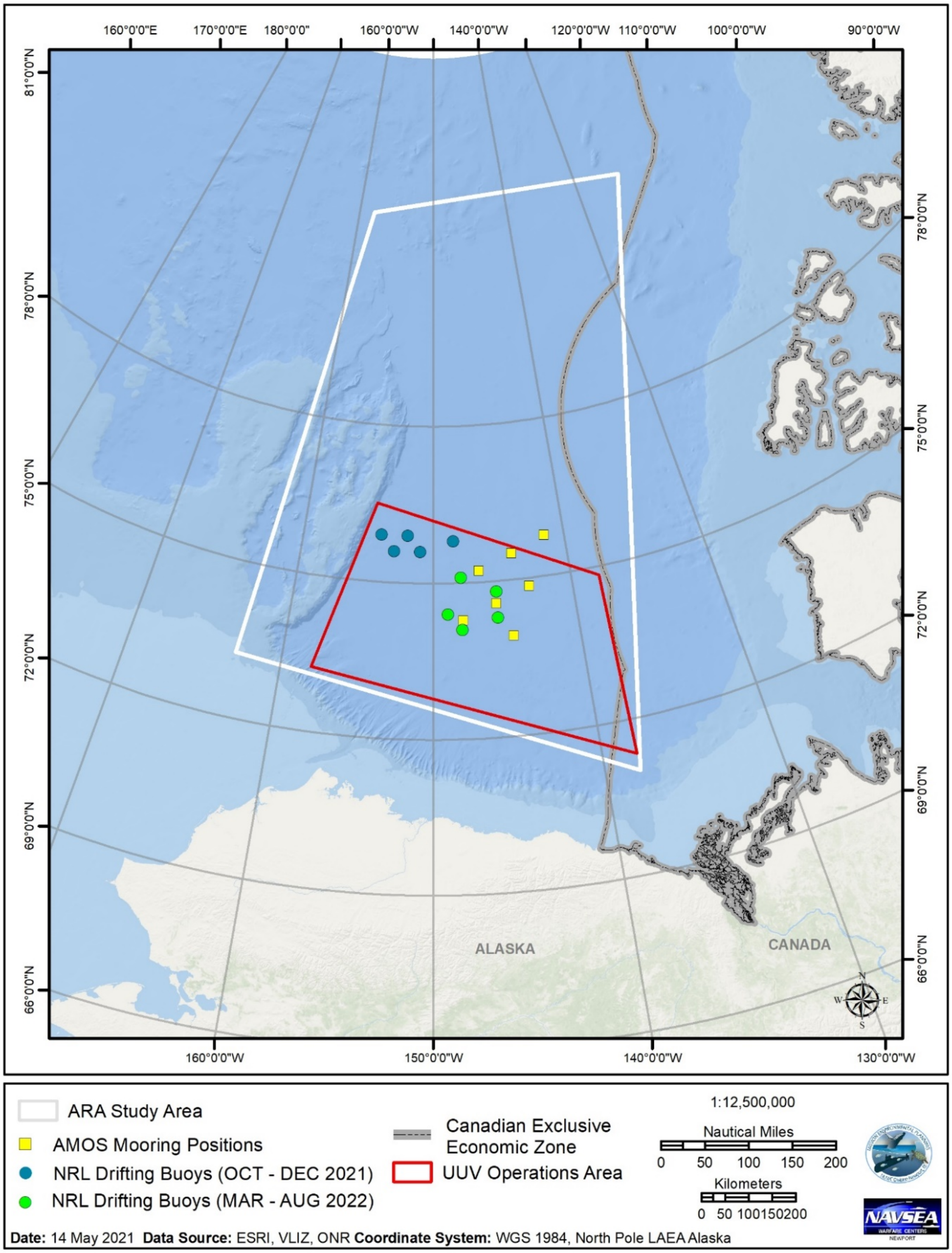

Figure 1. Study area for the Office of Naval Research's Arctic Research Activities.

2. Description of the Proposed Action and Action Area

2.1. Proposed Action

“Action” means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies in the United States or upon the high seas (50 CFR 402.02).

The Proposed Action includes multiple scientific objectives that support the Arctic and Global Prediction Program and the Acoustics Division of the Naval Research Laboratory (NRL). The Proposed Action constitutes the development of a new system under the ONR Arctic Mobile Observing System (AMOS) involving very low, low, and mid frequency transmissions (35 Hertz [Hz], 900 Hz, and 10 kilohertz [kHz] respectively). The AMOS project would utilize acoustic sources and receivers to provide a means of performing under-ice navigation for gliders and unmanned undersea vehicles (UUVs). This would allow for the possibility of year-round scientific observations of Arctic environmental conditions. As an environment particularly affected by climate change, year-round observations under a variety of ice conditions are required to study the effects of this changing environment for military readiness, as well as the implications of environmental change to humans and animals. The use of a very low frequency (VLF) source is limited to a single source on the ship. Very low-frequency technology is an important method of observing ocean warming, and the continued development of these types of acoustic sources would allow for characterization of larger areas. The technology also has the potential to allow for development and use of navigational systems that would not be heard by some marine species, and therefore would be less impactful overall.

Additional leave-behind sources would be deployed by aircraft and would support the NRL project for rapid environmental characterization. This project would use groups of drifting buoys with sources and receivers communicating oceanographic information to a satellite in near real time. These sources would employ low frequency transmissions only (900 Hz). NRL currently has four active buoys covered under a current IHA that lasts until September 13, 2021; the current IHA application seeks to re-activate three devices for observation in the far north from October to December 2021, as well as a deployment of five additional sources to be active from March to August 2022.

ONR is also supporting a project called UpTempO that would use two drifting buoys to observe oceanographic conditions in the seasonal ice zone. These buoys would not have active acoustic sources. They would be deployed during the October 2021 and October 2022 cruises.

The proposed action has the following schedule:

- October 2021: R/V Sikuliaq travels from Nome to the Beaufort Sea and back to Nome.
- October 2021: Research cruise onboard the R/V Sikuliaq, including on-site source testing with UUVs. Deployment of fixed navigation sources.
- October 2021-December 2021: Re-activation of existing NRL drifting sources.
- October 2021-October 2022: Transmissions from fixed navigation sources
- March-August 2022: Deployment and activation of five NRL drifting sources

- October 2022: Second research cruise, using CGC HEALY or other vessel, returns to area. Completion of Proposed Action.

2.1.1. Proposed Activities

The research activities involve both a research vessel and the deployment of a variety of devices described below.

2.1.1.1. Research Vessels

The research vessel (R/V) Sikuliaq would perform the research cruise in October 2021, and conduct testing of acoustic sources during the cruise, as well as leave sources behind to operate as a year-round navigation system. The ship to be used in October 2022 is yet to be determined. The most probable option would be the Coast Guard Cutter (CGC) HEALY.

The R/V Sikuliaq has a maximum speed of approximately 12 knots with a cruising speed of 11 knots (https://en.wikipedia.org/wiki/RV_Sikuliaq). The R/V Sikuliaq is not an ice breaking ship, but an ice strengthened ship. It would not be icebreaking and therefore acoustic signatures of icebreaking for the R/V Sikuliaq are not relevant. CGC HEALY travels at a maximum speed of 17 knots with a cruising speed of 12 knots and a maximum speed of 3 knots when traveling through 3.5 feet (ft; 1.07 meters [m]) of sea ice (https://www.pacificarea.uscg.mil/Our-Organization/Area-Cutters/CGC-Healy/Ship/) For the purposes of this IHA application and biological opinion, there would be no icebreaking activity.

The R/V Sikuliaq, CGC HEALY, or any other vessel operating a research cruise associated with the proposed action may perform the following activities during their research cruises:

- Deployment of moored and/or ice-tethered passive sensors (oceanographic measurement devices, acoustic receivers);
- Deployment of moored and/or ice-tethered active acoustic sources to transmit acoustic signals;
- Deployment of unmanned underwater and air vehicles;
- Deployment of drifting boys, with or without acoustic sources;
- Recovery of equipment.

Additional oceanographic measurements would be made using ship-based systems, including the following:

- Modular Microstructure Profiler, a tethered profiler that would measure oceanographic parameters within the top 984 ft (300 m) of the water column;
- Shallow Water Integrate Mapping System, a winched towed body with a Conductivity Temperature Depth sensor, upward and downward looking Acoustic Doppler Current Profilers (ADCPs), and a temperature sensor within the top 328 ft (100 m) of the water column;
- Three dimensional Sonic Anemometer, which would measure wind stress from the

foremast of the ship; and,

- Surface Wave Instrument Float with Tracking are freely drifting buoys measuring winds, waves, and other parameters with deployments spanning from hours to days.

2.1.1.2. Moored/Drifting Acoustic Sources

2.1.1.2.1. Arctic Mobile Observing System (AMOS)

During the October 2021 cruise, acoustic sources would be deployed from the ship on UUVs or drifting buoys. This would be done for intermittent testing of the system components. The total amount of active source testing for ship-deployed sources used during the cruise would be 120 hours. The testing would take place in the vicinity of the seven source locations on Figure 1, with UUVs running tracks within the designated box (outlined in red). During this testing, 35 Hz, 900 Hz, and acoustic modems would be employed.

Up to seven fixed acoustic navigation sources transmitting at 900 Hz (Table 1) would remain in place for a year. These moorings would be anchored on the seabed and held in the water column with subsurface buoys. All sources would be deployed by shipboard winches, which would lower sources and receivers in a controlled manner. Anchors would be steel “wagon wheels” typically used for this type of deployment. All navigation sources would be recovered. The purpose of the navigation sources is to orient UUVs and gliders in situations when they are under ice and cannot communicate with satellites.

2.1.1.2.2. Rapid Environmental Characterization

The Naval Research Lab deployed six drifting sources under the current 2021 IHA for ONR Arctic Research Activities. A maximum of three may still be available for reactivation in October 2021 and transmission until December 2021. The sources can be turned on or off remotely in accordance with permitting requirements, or when they drift outside of the Study Area. The purpose of the sources is near-real time environmental characterization, which is accomplished by communicating information from the drifting buoys to a satellite. These buoys were deployed in the ice (via fixed-wing aircraft) for purposes of buoy stability but are now drifting in open water. An additional set of five buoys would be deployed on the ice in March 2022 using fixed-wing aircraft and transmit until August 2022.

The acoustic parameters of sources for the AMOS and NRL projects are given in Table 1. A distinction is made between sources that would have limited testing when the ship is on-site and leave behind sources that would transmit for the full year.

Table 1. Characteristics of the modeled acoustic sources for the proposed action

Source Name	***Frequency (Hz)***	***Sound Pressure Level (dB$_{rms}$ re 1 µPa at 1 m)***	***Pulse Length (seconds)***	***Duty Cycle (Percent)***	***Source Type***	***Usage***
AMOS Navigation Sources (LF) [leave behind]	900-950	180	30	<1 %	Moored	7 sources transmitting 30 seconds every 4 hours
AMOS Navigation sources (LF) [on-site; UUV and ship]	900-950	180	30	4%	Moving	2 sources, transmitting 5 times an hour with 30 sec pulse length
AMOS Navigation sources (LF) [onsite; buoy]	900-950	180	30	<1%	Drifting	1 source, transmitting every 4 hours
AMOS VLF Navigation Source	35	190	600	1%	Ship-deployed	2 times per day
NRL Real-Time Sensing Sources (2021)	900- 1000	184	30	<1%	Drifting	3 sources transmitting 30 seconds every 6 hours
NRL Real-Time Sensing Sources (2022)	850-1050	184	60	<1%	Drifting	5 sources transmitting 1 minute every 8 hours
WHOI micromodem (on-site; UUV)	8-14 kHz	185	4	10%	Moving	Medium duty cycle acoustic communications

2.1.1.3. De minimis sources

De minimis sources have the following parameters: low source levels, narrow beams, downward directed transmission, short pulse lengths, frequencies above (outside) known marine mammal hearing ranges, or some combination of these factors (Navy 2013). Additionally, any sources 200 kHz or above in frequency and 160 decibels (dB) or below in source level are automatically considered *de minimis*. Sources 200 kHz or above are considered outside of marine mammal hearing ranges. Assuming spherical spreading for a 160 dB re 1 µPa source, the sound will attenuate to less than 140 dB within 32 ft (10 m) and less than 120 dB within 328 ft (100 m) of the source. Ranges would be even shorter for a source less than 160 dB re 1 µPa source level. All of the sources described in this section are considered *de minimis* by ONR, the Permits Division, and AKR (Table 2).

The following are the planned *de minimis* sources which would be used during the Proposed Action: Woods Hole Oceanographic Institution (WHOI) micromodem, Acoustic Doppler Current Profilers (ADCPs), ice profilers, ADCPs may be used on moorings. Ice-profilers measure ice properties and roughness. The ADCPs and ice-profilers would all be above 200 kHz and therefore out of marine mammal hearing ranges, with the exception of the 75 kHz ADCP which has the characteristics and de minimis justification listed in Table 2. They may be employed on moorings or UUVs.

The WHOI micromodem (see Table 1) will also be employed during the leave behind period. During this period, it is being used for very intermittent communication (switched on 5 times) with vehicles to communicate vehicle status for safety of navigation purposes and is treated as *de minimis* while employed in this manner.

Table 2. Parameters for de minimis non-impulsive sources, 2021-2022.

Source Name	**Frequency Range (kHz)**	**Sound Pressure Level (dB_{rms} re 1 µPa at 1 m)**	**Pulse Length (seconds)**	**Duty Cycle (Percent)**	**Beamwidth**	**De minimis Justification**
ADCP	>200, 150, or 75	190	<0.001	<0.1	2.2	Very low pulse length, narrow beam, moderate source level

2.1.1.4. Drifting Oceanographic Sensors

Observations of ocean-ice interactions require the use of sensors that are moored and embedded in the ice. For the proposed action, it will not be required to break ice to do this, as deployments can be performed in areas of low ice-coverage or free floating ice. Sensors are deployed within a few dozen meters of each other on the same ice floe. Three types of sensors would be used: autonomous ocean flux buoys, Integrated Autonomous Drifters, and Ice Tethered Profilers. The autonomous ocean flux buoys (Figure 2) measure oceanographic properties just below the ocean-ice interface. The autonomous ocean flux buoys would have ADCPs and temperature chains attached, to measure temperature, salinity, and other ocean parameters in the top 20 ft (6 m) of the water column. Integrated Autonomous Drifters have a 200 m long string of thermistors that measure temperature at discrete points along its length. Part of the string is frozen into the sea ice, the rest extends into the ocean below. Differences in temperature are used to infer the properties of sea ice and to distinguish ice from water. The Ice Tethered Profilers would collect information on ocean temperature, salinity and velocity down to 1,600 - 2625 ft (500 - 800 m) depth.

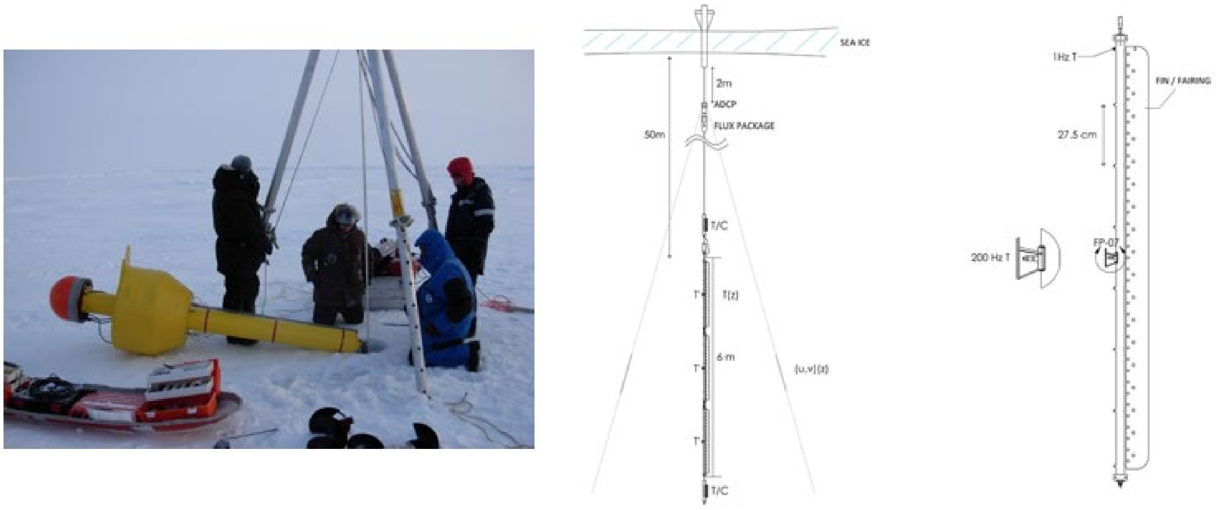

Figure 2. Autonomous Ocean Flux Buoy deployment, with schematic depicting system components.

ONR is also supporting a project called UpTempO that would use two drifting buoys to observe oceanographic conditions in the seasonal ice zone. These buoys would not have active acoustic sources. They would be deployed during the October 2021 and October 2022 cruises.

2.1.1.5. Activities Involving Aircraft and Unmanned Air Vehicles

The deployment of the NRL sources in 2022 would be accomplished by using aircraft that would land on the ice. Five round trip flights from Prudhoe Bay are expected. Flights would be conducted with a Twin Otter aircraft or a single engine alternative that would be quieter. Flights would transit at a minimum of 1,500 ft above sea level. At a distance of 2,152 ft (656 m) away, the received pressure levels of a Twin Otter range from 80 to 98.5 A-weighted decibels (expression of the relative loudness in the air as perceived by the human ear) and frequency levels ranging from 20 Hz to 10 kHz, though they are more typically in the 500 Hz range (Metzger 1995). Once on the floating ice, the team would drill holes of up to a 10-inch (in; 25.4 centimeter [cm]) diameter to deploy scientific equipment (e.g. source, hydrophone array, EMATT) into the water column.

The Proposed Action includes the use of an Unmanned Aerial System (UAS). The UAS would be utilized for aid of navigation and to confirm and study ice cover. The UAS would be deployed ahead of the ship to ensure a clear passage for the vessel and would have a maximum flight time of 20 minutes. The UAS would not be used for marine mammal observations or hover close to the ice near marine mammals. There would be no videotaping or picture taking of marine mammals as part of the Proposed Action. The UAS that would be used during the Proposed Action is a small commercially available system that generates low sound levels and is smaller than military grade systems. The dimensions of the proposed UAS are, 11.4 in, (29 cm) by 11.4 in (29 cm) by 7.1 in (18 cm) and weighs only 2.5 pounds (1.13 kilograms [kg]). The UAS can operate up to 984 ft (300 m) away, which would keep the device in close proximity to the ship.

The planned operation of the UAS is to fly it vertically above the ship to examine the ice conditions in the path of the ship and around the area (i.e., not flown at low altitudes around the vessel). Currently acoustic parameters are not available for the proposed models of UASs to be utilized in the Proposed Action. As stated above these systems are very small and are similar to a remote-controlled helicopter.

2.1.1.6. On-ice Measurement Systems

On-ice measurement systems would be used to collect weather data. These would include an Autonomous Weather Station and an Ice Mass Balance Buoy. The Autonomous Weather Station would be deployed on a tripod; the tripod has insulated foot platforms that are frozen into the ice (Figure 3). The system would consist of an anemometer, humidity sensor, and pressure sensor.

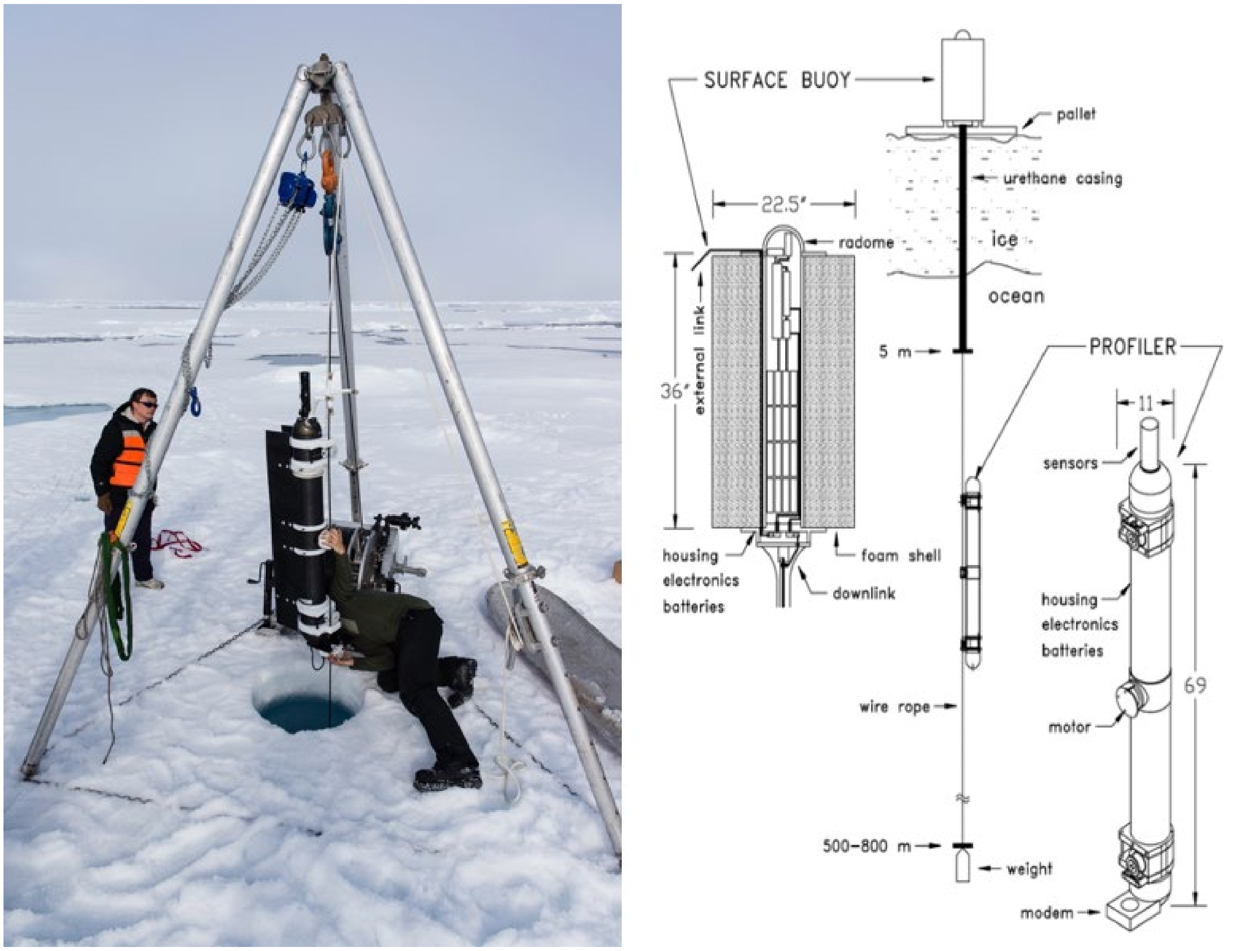

Figure 3. Ice-Tethered Profiler with schematic depicting system components.

The Autonomous Weather Station also includes an altimeter that is *de minimis* due to its very high frequency (200 kHz). The Ice Mass Balance Buoy is a 20 ft (6 m) sensor string, which is deployed through a 2 in (5 cm) hole drilled into the ice. The string is weighted by a 2.2 lb (1 kg) lead weight and is supported by a tripod. The buoy contains a *de minimis* 200 kHz altimeter and snow depth sensor. Autonomous Weather Stations and Ice Mass Balance Buoys will be deployed, and will drift with the ice, making measurements, until their host ice floes melt, thus destroying the instruments (likely in summer, roughly one year after deployment). After the on-ice instruments are destroyed they cannot be recovered and will sink to the seafloor as their host ice floes melted.

2.1.1.7. Glider Surveys

Long-endurance, autonomous seagliders are used in extended missions in ice-covered waters. Gliders are buoyancy-driven, equipped with satellite modems providing two-way communication, and are capable of transiting to depths of up to 3,280 ft (1,000 m). Gliders would collect data in the area of the shallow water sources and moored sources, moving at a speed of 0.25 meters per second (0.56 mph). Seagliders have a one-year life. When operating in ice-covered waters, gliders navigate by trilateration from moored acoustic sound sources (or dead reckoning should navigation signals be unavailable). Hibernating gliders would continue to track their position, waking to reposition should they drift too far from their target region. Gliders would measure temperature, salinity, dissolved oxygen, rates of dissipation of temperature variance (and vertical turbulent diffusivity), and multi-spectral downwelling irradiance. Five gliders are expected to be deployed with 2 overwintering.

2.1.1.8. Unmanned Underwater Vehicles

The REMUS 600 is a 12-inch diameter autonomous vehicle that has a depth capability of 600 m. The vehicle is approximately 14 ft (4.3 m) long and weighs 240 kg (530 lbs) in air. It can travel at a speed up to 5 knots. The vehicle is equipped with communications equipment including Iridium and Wi-Fi for above water, and multiple acoustic systems for communications while submerged. Emergency systems include a strobe and backup battery for extended tracking while drifting on the surface. Leak detection and ground-fault detection are also built into the vehicle safety system. Sensors installed in this vehicle include conductivity, temperature and depth, plus a five-beam Nortek Signature sonar that can be configured in an upward or downward orientation. The vehicle is powered by rechargeable lithium-ion batteries. One device will be deployed.

2.1.1.9. Weather Balloons

To support weather observations and research objectives, up to forty Kevlar or latex balloons would be launched per year for the duration of the Proposed Action. These balloons and associated radiosondes (a sensor package that is suspended below the balloon) are similar to those that have been deployed by the National Weather Service since the late 1930s. When released, the balloon is approximately 5-6 ft (1.5-1.8 m) in diameter and gradually expands as it rises owing to the decrease in air pressure. When the balloon reaches a diameter of 13-22 ft (4-7 m), it bursts and a parachute is deployed to slow the descent of the associated radiosonde. Weather balloons would not be recovered. Figure 4 shows the remains of a burst weather balloon that was retrieved from an Alaskan Lake.

Figure 4. Example of a spent weather balloon retrieved from a lake in Alaska. The radiosonde was housed in the white Styrofoam container, the orange is the remains of the parachute, shards of the white plastic balloon can also be seen.

2.2. Standard Operating Procedures and Mitigation Measures

While in transit (Figure 5), CGC Healy and RV Sikuliaq will follow the U.S. Coast Guard's Standard Operating Procedures (SOPs) for operating in Alaska (see pgs. 5-6, USCG (2011)). Once at the study area (Figure 1), ONR will follow both standard operating procedures and mitigation measures as outlined in their Biological Evaluation (ONR 2018) and IHA application (ONR 2021). Standard operating procedures serve the primary purpose of providing safety and mission success, and are implemented regardless of their secondary benefits (e.g., to a resource), while mitigation measures are used to avoid or reduce potential impacts to protected resources.

Standard Operating Procedures

Ships operated by or for the Navy have personnel assigned to stand watch at all times, day and night, when moving through the water (underway). Watch personnel undertake extensive training in accordance with the U.S. Navy Lookout Training Handbook or civilian equivalent, including on-the-job instruction and a formal Personal Qualification Standard program (or equivalent program for supporting contractors or civilians), to certify that they have demonstrated all necessary skills (such as detection and reporting of floating or partially submerged objects). Their duties may be performed in conjunction with other job responsibilities, such as navigating the ship or supervising other personnel. While on watch, personnel employ visual search techniques, including the use of binoculars, using a scanning method in accordance with the U.S. Navy Lookout Training Handbook or civilian equivalent. A primary duty of watch personnel is to detect and report all objects and disturbances sighted in the water that may be indicative of a threat to the ship and its crew, such as debris, or surface disturbance. Per safety requirements, watch personnel also report any marine mammals sighted that have the potential to be in the direct path of the ship as a standard collision avoidance procedure.

Mitigation Measures

The proposed IHA includes the following mitigation, monitoring, and reporting requirements which will be incorporated by ONR to minimize potential impacts from project activities:

1. All ships operated by or for the Navy shall have personnel assigned to stand watch at all times while underway.
2. Ships operated by or for the Navy have personnel assigned to stand watch at all times, day and night, when moving through the water. While in transit, ships must use extreme caution and proceed at a safe speed (1-3 knots in ice; <10 knots in open ice-free waters) such that the ship can take proper and effective action to avoid a collision with any marine mammal and can be stopped within a distance appropriate to the prevailing circumstances and conditions.
3. For all towed active acoustic sources, ONR shall implement a minimum shutdown zone of 200 yards (183 meters (m)) radius from the source. If a marine mammal comes within or approaches the shutdown zone, such operations shall cease. Active transmission may recommence if any one of the following conditions are met:
    a. The animal is observed exiting the shutdown zone;
    b. The shutdown zone has been clear from any additional sightings for a period of 30 minutes; or
    c. The ship has transited more than 400 yards (366 m) beyond the location of the last sighting.
4. During mooring deployment, ONR shall implement a shutdown zone of 60 yards (55 m) around the deployed mooring. Deployment will cease if a marine mammal comes within or approaches the shutdown zone. Deployment may recommence if any one of the following conditions are met:
    a. The animal is observed exiting the shutdown zone;
    b. The shutdown zone has been clear from any additional sightings for a period of 15 minutes.
5. Ships will avoid approaching marine mammals head on and will maneuver to remain at least 500 yd (457 m) from all whales, and 200 yd (183 m) around all other marine mammals,

6. These requirements do not apply if a vessel's safety is at risk, such as when a change of course would create an imminent and serious threat to safety, person, vessel, or aircraft, and to the extent vessels are restricted in their ability to maneuver. No further action is necessary if a marine mammal other than a whale continues to approach a vessel after there has already been one maneuver and/or speed change to avoid the animal. Avoidance measures shall continue for any observed whale in order to maintain an exclusion zone of 500 yd (457 m).

Monitoring

ONR will conduct marine mammal monitoring during Arctic Research Activities. Monitoring and reporting shall be conducted in accordance with the Integrated Comprehensive Monitoring Program (ICMP).[1]

7. While underway, all ships utilizing active acoustics and towed in-water devices shall have at least one person on watch during all activities.
8. During deployment of moored sources, visual observation shall begin 15 minutes prior to deployment and continue throughout the source deployment by an assigned observer.

Although only basic information about marine mammals (latitude, longitude, species, number, behavior) will be recorded when ships are under way, the Navy will have an assigned observer record the following additional information during deployments of the scientific instruments:

9. Weather parameters (e.g., percent cloud cover, percent glare, visibility, percent ice cover) and sea state where the Beaufort Wind Force Scale will be used to determine sea-state (https://www.weather.gov/mfl/beaufort) affecting visibility and detectability of marine mammals;
10. Species numbers, and, if possible, sex and age class of observed marine mammals, along with the date, time, and location of the marine mammal observation;
11. The predominant sound-producing activities occurring during each marine mammal sighting;
12. Marine mammal behavior patterns observed, including bearing and direction of travel;
13. Behavioral reactions of marine mammals just prior to, or during, sound producing activities;
14. Initial, closest, and last location of marine mammals, including distance from observer to the marine mammal, and distance from the predominant sound-producing activity or activities to marine mammals;
15. Whether the presence of marine mammals necessitated the implementation of mitigation measures, and the duration of time that normal operations were affected by the presence of marine mammals; and
16. 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).

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[1] https://www.navymarinespeciesmonitoring.us/about/integrated-comprehensive-monitoring-program/

17. Estimates of "take by harassment" and "take by mortality" (if applicable).

Reporting

ONR will:

18. Submit a draft report to the Permits Division on all monitoring conducted under the IHA within 90 calendar days of the completion of marine mammal monitoring. The report shall include data regarding acoustic source use and any marine mammal sightings. If no comments are received from NMFS within 30 days of submission of the draft final report, the draft final report will constitute the final report. If comments are received, a final report must be submitted within 30 days after receipt of comments.
19. Report injured or dead marine mammals unrelated to project activities to the Stranding Hotline (Table 3).
20. In the unanticipated event that the specified activity causes the take of a marine mammal in a manner prohibited by the IHA, such as an injury (Level A harassment), serious injury, or mortality, ONR shall immediately cease the specified activities and report the incident to the Office of Protected Resources, NMFS, and the Alaska Regional Stranding Coordinator. Contact information is in Table 3. The following information will be included:
    a. Time, date, and location of the discovery;
    b. Species identification (if known) or description of the animal(s) involved;
    c. Condition of the animal(s) (including carcass condition if the animal is dead);
    d. Observed behaviors of the animal(s), if alive;
    e. If available, photographs or video footage of the animal(s); and
    f. General circumstances under which the animal(s) was discovered (e.g., deployment of moored or drifting sources, during on-ice experiments, or by transiting vessel).

Table 3. Summary of Agency Contact Information

Reason for Contact	**Contact Information**
Consultation Questions & Unauthorized Take	Greg Balogh: greg.balogh@noaa.gov Marilyn Myers: Marilyn.myers@noaa.gov and Jon Kurland: jon.kurland@noaa.gov Kelsey Potlock: Kelsey.potlock@noaa.gov
Reports & Data Submittal	AKR.section7@noaa.gov (please include NMFS consultation number AKRO 2021-09126)
Stranded, Injured, or Dead Marine Mammal *(not related to project activities)*	Stranding Hotline (24/7 coverage) 877-925-7773

Reason for Contact	Contact Information
Oil Spill & Hazardous Materials Response	U.S. Coast Guard National Response Center: 1-800-424-8802 (or U.S. Coast Guard 17th District Command Center: 907-463-2000) & NMFS AKR Protected Resources Oil Spill Response Coordinator: 907-586-7630 AKRNMFSSpillResponse@noaa.gov and/or Sadie.wright@noaa.gov

2.3. 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 Proposed Action would occur within the Study Area (Figure 1), which overlaps portions of the U.S. Exclusive Economic Zone (EEZ), international waters, and the Canadian EEZ. The Proposed Action would primarily occur in the Beaufort Sea, but the analysis considers the drifting of active sources on buoys into the Chukchi Sea. The closest point of the Study Area to the Alaska coast is 110 nautical miles (nm; 204 kilometers [km]). The Study Area is further from the coast than in previous IHA applications for ONR Arctic Research Activities. To allow for the equipment drift or the need to navigate around ice, small areas of the Canadian EEZ are also included in the Study Area; the appropriate permission for conducting scientific research in the Canadian EEZ would be obtained from Canada in the form of a Marine Scientific Research (MSR) permit. Figure 1 shows the positions of fixed sources and the initial positions at which drifting sources will transmit. The anticipated movement of drifting sources is included in the analysis. The action area also includes the transit route to and from the study area from Nome, Alaska to the Beaufort Sea (Figure 5).

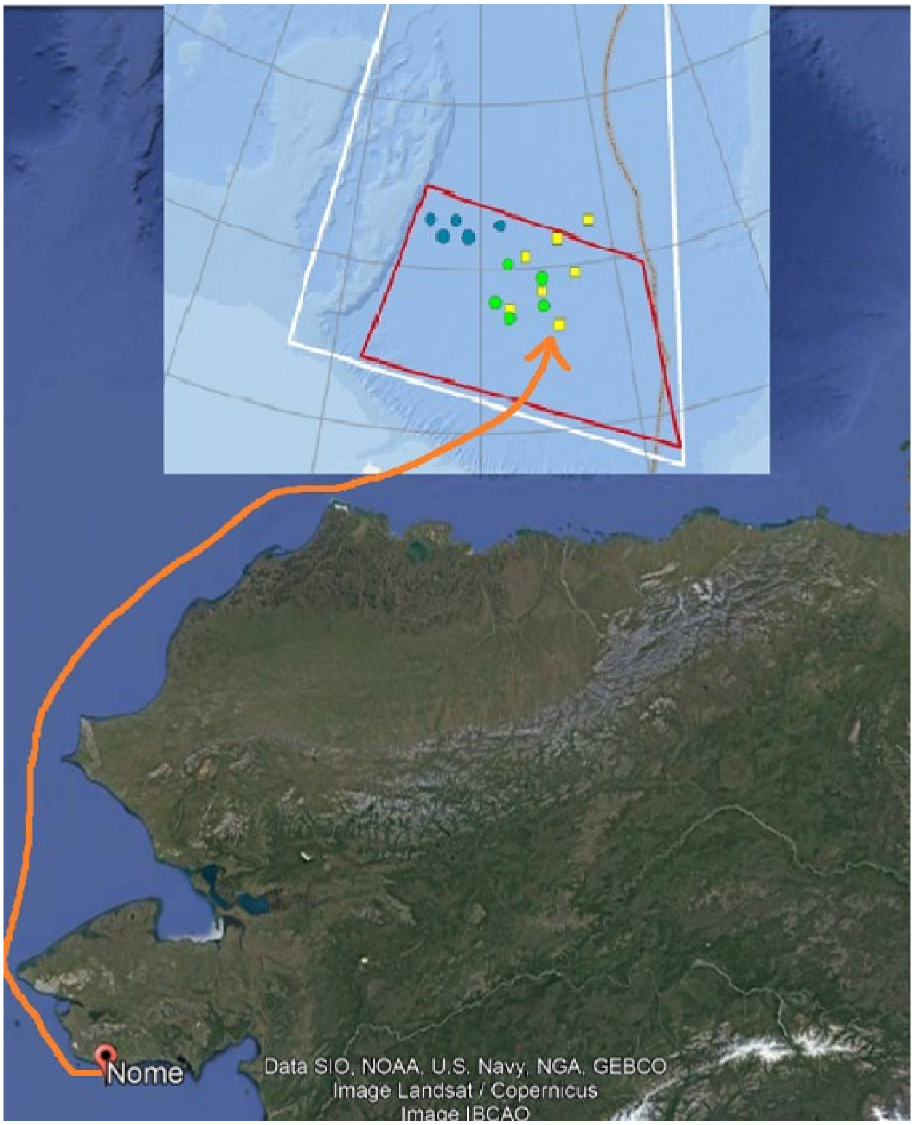

Figure 5. Approximate route and destination of the R/V Sikuliaq in October 2021.

3. Approach to the Assessment

Section 7(a)(2) of the ESA requires Federal agencies, in consultation with NMFS, to ensure 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 reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species (50 CFR § 402.02). As NMFS explained when it promulgated this definition, NMFS considers the likely impacts to a species' survival as well as likely impacts to its recovery. Further, it is possible that in certain, exceptional circumstances, injury to recovery alone may result in a jeopardy biological opinion (51 FR 19926, 19934; June 3, 1986).

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 as a whole for the conservation of a listed species (50 CFR § 402.02).

The designations of critical habitat for North Pacific right whales and Steller sea lions use the term primary constituent element (PCE) or essential features. The 2016 critical habitat regulations (81 FR 7414; February 11, 2016) replaced 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 PCEs, PBFs, or essential features. In this biological opinion, we use the term PBF to mean PCE or essential feature, as appropriate for the specific critical habitat.

We use the following approach to determine whether the proposed action described in Section 2 of this opinion 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 effects on listed species or critical habitat. As part of this step, we identify the action area – the spatial and temporal extent of these 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 PBFs - which were identified when the critical habitat was designated. Species and critical habitat status are discussed in Section 4 of this opinion.
- 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 action. 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 PBFs. The effects of the action are described in Section 6 of this opinion with the exposure analysis described in Section 6.2 of this opinion.
- Once we identify which listed species are likely to be exposed to an action's effects and the nature of that exposure, we examine the scientific and commercial data available to determine whether and how those listed species are likely to respond given their exposure

(these represent our *response analyses*). Response analysis is considered in Section 6.3 of this opinion.

- Describe any cumulative effects. Cumulative effects, as defined in NMFS's implementing regulations (50 CFR § 402.02), are the effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area. Future Federal actions that are unrelated to the proposed action are not considered because they require separate section 7 consultation. Cumulative effects are considered in Section 7 of this opinion.
- Integrate and synthesize the above factors to assess the risk that the proposed action poses to species and critical habitat. In this step, NMFS adds the effects of the action (Section 6) to the environmental baseline (Section 5) and the cumulative effects (Section 7) to assess whether the action could reasonably be expected to: (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) appreciably diminish 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 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. The reasonable and prudent alternative must not be likely to jeopardize the continued existence of ESA-listed species nor adversely modify their designated critical habitat and it must meet other regulatory requirements.

For all analyses, we use the best available scientific and commercial data. For this consultation, we primarily relied on:

- The Navy's IHA application (August revision)
- The Draft Supplemental Overseas Environmental Assessment for ONR Research Arctic Research Activities in the Beaufort Sea October 2021 – October 2022
- The Permits Division Federal Register notice for the proposed IHA
- Stock Assessment Reports
- Published and unpublished scientific information on endangered and threatened species and their surrogates
- Scientific information such as reports from government agencies and peer-reviewed literature

4. Rangewide Status of the Species and Critical Habitat

This opinion considers the effects of the proposed action on the species and designated critical habitats specified in Table 4. The nearest designated critical habitat is for the North Pacific right whale, which is approximately 800 km south of Nome, the departure point of the research vessel that will be heading north. Consequently, no designated critical habitat for any species will be affected by this project.

Table 4. Listing status and critical habitat designation for marine mammals considered in this opinion.

Species	Status	Listing	Critical Habitat
Bowhead Whale (*Balaena mysticetus*)	Endangered	NMFS 1970, 35 FR 18319	Not designated
Fin Whale (*Balaeneoptera physalus*)	Endangered	NMFS 1970, 35 FR 18319	Not designated
Humpback Whale, Western North Pacific DPS (*Megaptera novaeangliae*)	Endangered	NMFS 2016, 81 FR 62260	NMFS 2021, 86 FR 21082
Humpback Whale, Mexico DPS (*Megaptera novaeangliae*)	Threatened	NMFS 2016, 81 FR 62260	NMFS 2021, 86 FR 21082
North Pacific Right Whale (*Eubalaena japonica*)	Endangered	NMFS 2008, 73 FR 12024	NMFS 2008, 73 FR 19000
Gray whale, Western North Pacific DPS (*Eschrichtius robustus*)	Endangered	NMFS 1970, 35 FR 18319	Not designated
Ringed Seal, Arctic Subspecies (*Phoca hispida hispida*)	Threatened	NMFS 2012, 77 FR 76706	Proposed 86 FR 1452
Bearded Seal, Beringia DPS (*Erignathus barbatus nauticus*)	Threatened	NMFS 2012, 77 FR 76740	Proposed 86 FR 1433

4.1. Species and Critical Habitat Not Likely to be Adversely Affected by the Action

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 ONR's Arctic Research Activities and a listed species or designated critical habitat. As mentioned above, no designated critical habitat for any species will be near the proposed activities or vessel transit route for this project, therefore, no critical will be affected. Critical habitat has been proposed for ringed and bearded seals and the vessel route would pass through what is currently proposed for critical habitat. However, the vessel transit would not affect the Physical and Biological Features that are considered essential to the conservation of these species. 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 produced by vessels, 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 exposure.

We applied these criteria to the species listed above and determined that the following species are not likely to be adversely affected by the proposed action: Western North Pacific DPS humpback whale, Mexico DPS humpback whale, fin whales, Western DPS gray whales, North Pacific right whales, bowhead whales, and bearded seals. Western North Pacific DPS humpback whale, Mexico DPS humpback whale, fin whales, Western DPS gray whales, and North Pacific right whales are all sub-Arctic species greatly reducing the probability of exposure of these species to the transit of the research vessel. The range of bowhead whales and bearded seals includes both sub-Arctic and Arctic waters. Consequently, they are more likely to be exposed to the transit of the research vessel and are discussed individually in more detail below. Neither of these species will be present in the deep Arctic waters of the Beaufort Sea when the potentially harmful active acoustic sounds from the scientific equipment will be operating.

4.1.1. Sub-Arctic Cetaceans

Vessels transiting from Nome to the Beaufort Sea and back will overlap with the ranges of Western North Pacific DPS humpback whales, Mexico DPS humpback whales, fin whales, Western DPS gray whales, and North Pacific right whales. Vessel transit is the only aspect of this project that could potentially impact the other cetaceans as none are expected to be in the Beaufort Sea during the research activities. Only two roundtrips will be made, one in October 2021 and one in October of 2022. For Western North Pacific DPS humpback whales, Mexico DPS humpback whales, fin whales, Western DPS gray whales, and North Pacific right whales, the transit route and timing greatly reduce the probability of overlap with the vessel transit.

Mitigation measures that apply to all cetaceans include: 1) ships will avoid approaching marine mammals head-on and will maneuver to maintain an exclusion zone of 500 yards (yd; 457 m) around observed whales; 2) the Navy will have personnel assigned to stand watch at all times, day and night, when in transit; and 3) ships must use extreme caution and proceed at a safe speed (1-3 knots in ice; <10 knots in open ice-free waters). We expect that these mitigation measures will greatly reduce the probability of ship strike. These mitigation measures as well as characteristics of the species' biology and/or population size discussed below greatly reduce the likelihood of exposure of the cetaceans to stressors from the research vessels.

Two primary stressors are associated with vessels, noise and strikes. There will be no ice breaking activity as part of this project which eliminates that source of noise as a stressor. Although listed marine mammals may be exposed to acoustic stressors from vessel transit, the nature of the exposure will be low-frequency, with much of the acoustic energy emitted by the vessels at frequencies below the best hearing ranges of the marine mammals expected to occur within the action area. In addition, because vessels will be in transit, the duration of the exposure will be very brief (NMFS calculates that at 10 knots, the project vessel will ensonify a given point to levels above 120 dB for less than 9 minutes). If animals are exposed to vessel noise and presence, they may exhibit deflection from the noise source, engage in low level avoidance behavior, exhibit short-term vigilance behavior, or experience and respond to short-term acoustic masking behavior, but these behaviors are not likely to result in significant disruption of normal behavioral patterns. While a few whales may be exposed to short-term vessel noise, the effects are anticipated to be too small to detect or measure and are not likely to significantly disrupt normal whale behavioral patterns.

Vessel strike is an ongoing problem for large cetaceans. Vessel speed is a principal factor in whether a vessel strike results in death (Laist et al. 2001; Vanderlaan and Taggart 2007). With the low number of transits, implementation of the mitigation measures (person on watch at all times vessel is moving, speed < 10 knots), and the expected location of the cetaceans in October 2021 and spring of 2022, the probability of vessel strike is highly unlikely. Factors related to the biology of the individual species that reduce the chance of vessel strike are discussed below.

Western North Pacific DPS and Mexico DPS Humpback Whales

Based on an analysis of migration between winter mating/calving areas and summer feeding areas using photo-identification, Wade (2021)concluded that humpback whales feeding in Alaskan waters belong primarily to the Hawaii DPS (recovered), with small contributions of Western North Pacific DPS (endangered) and Mexico DPS (threatened) individuals. The overlap of humpback whales with the proposed action could occur during vessel transit from Nome through the Chukchi Sea. In this area we consider the Hawaii DPS humpbacks to comprise 91 percent of the individuals present, the Mexico DPS individuals to comprise 7 percent, and the Western North Pacific DPS individuals to comprise 2 percent (Wade 2021).

Humpback whales are relatively uncommon along the northwestern coast of Alaska. In 2019, the Aerial Surveys of Arctic Marine Mammals (ASAMM) which were conducted from July through October, documented 15 sightings of humpback whales in the Chukchi Sea (none in the Beaufort Sea) (Clarke et al. 2020). Of these, six occurred in September and one in October. We would expect that individuals of this species would be absent from the area traversed by the research vessel in the fall because of the humpback’s annual migration to temperate waters to calve and breed. This fact combined with the very low potential for individuals of a listed DPS to be present (2 or 7 percent) and the few total transits by the vessel, leads us to conclude that it is extremely unlikely that listed humpback whales will be exposed to the stressors caused by vessels.

Fin whales

Although there are signs of recovery from the population depletions caused by whaling, fin whales remain rare in the Chukchi Sea (Delarue et al. 2013). Fin whale calls were detected in the northeastern Chukchi Sea from July through October in three years (2007, 2009, and 2010) using large scale acoustic recorders (Delarue et al. 2013). The acoustic data suggest that several fin whale stocks may feed in the Bering Sea, but only one of the putative Bering Sea stocks appears to migrate north into the Chukchi Sea to feed in the summer (Delarue et al. 2013). Fin whales have recently been observed in the waters of the northern Bering Sea and southern Chukchi Sea (Clarke et al. 2020). The ASAMM documented 19 sightings of 36 fin whales in 2019, including 7 in September and 22 in October (Clarke et al. 2020). A Biologically Important Feeding Area has been identified for fin whales in the Bering Sea, south of St Lawrence Island, over 300 km south of Nome, the departure port for the research vessel (Ferguson et al. 2015). Fin whales are primarily found in deep offshore waters.

Fin whale presence in the fall in the vicinity of the research vessel transit route indicates that there is the possibility that fin whale occurrence could overlap with the vessel. However, the combination of the very low number of fin whales expected to be in the area, the adherence to the mitigation measures, and the low number of vessel transits (4 total) indicates that fin whales are highly unlikely to be exposed to stressors related to the vessel transit.

Western North Pacific DPS Gray Whale

Commercial whaling brought the Eastern and Western Pacific gray whale populations to near extinction, and international conservation measures were enacted in the 1930s and 1940s to protect whales from over-exploitation. Using photo-ID data, the estimated population size for Sakhalin and Kamchatka in 2016 was 231 whales (Cooke et al. 2019; Cooke et al. 2017). If there is a distinct western North Pacific breeding stock the range of estimates for the number of mature animals in that stock is well below 50 individuals (Cooke et al. 2017).

In the western North Pacific, gray whales feed during summer and fall in the Okhotsk Sea off northeast Sakhalin Island, Russia, and off southeastern Kamchatka in the Bering Sea (Burdin et al. 2017; Tyurneva et al. 2010; Weller et al. 2002; Weller et al. 1999). Some whales that feed off Sakhalin Island in summer migrate east across the Pacific to the west coast of North America in winter, while others migrate south to waters off Japan and China (Weller et al. 2016). Given the listed gray whales distribution, their low population number, and the limited number of vessel transits, it is extremely unlikely that individuals from Western North Pacific DPS would overlap with the research vessel transit route and thus effects due to vessel transit are extremely unlikely.

North Pacific right whale

The eastern North Pacific right whale population is estimated to be about 31 individuals (Muto et al. 2021). Migratory patterns of these whales are unknown, although it is thought they migrate from high-latitude feeding grounds in the summer to more temperate waters during winter. Calving grounds have not been found. Acoustic recorders deployed in the southeastern Bering Sea from 2000-2018 indicate that right whales remain in the southeastern Bering Sea from May through December with peak call detection in September (Muto et al. 2021). Monitoring from the eastern Bering shelf (2011-2015) indicated that North Pacific right whales occurred in two passes of the eastern Aleutian Islands (Umnak and Unimak Pass) and that North Pacific right whale calling occurred at consistently high levels in the southeastern Bering shelf during ice-free months (Wright 2016; Wright et al. 2019). Recent detections through visual sightings or passive acoustic monitors have been centered in the southeastern portion of the Bering Sea within critical habitat or east of critical habitat near Bristol Bay (Muto et al. 2021). Right whales are highly unlikely to be near Nome as it appears that their current distribution occurs south of the Bering Strait. Their current distribution and the limited number of transits (2 in the fall of 2021 and 2 in the fall of 2022) lead us to conclude that effects of vessel transit are extremely unlikely to occur and thus effects due to vessel transit are extremely unlikely.

4.1.2. Bowhead whale

4.1.2.1. Status and Population Structure

The International Whaling Commission (IWC) recognizes four stocks of bowhead whale for management purposes. The Western Arctic stock (also known as the Bering-Chukchi-Beaufort stock) is the largest and only stock found in U.S. waters and the action area (Muto et al. 2021).

The bowhead whale was listed as endangered under the Endangered Species Conservation Act (ESCA) of 1969 on December 2, 1970 (35 FR 18319). Congress replaced the ESCA with the ESA in 1973, and bowhead whales continued to be listed as endangered. Critical habitat has not been designated for bowhead whales. The bowhead whale became endangered because of past commercial whaling. The IWC placed a moratorium on commercial whaling, and called for a ban on subsistence whaling in 1977. The United States requested a modification of the ban on subsistence whaling, resulting in a limited quota for aboriginal subsistence whaling countries, including the U.S., promulgated and managed by the IWC.

Woodby and Botkin (1993) summarized previous efforts to determine a minimum worldwide population estimate prior to commercial whaling and reported a minimum pre-exploration estimate for all stocks of 50,000 whales, with 10,400 to 23,000 in the Western Arctic stock (dropping to less than 3,000 at the end of commercial whaling). Subsequently, Brandon and Wade (2006) used Bayesian model averaging to estimate that the Western Arctic stock consisted of 10,960 (9,190 to 13,950; 5th and 95th percentiles, respectively) bowheads in 1848 at the start of commercial whaling.

Givens et al. (2013) estimated that, from 1978 to 2011, the Western Arctic stock of bowhead whales increased at a rate of 3.7 percent (95 percent confidence interval of 2.8 to 4.7 percent) during which time abundance tripled from approximately 5,000 to approximately 16,000 whales. Similarly, using sight-resight analysis of aerial photographs, Schweder et al. (2010) estimated the yearly growth rate of this stock between 1984 and 2003 to be 3.2 percent. Based on corrected counts of bowhead whales by ice-based observers in 2001, the abundance of the Western Arctic stock was estimated to be 10,545 individuals (coefficient of variation, 0.128) (updated from George et al. (2004) by Zeh and Punt (2005)). Ten years later in 2011, the ice-based abundance estimate was 16,820 individuals (95 percent confidence interval, 15,704 to 18,928) (Givens et al. 2013). Using the 2011 population estimate of 16,820 and its associated coefficient of variation of 0.052, the most recent minimum population estimate for the Western Arctic stock of bowhead whales is 16,100 (Muto et al. 2021).

4.1.2.2 Distribution

Western Arctic bowhead whales are distributed in seasonally ice-covered waters of the Arctic and near-Arctic, generally north of 60°N and south of 75°N in the western Arctic Basin (Braham 1984; Moore and Reeves 1993). During winter and spring, bowhead whales are closely associated with 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. During summer, most of the population is in relatively ice-free waters in the southeastern Beaufort Sea; however, some whales move back and forth between the Alaskan and Canadian Beaufort Sea during the summer feeding season (Quakenbush et al. 2010).

The majority of the Western Arctic stock migrates annually from wintering areas (December to March) in the northern Bering Sea, through the Chukchi Sea in the spring (April through May), to the eastern Beaufort Sea where they spend much of the summer feeding (June through early to mid-October) before returning again to the Bering Sea in the fall (September through December) to overwinter (Muto et al. 2021) (Figure 9).

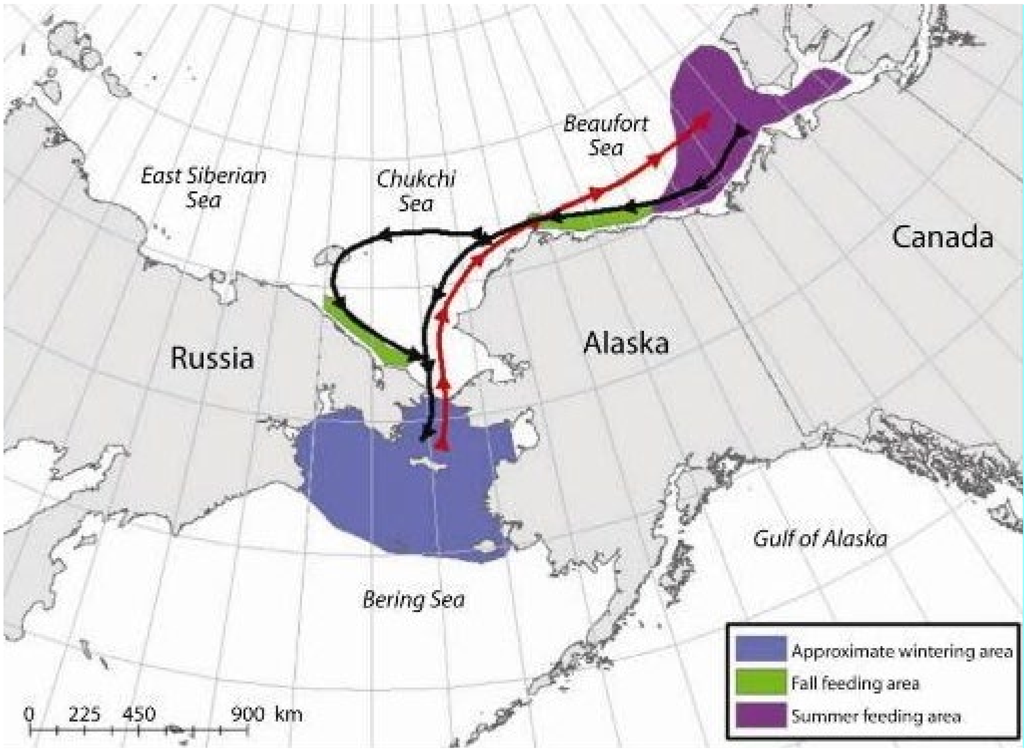

Figure 6. Generalized migration route, feeding areas, and wintering area for Western Arctic bowhead whale (Moore et al. 2006).

4.1.2.3 Occurrence in the Action Area

The vast majority of the bowhead population migrate to the Bering Sea during the fall and do not return eastwards through the Beaufort Sea again until the spring. During the eastward (spring) migration, the whales are distributed farther offshore. While a few whales may occur in the Central Beaufort Sea area throughout the summer, most of the population spend the summer in the eastern Beaufort Sea before passing through again during the latter part of summer and fall as they migrate west to over winter in the Bering Sea. Bowhead whales are most likely to be encountered during the fall migration when they travel closer to shore in water ranging from 15 to 200 m deep (50 to 656 ft) (Clarke et al. 2012; Miller et al. 2002). The fall migration trajectory varies annually and is influenced by ice presence (Moore and Reeves 1993). Treacy et al. (2006) found that the main migration corridor for bowhead whales during the fall migration was 73.4 km (46 mi) offshore in years of heavy ice conditions, 49.3 km (31 mi) offshore during moderate ice conditions, and 31.2 km (19 mi) offshore during light ice conditions.

Clarke et al. (2015) evaluated biologically important areas (BIAs) for bowheads in the U.S. Arctic region and identified nine BIAs. The fall (September-October) migratory corridor BIA (western Beaufort on and north of the shelf) for bowheads is relatively close to shore and will be crossed by the vessel transit (Figure 10). Clarke et al. (2015) also identified four BIAs for bowheads that are important for reproduction and encompassed areas where the majority of bowhead whales identified as calves were observed each season; the research vessel could pass through the western portion of this BIA (Figure 11d). Finally, three bowhead feeding BIAs were identified (Clarke et al. 2015). The September-October feeding BIA (bowheads feeding on the western Beaufort continental shelf, out to approximately the 50-m isobaths) would likely be crossed by the research vessel depending on its route (Figure 12).

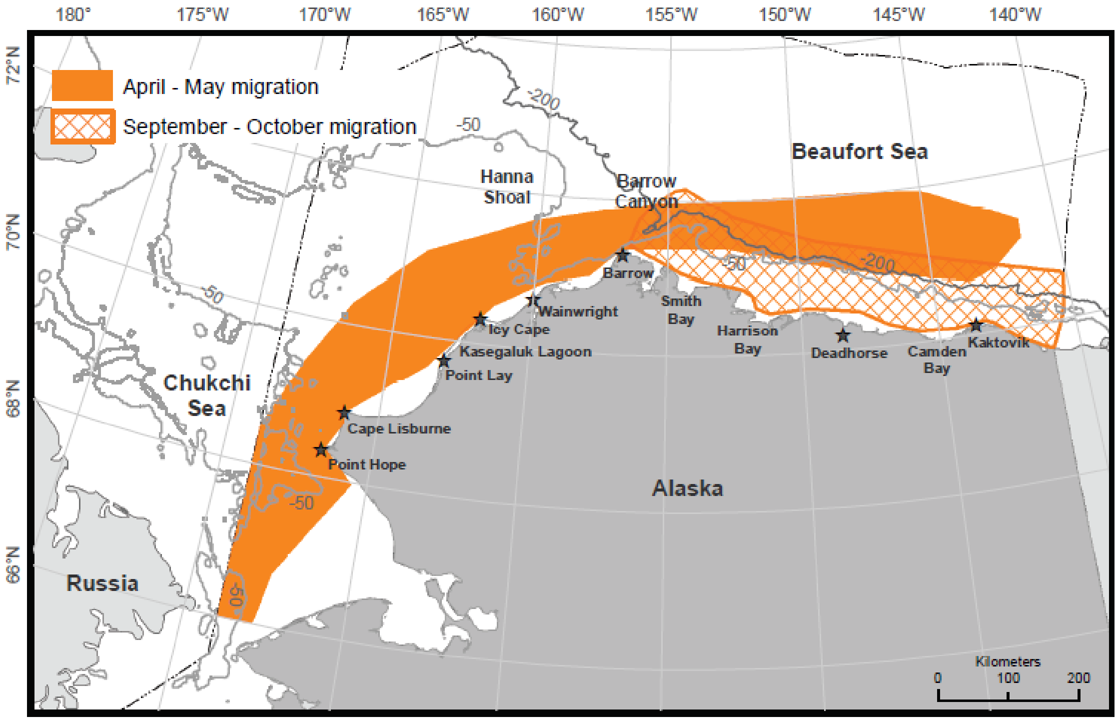

Figure 7. Bowhead whale migratory corridor BIAs for spring (April-May) and fall (September-October), determined from aerial- and ice-based surveys, satellite telemetry, and passive acoustic monitoring; also shown are the 50- and 200-m depth contours. (Clarke et al. 2015b, Figure 8.3)

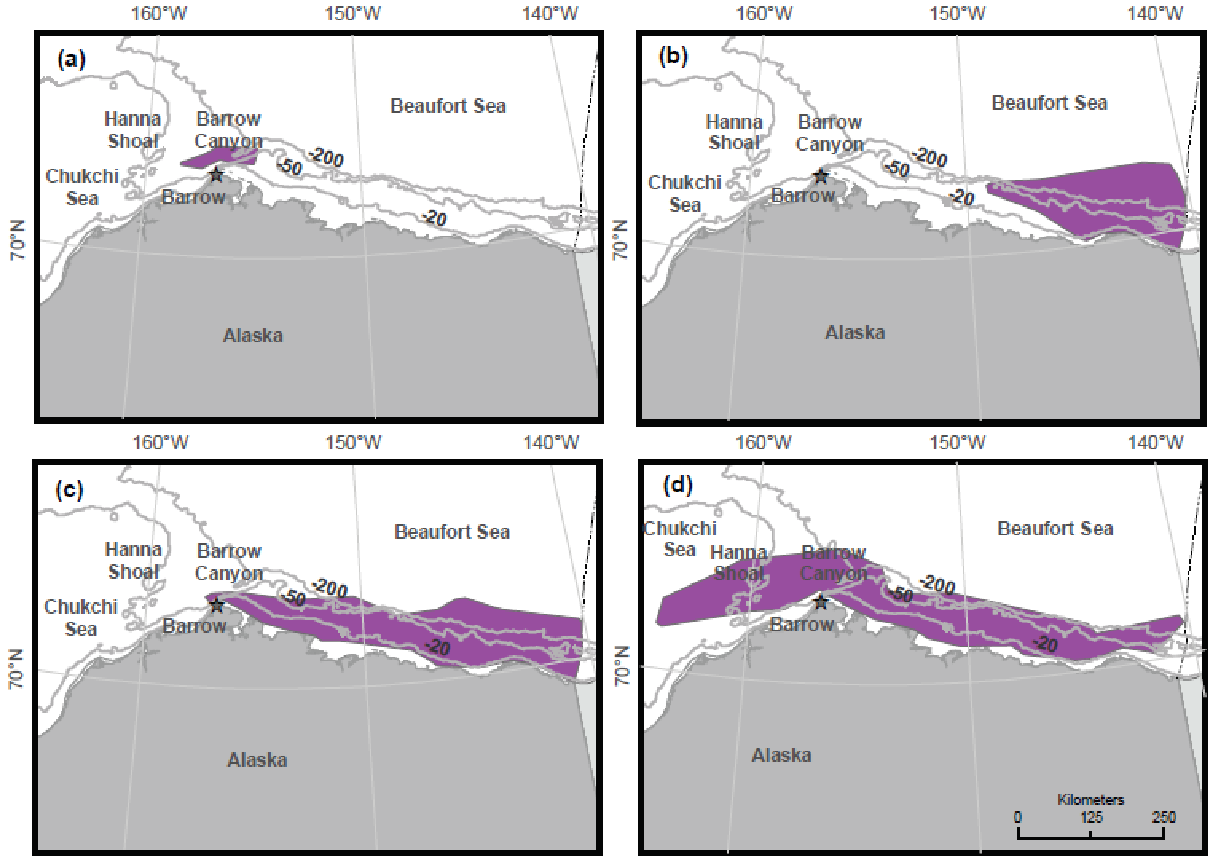

Figure 8. Bowhead whale reproduction BIAs during (a) spring and early summer (April through early June); (b) summer (July and August); and fall (c) September and (d) October, determined from calf sightings collected during aerial- and ice-based surveys. Also shown are the 20-, 50-, and 200-m depth contours (Clarke et al. 2015, Figure 8.1).

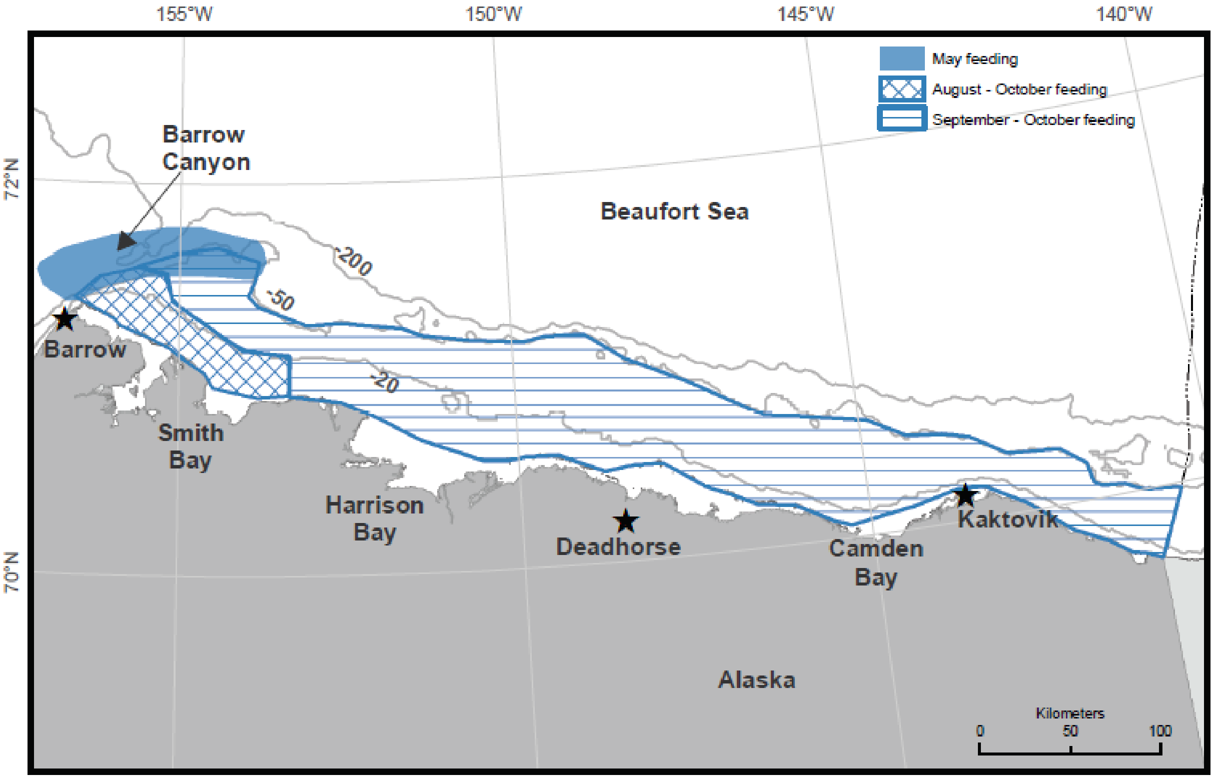

Figure 9. Bowhead whale feeding BIAs identified during the eastward spring migration in May near Barrow Canyon; from Smith Bay to Point Barrow in August through October, generally shoreward of the 20-m isobaths; and during the westward fall migration from September through October, generally shoreward of the 50-m isobath. BIAs were determined using aerial survey data. Also shown are the 20-, 50-, and 200-m depth contours (Clarke et al. 2015, Figure 8.2).

Ferguson et al. (2015) identified another bowhead migratory corridor and feeding BIA through the Bering Strait (Figure 13). The research vessel would need to pass through the northern portion of this migratory and feeding corridor on its way to and from the Bering Sea.

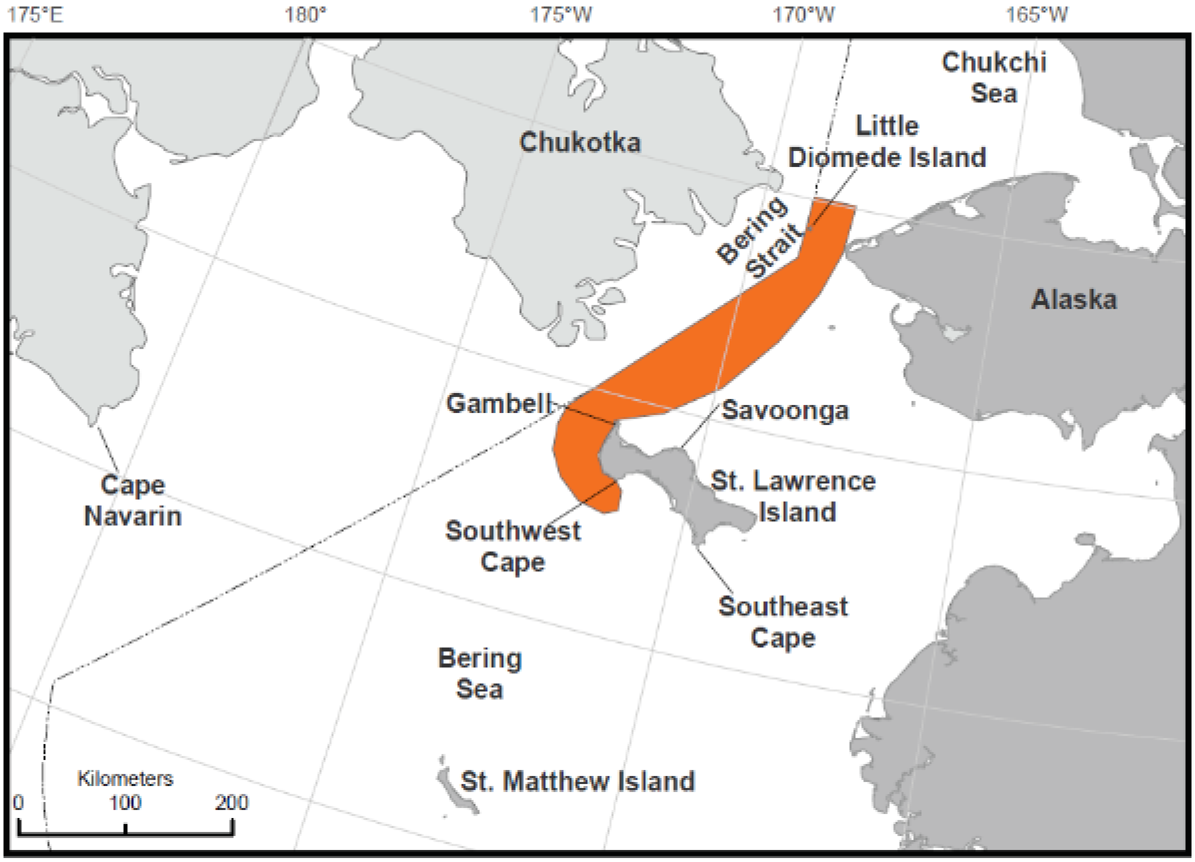

Figure 10. Bowhead whale BIA for the spring (northbound) migratory corridor through the Bering Sea; highest densities are from March through June, substantiated through aerial surveys, traditional ecological knowledge, and satellite-tagging data (Ferguson et al. 2015, Figure 7.2).

The Aerial Surveys of Arctic Marine Mammals (ASAMM) project is a continuation of the Bowhead Whale Aerial Survey Project and Chukchi Offshore Monitoring in Drilling Area marine mammal aerial survey project. The flights for these surveys typically occur from July through October. The distribution of bowhead whales recorded by these surveys is shown in Figure 14 and indicates that the route of the research vessels in October will intersect with bowhead whales as they move eastward in their fall migration. Halliday et al. (2021) found that within the Beaufort and Chukchi Seas during the shipping seasons in 2015-2017, the greatest ship traffic and modeled underwater noise from ships occurred in the southern Chukchi Sea near the Bering Strait. Because bowheads are in this area in September and October, the whales likely experience the highest number of underwater noise events and greatest overlap with ship traffic at this time.

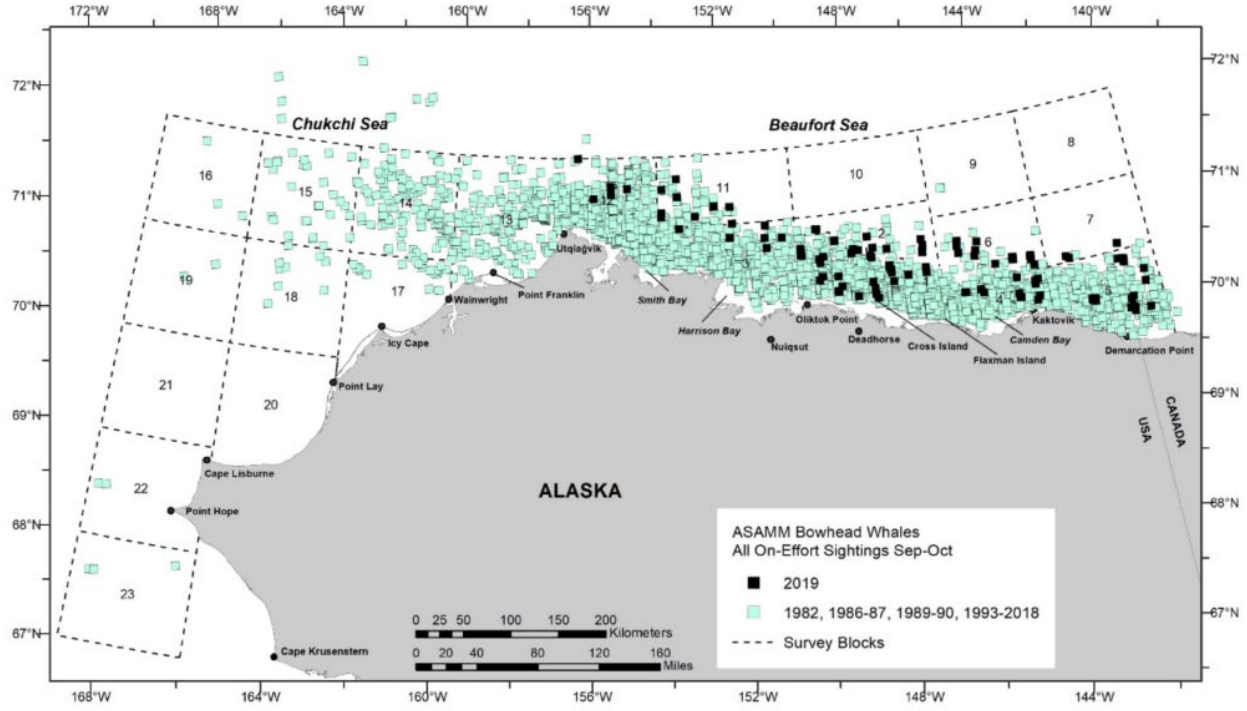

Figure 11. ASAMM bowhead whale sightings in the ASAMM study area, fall (September-October)

4.1.2.2. Hearing, Vocalizations, and Other Sensory Abilities

Bowhead whales are among the more vocal of the baleen whales (Clark and Johnson 1984). 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 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 3,500 Hz and lasts 0.3 to 7.2 seconds (Clark and Johnson 1984; Erbe 2002; Würsig and Clark 1993).

NMFS categorizes bowhead whales in the low-frequency cetacean (i.e., baleen whale) functional hearing group, with an estimated hearing range of 7 Hz to 35 kHz (NMFS 2018b). Inferring from their vocalizations, bowhead whales should be most sensitive to frequencies between 20 Hz and 5 kHz, with maximum sensitivity between 100 Hz and 500 Hz (Erbe 2002).

4.1.2.3. Effects

Vessel Noise

The proposed action includes one roundtrip of a research vessel from Nome to the Beaufort Sea and back in early October 2021 and one in the spring of 2022. No ice breaking will be involved. As described above mitigation measures include: 1) ships will avoid approaching marine mammals head-on and will maneuver to maintain an exclusion zone of 500 yards (yd; 457 m) around observed whales; 2) the Navy will have personnel assigned to stand watch at all times, day and night, when in transit; and 3) ships must use extreme caution and proceed at a safe speed

(1-3 knots in ice; <10 knots in open ice-free waters).

Disturbance to the bowhead whale from vessel noise could occur during the vessel transit. Behavioral reactions of marine mammals to vessels vary depending on the type and speed of the vessel, the spatial relationship between the animal and the vessel, the species, and the behavior of the animal prior to the disturbance from the vessel. Response also varies between individuals of the same species exposed to the same sound. Individual animals' past experiences with vessels appear to be important in determining an individual's response (Shell 2012).

The amount of underwater noise produced by large vessels ranges from 161 dB re 1 μPa at 1 m for military vessels to 192 dB re 1 μPa at 1 m for icebreakers (Halliday et al. 2021). The R/V *Sikuliaq* has a source level of 130 to 172 dB re 1 μPa at 1 m when travelling at maximum speed of 11 knots. Because the vessels will be in transit, the duration of the exposure to ship noise will be temporary. NMFS calculates that at 10 knots, the project vessel will ensonify a given point in space to levels above 120 dB for less than 9 minutes. The project vessel will emit continuous sound while in transit, which will alert marine mammals to the vessel's presence before the received sound level exceeds 120 dB. Therefore, a startle response is not expected. Rather, slight deflection and avoidance are expected to be common responses in those instances where there is any response at all. Although it is more likely that bowhead whales will be exposed to vessel noise than the sub-Arctic cetaceans, based on the low number of transits (4), the implementation of mitigation measures as specified in Section 2.2, the transitory and short-term exposure, and the expected response, NMFS concludes that the effects to bowhead whales from vessel noise are expected to be too small to detect or measure and are not likely to significantly disrupt normal whale behavioral patterns.

Vessel strike

Vessel strike is an ongoing problem for large cetaceans. Vessel speed is a principal factor in whether a vessel strike results in death (Laist et al. 2001; Vanderlaan and Taggart 2007). The research vessels used in this project will be traveling at 10 knots or less which provides more time for whale sighting and evasion. In addition, ships will avoid approaching marine mammals head-on and will maneuver to maintain an exclusion zone of 500 yards (yd; 457 m) around observed whales and personnel will be on watch at all times, day and night, when in transit. We expect that these mitigation measures will greatly reduce the probability of ship strike.

As discussed above the research vessel will pass through the migratory path and Biologically Important Areas in its transit across the coastal shelves of the Chukchi and Beaufort seas in October of 2021 and October 2022. The vessels will be crossing the migratory path of the bowheads for approximately 450 km, exposing the bowheads to strike for approximately 24 hours. Although there is annual overlap between ships using the Northern Sea Route and the Northwest Passage, scars associated with ship strike are seen on about 2 percent of harvested whales (George et al. 2017). Some whales may be struck and never seen. However, the bowhead whale population has been growing at a steady rate of 3.2 to 3.7 percent per year (Muto et al. 2021) indicating that although bowhead whales that may be struck, killed, and undetected their loss is not impeding continued population growth.

Because of the protective mitigation measures, the limited spatial and temporal overlap between the bowheads and the vessels, and little evidence to indicate that bowhead whale strike is currently occurring or inhibiting population recovery, we conclude that it is extremely unlikely that a bowhead whale will be struck by a research vessel.

4.1.3. Bearded Seals

4.1.3.1. Status and Population Structure

There are two recognized subspecies of the bearded seal: *E. b. barbatus*, often described as inhabiting the Atlantic sector (Laptev, Kara, and Barents seas, North Atlantic Ocean, and Hudson Bay; (Rice 1998)); and *E. b. nauticus*, which inhabits the Pacific sector (remaining portions of the Arctic Ocean and the Bering and Okhotsk seas; (Heptner et al. 1976; Manning 1974; Ognev 1935; Scheffer 1958). Based on evidence for discreteness and ecological uniqueness, NMFS concluded that the *E. b. nauticus* subspecies consists of two DPSs-the Okhotsk DPS in the Sea of Okhotsk, and the Beringia DPS, encompassing the remainder of the range of this subspecies (75 FR 77496; December 10, 2010). Only the Beringia DPS is found in U.S. waters (and the action area), and this portion is recognized by NMFS as a single Alaska stock. NMFS listed the Beringia DPS of bearded seals as threatened under the ESA on December 28, 2012 (77 FR 76740).

A reliable population estimate for the entire Alaska stock is not available, but research programs have recently developed new survey methods and partial, but useful, abundance estimates. In spring of 2012 and 2013, U.S. and Russian researchers conducted aerial abundance and distribution surveys over the entire Bering Sea and Sea of Okhotsk (Moreland et al. 2013). The data from these image-based surveys are still being analyzed, but for the U.S. portion of the Bering Sea, Boveng et al. (2017) reported model-averaged abundance estimates of 170,000 and 125,000 bearded seals in 2012 and 2013, respectively. These results reflect use of an estimate of availability (haulout correction factor) based on data from previously deployed satellite tags. The authors suggested that the difference in seal density between years may reflect differences in the numbers of bearded seals using Russian versus U.S. waters between years, and they noted that if this was the case, the eventual development of comprehensive estimates of abundance for bearded seals in the Bering Sea that incorporate data in Russian waters may show less difference between years.

4.1.3.1. Distribution

The Beringia DPS of the bearded seal includes all bearded seals from breeding populations in the Arctic Ocean and adjacent seas in the Pacific Ocean between 145°E longitude in the East Siberian Sea and 130°W longitude in the Canadian Beaufort Sea, except west of 157°W longitude in the Bering Sea and west of the Kamchatka Peninsula (where the Okhotsk DPS is found). 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 of known extent that are in waters less than 500 m (1,640 ft) deep.

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 moving ice that produces natural openings and areas of open-water (Fedoseev

1984; Heptner et al. 1976; Nelson et al. 1984). They usually avoid areas of continuous, thick, shorefast ice and are rarely seen in the vicinity of unbroken, heavy, drifting ice or large areas of multi-year ice (Burns 1981; Burns and Frost 1979; Burns and Harbo 1972; Fedoseev 1965; Fedoseev 1984; Nelson et al. 1984; Smith 1981). Within the U.S. range of the Beringia DPS, the extent of favorable ice conditions for bearded seals is most restricted in the Beaufort Sea, where there is a relatively narrow shelf with suitable water depths. In comparison, suitable ice conditions and water depths occur in limited areas of the Chukchi Sea, and over much broader areas in the Bering Sea (Burns 1981). During winter, the central and northern parts of the Bering Sea shelf, where heavier pack ice occurs, have the highest densities of adult bearded seals (Heptner et al. 1976, Burns and Frost 1979, Burns 1981, Nelson et al. 1984, Cameron et al. 2018), possibly reflecting the favorable ice conditions there. In contrast, Cameron et al. (2018) found that young bearded seals were closely associated with the ice edge farther south in the Bering Sea.

Spring surveys conducted in 1999 through 2000 along the Alaska coast of the Chukchi Sea, and in 2001 near St. Lawrence Island, indicated that bearded seals tended to prefer areas of between 70 and 90 percent ice coverage, and were typically more abundant in offshore pack ice 37 to 185 km (20 to 100 nautical miles [nm]) from shore than within 37 km (20 nm) from shore, except for high concentrations nearshore to the south of Kivalina (Bengtson et al. 2005; Simpkins et al. 2003).

It is thought that in the fall and winter most bearded seals move south with the advancing ice edge through Bering Strait into the Bering Sea where they spend the winter, and in the spring and early summer, as the sea ice melts, many of these seals move north through the Bering Strait into the Chukchi and Beaufort Seas (Burns 1967; Burns 1981; Burns and Frost 1979; Cameron and Boveng 2007; Cameron and Boveng 2009; Cameron et al. 2018). The overall summer distribution is quite broad, with seals rarely hauled out on land (Burns 1967, Heptner et al. 1976, Burns 1981, Nelson et al. 1984). However some seals, mostly juveniles, have been observed hauled out on land along lagoons and rivers in some areas of Alaska, such as in Norton Bay (Huntington 2000), near Wainwright (Nelson 1981), and on sandy islands near Barrow (Cameron et al. 2010).

4.1.3.2. Occurrence in the Action Area

Bearded seals are expected to be present along the vessel transit route through the Bering, Chukchi, and Beaufort seas. Although bearded seal vocalizations (produced by adult males) have been recorded nearly year-round in the Beaufort Sea (MacIntyre et al. 2013; MacIntyre et al. 2015), all the recorders were on the shelf area in water depths ranging from 46 to 131 m and less than 100 km from shore. The area where the active acoustic sources will be deployed for this project is more than 200 km offshore in water depths greater than 500 m (Figure 1). Bearded seals are primarily benthic feeders and are typically found in relatively shallow water (< 200 m) of the shelf areas of the Bering, Chukchi, and Beaufort seas, presumably because their prey is more accessible to them in the shallower water. Research activities will be taking place in water depths 500 m and greater. In addition, bearded seals prefer areas of high ice density and because an ice breaker is not going to be used, the vessel transit route will avoid areas of high ice density where bearded seals are more likely to be found.

4.1.3.1. Hearing and Vocalizations

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 (19 mi), are up to 60 seconds in duration, and are usually associated with stereotyped dive displays (Cleator et al. 1989; Van Parijs 2003; Van Parijs and Clark 2006; Van Parijs et al. 2001; Van Parijs et al. 2003; Van Parijs et al. 2004).

Underwater audiograms for phocids suggest that they have very little hearing sensitivity below 1 kHz, and make calls between 90 Hz and 16 kHz (Richardson et al. 1995). NMFS defines the functional hearing range for phocids as 50 Hz to 86 kHz (NMFS 2018b). Phocids (ringed and bearded seals) 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 vessel noise (Gordon et al. 2003).

4.1.3.2. Effects

Vessel noise

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) (Cameron et al. 2010); the research vessels will be traversing through potentially occupied habitat in October. Consequently, adverse effects that could occur to bearded seal vocalizations from vessel noise (masking), will be avoided because there will not be temporal overlap. Although some bearded seals will likely be exposed to vessel noise, based on the low number of transits (4), the implementation of mitigation measures as specified in Section 2.2, the transitory and short-term exposure, and the expected response, NMFS concludes that the effects to bearded seals from vessel noise are expected to be too small to detect or measure and are not likely to significantly disrupt normal bearded seal behavioral patterns.

Vessel strike

Bearded seals will likely be able to hear the research vessels from many kilometers away, and if disturbed, would likely move away from the vessel noise before it comes in close proximity. Although Sternfeld (2004) documented a single spotted seal stranding in Bristol Bay, Alaska that may have resulted from a propeller strike, no incidents of ship strike with bearded or ringed seals are noted in the Stock Assessment Reports (Muto et al. 2021) or in recent reports of human caused mortality and serious injury of listed marine mammals in Alaska (Delean et al. 2020). In addition, bearded seals are extremely agile and capable of moving quickly in the water greatly reducing the probability of being struck by a vessel traveling at 10 knots. Finally, personnel will be watching for marine mammals during marine operations, further reducing the possibility of ship strike. Therefore, we conclude that the probability of project vessels or equipment striking a bearded seal is very small, and adverse effects to bearded seals are extremely unlikely to occur.

4.2 Climate Change

One threat common to all the species we discuss in this opinion is global climate change. Because of this commonality, we present an overview of this shared threat here rather than in each of the species-specific narratives. A vast amount of literature is available on climate change and for more detailed information we refer the reader to these websites which provide the latest data and links to the current state of knowledge on the topic in general, and in the Arctic specifically:

https://www.ipcc.ch/reports/

https://climate.nasa.gov/evidence/

http://nsidc.org/arcticseaicenews/

https://arctic.noaa.gov/Report-Card

The listed marine mammals we consider in this opinion live in the ocean and depend on the ocean for nearly every aspect of their life history. Factors which affect the ocean, like temperature and pH, can have direct and indirect impacts on marine mammals and the resources they depend upon. Global climate change may affect all the species we consider in this opinion, but it is expected to affect them differently. First, we provide background on the physical effects climate change has caused on a broad scale; then we focus on changes that have occurred in Alaska. Finally, we provide an overview of how these physical changes translate to biological effects.

4.2.1 Physical Effects

4.2.1.1 Air Temperature

There is consensus throughout the scientific community that atmospheric temperatures are increasing, and will continue to increase, for at least the next several decades (Oreskes 2004; Watson and Albritton 2001). The Intergovernmental Panel on Climate Change (IPCC) estimated that since the mid-1800s, average global land and sea surface temperature has increased by 0.85°C (±0.2°C), with most of the change occurring since 1976 (IPCC 2019). 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).

Continued emission of greenhouse gases is expected to cause further warming and long-lasting changes in all components of the climate system, increasing the likelihood of severe, pervasive and irreversible impacts for people and ecosystems (IPCC 2019). The decadal global land and ocean surface average temperature anomaly for 2011–2020 indicates that it was the warmest decade on record for the globe, with a surface global temperature of +0.82°C (+1.48°F) above the 20th century average[2]. This surpassed the previous decadal record (2001–2010) value of +0.62°C (+1.12°F)[3]. The 2020 Northern Hemisphere land and ocean surface temperature was the highest in the 141-year record at +1.28°C (+2.30°F) above average. This was 0.06°C (0.11°F) higher than the previous record set in 2016[2].

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[2] https://www.ncdc.noaa.gov/sotc/global/202013 viewed on 5/31/2021

[3] https://www.ncdc.noaa.gov/sotc/global/202013 viewed on 5/31/2021

The impacts of climate change are especially pronounced at high latitudes. Since 2000, the Arctic (latitudes between 60ºN and 90ºN) has been warming at more than two times the rate of lower latitudes because of “Arctic amplification,” a characteristic of the global climate system influenced by changes in sea ice extent, atmospheric and oceanic heat transports, cloud cover, albedo, black carbon, and many other factors[4] (Overland et al. 2017; Serreze and Barry 2011). Across Alaska, average air temperatures have been increasing, and the average annual temperature is now 1.65-2.2°C (3-4°F) warmer than during the early and mid-century (Thoman and Walsh 2019). Winter temperatures have increased by 3.3°C (6˚F) (Chapin et al. 2014) and the snow season is shortening (Thoman and Walsh 2019). The statewide average annual temperature in 2020 was 27.5°F, 1.5°F above the long-term average even though it was the coldest year since 2012[5]. Some of the most pronounced effects of climate change in Alaska include disappearing sea ice, shrinking glaciers, thawing permafrost, and changing ocean temperatures and chemistry (Chapin et al. 2014).

4.2.1.2 Ocean Heat

Higher air temperatures have led to higher ocean temperatures. More than 90% of the excess heat created by global climate change is stored in the world’s oceans, causing increases in ocean temperature (Cheng et al. 2020; IPCC 2019). The upper ocean heat content, which measures the amount of heat stored in the upper 2000 m (6,561 ft) of the ocean, was the highest on record in 2019 by a wide margin, and is the warmest in recorded human history (Cheng et al. 2020). The seas surrounding Alaska have been unusually warm in recent years, with unprecedented warmth in some cases (Thoman and Walsh 2019). This effect can be seen throughout the Alaska region, including the Bering, Chukchi, and Beaufort seas (Figure 6) (Thoman and Walsh 2019).

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[4] NASA wepbage. State of the Climate: How the World Warmed in 2019. Available at https://www.carbonbrief.org/state-of-the-climate-how-the-world-warmed-in-2019, accessed January 20, 2020.

[5] https://www.ncdc.noaa.gov/sotc/national/202013 viewed on 5/31/2021

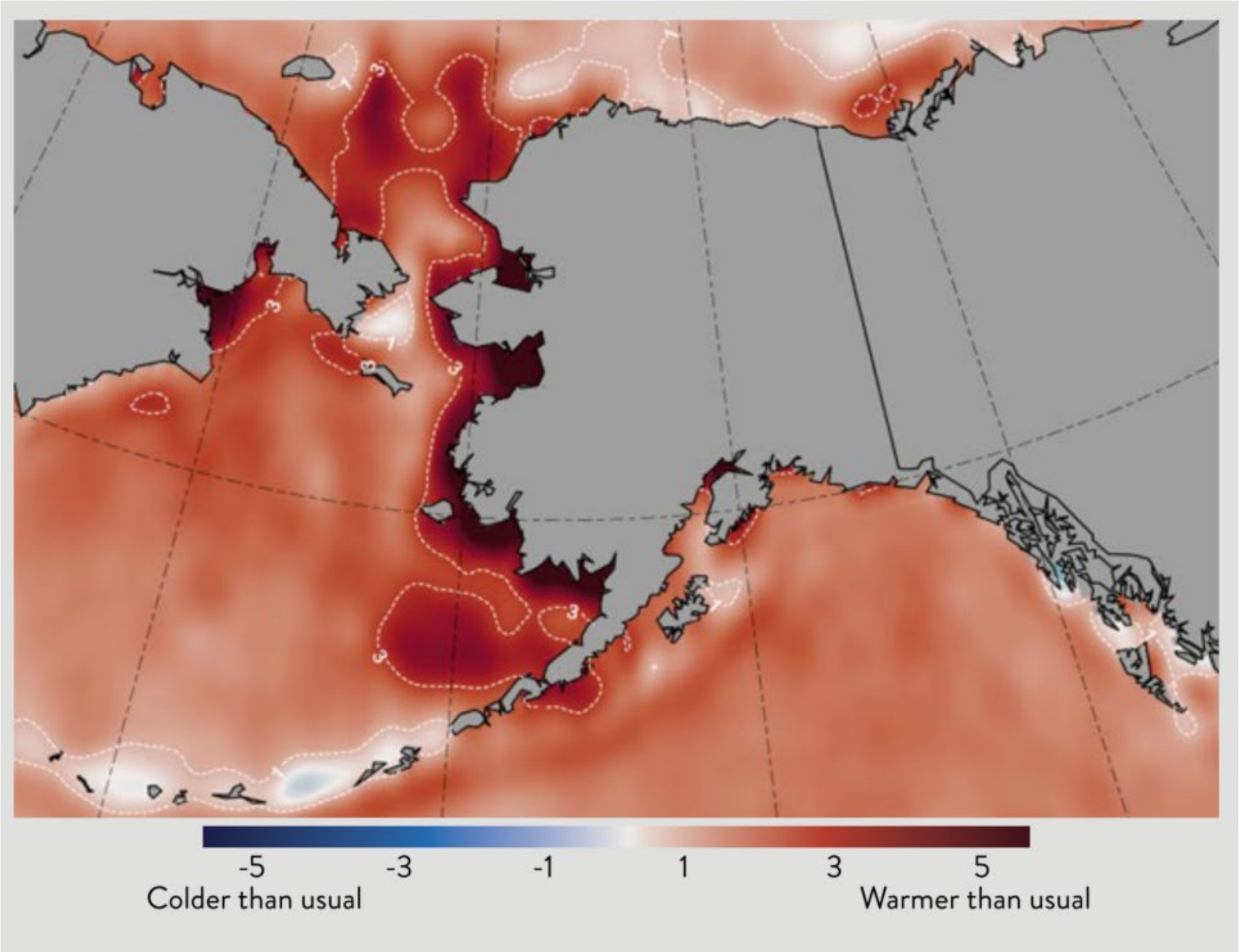

Figure 12. Arctic summer sea surface temperatures, 2019 (Thoman and Walsh 2019).

Warmer ocean water affects sea ice formation and melt. In the first decade of the 21st century, Arctic sea ice thickness and annual minimum sea ice extent (i.e., September sea ice extent) declined at a considerably accelerated rate and continues to decline (Stroeve et al. 2007; Stroeve and Notz 2018) (Figure 7). Approximately three-quarters of summer Arctic sea ice volume has been lost since the 1980s (IPCC 2013). In addition, old ice (> 4 years old), which is thicker and more resilient to melting than young ice, constituted 33% of the ice pack in 1985, but by March 2019, it represented only 1.2% of the ice pack in the Arctic Ocean (Perovich et al. 2019). Multiyear ice for 2021 in the Artic as a whole is at a record low[6]. Overland (2020) suggests that the loss of the thicker older ice makes the Arctic ecosystem less resilient. Both the maximum sea ice extent (March) and the minimum (September) have consistently been decreasing, although the summer minimums are more pronounced (Perovich et al. 2019) (Figure 7). The minimum Arctic sea ice extent in 2019 was effectively tied with 2007 and 2016 for second lowest, only behind 2012, which is the record minimum[7].

Wang and Overland (2009) estimated that the Arctic will become essentially ice-free (i.e., sea ice

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[6] http://nsidc.org/arcticseaicenews/ viewed August 23, 2021

[7] National Snow and Ice Data Center. Monthly Archives. http://nsidc.org/arcticseaicenews/2019/09/

extent will be less than 1 million km^2) during the summer between the years 2021 and 2043 and modeling with the new generation climate models provides independent support of an ice-free Arctic in mid-century or earlier (Guarino et al. 2020; Notz and Stroeve 2016; SIMIP Community 2020). Once the entire Arctic Ocean becomes a seasonal ice zone, its ecosystem will change fundamentally as sea ice is the key forcing factor in polar oceans (Wassmann et al. 2011).

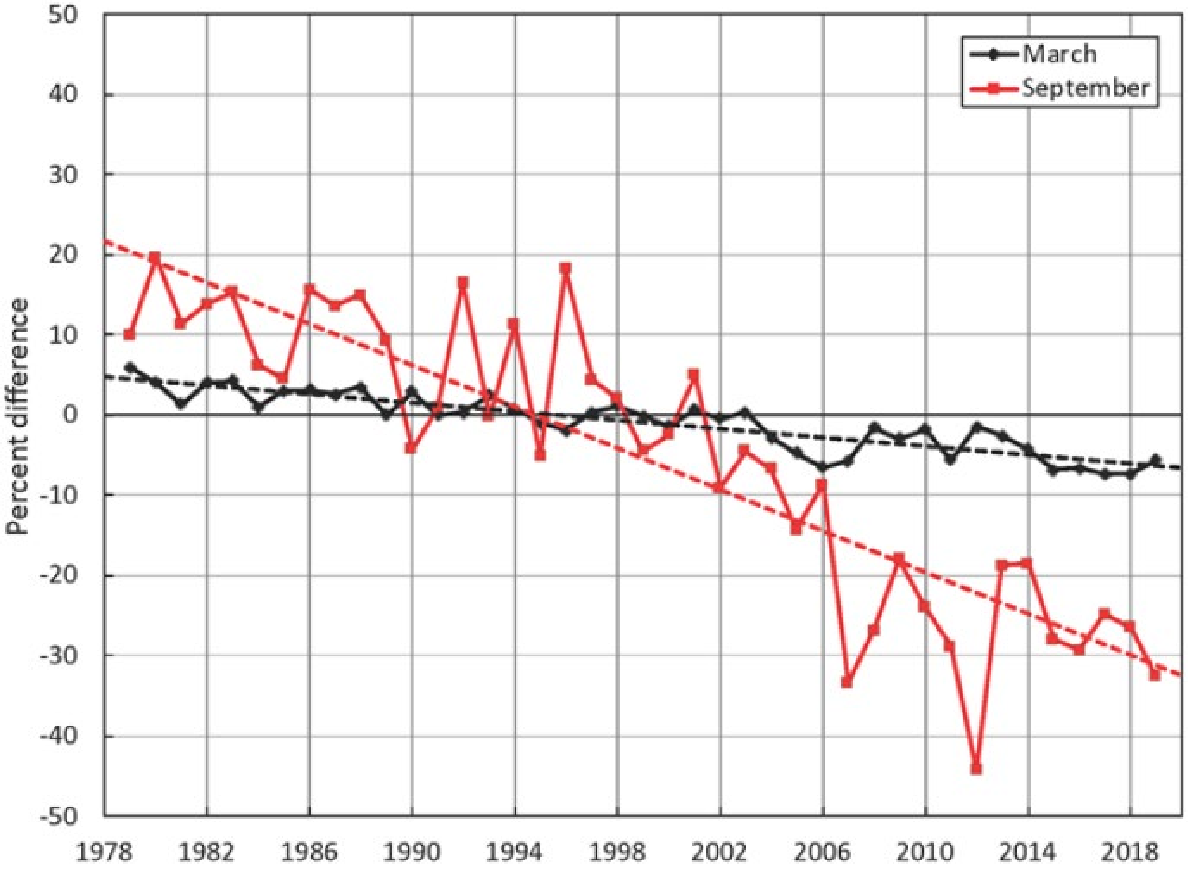

Figure 13. Arctic ice extent declines in September (red) and in March (black). The value for each year is the difference in percent in ice extent relative to the mean values for 1981-2010. Both trends are significant at the 99% confidence level. The slopes of the lines indicate losses of -2.7 for the maximum ice extent and -12.9 percent for the minimum ice extent, per decade.

Related to the loss of sea ice is the northward shift and near loss of the cold-water pool in the eastern Bering Sea. Winter sea ice creates a pool of cold (<2ºC) bottom water that is protected from summer mixing by a thermocline (Mueter and Litzow 2008). With the reduction in winter sea ice, the cold-water pool has shrunk (Figure 8). Many temperate species, especially groundfish, are intolerant of the low temperatures so the extent of sea ice determines the boundary between arctic and subarctic seafloor communities and demersal vs pelagic fish communities (Grebmeier et al. 2006). In the Pacific Arctic, large scale, northward movements of commercial stocks are underway as previously cold-dominated ecosystems warm and fish move northward to higher latitude, relatively cooler environments (Eisner et al. 2020; Grebmeier et al. 2006). Not only fish, but plankton, crabs and ultimately, sessile invertebrates like clams are affected by these changes in water temperature (Fedewa et al. 2020; Grebmeier et al. 2006).

Another ocean water anomaly is described as a marine heat wave. Marine heat waves are described as a coherent area of extreme warm temperature at the sea surface that persists (Frölicher et al. 2018). Marine heatwaves are a key ecosystem driver and there has been an increase from 30 percent in 2012 to nearly 70 percent of global oceans in 2016 experiencing strong or severe heatwaves (Suryan et al. 2021). The largest recorded marine heat wave occurred in the northeast Pacific Ocean from 2013-2015 (Frölicher et al. 2018). Initially called “the blob” the northeast Pacific marine heatwave (PMH) first appeared off the coast of Alaska in the winter of 2013-2014 and by the end of 2015 it stretched from Alaska to Baja California. In mid-2016, the PMH began to dissipate, based on sea surface temperature data but warming re-intensified in late-2018 and persisted into fall 2019 (Suryan et al. 2021). Consequences of this event included an unprecedented harmful algal bloom that extended from the Aleutian Islands to southern California, mass strandings of marine mammals, shifts in the distribution of invertebrates and fish, and shifts in abundance of several fish species (Cavole et al. 2016). Cetaceans, forage fish (capelin and herring), Steller sea lions, adult cod, chinook and sockeye salmon in the Gulf of Alaska were all impacted by the PMH (Bond et al. 2015; Peterson et al. 2016; Sweeney et al. 2018).

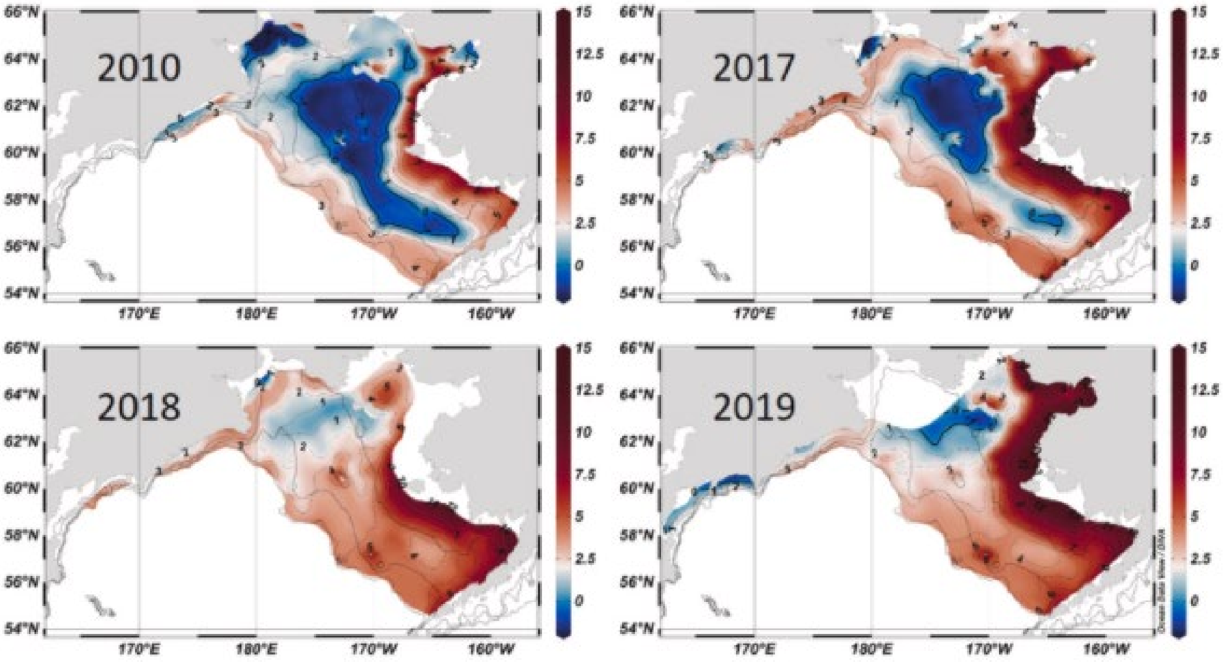

Figure 14. Bottom temperatures from summer oceanographic surveys. Graphic display of the shrinkage of the cold pool over time. From (Eisner et al. 2020).

The 2018 Pacific cod stock assessment[8] estimated that the female spawning biomass of Pacific cod (an important prey species for Steller sea lions) was at its lowest point in the 41-year time series, following three years of poor recruitment and increased natural mortality as a result of the PMH. In 2020 the spawning stock biomass dropped below 20 percent of the unfished spawning biomass and the federal Pacific cod fishery in the Gulf of Alaska was closed by regulation to

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[8] NOAA Fisheries, Alaska Fisheries Science Center website. Available at https://apps-afsc.fisheries.noaa.gov/REFM/stocks/Historic_Assess.htm, accessed December 2, 2020.

directed Pacific cod fishing (Barbeaux et al. 2020). Twenty percent is a minimum spawning stock size threshold instituted to help ensure adequate forage for the endangered western stock of Steller sea lions.

4.2.1.3 Ocean Acidification

For 650,000 years or more, the average global atmospheric carbon dioxide (CO_2) concentration varied between 180 and 300 parts per million (ppm), but since the beginning of the industrial revolution in the late 1700s, atmospheric CO_2 concentrations have been increasing rapidly, primarily due to anthropogenic inputs (Fabry et al. 2008; Lüthi et al. 2008). The world's oceans have absorbed approximately one-third of the anthropogenic CO_2 released, which has buffered the increase in atmospheric CO_2 concentrations (Feely et al. 2009; Feely et al. 2004). Despite the oceans' role as large carbon sinks, the CO_2 level continues to rise and is currently over 410 ppm[9].

As the oceans absorb CO_2, the pH of seawater is reduced. This process is referred to as ocean acidification. Ocean acidification reduces the saturation states of certain biologically important calcium carbonate minerals like aragonite and calcite that many organisms use to form and maintain shells (Bates et al. 2009; Reisdorph and Mathis 2014). When seawater is supersaturated with these minerals, calcification (growth) of shells is favored. Likewise, when the sea water becomes undersaturated, dissolution is favored (Feely et al. 2009).

High latitude (colder) oceans have naturally lower saturation states of calcium carbonate minerals than more temperate or tropical waters, making Alaska's oceans more susceptible to the effects of ocean acidification (Fabry et al. 2009; Jiang et al. 2015). Model projections indicated that aragonite undersaturation would start to occur by about 2020 in the Arctic Ocean and by 2050, all of the Arctic will be undersaturated with respect to aragonite (Feely et al. 2009; Qi et al. 2017). Large inputs of low-alkalinity freshwater from glacial runoff and melting sea ice contribute to the problem by reducing the buffering capacity of seawater to changes in pH (Reisdorph and Mathis 2014). As a result, seasonal undersaturation of aragonite was already detected in the Bering Sea at sampling stations near the outflows of the Yukon and Kuskokwim Rivers, and the Chukchi Sea (Fabry et al. 2009). Models and observations indicate that rapid sea ice loss will increase the uptake of CO_2 and exacerbate the problem of aragonite undersaturation in the Arctic (DeGrandpre et al. 2020; Yamamoto et al. 2012).

Undersaturated waters are potentially highly corrosive to any calcifying organism, such as corals, bivalves, crustaceans, echinoderms and many forms of zooplankton such as copepods and pteropods, and consequently may affect Arctic food webs (Bates et al. 2009; Fabry et al. 2008). Pteropods, which are often considered indicator species for ecosystem health, are prey for many species of carnivorous zooplankton, fishes including salmon, mackerel, herring, and cod, and baleen whales (Orr et al. 2005). Because of their thin shells and dependence on aragonite, under increasingly acidic conditions, pteropods may not be able to grow and maintain shells (Lischka and Riebesell 2012). It is uncertain if these species, which play a large role in supporting many levels of the Alaskan marine food web, may be able to adapt to changing ocean conditions (Fabry et al. 2008; Lischka and Riebesell 2012)

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[9] NOAA Global Monitoring Laboratory website. Trends in Atmospheric Carbon Dioxide. Available at https://www.esrl.noaa.gov/gmd/ccgg/trends/, accessed November 10, 2020.

4.2.2 Biological Effects

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 (Burek et al. 2008; Doney et al. 2012; Hinzman et al. 2005; Huntington et al. 2020). The physical effects on the environment described above have impacted, are impacting, and will continue to impact marine species in a variety of ways (IPCC 2014), such as:

- Shifting abundances
- Changes in distribution
- Changes in timing of migration
- Changes in periodic life cycles of species.

Some of the biological consequences of the changing Arctic conditions are shown in Table 5.

Table 5. A summary of possible direct and indirect health effects for Arctic marine mammals related to climate change, adapted from (Burek et al. 2008).

Effect	Result
Direct	
Increase in ocean temperature	Changes in distribution and range (fish, whales) Increase in harmful algal blooms (all affected) Loss of suitable habitat Change in prey base
Loss of sea ice platform (seals)	Reduction of suitable habitat for feeding, resting, molting, breeding Movement, distribution, life history may be affected
Changes in weather	Reduction in snow on sea ice, loss of suitable lair habitat for ringed seals
Ocean acidification	Changes in prey base (all affected)
Indirect	
Changes in infectious disease transmission (changes in host–pathogen associations due to altered pathogen transmission or host resistance)	Increased host density due to reduced habitat, increasing density-dependent diseases. Epidemic disease due to host or vector range expansion. Increased survival of pathogens in the environment. Interactions between diseases, loss of body condition, and increased immunosuppressive contaminants, resulting in increased susceptibility to endemic or epidemic disease.
Alterations in the predator–prey relationship	Affect body condition and, potentially, immune function.

Effect	Result
Changes in toxicant pathways (harmful algal blooms, variation in long-range transport, biotransport, runoff, increased use of the Arctic)	Mortality events from biotoxins Toxic effects of contaminants on immune function, reproduction, skin, endocrine systems, etc.
Other negative anthropogenic impacts related to longer open water period	Increased likelihood of ship strikes, fisheries interactions, acoustic injury Chemical and pathogen pollution due to shipping or aquaculture practices. Introduction of nonnative species

Climate change is likely to have its most pronounced effects on species whose populations are already in tenuous positions (Isaac 2009). For species that rely primarily on sea ice for major parts of their life history, we expect that the loss of sea-ice would negatively impact those species' ability to thrive. Consequently, we expect the future population viability of at least some ESA-listed species to be affected with global warming.

Changes in ocean surface temperature may impact species migrations, range, prey abundance, and overall habitat quality. For ESA-listed species that undertake long migrations, if either prey availability or habitat suitability is disrupted by changing ocean temperature regimes, the timing of migration can change. For example, cetaceans with restricted distributions linked to cooler water temperatures may be particularly exposed to range restriction (Isaac 2009; Learmonth et al. 2006). Macleod (2009) estimated that, based on expected shifts in water temperature, 88 percent of cetaceans will be affected by climate change, 47 percent will be negatively affected, and 21 percent will be put at risk of extinction. Of greatest concern are cetaceans with ranges limited to non-tropical waters, and preferences for shelf habitats (Macleod 2009).

4.3 Status of Listed Species Likely to be Adversely Affected by the Action

This opinion examines the status of the species likely to be adversely affected by the proposed action. The status is determined by the level of extinction risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. This informs the description of the species' likelihood of both survival and recovery. The species status section also helps to inform the description of the species' current "reproduction, numbers, or distribution" as described in 50 CFR § 402.02. The opinion also examines the condition of critical habitat throughout the designated area and discusses the current function of the essential Physical and Biological Features that help to form that conservation value.

For each species, we present a summary of information on the population structure and distribution to provide a foundation for the exposure analyses that appear later in this opinion. Then we summarize information on the threats to the species and the species' status given those threats to provide points of reference for the jeopardy determinations we make later in this opinion. That is, we rely on a species' status and trend to determine whether an action's effects are likely to increase the species' probability of becoming extinct.

More detailed background information on the status of ringed seal can be found in a number of published documents including stock assessment reports on Alaska marine mammals by Muto et al. (2021). Kelly et al. (2010b) provided a status review of ringed seals. Richardson et al. (1995), Tyack (2000), and Tyack (2009) provided detailed analyses of the functional aspects of cetacean communication and their responses to anthropogenic noise.

4.3.1 Ringed seal

4.3.1.1 Status and Population Structure

Under the MMPA, NMFS recognizes one stock of Arctic ringed seals, the Alaska stock, in U.S. waters (and the action area). The Arctic ringed seal was listed as threatened under the ESA on December 28, 2012, primarily due to expected impacts on the population from declines in sea ice and snow cover stemming from climate change within the foreseeable future (77 FR 76706). NMFS has not prepared a Recovery Plan for the Arctic subspecies of ringed seal.

Ringed seal population surveys in Alaska have used various methods and assumptions, incompletely covered their habitats and range, and were conducted more than a decade ago; therefore, current and comprehensive abundance estimates or trends for the Alaska stock are not available. Frost et al. (2004) conducted aerial surveys within 40 km (25 mi) of shore in the Alaska Beaufort Sea during May and June from 1996 through 1999 and observed ringed seal densities ranging from 0.81 seals per square kilometer in 1996 to 1.17 seals per square kilometer in 1999. Moulton et al. (2002) conducted similar, concurrent surveys in the Alaska Beaufort Sea between 1997 and 1999, but reported substantially lower ringed seal densities than Frost et al. (2004). The reason for this disparity was unclear (Frost et al. 2004). Bengtson et al. (2005) conducted aerial surveys in the Alaska Chukchi Sea during May and June of 1999 and 2000. While the surveys were focused on the coastal zone within 37 km (23 mi) of shore, additional survey lines were flown up to 185 km (115 mi) offshore. Population estimates were derived from observed densities corrected for availability bias using a haul-out model from six tagged seals. Ringed seal abundance estimates for the entire survey area were 252,488 (standard error = 47,204) in 1999 and 208,857 (standard error = 25,502) in 2000. Using the most recent survey estimates from surveys by (Bengtson et al. 2005) and Frost et al. (2004) in the late 1990s and 2000, Kelly et al. (2010b) estimated the total population in the Alaska Chukchi and Beaufort seas to be at least 300,000 ringed seals. This estimate is likely an underestimate since the Beaufort Sea surveys were limited to within 40 km from shore.

Though a reliable population estimate for the entire Alaska stock is not available, research programs have recently developed new survey methods and partial, but useful, abundance estimates. In spring of 2012 and 2013, U.S. and Russian researchers conducted image-based aerial abundance and distribution surveys of the entire Bering Sea and Sea of Okhotsk (Moreland et al. 2013). The data from these surveys are still being analyzed, but for the U.S. portion of the Bering Sea, Boveng et al. (2017) reported model-averaged abundance estimates of 186,000 and 119,000 ringed seals in 2012 and 2013, respectively. It was noted that these estimates should be viewed with caution because a single point estimate of availability (haul-out correction factor) was used and the estimates did not include ringed seals in the shorefast ice zone, which was surveyed using a different method. The authors suggested that the difference in seal density between years may reflect differences in the numbers of ringed seals using Russian versus U.S.

waters between years, and they noted that if this was the case, the eventual development of comprehensive estimates of abundance for ringed seals in the Bering Sea that incorporate data in Russian waters may show less difference between years. Due to the lack of precise population estimates, the population trends for the Arctic subspecies and Alaska stock are unknown. For the purposes of the IHA, the Permits Division used a conservative population estimate of 171,418 (95 percent CI: 141,588-201,090) based on a subsample of data collected from the U.S. portion the Bering Sea in 2012 (Conn et al. 2014).

4.1.3.3. Distribution

Arctic ringed seals have a circumpolar distribution and are found throughout the Arctic basin and in adjacent seasonally ice-covered seas. They remain with the ice most of the year and use it as a haul-out platform for resting, pupping, and nursing in late winter to early spring, and molting in late spring to early summer. During summer, ringed seals range hundreds to thousands of kilometers to forage along ice edges or in highly productive open-water areas (Freitas et al. 2008; Harwood et al. 2015; Harwood and Stirling 1992; Kelly et al. 2010b). Harwood and Stirling (1992) reported that in late summer and early fall, aggregations of ringed seals in open-water in some parts of their study area in the southeastern Canadian Beaufort Sea where primary productivity was thought to be high. Harwood et al. (2015) also found that in the fall, several satellite-tagged ringed seals showed localized movements offshore east of Point Barrow in an area where bowhead whales are known to concentrate in the fall to feed on zooplankton. With the onset of freeze-up in the fall, ringed seal movements become increasingly restricted. Seals that have summered in the Beaufort Sea are thought to move west and south with the advancing ice pack, with many seals dispersing throughout the Chukchi and Bering seas while some remain in the Beaufort Sea (Crawford et al. 2012; Frost and Lowry 1984; Harwood et al. 2012). Some adult ringed seals return to the same small home ranges they occupied during the previous winter (Kelly et al. 2010).

4.1.3.4. Occurrence in the Action Area

In Alaskan waters, during winter and early spring when sea ice is at its maximal extent, ringed seals are abundant in the northern Bering Sea, Norton and Kotzebue Sounds, and throughout the Chukchi and Beaufort seas (Frost 1985; Kelly 1988), and therefore are in the study area. Passive acoustic monitoring (PAM) of ringed seals from a high frequency recording package deployed at a depth of 787 ft. (240 m) in the Chukchi Sea (65 nm) 120 km north-northwest of Barrow, Alaska detected ringed seals in the area between mid-December and late May over the four year study (Jones et al. 2014). At the onset of the fall freeze, ringed seal movements become increasingly restricted and seals will either move west and south with the advancing ice pack into the Chukchi and Bering Seas, with some remaining in the Beaufort Sea (Crawford et al. 2012; Frost and Lowry 1984; Harwood et al. 2012).

A density estimate of 0.3958 ringed seals per km^2 was used (among other information) to estimate take (see Section 10). This density estimate was derived from habitat-based modeling by (Kaschner 2004) and (Kaschner et al. 2006). The study area in the Beaufort Sea has not been surveyed in a manner that supports quantifiable density estimation of marine mammals. In the absence of empirical survey data, information on known or inferred associations between marine habitat features and the likelihood of the presence of specific species have been used to predict densities using model-based approaches. These habitat suitability models include relative environmental suitability (RES) models. Habitat suitability models can be used to understand the possible extent and relative expected concentration of a marine species distribution. These models are derived from an assessment of the species occurrence in association with evaluated environmental explanatory variables that results in defining the RES suitability of a given environment. A fitted model that quantitatively describes the relationship of occurrence with the environmental variables can be used to estimate unknown occurrence in conjunction with known habitat suitability. Abundance can thus be estimated for each RES value based on the values of the environmental variables, providing a means to estimate density for areas that have not been surveyed.

4.1.3.5. Feeding, Diving, Hauling out and Social Behavior

Ringed seal pups are born and nursed in the spring (March through May), normally in subnivean birth lairs, with the peak of pupping occurring in early April (Frost and Lowry 1981). Subnivean lairs provide thermal protection from cold temperatures, including wind chill effects, and some protection from predators (Smith 1976; Smith and Stirling 1975). These lairs are especially important for protecting pups. Arctic ringed seals appear to favor shore-fast ice for whelping habitat. Ringed seal whelping has also been observed on both nearshore and offshore drifting pack ice (e.g., Lentfer 1972). Seal mothers continue to forage throughout lactation, and move young pups between lairs within their network of lairs. The pups spend time learning diving skills, using multiple breathing holes, and nursing and resting in lairs (Lydersen and Hammill 1993; Smith and Lydersen 1991). After a 5 to 8 week lactation period, pups are weaned (Lydersen and Hammill 1993; Lydersen and Kovacs 1999).

Mating is thought to take place under the ice in the vicinity of birth lairs while mature females are still lactating (Kelly et al. 2010a). Ringed seals undergo an annual molt (shedding and regrowth of hair and skin) that occurs between mid-May to mid-July, during which time they spend many hours hauled out on the ice (Reeves 1998). The relatively long periods of time that ringed seals spend out of the water during the molt have been ascribed to the need to maintain elevated skin temperatures during new hair growth (Feltz and Fay 1966). Figure 15 summarizes the approximate annual timing of Arctic ringed seal reproduction and molting (Kelly et al. 2010a).

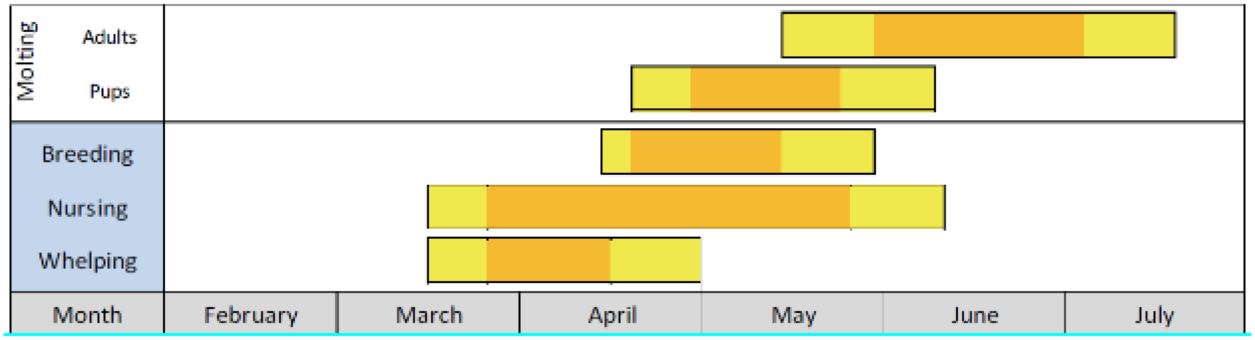

Figure 15. Approximate annual timing of Arctic ringed seal reproduction and molting. Yellow bars indicate the “normal” range over which each event is reported to occur and orange bars

indicate the “peak” timing of each event (Kelly et al. 2010a).

Ringed seals tend to haul 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 (Carlens et al. 2006; Kelly et al. 2010a; Kelly et al. 2010b; Kelly and Quakenbush 1990; Lydersen 1991; Teilmann et al. 1999).

Ringed seals feed year-round, but forage most intensively during the open-water period and early freeze-up, when they spend 90 percent or more of their time in the water (Kelly et al. 2010a). 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. Fish 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 (Holst et al. 2001; Labansen et al. 2007; Lowry et al. 1980; Smith 1987). Quakenbush et al. (2011) reported evidence that in general, the diet of Arctic ringed seals sampled from Alaska waters consisted of cod, amphipods, and shrimp. Fish 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., Holst et al. 2001; Lowry et al. 1980).

4.1.3.6. Hearing, Vocalizations, and Other Sensory Capabilities

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, and make calls between 90 Hz and 16 kHz (Richardson et al. 1995). NMFS defines the function hearing range for phocids as 50 Hz to 86 kHz (NMFS 2018).

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).

5. Environmental Baseline

The “environmental baseline” refers to the condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. 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 areas that have already undergone formal or early section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation process. The consequences to listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline (50 CFR § 402.02). This section discusses the environmental baseline, focusing on existing anthropogenic and natural activities within the action area and their influences on listed species and their critical habitat that may be adversely affected by the proposed action.

5.1. Climate Change

All areas of the action area are being affected by climate change. Although the species living in the Arctic successfully adapted to changes in the climate in the past, the current rate of change is accelerated (Simmonds and Eliott. 2009). As described in Section 4.2, effects to Arctic ecosystems are very pronounced, wide-spread, and well documented. While a changing climate may create opportunities for range expansion for some species, the life cycles and physiological requirements of many specialized polar species are closely linked to the annual cycles of sea ice and photoperiod and they may be less adaptable (Doney et al. 2009; Wassmann et al. 2011). Because the rate of change is occurring so quickly, the changes may exceed species' ability to adapt. Additionally, the loss of sea ice as a barrier increases the potential for further anthropogenic impacts as vessel traffic for transportation and tourism increases, resource extraction activities expand, and pathogens or disease have a path into newly ice-free regions.

As discussed in Section 4.2, the Arctic is warming at two or more times the global average. One consequence of the warming is a reduction in the length of the snow season (Figure 16). The depth and duration of snow cover are projected to continue to decline substantially throughout the range of the Arctic ringed seal, reducing the areas with suitable snow depths for their lairs by an estimated 70 percent by the end of this century (Hezel et al. 2012). It has been observed that the mean thickness of snow accumulating on sea ice has declined from approximately 35 to 22 cm in the western Arctic and 33 to 15 cm in the Beaufort and Chukchi Seas since the mid-1900s (Webster et al. 2014). A decrease in the availability of suitable sea ice conditions (including depth of snow on ice available for lair formation) may not only lead to high mortality of ringed seal pups but may also produce behavioral changes in seal populations (Loeng et al. 2005). The persistence of this species will likely be challenged as decreases in ice and, especially, snow cover lead to increased juvenile mortality from premature weaning, hypothermia, and predation (Kelly et al. 2010b).

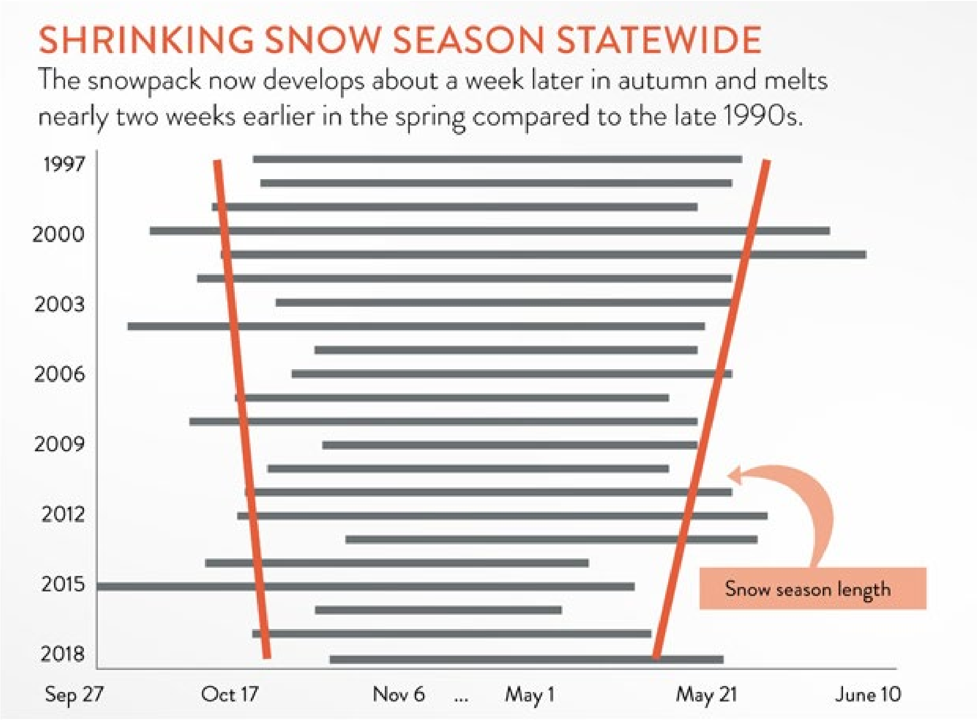

Figure 16. Length of the snow season (gray bars) in Alaska each year from 1997-2018. Orange slanting bars show the trends of the date when the state becomes 50 percent snow covered in fall and when half the winter snow has melted in spring. Image by Rick Thoman, Alaska Center for Climate and Policy.

Because the sea ice extent and thickness have been decreasing consistently, vessel traffic, and more importantly for seals, ice breaker traffic will be increasing in the Arctic (NMFS 2020; U.S. Committee on the Marine Transportation System 2019). Although seals are maneuverable enough to avoid vessels in open water, icebreakers could be lethal to nursing pups through collisions or crushing by displaced ice (Wilson et al. 2020; Wilson et al. 2017). In a study of Caspian seals (*Pusa capsica)* from 2006-2013, Wilson et al. (2017) documented the response of seals to ice breakers that made regular transits across the Caspian Sea. The ice breaking route had high densities of breeding seals in most years. A whole range of impacts to mothers and their pups was documented including being struck by the ice breaker, moving away from the ice breaker as it approached, and having mothers and pups separated. Vessel passage may destroy birth sites, water access holes, and pup shelters replacing those features with brash ice or open water. Often pups were marooned on fragments of intact ice or wetted in brash ice. Fragmented brash ice may cause disorientation, stress, and increased energetic demands (Wilson et al. 2017). With the Northern Sea Route and Northwest Passage being available more often and an increase in icebreakers, we would expect that ice dependent seals could be affected.

With an earlier retreat of sea ice in the spring and warmer ocean temperatures (Section 4.2.1.2), there have been changes in the distribution of whales. Aerial surveys to study the distribution, relative abundance, and behavior of marine mammals have been conducted in the eastern Chukchi Sea, primarily during July through October, 1982–1991 and 2008–2016, for the Aerial

Surveys of Arctic Marine Mammals (ASAMM) project and its precursors (Brower et al. 2018). Although historical records from commercial whaling and scientific research document humpback, fin, and minke whales from June through October in the western Chukchi Sea and near the Chukotka coast, few records of these subarctic species exist in the eastern Chukchi Sea (Clarke et al. 2013) and these species were entirely absent from this area in the 1982–1991 surveys (Brower et al. 2018). In contrast, there were 159 sightings of 250 individuals of these species in 2008–2016 in the eastern Chukchi Sea (Brower et al. 2018).

In addition to these observations, passive acoustic monitors (PAM) have been recording the presence of subarctic species in various parts of the Chukchi Sea (Crance et al. 2015; Delarue et al. 2013; Hannay et al. 2013; Tsujii et al. 2016). These species generally arrive in the southern Chukchi Sea after the sea ice melts (late July) and leave before it extends over the area in October or early November (Hannay et al. 2013; Tsujii et al. 2016). PAM also recorded the farthest northeast record of fin whale calls in the Alaskan Arctic (Crance et al. 2015). We would expect as sea ice continues to decline, presence of these subarctic species in more northerly latitudes will increase.

As mentioned earlier, shipping in the Arctic is expected to increase as sea ice decreases. Both major shipping routes, the Northern Sea Route along the northern Russian coast and the Northwest Passage through the Canadian Archipelago, pass through Bering Strait. The entire population of bowhead whales passes through Bering Strait each spring and fall between wintering and summering areas (Quakenbush et al. 2012). There are about 33 km (20 mi) between the west side of the Diomedes Islands and the Chukotka coast. Ships traveling along the coast between October and December could encounter a high proportion of the bowhead population (Quakenbush et al. 2012). Ship strikes are the greatest source of mortality for North Atlantic right whales (*Eubalaena glacialis*) and bowhead and North Pacific right whales may be as vulnerable to ship strikes as North Atlantic right whales due to their swimming speed and feeding behavior (Reeves et al. 2012). Two percent of subsistence-harvested bowheads bear scars from vessel encounters (George et al. 2017). In addition, with the expansion of habitat by the subarctic species to the north, interactions with ship traffic in the Bering Strait is an area of concern for all species (Reeves et al. 2012).

Some Arctic species may benefit from some aspects of climate change. Conceptual models suggested that overall reductions in sea ice cover should increase the Western Arctic stock of bowhead whale prey availability (Moore and Laidre 2006). 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). (George et al. 2006), showed that harvested bowheads had better body condition during years of light ice cover. Similarly, George et al. (2015) found an overall improvement in bowhead whale body condition and a positive correlation between body condition and summer sea ice loss over the last 2.5 decades in the Pacific Arctic. George et al. (2015) speculated that sea ice loss has positive effects on secondary trophic production within the Western Arctic bowhead whale's summer feeding region. Moore and Huntington (2008) anticipated that bowhead whales will alter migration routes and occupy new feeding areas in response to climate related environmental change.

5.1.1.1. Biotoxins

As temperatures in the Arctic waters warm and sea ice diminishes, marine mammal health may be compromised through nutritional and physiological stress, toxins from harmful algal blooms, and exposure to new pathogens. As mentioned in Section 4.2.1.2, an unprecedented harmful algal bloom extended from the Aleutian Islands to southern California as a result of the Pacific marine heatwave causing mass strandings of marine mammals (Cavole et al. 2016). Fey et al. (2015) found that across all animal taxa biotoxicity from harmful algal blooms was one of the events most often associated with mass mortality events. Two of the most common biotoxins along the West Coast of the Pacific are the neurotoxins domoic acid and saxitoxin (Lefebvre et al. 2016). Although these toxins can cause death, they can also cause sublethal effects including reproductive failure and chronic neurological disease (Broadwater et al. 2018).

Domoic acid was first recognized as a threat to marine mammal health in 1998 when hundreds of California sea lions (*Zalophus californianus*) died along beaches in central California or exhibited signs of neuroexcitotoxicity including seizures, head weaving, and ataxia (Scholin et al. 2000). Along the west coast of the United States and Canada, a coastwide bloom of the toxigenic diatom *Pseudo-nitzschia* in spring 2015 resulted in the largest recorded outbreak of domoic acid. Record-breaking concentrations of the marine neurotoxin caused unprecedented widespread closures of commercial and recreational shellfish and finfish fisheries and contributed to the stranding of numerous marine mammals along the U.S. west coast (McCabe et al. 2016).

Lefebvre et al. (2016) examined 13 species of marine mammals from Alaska including 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 (Figure 17). Domoic acid was detected in all 13 species examined and had the greatest prevalence in bowhead whales (68%) and harbor seals (67%). Saxitoxin was detected in 10 of the 13 species, with the highest prevalence in humpback whales (50%) and bowhead whales (32%) and 5% of the animals tested had both toxins present (Lefebvre et al. 2016). It is not known if exposure to multiple toxins result in additive or synergistic effects or perhaps suppress immunity to make animals more vulnerable to secondary stressors (Broadwater et al. 2018). With declining sea ice, warmer water temperatures, and changes in ocean circulation patterns, NOAA anticipates that harmful algal blooms in the Arctic will likely worsen in the future[10].

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[10] NOAA Arctic Program. Arctic Report Card: Update for 2018, Available at https://arctic.noaa.gov/Report-Card/Report-Card-2018/ArtMID/7878/ArticleID/789/Harmful-Algal-Blooms-in-the-Arctic, accessed November 10, 2020.

Figure 17. Algal toxins detected in 13 species of marine mammals from southeast Alaska to the Arctic from 2004 to 2013 (Lefebvre et al. 2016).Marine mammal species are listed as follows: (A) humpback whales, (B) bowhead whales, (C) beluga whales, (D) harbor porpoises, (E) northern fur seals, (F) Steller sea lions, (G) harbor seals, (H) ringed seals, (I) bearded seals, (J) spotted seals, (K) ribbon seals, (L) Pacific walruses and (M) northern sea otters.

5.1.1.2. Disease

In addition to influencing animal nutrition and physiological stress, environmental shifts caused by climate change may foster exposure to new pathogens in Arctic marine mammals. Through altered animal behavior and absence of physical barriers, loss of sea ice may create new pathways for animal movement and introduction of infectious diseases into the Arctic. The health impacts of this new normal in the Arctic are unknown, but new open water routes through the Arctic suggest that opportunities for Phocine distemper virus (PDV) and other pathogens to cross between North Atlantic and North Pacific marine mammal populations may become more common (VanWormer et al. 2019). PDV is a pathogen responsible for extensive mortality in European harbor seals (*Phoca vitulina vitulina*) in the North Atlantic. Prior to 2000, serologic surveys of Pacific harbor seals (*Phoca vitulina richardsii*), Steller sea lions, and northern sea otters off Alaska showed little evidence of exposure to distemper viruses, and PDV had not been identified as a cause of illness or death. PDV was not confirmed in the North Pacific Ocean until it was detected in northern sea otters sampled in 2004 (VanWormer et al. 2019). In addition to PDV, *Brucella*, and Phocid herpesvirus-1 have been found in Alaskan marine mammals (Zarnke et al. 2006). Herpesviruses were implicated in fatal and nonfatal infections of harbor seals in the North Pacific (Zarnke et al. 2006).

Ringed and bearded seals have co-evolved with numerous parasites and diseases, and these relationships are presumed to be stable. However, beginning in mid-July 2011, elevated numbers of sick or dead seals, primarily ringed seals, with skin lesions were discovered in the Arctic and Bering Strait regions. By December 2011, there were more than 100 cases of affected pinnipeds, including ringed seals, bearded seals, spotted seals, and walruses, in northern and western Alaska. Due to the unusual number of marine mammals discovered with similar symptoms across a wide geographic area, NMFS and USFWS declared a Northern Pinniped Unusual Mortality Event (UME) on December 20, 2011. Disease surveillance efforts in 2012 through 2014 detected few new cases similar to those observed in 2011. To date, no specific cause for the disease and deaths has been identified.

Likewise, in 2019, a UME was declared for bearded, ringed, and spotted seals in the Bering and Chukchi seas because of elevated mortality documented starting in June 2018 and continuing through the summer of 2019[11]. Since June 1, 2018, NMFS confirmed 311 strandings[12] (Table 6). The cause of the UME has not been determined but many of the seals had low fat thickness. All age classes were affected. The seals that were sampled did not have the hair loss or skin lesions that were prominent in the prior UME. Subsistence hunters noted that some of the seals had less fat than normal. The lowest sea ice maximums occurred in 2017 and 2018 when the retreat of sea ice was very rapid. It is unknown if these extreme sea ice conditions played a role in the health of the seals.

Table 6. Stranded seals in the Bering and Chukchi seas from 2018-2021.

Year	Bearded	Ringed	Spotted	Unidentified	Total
2018 (June 1-Dec 31)	35	29	20	28	112
2019	49	36	23	57	165
2020	10	9	8	11	38
2021 (as of September 3)	14	13	4	34	65
Total*	**108**	**87**	**55**	**130**	**380**
*June 1, 2018 - 27 August 2021. Source: https://www.fisheries.noaa.gov/alaska/marine-life-distress/2018-2020-ice-seal-unusual-mortality-event-alaska					

5.2. Fisheries

Commercial, subsistence, and recreational fisheries along the marine transit route portion of the action area may harm or kill listed marine species through direct bycatch, gear interactions (entrapments and entanglements), vessel strikes, contaminant spills, habitat modification, competition for prey, and behavioral disturbance or harassment.

Globally, 6.4 million tons of fishing gear is lost in the oceans every year (Wilcox et al. 2015). Entrapment and entanglement in fishing gear is a frequently documented source of human-

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[11] Barbara Mahoney, 2019, unpublished document. Ice Seal UME Update in the Alaska Region Marine Mammal Stranding Network Fall/Winter 2019 newsletter.

[12] NOAA Fisheries. 2018-2020 Ice seal unusual mortality event in Alaska webpage. Available at: https://www.fisheries.noaa.gov/alaska/marine-life-distress/2018-2020-ice-seal-unusual-mortality-event-alaska, accessed November 10, 2020.

caused mortality in cetaceans (see Dietrich et al. 2007). Fisheries interactions have an impact on many marine mammal species. More than 97 percent of whale entanglements are caused by derelict fishing gear (Baulch and Perry 2014). Materials entangled tightly around a body part may cut into tissues, enable infection, and severely compromise an individual's health (Derraik 2002a). Mortality from entanglement may be underreported, as many marine mammals that die from entanglement tend to sink rather than strand ashore. Entanglement may also make marine mammals more vulnerable to additional dangers, such as predation and ship strikes, by restricting agility and swimming speed.

Entanglement can include many different gear interaction scenarios, but the following have occurred with listed species covered in this opinion:

- Cetaceans may ingest fishing gear, likely mistaking it for prey, which can lead to fitness consequences and mortality. Ingestion of gear and/or hooks can cause serious injury depending on whether the gear works its way into the gastrointestinal tract, whether the gear penetrates the gastrointestinal tract lining, is lodged in the esophagus, and the location of the hooking (e.g., embedded in the animal's stomach or other internal body parts) (Andersen et al. 2008; Helker et al. 2019). Necropsies of stranded whales have found that ingestion of net pieces, ropes, and other fishing debris has resulted in gastric impaction and ultimately death (Jacobsen et al. 2010).
- Gear loosely wrapped around the marine mammal's body that moves or shifts freely with the marine mammal's movement and does not indent the skin can result in disfigurement.
- Gear that encircles any body part and has sufficient tension to either indent the skin or to not shift with marine mammal's movement can cause lacerations, partial or complete fin amputation, organ damage, or muscle damage and interfere with mobility, feeding, and breathing. Lines from weighed gear (e.g., crab pots) that becomes entangled with whales can cause drowning or exhaustion. In July 2010, a dead bowhead whale was found in Kotzebue Sound, entangled in crab pot gear similar to that used in the Bering Sea (Suydam et al. 2011). In 2015, a dead female bowhead whale was found near St. Lawrence Island in the Bering Strait, entangled in fishing gear. The gear was identified as originating in the 2012/2013 winter commercial king crab fishery from the northern Bering Sea, near St. Matthew Island (Muto et al. 2018; Suydam et al. 2016).
- Chronic tissue damage from line under pressure can compromise a whale's physiology. Fecal samples from entangled whales had extremely high levels of cortisols (Rolland et al. 2005), an immune system hormone. Extended periods of pituitary release of cortisols can exhaust the immune system, making a whale susceptible to disease and infection.

From 2013 to 2017, the minimum estimated mean annual mortality and serious injury rate for bearded seals in U.S. commercial fisheries between 2013 and 2017 is 1.6 from three federally-managed US commercial fisheries in the Bering Sea and Aleutian Islands (Bering Sea/Aleutian Islands (BSAI) pollock trawl, BSAI flatfish trawl, and BSAI Pacific trawl fisheries) (Muto et al. 2020). During the same timeframe, the minimum estimated mean annual mortality and serious injury rate for ringed seals by the U.S. commercial fisheries was 2.4 for BSAI flatfish trawl (Muto et al. 2020). Entanglement and entrapment in trawl fishery gear was the leading cause of serious injury and mortality for all phocids analyzed in Helker et al. (2019).

Because no commercial fisheries occur in the Chukchi and Beaufort seas, any observed serious injury or mortality to listed species in the Arctic that can be associated with commercial fisheries is currently attributable to interactions with fisheries in other areas, including in the Bering Sea/Aleutian Islands (BSAI) management area and Gulf of Alaska (GOA). For example, George et al. (2017) analyzed scarring data for bowhead whales harvested between 1990 and 2012 to estimate the frequency of line entanglement. Approximately 12 percent of the harvested whales examined for signs of entanglement (59/486) had scar patterns that were identified with high confidence as entanglement injuries (29 whales with possible entanglement scars were excluded). Most of the entanglement scars occurred on the peduncle, and entanglement scars were rare on smaller subadult and juvenile whales (body length <10 m). The authors suspected the entanglement scars were largely the result of interactions with derelict fishing/crab gear in the Bering Sea. The estimate of 12 percent entanglement does not include bowheads that may have died as a result of entanglement.

There are no Federal Fishery Observer Program records of bowhead whale mortality incidental to U.S. commercial fisheries in Alaska. However, in early July 2010 a dead bowhead whale was found floating in Kotzebue Sound entangled in crab pot gear similar to that used by commercial crabbers in the Bering Sea (Suydam et al. 2011); and during the 2011 spring aerial photographic survey of bowhead whales near Point Barrow, an entangled bowhead whale was photographed (Mocklin et al. 2012). No details about the entanglement were provided. Citta et al. (2015) found that the distribution of satellite-tagged bowhead whales in the Bering Sea overlapped spatially and temporally with areas where commercial pot fisheries occurred and noted the potential risk of entanglement in lost gear. The total estimated annual mortality and serious injury rate in U.S. commercial fisheries in 2012 through 2016 is 0.2 bowhead whales (Muto et al. 2019); however, the actual rate is currently unknown. As mentioned above, George et al. (2017) found evidence of past entanglements (entanglement scars). This is thought to be an underestimate, as animals killed as a result of entanglement are no longer part of this sampled population.

Humpback whales can be killed or injured during interactions with commercial fishing gear, although the evidence available suggests that the frequency of these interactions may not have significant adverse consequence for humpback whale populations. From 2012 to 2016, mortality and serious injury of humpback whales occurred once in the Bering Sea/Aleutian Islands pollock trawl fishery (1 in 2012). The estimated average annual mortality and serious injury rate from observed U.S. commercial fisheries is 0.8 Western North Pacific DPS humpback whales from 2012 to 2016 (Muto et al. 2019). In 2015, there was one entangled Western North Pacific DPS humpback entangled in BSAI commercial pot gear, which is in the action area of this project in the marine transit route.

5.3. Oil & Gas

Offshore petroleum exploration activities have been conducted in the action area both within State of Alaska waters and the Outer Continental Shelf (OCS) of the Beaufort and Chukchi seas, and nearby in Canada's eastern Beaufort Sea off the Mackenzie River Delta, in Canada's Arctic Islands, in the Russian Arctic, and around Sakhalin Island in the Sea of Okhotsk (NMFS 2016a). In the central Beaufort Sea in Alaska, 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. Stressors associated with these activities that are of primary concern for marine mammals include noise, physical disturbance, and pollution, particularly in the event of a large oil spill.

Oil and gas exploration activities have occurred on the North Slope since the early 1900s, and oil production started at Prudhoe Bay in 1977. Oil production has occurred for over 40 years in the region, and presently spans from the Alpine field, which is approximately 96 km (60 mi) west of Prudhoe Bay, to the Point Thomson project, which is approximately 96 km east of Prudhoe Bay. Additionally, onshore gas production from the Barrow gas field began over 60 years ago. Associated industrial development has included the creation of industry-supported community airfields at Deadhorse and Kuparuk, and an interconnected industrial infrastructure that includes roadways, pipelines, production and processing facilities, gravel mines, and docks.

Endicott Satellite Drilling Island, built in 1987, was constructed to support the first continuous production of oil from an offshore field in the Arctic. Subsequently, the Northstar offshore island was constructed in 1999 and 2000 to support oil production. Northstar, as well as the Nikaitchuq and Oooguruk developments, currently operates in nearshore areas of the Beaufort Sea, and is expected to continue operating in the future. Other oil and gas related activities that have occurred in the Beaufort Sea and Chukchi Sea OCS to date include exploratory drilling, exploration seismic surveys, geohazard surveys, geotechnical sampling programs, and baseline biological studies and surveys. There are also several exploration and development projects occurring on the North Slope including Greater Moose's Tooth 1 and 2, Smith Bay, Nuna, and Nanushuk.

In addition, the Alaska Gasoline Development Corporation is developing a liquid natural gas pipeline that would extend from Prudhoe Bay, generally following the existing Trans Alaska Pipeline System through interior Alaska, to end at the Liquefaction Facilities in Nikiski in Southcentral Alaska. Construction infrastructure would include shipping traffic through the Bering, Chukchi, and Beaufort seas.

Since 1975, 84 exploration wells, 14 continental offshore stratigraphic test wells (i.e., COST), and six development wells have been drilled on the Arctic OCS (BOEM 2012). Historical data on offshore oil spills for the Alaska Arctic OCS region consists of all small spills (i.e., less than 1,000 barrels [31,500 gallons]) (NMFS 2013a).

Offshore oil and gas development in Alaska poses a number of threats to listed marine species, including increased ocean noise, risk of hydrocarbon spills, production of waste liquids, habitat alteration, increased vessel traffic, and risk of ship strike. NMFS reviewed the potential effects of oil and gas development in a Final Environmental Impact Statement for the effects of oil and gas activities in the Arctic Ocean (NMFS 2013a) and has conducted numerous Section 7 consultations on oil and gas activities in the Chukchi and Beaufort Seas (available at https://www.fisheries.noaa.gov/alaska/consultations/section-7-biological-opinions-issued-alaska-region). Increased oil and gas development in the U.S. Arctic has led to an increased risk of various forms of pollution to whale and seal habitat, including oil spills, other pollutants, and nontoxic waste (Allen and Angliss 2015). Spills can occur from produced fluids, diesel, sales oil, bulk storage tanks, and more (Table 7).

Table 7. Relative rate of occurrence for spills from main sources (BLM 2019).

Source	**Spill Size**				
	Very Small	**Small**	**Medium**	**Large**	**Very Large**
Produced fluids	H	H	M	L	VL
Saltwater	H	H	M	L	VL
Diesel	H	M	L	VL	0
Sales oil	M	M	M	L	VL
Bulk storage tanks and containers on pads	L	L	L	VL	0
Tank vehicles	H	M	L	VL	0
Vehicle and equipment operation and maintenance	VH	VH	M	VL	0
Other routine operations	VH	VH	H	L	VL
Drilling blowout	VL	VL	VL	VL	VL
Production uncontrolled release	VL	VL	VL	VL	VL
<u>Notes</u>:					
VL = Very low rate of occurrence VH = Very high rate of occurrence L = Low rate of occurrence M = Medium rate of occurrence H = High rate of occurrence 0 = Would not occur	Very small: <0.24 barrels (10 gallon) Small: 0.24-2.37 barrels (10-99.5 gallons) Medium: 2.38-23.8 barrels (100-999.5 gallons) Large: 23.8-2,380 barrels (1,000-100,000 gallons) Very Large: >2,380 barrels (>100,000 gallons)				

Many of the consultations have authorized the take (by harassment) of bowhead whales and bearded and ringed seals from sounds produced during geophysical (including seismic) surveys and drilling operations conducted by leaseholders during open water (i.e., summer) months. Geophysical seismic survey activity has been described as one of the loudest man-made underwater noise sources, with the potential to harass or harm marine mammals (Richardson et al. 1995). Controlled-source, deep-penetration reflection seismology, similar to sonar and echolocation, is the primary tool used for onshore and offshore oil exploration (Smith et al. 2017). Seismic surveys are conducted by towing long arrays of sensors affixed to wires at approximately 10 knots behind large vessels following a survey grid. High power air cannons are fired below the water surface, and the sound waves propagate through the water and miles into the seafloor. When those soundwaves encounter strong impedance contrasts (e.g., between water and the ocean floor, or between different densities of substrates), a reflection signal is detected by the sensors. Those signals can be interpreted to determine the stratigraphy of the substrate and identify oil and gas deposits.

Seismic surveying has acoustic impacts on the marine environment. The noise generated from seismic surveys has been linked to behavioral disturbance of wildlife, masking of cetacean communication, and potential auditory injury to marine mammals in the marine environment (Smith et al. 2017). Seismic surveys are often accompanied by test drilling. Test drilling involves fewer direct impacts than seismic exploration, but the potential risks of test drilling, such as oil spills, may have broader consequences (Smith et al. 2017). Oil and gas exploration, including seismic surveys, occur within the action area and across the ranges of many of the species considered in this Biological Opinion.

5.3.1. Pollution and Discharges (Excluding Spills)

Previous development and discharges in portions of the action area are the source of multiple pollutants that may be bioavailable (i.e., may be taken up and absorbed by animals) to ESA-listed species or their prey items (NMFS 2013a). Drill cuttings and fluids contain contaminants that have high potential for bioaccumulation, such as dibenzofuran and polycyclic aromatic hydrocarbons. Historically, drill cuttings and fluids have been discharged from oil and gas developments in the Beaufort Sea near the action area, and residues from historical discharges may be present in the affected environment (Brown et al. 2010). Polycyclic aromatic hydrocarbons are also emitted to the atmosphere by flaring waste gases at production platforms or gas treatment facilities. For example, approximately 162,000 million standard cubic feet of waste gas was flared at Northstar in 2004 (Neff 2010).

Marine mammals can ingest spilled compounds while feeding, inhale the volatile components, or be affected by direct contact. For example, whales can experience baleen fouling upon encountering petroleum products. Effects of oil ingestion on marine mammals can range from progressive organ damage to death, depending on the quantity and composition of the ingested oil (Geraci and St. Aubin 1990). Surface contact with oil spills can damage mucous membranes and eyes of seals, or disrupt thermoregulation in seal pups (Geraci and St. Aubin 1990).

The Clean Water Act of 1972 (CWA) has several sections or programs applicable to activities in offshore waters. Section 402 of the CWA authorizes the U.S. Environmental Protection Agency (EPA) to administer the National Pollutant Discharge Elimination System (NPDES) permit program to regulate point source discharges into waters of the United States. Section 403 of the CWA requires that EPA conduct an ocean discharge criteria evaluation for discharges of pollutants from point sources into the territorial seas, contiguous zones, and the oceans. The Ocean Discharge Criteria (40 CFR part 125, subpart M) sets forth specific determinations of unreasonable degradation that must be made before permits may be issued.

On November 28, 2012, EPA issued a NPDES general permit for discharges from oil and gas exploration facilities on the outer continental shelf and in contiguous state waters of the Beaufort Sea (Beaufort Sea Exploration General Permit (GP)). The general permit authorizes 13 types of discharges from exploration drilling operations and establishes effluent limitations and monitoring requirements for each waste stream.

On January 21, 2015, EPA issued a NPDES general permit for wastewater discharges associated with oil and gas geotechnical surveys and related activities in Federal waters of the Beaufort and Chukchi Seas (Geotechnical GP). This general permit authorizes twelve types of discharges from facilities engaged in oil and gas geotechnical surveys to evaluate the subsurface characteristics of the seafloor and related activities in federal waters of the Beaufort and Chukchi Seas.

Both the Beaufort Sea Exploration GP and the Geotechnical GP establish effluent limitations and monitoring requirements specific to each type of discharge and include seasonal prohibitions and area restrictions for specific waste streams. For example, both general permits prohibit the discharge of drilling fluids and drill cuttings to the Beaufort Sea from August 25 until fall bowhead whale hunting activities by the communities of Nuiqsut and Kaktovik have been completed. Additionally, both general permits require environmental monitoring programs to be conducted at each drill site or geotechnical site location, corresponding to before, during, and after drilling activities, to evaluate the impacts of discharges from exploration and geotechnical activities on the marine environment.

The principal regulatory mechanism for controlling pollutant discharges from vessels (grey water, black water, coolant, bilge water, ballast, deck wash, etc.) into waters of the Arctic OCS is also the CWA. Discharges are covered under the Vessel Incidental Discharge Act, which is in the new CWA Section 312(p)[13]. In addition, the U.S. Coast Guard has issued regulations that address pollution prevention with respect to discharges from vessels carrying oil, noxious liquid substances, garbage, municipal or commercial waste, and ballast water (33 CFR part 151). The State of Alaska regulates water quality standards within three miles of the shore.

5.3.2. Spills

BOEM and BSEE define small oil spills as <1,000 barrels (bbl). Large oil spills are defined as 1,000-150,000 bbl, and very large oil spills (VLOS) are defined as ≥ 150,000 bbl (BOEM 2017). Offshore petroleum exploration activities have been conducted in State of Alaska waters adjacent of the Beaufort and Chukchi seas since the late 1960s. Based on a review of potential discharges and on the historical oil spill occurrence data for the Alaska OCS and adjacent State of Alaska waters, several small spills in the Beaufort Sea from refueling operations (primarily at West Dock) were reported to the National Response Center. Small oil spills have occurred with routine frequency and are considered likely to occur (BOEM 2017).

In the past 30 years, only 43 wells have been drilled in the Beaufort and Chukchi seas lease program areas. From 1985 to 2013, eight crude oil spills of ≥ 550 bbl were documented along the Alaska North Slope, one of which was ≥ 1,000 bbl. During the same time period, total North Slope production was 12.80 billion bbl (Bbbl) of crude oil and condensate. From 1971 through 2011, the highest mean volume of North Slope spills was from pipelines. The mean spill size for pipelines was 145 bbl. The spill rate for crude oil spills ≥ 500 bbl from pipelines (1985 to 2013) was 0.23 pipeline spills per Bbbl of oil produced (BOEM 2016).

From 1995 to 2012, approximately 400 spills (100 to 300,000 gallons) occurred in Alaska's marine waters. Most were in nearshore and shallow coastal waters and were primarily diesel (BLM 2019). Only 1% of the spills were crude oil. If a pinniped came in direct contact with a small, refined oil spill it could experience inhalation and respiratory distress from hydrocarbon vapors, or ingestion directly or indirectly by consuming contaminated prey, and less likely skin and conjunctive tissue irritation (Engelhardt 1987). Oil may also foul pinniped pelage and be ingested during cleaning. Small offshore spills of refined petroleum products are expected to dissipate rapidly. A small spill could impact pinnipeds through their ingestion of contaminated prey, but prey contamination likely would be localized and temporary.

With respect to the ringed and bearded seals, small spills could result in irritation of the eyes, mouth, lungs, and anal and urogenetical surfaces (St. Aubin 1990). The effects of an oil spill on

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[13] https://www.epa.gov/vessels-marinas-and-ports/vessel-incidental-discharge-act-vida

ringed or bearded seals would depend largely on the size, season, and location of the spill. If a spill were to occur during the ice free, open water season, seals may be exposed to oil through direct contact, or perhaps through contaminated food items. However, St. Aubin (1990) notes that with their keen sense of olfaction and good sense of vision ringed and bearded seals may be able to detect and avoid oil spills in the open water season (St. Aubin 1990).

Immersion studies by Geraci and Smith (1976a) found ringed seals may develop mild liver injury, kidney lesions and eye injury from immersion in crude oil. The eye damage was often severe, suggesting permanent eye damage might occur with longer periods of exposure to crude oil, and the overall severity of the injuries was most likely associated with the exposure duration to crude oil. Geraci and Smith (1976a) concluded the direct effects of an oil blow-out or spill may result in transient eye damage to healthy seals in open water; however, ringed seals exposed to a slick of crude oil showed no impairment in locomotion or breathing.

A small spill could affect the zooplankton populations upon which whales feed, but the prey contamination is likely to be localized and small in comparison to the overall food resource available. Vessel activity associated with spill response would likely keep bowhead whales away from the spill area. Oil adheres poorly to the skin of mysticete whales, and cetaceans are believed to have the ability to detect and avoid oil spills (Geraci 1990; NMFS 2016a); however, an animal’s need for food, shelter, or other biological requirements can override any avoidance behaviors to oil (Vos et al. 2003). It is expected that weathering would quickly break up or dissipate small oil or fuel spills to harmless residual levels that eventually become undetectable.

5.3.3. Contaminants Found in Listed Species

Metals and hydrocarbons introduced into the marine environment from offshore exploratory drilling activities are not likely to enter the Beaufort Sea food webs in ecologically significant amounts. However, there is a growing body of scientific literature on concentrations of metals and organochlorine chemicals (e.g., pesticides and polychlorinated biphenyls [PCBs]) in tissues of higher trophic level marine species, such as marine mammals, in cold-water environments.

There is particular concern about mercury in Arctic marine mammal food webs (MacDonald 2005). Mercury concentrations in marine waters in much of the Arctic are higher than concentrations in temperate and tropical waters due in large part to deposition of metallic and inorganic mercury from long-range transport and deposition from the atmosphere (Outridge et al. 2008). However, there is no evidence that significant amounts of mercury are coming from oil operations around Prudhoe Bay (Snyder-Conn et al. 1997) or from offshore drilling operations (Neff 2010).

Heavy metals can enter marine mammals through uptake from the atmosphere through the lungs, absorption through the skin, across the placenta before birth, via milk during lactation, ingestion of sea water and ingestion of food (Vos et al. 2003). The major route of heavy metal contamination for marine mammals seems to be via feeding. Additionally, being a top predator in the food web can influence heavy metal levels, such as mercury, especially in marine mammals relying on fish (Vos et al. 2003).

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) indicated that bowhead whales had very low levels of mercury, PCBs, and chlorinated hydrocarbons, but they had 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 percent 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 to 1990. They observed considerable variation in tissue metal concentration among the whales tested. Metal concentrations evaluated did not appear to increase over time. 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. Mossner and Ballschmiter (1997) reported that total levels of polychlorinated biphenyls and chlorinated pesticides in bowhead blubber from the North Pacific and Arctic Oceans were many times lower than those 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 blubber tested from bowhead whales than from three marine mammal species sampled in the North Atlantic (pilot whale, common dolphin, and harbor seal). These results were believed to be due to the lower trophic level of the bowhead as compared to the other marine mammals tested.

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 organochlorine 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 (Kelly et al. 2010b).

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. 2010). 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. 2005; Gaden et al. 2009). Becker et al. (1995) reported ringed seals had higher levels of arsenic in Norton Sound (inlet in the Bering Sea) than ringed seals taken by residents of Point Hope, Point Lay, and Barrow (now Utqiaġvik). Arsenic levels in ringed seals from Norton Sound were quite high for marine mammals, which might reflect localized natural arsenic sources.

Research on contaminants in bearded seals is limited compared to the information for ringed seals. However, pollutants such as organochlorine compounds and heavy metals have been found in most bearded seal populations. Climate change has the potential to increase the transport of pollutants from lower latitudes to the Arctic (Tynan and Demaster 1997).

Lee et al. (1996) compared persistent organochlorine pesticides and PCBs in Steller sea lions in the Gulf of Alaska to Steller sea lions in the Russian waters of the Bering Sea. PCBs were the predominant organochlorine in Steller sea lion blubber, followed by DDT. The level of PCBs in male Steller sea lions were higher than those in ringed seals in Arctic waters. Steller sea lions in the Bering Sea had significantly lower DDTs and PCBs than those from the Gulf of Alaska (Lee et al. 1996). Ferdinando (2019) assessed heavy metals in marine mammals including Steller sea lions. In the southwest Alaska area consisting of the Aleutian Islands, mercury was the highest concentration of heavy metal found in Steller sea lions, followed by lead, nickel, and copper and were concentrated in the fur, tendon, and muscle tissues (Ferdinando 2019).

5.4. Vessels

The general seasonal pattern of vessel traffic in the Arctic is correlated with seasonal ice conditions, which results in the bulk of the traffic being concentrated within the months of July through October, and unaided navigation being limited to an even narrower time frame. However, this pattern appears to be rapidly changing, as ice-diminished conditions become more extensive during the summer months.

The number of unique vessels tracked via AIS in U.S. waters north of the Pribilof Islands increased from 120 in 2008 to 250 in 2012, and is expected to continue to increase (Azzara et al. 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 waters off Prudhoe Bay from oil and gas exploration activity is particularly pronounced (ICCT 2015). The number of vessels identified in this region in 2012 includes a spike in vessel traffic associated with the offshore exploratory drilling program that was conducted by Shell on the outer continental shelf (OCS) of the Chukchi Sea that year. A comparison of the geographic distribution of vessel track lines between 2011 and 2012 provides some insight into the changes in vessel traffic patterns that may occur as a result of such activities (Figure 18). Overall, in 2012 there was a shift toward more offshore traffic, and there were also noticeable localized changes in vessel traffic concentration near Prudhoe Bay and in the vicinity of the drilling project in the Chukchi Sea (Azzara et al. 2015).

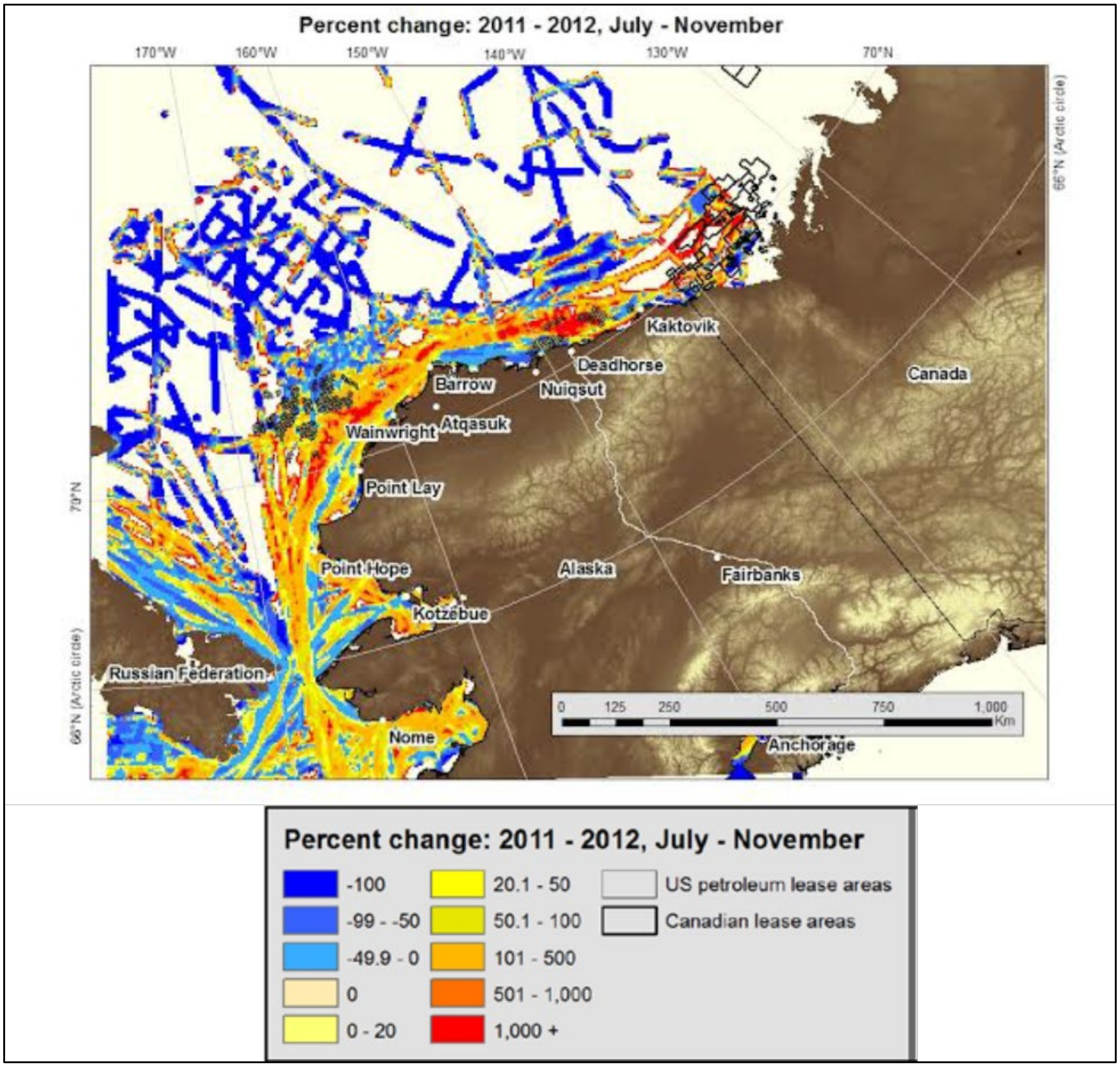

Figure 18. Percent difference in vessel activity between 2011 and 2012 using 5-km grid cells. (Azzara et al. 2015)

Marine vessel traffic may pose a threat to pinnipeds and cetaceans in the action area, because of ship strikes and vessel noise. The U.S. Committee on the Marine Transportation System (CMTS) reported that about 255 vessels transited through the US Arctic and surrounding region from 2015-2017, as determined by automatic identification system (AIS) data.

Vessel traffic in the Chukchi and Beaufort seas is currently limited to late spring, summer, and early autumn. However, surface air temperatures in the Arctic Region are increasing at double the rate of the global average (Adams and Silber 2017). Continued expansion of the duration and extent of seasonal ice-free waters in the Chukchi and Beaufort seas is anticipated over the coming decades, likely resulting in increased vessel traffic and increased duration of the navigation season. As seasonal ice-free waters expand, the international commercial transport of goods and people in the area is projected to increase 100-500 percent in some Arctic areas by

2025 (Adams and Silber 2017).

The U.S. Committee on the Marine Transportation System (CMTS) reported that the number of vessels operating in the Chukchi and Beaufort seas has increased 128% from 2008 to 2018. The vessels include those used for research, natural resource exploration and extraction, commercial shipping, government/law enforcement/search and rescue, and tourism. Of the 255 vessels that transited through the US Arctic and surrounding region from 2015-2017, over 50% were tug, towing, and cargo vessels. Thirty-two flag states transited the region, although US flagged vessels were the most prevalent. The length of the navigation season has been growing by as much as 7-10 days annually, which, extrapolated over the next decade, could result in 2.5 months of additional navigation season over what was currently seen in 2019 (U.S. Committee on the Marine Transportation System 2019).

In the projections developed by the CMTS for the most plausible scenario, 72 vessels are expected to be active annually by 2030 in natural resource exploration and development, which is also the activity ranked as the largest contributor to projected traffic growth. More than 50% of this growth is anticipated to be from non-US natural resource extraction (Russian exports of LNG and mineral extraction in Canada). By 2030 in the most plausible scenario, 28 vessels are anticipated to be active for rerouted shipping through the Arctic and 17 vessels in the expansion of the Arctic fleet (icebreakers, and ice-hardened cruise ships). However, these estimates do not include the small vessel transits used for commercial fishing, subsistence harvest, or lightering goods from large barges to shore using smaller vessels.

5.4.1. Vessel Noise

Vessel noise can create auditory interference, or masking, in which the noise can interfere with an animal's ability to understand, recognize, or even detect sounds of interest. This can lead to behavioral changes in marine mammals, such as increasing their communication sound levels or causing them to avoid noisy areas. 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 operating in the Beaufort Sea typically include barges, skiffs with outboard motors, icebreakers, scientific research vessels, and vessels associated with oil and gas exploration, development, and production. The primary underwater noise associated with vessel operations is the continuous noise produced from propellers and other on-board equipment. Cavitation noise is expected to dominate vessel acoustic output when tugs are pushing or towing a barges or other vessels. Other noise sources include onboard diesel generators and the main engine, but both are subordinate to propeller harmonics (Gray and Greeley 1980). Shipping sounds are often at source levels of 150 to 190 dB re 1 μPa at 1 m (BOEM 2011) with frequencies of 20 to 300 Hz (Greene and Moore 1995). Sound produced by smaller boats is typically 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). Noise from icebreakers comes from the ice physically breaking, the propeller cavitation of the vessel, and the "bubbler systems" that blow compressed air under the hull which moves ice out of the way of the ship. Broadband source levels for icebreaking operations are typically between 177 and 198 dB re 1 μPa at 1m (Austin et al. 2015; Greene and Moore 1995); however, they can be extremely variable mainly due to the varying thickness of ice that is being broken and the resulting horsepower required to break the ice.

5.4.2. Vessel Strikes

Current shipping activities in the Arctic pose varying levels of threats to marine mammals depending on the type and intensity of the shipping activity and its degree of spatial and temporal overlap with their habitats. The presence and movements of ships in the vicinity of seals can affect their normal behavior (Jansen et al. 2010) and may cause them to abandon their preferred breeding habitats in areas with high traffic (Mansfield 1983; Smiley and Milne 1979). 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.

Vessel strikes of whales occur throughout Alaska, but are less common in the action area than in the Gulf of Alaska and Southeast Alaska. Free-ranging marine mammals often engage in avoidance behavior when surface vessels move toward them. It is not clear whether these responses are caused by the physical presence of a surface vessel, the underwater noise generated by the vessel, or an interaction between the two (Goodwin and Cotton 2004; Lusseau 2006). These studies suggest that the behavioral responses of marine mammals to surface vessels are similar to their behavioral responses to predators. There has been one reported vessel strike of a bowhead whale from Utqiaġvik in 2015 (NMFS unpublished data); evidence from subsistence-harvested bowhead whales indicate about 2 percent of animals have experienced vessel collisions (George et al. 2017). Increased vessel traffic resulting from a reduction in sea ice in the Arctic may lead to more vessel strike incidents in the future.

5.5. Ocean Noise

In addition to vessel noise described above, ESA-listed species in the action area are exposed to several other sources of natural and anthropogenic noise. Natural sources of underwater noise include sea ice, wind, waves, precipitation, and biological noise from marine mammals, fishes, and crustaceans. Other anthropogenic sources of underwater noise of concern to listed species in the action area include in-water construction activities such as drilling, dredging, and pile driving; oil, gas, and mineral exploration and extraction; Navy sonar and other military activities; geophysical seismic surveys; and ocean research activities. Levels of anthropogenic (human-caused) sound can vary dramatically depending on the season, type of activity, and local conditions. The combination of anthropogenic and natural noises contributes to the total noise at any one place and time. Noise impacts to listed marine mammal species from many of these activities are mitigated through ESA Section 7 consultations.

Noise is of particular concern to marine mammals because many species use sound as a primary sense for navigating, finding prey, avoiding predators, and communicating with other individuals. As described in greater detail later in this opinion, noise may cause marine mammals to leave a habitat, impair their ability to communicate, reduce their survival rate, or cause stress. Noise can cause behavioral disturbances, can mask other sounds, including their own vocalizations, may result in injury, and, in some cases, may result in behaviors that ultimately lead to death. The severity of these impacts can vary greatly between minor impacts that have no real cost to the animal, to more severe impacts that may have lasting consequences.

Because responses to anthropogenic noise vary among species and individuals within species, it is difficult to determine long-term effects. Habitat abandonment due to anthropogenic noise exposure has been found in terrestrial species (Francis and Barber 2013). The presence and movements of ships in the vicinity of seals can affect their normal behavior (Jansen et al. 2010) and may cause them to abandon their preferred breeding habitats in areas with high traffic (Allen 1984; Edrén et al. 2010; Henry and Hammill 2001; London et al. 2012; Sullivan 1980). (Clark et al. 2009) identified increasing levels of anthropogenic noise as a habitat concern for whales because of its potential effect on their ability to communicate (i.e., masking). Some research (McDonald et al. 2006; Parks 2003; Parks 2009) suggests marine mammals compensate for masking by changing the frequency, source level, redundancy, and timing of their calls. However, the long-term implications of these adjustments, if any, are currently unknown.

Because noise is a primary source of disturbance to marine mammals, and the category of disturbance most focused on in Incidental Harassment Authorizations and Letters of Authorization, this opinion considers it as a separate category of the Environmental Baseline.

5.5.1. Ambient Noise

Ambient sound, as it is considered here, refers to naturally produced sound in the absence of measurable anthropogenic sound. Ambient sound is different from “background sound” which can include anthropogenic sounds that are typical for a particular location.

The presence of ice can contribute significantly to ambient sound levels and affects sound propagation. While sea ice can produce substantial amounts of ambient sounds, it also can function to dampen or heighten ambient sound. Smooth annual ice can enhance sound propagation compared to open water conditions (Richardson et al. 1995). However, with increased cracking, ridging, and other forms of sub-surface deformation, transmission losses generally become higher compared to open water (Blackwell and Greene 2001; Richardson et al. 1995). Urick (1996) discussed variability of ambient noise in water, including under Arctic ice. He stated that “the ambient background depends upon the nature of ice, whether continuous, broken, moving or ground-fast, the temperature of air, and the speed of the wind.” 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 re 1 µPa at 1 m within 24 hours due to diurnal variability in air temperatures (BOEM 2011). Data are limited, but in at least one instance it has been shown that ice-deformation sounds produced frequencies of 4 to 200 Hz (Greene 1981).

During the open-water season in the Arctic, wind and waves are important sources of ambient sound with levels tending to increase with increased wind and sea state, all other factors being equal (Richardson et al. 1995). Wind, wave, and precipitation noise originating close to the point of measurement dominate frequencies from 500 to 50,000 Hz.

There are many marine mammals in the Arctic marine environment whose vocalizations contribute to ambient sound including bowhead whales, gray whales, beluga whales, walrus, ringed seals, bearded seals, and spotted seals. Ringed seal calls have a source level of 95 to 130 dB re 1 μPa at 1 m, with the dominant frequency under 5 kHz (Cummings et al. 1986; Thomson and Richardson 1995).

Sound levels recorded during the open-water season (July 6 through September 22) in Foggy Island Bay varied from approximately 88 to 103 dB re uPa broadband (Aerts et al. 2008). These sound levels may have been influenced by vessel activities occurring nearby (Aerts et al. 2008), and may therefore be better characterized as background sound rather than ambient sound. Broadband background sound levels recorded in the water under the ice at 9.4 km (5.8 mi) from Northstar Island were 77 dB 1 re μPa and 76 dB re μPa in 2001 and 2002, respectively (Blackwell et al. 2004a).

5.5.2. Oil and Gas Exploration, Drilling, and Production Noise

NMFS has conducted numerous ESA section 7 consultations related to oil and gas activities in the Beaufort Sea. Many of the consultations have authorized the take (by harassment) of bowhead whales and estimated take of ringed and bearded seals from sounds produced during geophysical (including seismic) surveys and other exploration and development activities. Below are some key consultations completed in the action area, but this is not an exhaustive list.

The ESA does not prohibit the taking of threatened species unless special regulations have been promulgated, pursuant to ESA Section 4(d), to promote the conservation of the species. ESA Section 4(d) rules have not been promulgated for Arctic ringed seals or Beringia DPS bearded seals; therefore, ESA section 9 take prohibitions do not apply to these species. In our biological opinions, we estimate take of these threatened species, we determine whether the action may jeopardize the continued existence of these species, and we work with the action agency to minimize take. We do not, however, authorize take of threatened species for which take is not prohibited under the ESA.

For each consultation, the process to estimate take of listed species is very specific to that action, relying on assumptions specific to the proposed action, and the best available information at that time for species density, and the best available science at that time to understand the scope and intensity of a stressor (e.g., acoustics, sound source verification, transmission loss, etc.). The estimates of take are conservative and thus are, most likely, overestimates. We also make assumptions about the ability of an action agency to accurately recognize that take has occurred during the course of an action—that whales and pinnipeds are not always available to be observed, or they can be affected in ways that are not observable. It is possible that the actual take numbers reported by an action agency may underestimate the instances of take of listed species. We present these caveats to provide context for the authorized take estimates below.

In 2013, NMFS completed an incremental step consultation with BOEM and Bureau of Safety and Environmental Enforcement (BSEE) on the effects of the authorization of oil and gas leasing and exploration activities in the U.S. Beaufort and Chukchi seas over a 14-year period, from March 2013 to March 2027 (i.e., the Arctic Regional Biological Opinion (NMFS 2013b)). The incidental take statement issued with the biological opinion for the 14-year period allows for takes (by harassment) from sounds associated with high-resolution, deep penetration, and in-ice deep penetration seismic surveys of 87,878 bowhead whales, 896 fin whales, 1,400 humpback whales, and estimated take of 91,616 bearded seals, and 506,898 ringed seals. Take will be more accurately evaluated and authorized for project-specific consultations that fall under this over-arching consultation (i.e., stepwise consultations), and the cumulative take for all subsequent consultations will be tracked and tiered to these consultations.

In 2014, NMFS Alaska Region conducted three internal consultations with NMFS Permits Division on the issuance of IHAs to take marine mammals incidental to 3D ocean bottom sensor seismic and shallow geohazard surveys in Prudhoe Bay, Foggy Island Bay, and the Colville River Delta, in the Beaufort Sea, Alaska, during the 2014 open-water season (NMFS 2014a; NMFS 2014b; NMFS 2014c). These project-specific consultations were either directly or indirectly linked to the Arctic regional biological opinion. The incidental take statements issued with the three biological opinions allowed for take (by harassment) of 138 bowhead whales, and estimates take of 744 bearded seals and 427 ringed seals, as a result of exposure to impulsive sounds at received levels at or above 160 dB re 1 μParms.

NMFS completed an incremental step consultation with BOEM and BSEE in 2015 on the effects of oil and gas exploration activities for lease sale 193 in the Chukchi Sea, Alaska, over a nine-year period, from June 2015 to June 2024 (AKR-2015-9422) (NMFS 2015a) (Table 8).The incidental take statement issued with the biological opinion allows for takes (by harassment) from sounds associated with seismic, geohazard, and geotechnical surveys, and exploratory drilling of 8,434 bowhead whales, 133 fin whales, 133 humpback whales, while also estimating take of 1,045,985 ringed seals, and 832,013 bearded seals.

Subsequently in 2015, NMFS Alaska Region consulted with the NMFS Permits Division on the issuance of an IHA to take marine mammals incidental to Shell's exploration drilling activities in the Chukchi Sea, Alaska (AKR-2015-9449) (NMFS 2015b). The incidental take statement issued with the biological opinion allowed for takes (by harassment) of 1,038 bowhead whales, 14 fin whales, 14 humpback whales, while estimating take of 1,722 bearded seals, and 25,217 ringed seals as a result of exposure to continuous and impulsive sounds at received levels at or above 120 dB re 1 μParms and 160 dB re 1 μParms, respectively.

Table 8. 2015 consultations and exposure numbers in the Chukchi Sea and Beaufort Sea related to oil and gas production.

Consultation Number	Topic	Project proponent	Bowhead whales	Fin whales	Humpback whales	Ringed seals	Bearded seals
AKR-2015-9422	Lease sale 193	BLM	8,434	133	133	1,045,985	832,013
AKR-2015-9449	Drilling activities	Shell	1,038	14	14	1,722	25,217
AKR-2015-9448	Aviation activities	Shell	-	-	-	793	11
AKR-2015-9454	Shallow geohazard survey	Hilcorp	12	-	-	350	100
AKR-2015-9451	3-D seismic survey	SAE	9	-	-	443	22

In 2015, NMFS Alaska Region conducted an internal consultation with NMFS Permits Division on the issuance of an IHA to take marine mammals incidental to ice overflight and ice survey activities conducted by Shell Gulf of Mexico and Shell Offshore Inc., from May, 2015, to April, 2016, (AKR-2015-9448) (NMFS 2015c). The biological opinion estimated take (by harassment) of 793 ringed seals and 11 bearded seals as a result of exposure to visual and acoustic stimuli from aircraft. An IHA was issued for Hilcorp's proposed shallow geohazard survey in the Beaufort Sea[14] (AKR-2015-9454) that authorized harassment of 12 bowhead whales, 100 bearded seals, and 350 ringed seals (80 FR 27901). Lastly, NMFS Alaska Region developed a biological opinion[15] (AKR-2015-9451) in response to the issuance of an MMPA IHA authorizing take of 9 bowhead whales, and estimating take of 443 ringed seals, and 22 bearded seals for SAExploration's 3-D seismic survey (80 FR 20084).

There were no consultations for oil and gas activities completed with the NMFS Permits Division in 2016 and 2017.

In 2018, NMFS Alaska Region completed a consultation with BOEM, BSEE, EPA, and USACE for oil and gas exploration activities for the Liberty Project taking place from December 2020 to November 2045 (NMFS 2018a). In 2019, the NMFS Alaska Region reinitiated consultation with BOEM, BSEE, EPA, and USACE for the Liberty Project and conducted a consultation with the NMFS Permits Division on the issuance of a letter of authorization (LOA) to take marine mammals incidental to oil and gas exploration activities for the Liberty Oil and Gas Development and Production Activities (NMFS 2019a). The biological opinion estimates take of ringed seals: 831 by Level B harassment due to noise and physical presence, 8 by Level A harassment due to noise, and 10 by mortality, and for bearded seals, 130 by Level B harassment due to noise and physical presence and 4 by Level A harassment The biological opinion also authorized the following take for bowhead whales: 120 by Level B harassment and 4 by Level A harassment.

In 2019, NMFS Alaska Region completed a programmatic consultation with the Bureau of Land Management for the implementation of the oil and gas lease sales for the Arctic National Wildlife Refuge coastal plain (NMFS 2019b). The consultation was based on the most likely scenario for oil exploration, development, production, and abandonment. An incidental take statement is not issued for programmatic consultations; however, consultations will be required for future oil and gas activities within the refuge boundaries that may affect listed species.

5.5.3. Seismic Activity Noise

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 two-dimensional/three-dimensional (2D/3D) seismic survey with multiple guns emits sound at frequencies of about 10 Hz to 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

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[14] https://www.fisheries.noaa.gov/resource/document/biological-opinion-proposed-issuance-incidental-harassment-authorization-hilcorp

[15] https://www.fisheries.noaa.gov/resource/document/biological-opinion-issuance-incidental-harassment-authorization-saexploration-0

seismic operations in the Beaufort Sea and central Arctic Ocean during ice-free conditions also documented propagation distances up to 1,300 km (808 mi) (Richardson 1998; Richardson 1999; Thode et al. 2010). Because the Chukchi Sea continental shelf has a highly uniform depth of 30 to 50 m (98 to 164 ft), it strongly supports sound propagation in the 50 to 500 Hz frequency band (Funk et al. 2008).

In August through September 2021, the National Science Foundation will conduct a low-energy and high-energy marine seismic survey using an airgun array and other acoustic sound sources in the Beaufort Sea. The two-dimensional seismic survey will use a towed two or six airgun array with a maximum discharge volume of approximately 51,127.6 cubic centimeters (3,120 cubic inches) at a depth of nine meters (29.5 feet). The low-energy and high-energy seismic survey will take place in waters depths of approximately 200 to 4,000 m (656.2 to 13,123.4 ft). The seismic survey activities will last approximately 45 days, including approximately 30 days of airgun array operations and approximately seven days of equipment deployment and recovery. The seismic survey activities will be conducted along approximately 5,850 kilometers (3,158.7 nautical miles) of tracklines.

Several of the section 7 consultations discussed in the previous subsection include estimates of take (by harassment) of marine mammals from noise produced through seismic activity.

5.5.4. Aircraft Noise

The sound and visual presence of aircraft can result in behavioral changes in whales such as diving, altering course, vigorous swimming, and breaching (Patenaude et al. 2002). Oil and gas development projects often involve helicopters and fixed-winged aircraft, and aircraft are used for surveys of natural resources. Airborne sounds do not transfer well to water because much of the sound is attenuated at the surface or is reflected where angles of incidence are greater than 13°; however, loud aircraft noise can be heard underwater when aircraft are within or near the 13° overhead cone and surface conditions are calm (Richardson et al. 1995). Richardson et al. (1995) and Richardson and Malme (1993) observed that bowhead whales in the Beaufort Sea will dive or swim away when low-flying (500 m (1640 ft)) aircraft pass above them.

Ringed seals departed their lairs in response to a helicopter flying 5 km from the lair, and during helicopter landings and take-offs as far away as 3 km (Kelly et al. 1988). They are most adversely affected by noise disturbance in late March through June when they spend greater amounts of time out of the water and their movements are limited to small areas due to their dependent offspring (Kelly et al. 1988). One study indicated that the risk of scaring ringed seals into the water can be substantially reduced if small-type helicopters do not approach closer than 1500 m and small fixed-wing aircraft do not approach closer than 500 m (Born et al. 1999).

5.6. Direct Mortality

Within the proposed action area there are several potential sources of direct mortality of listed species, including subsistence harvest, stranding, and predation. Direct mortality associated with vessels strikes is addressed in Section 5.4.2.

5.6.1. Subsistence Harvest

The ESA and MMPA allow for the harvest of marine mammals by Alaska Natives for subsistence purposes and for the creation of traditional handicrafts. However, the Whaling Convention Act (16 USC §§ 916 *et seq*.) restricts the Alaska Native subsistence hunt of great whales, allowing only for the take of bowheads. Thus, subsistence hunters in Alaska are not authorized to take humpback whales. However, one humpback whale was illegally harvested in Kotlik in October, 2006, and another was illegally harvested in Toksook Bay in May, 2016 (Muto et al. 2019).

Whaling by Alaska Natives in the Alaskan Arctic and sub-arctic has taken place for at least 2,000 years (Marquette and Bockstoce 1980; Stoker and Krupnik 1993). In addition to subsistence hunting, commercial whaling occurred during the late 19th and early 20th centuries. 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 historical abundance of bowhead whales in this population was between 10,400 and 23,000 whales before commercial whaling began. Within the first two decades (1850 through 1870), over 60 percent of the estimated pre-whaling population was harvested, although whaling 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). Between 1848 and 1919, shore-based whaling operations (including landings as well as struck and lost estimates from U. S., Canada, and Russia) took an additional 1,527 animals. 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.

Subsistence harvest has been regulated by quotas set by the International Whaling Commission, implemented through the Whaling Convention Act, and allocated by the Alaska Eskimo Whaling Commission to Alaska Natives since 1977. Alaska Native subsistence hunters from 11 Alaska communities take approximately 0.1 to 0.5 percent of the population per annum (Philo et al. 1993; Suydam et al. 2011). Under this quota, the number of kills in any one year has ranged between 14 and 72. The maximum number of strikes per year is set by a quota which is determined by subsistence needs and bowhead whale abundance and trend estimates (Stoker and Krupnik 1993). Suydam and George (2012) summarized Alaska subsistence harvests of bowhead whales from 1974 to 2011 by village and reported that a total of 1,149 whales were landed by hunters from 12 villages, with Barrow (now Utqiaġvik) landing the most whales (n = 590) and Shaktoolik landing only one. The number of whales landed at each village varies greatly from year to year, as success is influenced by village size and ice and weather conditions (Table 9). The efficiency of the hunt (the percent of whales struck that are retrieved) has increased since the implementation of the bowhead whale quota in 1978. In 1978, the efficiency was about 50 percent. In 2018, 47 of 68 whales struck were landed, resulting in an efficiency of 69 percent, which was lower than the previous 10-year average of 78 percent (Suydam et al. 2019).

Table 9. Annual number of bowhead whales landed by Alaska natives

Year	Number of Landed Whales
2010	45
2011	38
2012	55
2013	46
2014	38
2015	38
2016	47
2017	43
2018	47
Sources: (Suydam et al. 2011; Suydam et al. 2012; Suydam et al. 2014; Suydam et al. 2013; Suydam et al. 2015; Suydam et al. 2016; Suydam et al. 2017, AEWC unpublished data, 2017; Suydam et al. 2019)	

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. No catches for Western Arctic bowhead whales were reported by either Canadian or Russian hunters for 2006 and 2007 (IWC 2008; IWC 2009) or by Russia in 2009, 2011, 2012, or 2014 (Ilyashenko 2013; Ilyashenko and Zharijov 2015; IWC 2011), but two bowhead whales were taken in Russia in 2008 (IWC 2010), two in 2010 (IWC 2012), and one in 2013 (Ilyashenko and Zharijov 2014).

Annual subsistence take by Natives of Alaska, Russia, and Canada from 2010 through 2014 averaged 44 bowhead whales. During the 2013 through 2018 time period, the IWC and Alaska Eskimo Whaling Commission (AEWC) allowed Alaskan and Chukotkan whalers to land up to 336 bowhead whales total[16]. The IWC set a catch limit of 392 bowhead whales landed for the years 2019 through 2025 combined.

Ringed and bearded seals are important subsistence species for many northern coastal communities. Approximately 64 Alaska Native communities in western and northern Alaska, from Bristol Bay to the Beaufort Sea, regularly harvest ringed and bearded seals for subsistence purposes (Ice Seal Committee 2019). Estimates of subsistence harvest of ringed and bearded seals are available for several of these communities based on annual household surveys (Table 10), but more than 50 other communities that harvest these species for subsistence were not surveyed within this time period or have never been surveyed. From 2012-2017, only 4 percent (3 of 64) of the coastal communities that harvest ice seals have been surveyed in two or more consecutive years (Ice Seal Committee 2019). Household surveys are designed to estimate

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[16] Alaska Eskimo Whaling Commission (AEWC) website. Bowhead harvest quota. Available at http://www.aewc-alaska.org/bowhead-quota.html, accessed March 30, 2018.

harvest for the specific community surveyed; extrapolation of harvest estimates beyond a specific community is not appropriate because of local differences in seal availability, cultural hunting practices, and environmental conditions (Ice Seal Committee 2019). From 2013 through 2017, the total annual ringed and bearded seal harvest estimates across surveyed communities ranged from 185 to 1,306 and 114 to 1,176, respectively (Table 10).

Table 10. Alaska ringed and bearded seal harvest estimates based on household surveys, 2013–2017

Community	**Estimated Ringed Seal Harvest**					**Estimated Bearded Seal Harvest**				
	2013	**2014**	**2015**	**2016**	**2017**	**2013**	**2014**	**2015**	**2016**	**2017**
Nuiqsut	-	58	-	-	-	-	26	-	-	-
Utqiaġvik	-	428	-	-	-	-	1,070	-	-	-
Point Hope	-	246	-	-	-	-	183	-	-	-
Kotzebue	-	69	-	-	-	-	228	-	-	-
Shishmaref	-	296	-	-	-	-	319	-	-	-
Hooper Bay	667	158	185	546	193	171	64	148	118	114
Tununak	-	-	-	117	-	-	-	-	19	-
Tuntutuliak	75	-	-	-	-	53	-	-	-	-
Quinhagak	160	51	-	26	-	49	16	-	38	-
Total	**902**	**1,306**	**185**	**689**	**193**	**273**	**1,176**	**148**	**175**	**114**
Source: adapted from Ice Seal Committee (2019). Villages with no landings were not included.										

5.6.2. Stranding

In 2019, there were 11 stranded bowhead whales in the Arctic[17]. The number of strandings in 2019 was high compared to the 3 strandings per year average from 2000-2018 (Table 11). The cause of death is unknown for most of these reports as the level of decomposition was too advanced. We are unaware of other large whale strandings in the action area for species discussed in this opinion.

Table 11. Number of stranded bowhead whales from 2015 to 2019, and the average from 2000 to 2018.

Year	**Number Stranded Bowheads**
2019	11
2018	7
2017	1
2016	6

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[17] https://www.fisheries.noaa.gov/resource/document/alaska-region-marine-mammal-annual-stranding-reports

Year	Number Stranded Bowheads
2015	13
Average per year 2000-2018	3

As discussed in Section 5.1.1.2 the NMFS AKR Stranding Network received reports of many stranded ice seals in spring and summer 2019. In September, NMFS declared an Unusual Mortality Event (UME) for ringed, bearded, and spotted seals, dating back to June 1, 2018. The cause, or causes, of these deaths is currently being investigated by NMFS.

5.6.3. Predation

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 humans and 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 between 1976 and 1992, 4.1 to 7.9 percent had scars indicating that they had survived attacks by killer whales (George et al. 1994). Of 378 complete records for killer whale scars collected from 1990 to 2012, 30 whales (8 percent) had scarring “rake marks” consistent with orca/killer whale injuries and another 10 had possible injuries (George et al. 2017). The mortality rate of bowhead whales due to killer whale predation remains unknown. Killer whales will also prey upon calves of many species of large whales (e.g., fin, sperm, and humpback whales) (Jefferson et al. 1991; Pitman et al. 2001), although the rate of mortality due to killer whale predation for these large whales is unknown.

Polar bears are the main predator of ringed and bearded seals (Cameron et al. 2010; Kelly et al. 2010b). Other predators of both species include walruses and killer whales (Burns and Eley 1976; Derocher et al. 2004; Fay et al. 1990; Heptner et al. 1976; Melnikov and Zagrebin 2005). In addition, Arctic foxes prey on ringed seal pups by burrowing into lairs; and gulls, ravens, and possibly snowy owls successfully prey on pups when they are not concealed in lairs (Kelly et al. 1986; Lydersen 1998; Lydersen et al. 1987; Lydersen and Smith 1989; Smith 1976). The threat currently posed to ringed and bearded seals by predation is considered moderate, but predation risk is expected to increase as snow and sea ice conditions change with a warming climate (Cameron et al. 2010; Kelly et al. 2010b).

Polar bear predation on ringed seal pups tripled when pups were prematurely exposed as a consequence of unseasonably warm conditions. Hammill and Smith (1991) further noted that polar bear predation on ringed seal pups increased four-fold when average snow depths in their study area decreased from 23 cm to 10 cm. Gulls, ravens, and possibly snowy owls prey on ringed seal pups when the latter are forced out of subnivean lairs prematurely because of low snow accumulation and/or early melts (Lydersen 1998; Lydersen et al. 1987; Lydersen and Ryg 1990; Lydersen and Smith 1989). Avian predation is facilitated not only by lack of sufficient snow cover but also by conditions favoring influxes of birds (Kelly et al. 2010b).

5.7 Plastics

A growing source of contaminants in the Arctic comes from plastics. Approximately 8,300 million metric tons (MT) of plastics have been produced to date with approximately 6,300 million MT becoming waste (Geyer et al. 2017). Jambeck et al. (2015), in an analysis of plastic waste generated by 20 coastal communities world-wide, estimated that 4.8 to 12.7 million MT of plastic waste entered the ocean in 2010. It is estimated that between 62,000 to 105,000 tons of plastic are transported to the Arctic Ocean each year (Zarfl and Matthies 2010). Larger sized plastics such as bottle caps, plastic bags, bottles, and strapping are problems for marine sea birds, turtles, and mammals because of ingestion and entanglement (Derraik 2002b; Laist 1997; Law 2017; Peeken et al. 2018). We have no documented reports of strandings of ringed or bearded seals caused by entanglement or plastic ingestion from the action area. However, entanglement of Northern fur seals (*Callorbinus ursinus*) from around the Pribilof Islands is well documented (Laist 1997; Savage 2019). With increased development in the Beaufort and Chukchi Seas, increased vessel traffic through the Northwest passage, an increased number of observers (tourists, scientists, employees), and longer periods of open water which can promote delivery of plastics to the Arctic, ingestion and entanglement of ringed and bearded seals is more likely to be documented in coming years.

Microplastics, defined as < 5 mm in size, occur due to the release of manufactured plastic particles in various products (primary microplastics) and the fragmentation of larger plastic pieces (secondary microplastics) (Cole et al. 2011). Microplastics are distributed globally. In an examination of ice cores from widely dispersed locations across the Arctic Ocean, Obbard et al. (2014) found from 38 to 234 particles per cubic meter of ice. The microplastic concentrations were several orders of magnitude greater than those reported in the North Pacific Subtropical Gyre (0.12 particles per cubic meter of water). The highest concentration of microplastics ever determined in sea ice was found in from the Makarov Basin in the central Arctic Ocean (Peeken et al. 2018). The ice core there contained concentrations comparable to those from South Korean waters, which were previously highest levels recorded (Peeken et al. 2018). The types of microplastics found in the Arctic included polystyrene, acrylic, polyethylene, polypropylene, nylon, polyester, and rayon (Obbard et al. 2014; Peeken et al. 2018). Microplastics are also abundant in Arctic benthic substrates (Bergmann et al. 2017; Lusher et al. 2015) and water (La Daana et al. 2020; La Daana et al. 2018).

Marine plastic debris is associated with a ‘cocktail of chemicals’, including chemicals added or produced during manufacturing (Lithner et al. 2011; Rochman 2015) and those present in the marine environment that accumulate onto the debris from surrounding seawater (Hirai et al. 2011; Mato et al. 2001). Persistent organic pollutants, including PCBs, and metals have been well documented as sorbing onto plastic particles in studies dating back to 1972 (Mato et al. 2001; Ogata et al. 2009; Zarfl and Matthies 2010). Microplastics and the persistent bioaccumulative toxins they carry have been documented in filter feeders including zooplankton, mussels, planktivorus fish and humpback whales (Besseling et al. 2015; Besseling et al. 2014; Fang et al. 2021) and benthic invertebrates from the shelf of the Bering and Chukchi Seas ((Fang et al. 2018). There is evidence that the sorbed contaminants are bioavailable to a variety of marine mammals and invertebrates (Rochman 2015; Teuten et al. 2009). Researchers are actively investigating whether these plastic-associated contaminants biomagnify in higher trophic levels as a direct result of plastic ingestion and how important bioaccumulation from plastic is relative to bioaccumulation from other sources of chemical contamination in the environment (Avio et al. 2015; Miller et al. 2020; Rochman 2015).

5.8 Other Arctic Projects

In the winters of 2014, 2017, 2018, and 2020 the U.S. Navy conducted submarine training, testing, and other research activities in the northern Beaufort Sea and Arctic Ocean from a temporary camp constructed on an ice flow toward the northern extent of the U.S. EEZ, about 185 to 370 km (115 to 230 mi) north of Prudhoe Bay. Equipment, materials, and personnel were transported to and from the ice camp via daily flights based out of the Deadhorse Airport (located in Prudhoe Bay). No takes were expected, nor authorized, for this activity. An IHA was subsequently issued to the U.S. Navy to incidentally harass (level B only) marine mammals during submarine training and testing activities associated with Ice Exercise 2020 north of Prudhoe Bay, Alaska from February 2020 through January 2021.

In 2016, NMFS Alaska Region conducted internal consultations with NMFS Permits Division on the issuance of three Incidental Harassment Authorizations (IHA) to take marine mammals incidental to dock construction and anchor retrieval in the Bering, Chukchi, and Beaufort seas during the 2016 open water season. The biological opinions estimated takes (by harassment) of 706 bearded seals and 7,887 ringed seals as a result of exposure to continuous or impulsive sounds at received levels at or above 120 dB or 160 dB re 1 μPa rms, respectively.

In 2016 and 2017, NMFS Alaska Region conducted internal consultations with NMFS Permits Division on the issuance of an IHA associated with the continuation of fiber optic cable laying. Quintillion was permitted to install 1,904 km (1,183 mi) of subsea fiber optic cable during the open-water season, including a main trunk line and six branch lines to onshore facilities in Nome, Kotzebue, Point Hope, Wainwright, Barrow, and Oliktok Point. The biological opinions estimated takes (by harassment) of 62 bearded seals and 855 ringed seals as a result of exposure to sounds of received levels at or above 120 dB re 1 μPa_{rms} from sea plows, anchor handling, and operation and maintenance activities (NMFS 2016b).

An IHA was issued to the Alaska Gasline Development Corporation to harass marine mammals during pile driving associated with the Alaska LNG project in Prudhoe Bay from July 2022 through June 2023. Estimates of Level A takes of ESA-listed animals associated with this project include 32 ringed seals and 5 spotted seals. Estimates of Level B takes of ESA-listed animals associated with this project include 110 bowhead whales, 1,765 ringed seals, and 300 bearded seals.

5.9 Scientific Research

Research is a necessary endeavor to assist in the recovery of threatened and endangered species; however, research activities can also disturb these animals. Research on marine mammals often requires boats, adding incrementally to the vessel traffic, noise, and pollution in the action area. Aerial surveys could also disturb whales, especially when circling at low-altitudes to obtain accurate group counts. Boat based surveys, such as photo-identification studies, often require the boat to closely approach whales or whale groups. Deployment and retrieval of passive acoustic monitoring devices requires a boat, which temporarily increases noise in the immediate area.

However, once the instruments are deployed, passive acoustic monitoring is noninvasive. Species considered in this Biological Opinion are taken incidentally during research directed towards other species. This includes various hydroacoustic surveys for fish species, the Alaska longline survey, the Arctic ecosystem integrated survey, and other research (NMFS 2019c).

NMFS issues scientific research permits that are valid for five years for ESA-listed species. When permits expire, researchers often apply for a new permit to continue their research. Additionally, applications for new permits are issued on an on-going basis; therefore, the number of active research permits is subject to change in the period during which this Opinion is valid.

Species considered in this Opinion also occur in Canadian waters. Although we do not have specific information about any permitted research activities in Canadian waters, we assume they will be similar to those described below.

Cetaceans

Whales are exposed to research activities documenting their biology, behavior, habitat use, stock structure, social organization, communication, distribution, and movements throughout their ranges. Activities associated with these permits occur in the action area, in some cases at the same time as the proposed project activities.

Currently permitted research activities include:

- Counting/surveying, aerial and vessel-based
- Opportunistic collection of sloughed skin and remains
- Behavioral and monitoring observations
- Various types of photography and videography
- Skin and blubber biopsy sampling
- Fecal sampling
- Suction-cup, dart/barb, satellite, and dorsal fin/ridge tagging
- Acoustic, active playback/broadcast, and passive recording
- Acoustic sonar for prey mapping

Some of these research activities require close vessel approach. The permits also include incidental harassment takes to cover such activities as tagging, where the research vessel may come within 100 yards of other whales while in pursuit of a target whale. These activities may cause stress to individual whales and cause behavioral responses. In some cases, take could occur and is authorized by the research permits.

Pinnipeds

Steller sea lions, ringed seals, and bearded seals are exposed to research activities documenting their population status and trends, health, movements, habitat use, foraging ecology, response to recovery activities, distribution, and movements throughout their ranges.

Of the more than 30 active scientific research permits, some include behavioral observations, counting/surveying, photo-identification, and capture and restraint (by hand, net, cage, or board), for the purposes of performing the following procedures:

Collection of:

- Blood
- Clipped hair
- Urine and feces
- Nasal and oral swabs
- Vibrissae (pulled)
- Skin, blubber, or muscle biopsies
- Weight and body measurements
- Injection of sedative
- Administration of drugs (intramuscular, subcutaneous, or topical)
- Attachment of instruments to hair or flippers, including flipper tagging
- Ultrasound

These activities may cause stress to individual pinnipeds and cause behavioral responses. In some cases, take could occur and is authorized by the research permits.

6. Effects of the Action

"Effects of the action" are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (50 CFR § 402.02).

This biological opinion relies on the best scientific and commercial information available. We try to note 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 analysis using a stressor identification – exposure – response – risk assessment framework for the proposed activities.

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.

NMFS identified and addressed all potential stressors; and considered all consequences of the proposed action, individually and cumulatively, in developing the analysis and conclusions in this opinion regarding the effects of the proposed action on ESA-listed species and designated critical habitat.

6.1. Project Stressors

Stressors are any physical, chemical, or biological entity that can induce and adverse response. The proposed activities will expose ringed seals to the sounds and physical presence of autonomous sea gliders and unmanned underwater vehicles, research vessels transiting to and from the project area, towed and moored acoustic sources, drifting and moored oceanographic sensors, manned aircraft and unmanned air vehicles, on-ice measurement systems, and weather balloons debris.

Based on our review of the data available, the proposed activities may cause these primary stressors:

1. sound field produced by active non-impulsive acoustic sources
2. sound fields produced by continuous noise sources such as: vessels, aircraft, and ice auguring
3. sound fields produced by *de minimis* sources
4. vessel strike and in-water device strikes
5. entanglement and ingestion of trash and debris through introduction of cables from abandoned instrumentation and weather balloons
6. pollution from unauthorized spills from vessel activities

6.1.1. Minor Stressors on ESA-Listed Species and Critical Habitat

The response of ringed seals to the following minor stressors are expected to be too small to detect or measure and are not likely to significantly disrupt their normal behavioral patterns.

6.1.1.1. Vessel Noise

The proposed action includes one roundtrip of a research vessel from Nome to the Beaufort Sea and back in early October 2021 and one in the spring of 2022. No ice breaking will be involved. The vessel will travel at 10 knots or less depending on the conditions.

Disturbance to ringed seals from vessel noise could occur during the vessel transit. Behavioral reactions of marine mammals to vessels vary depending on the type and speed of the vessel, the spatial relationship between the animal and the vessel, the species, and the behavior of the animal prior to the disturbance from the vessel. Response also varies between individuals of the same species exposed to the same sound. Individual animals' past experiences with vessels appear to be important in determining an individual's response (Shell 2012).

The amount of underwater noise produced by large vessels ranges from 161 dB re 1 μPa at 1 m for military vessels to 192 dB re 1 μPa at 1 m for icebreakers (Halliday et al. 2021). The R/V

Sikuliaq has a source level of 130 to 172 dB re 1 μPa at 1 m when travelling at maximum speed of 11 knots. Because the vessel will be in transit, the duration of the exposure to ship noise will be temporary. NMFS calculates that at 10 knots, the project vessel will ensonify a given point to levels above 120 dB for less than 9 minutes. The project vessel will emit continuous sound while in transit, which will alert ringed seals before the received sound level exceeds 120 dB. Therefore, a startle response is not expected. Rather, slight deflection and avoidance are expected to be common responses in those instances where there is any response at all. Based on the low number of transits (4), the implementation of mitigation measures as specified in Section 2.2, the transitory and short-term exposure, and the expected response, NMFS concludes that any disturbance of ringed seals from vessel noise will be temporary and have a very minor effect.

6.1.1.2. Noise from Aircraft Activity

Five NRL devices will be deployed on the ice using aircraft requiring five flights from Prudhoe Bay in the spring of 2022. A fixed wing Twin Otter aircraft or a single engine alternative that would be quieter will be used. All flights will be at 1,500 ft above sea level or higher.

It is uncertain if an animal reacts to the sound of the aircraft or to its physical presence flying overhead, or both. In the spring when the fixed-wing flights of the proposed action will occur, ringed seals may be on the ice or in the water, and ringed seals may be within their subnivean lairs below the flight path. Ringed seals that are hauled out may react to the noise or visual stimulus by looking up at the aircraft, moving on the ice, entering a breathing hole or crack in the ice, or entering the water (Blackwell et al. 2004b; Born et al. 2004). Reactions depend on several factors including the animal's behavioral state, activity, group size, habitat, and the flight pattern of the aircraft (Richardson et al. 1995). Additionally, a study conducted by Born et al. (1999) found that wind chill was also a factor in level of response of ringed seals hauled out on ice (higher wind chill increases probability of leaving the ice), as well as time of day and wind direction. Furthermore, Perry et al. (2002) found sex and age compositions of haul-out groups (for gray and harbor seals) are important factors in determining the degree of the reaction to aircraft, with mothers and pups more likely to react.

The responses of ringed seals in subnivean lairs are typically stronger than that of a basking ringed seal (Burns et al. 1982). Ringed seals were shown to leave their subnivean lairs and enter the water when a helicopter was at an altitude of less than 1,000 ft. (305 m) and within 1 nm (2 km) lateral distance (Richardson et al. 1995). However, ringed seal vocalizations in water were similar between areas subject to low-flying aircraft and areas that were less disturbed (Calvert and Stirling 1985). These data suggest that although a ringed seal may leave a subnivean lair, aircraft disturbance does not cause the animals to leave the general area. Additionally, ringed seals construct multiple breathing holes and lairs within their home ranges (Smith and Stirling 1975); these additional lairs and breathing holes are used as escape lairs from predators, and therefore would be a suitable alternative in the event they leave a lair directly below the flightpath of an aircraft.

The lowest observed adverse effects levels are rather variable for pinnipeds on land, ranging from just over 492 ft. (150 m) to about 6,562 ft. (2,000 m) (Efroymson and Suter 2001). A conservative (90th percentile) distance effects level for pinnipeds was found to be 3,773 ft. (1,150 m). Most thresholds represent movement away from the overflight. Generally, pinnipeds exposed to intense (approximately 110 to 120 dB re 20 µPa) non-pulse sounds often leave haul-out areas and seek refuge temporarily (minutes to a few hours) in the water (Southall et al. 2007).

Flights of fixed-wing aircraft will be of short duration (3 hrs) and will fly at altitudes of at least 1,500 ft (457 m) above sea level. At this altitude, the footprint of airborne noise at the ice surface would be approximately 0.77 mi^2 (2 km^2) along the flight path of the aircraft. Due to the relatively small area over which aircraft noise would radiate outward, the noise would be transient (about 15 sec, assuming a flight speed of 120 kts). As received sound levels would be reduced by the time the sound reaches the ice from an overhead flight (attenuating in the air column) and would still have to attenuate through the ice, underwater noise would be brief in duration, of reduced intensity, and would transfer to water along a narrow swath of ice (2,588 ft-wide swath). At a distance of 2,152 ft (656 m) away, the received pressure levels of a Twin Otter is 80 to 98.5 dBA (which is less than the Level B threshold for in-air sound (Metzger 1995).

Based on the intermittent and limited use of fixed-wing aircraft (one round trip), and the short-term impacts of any behavioral reactions from aircraft activities, we conclude that the impact of aircraft sound is very minor, and thus adverse effects to ringed seals will be brief and of very low intensity, with any reactions by the seals expected to be imperceptible or very brief. Therefore, we conclude that adverse effects from aircraft traffic will be minimal or undetectable.

Unmanned aerial systems (UAS) that will be used are small and will not hover over marine mammals. It is likely that marine mammals will not hear the device at all because they will be used in the immediate vicinity of the research vessel and the noise generated by the UAS will likely be masked by the vessel noise (Christiansen et al. 2016). The impact of UAS noise will be very minor, and adverse effects to ringed seals will be immeasurably small, if they occur at all. Therefore, we conclude that adverse effects from UAS on ringed seals will be minimal or undetectable.

6.1.1.3. Ice Auguring

Holes will be bored through the ice for deployment of the Autonomous Ocean Flux Buoys (Figure 2) and the Autonomous Weather Stations (Figure 3). Two Autonomous Ocean Flux Buoys will be deployed requiring holes approximately 5 cm in diameter. Three holes are augured per weather station and for the October deployment only one ice station is expected to be created. Up to three ice stations could be created during the spring cruise. It takes approximately 30-60 minutes to auger through the ice, depending on its thickness. Greene et al. (2008) recorded underwater noise from an ice auger during ice road construction at the Northstar Development (Beaufort Sea) and found noise levels at the source were below 100 dB re 1µPa. These levels are below the behavioral threshold for underwater noise harassment for seals. Ringed seals that are out of the water in February through April are expected to be in lairs. Airborne sounds would be greatly attenuated by the ice and snow. Background noise from wind and movements of the ice are expected to be louder and more consistent than the short duration noise created by ice auguring. For these reasons the effects of ice auguring on ringed seals is expected to be extremely unlikely.

6.1.1.4. Other In-water Acoustic Sources ("de minimis")

The proposed action will include devices that are acoustic sources which ONR refers to as "*de minimis*" sources, and have one or more of the following parameters: low source levels, narrow beams, downward directed transmission, short pulse lengths, low duty cycles (fraction of time that the sound is active), or frequencies above (outside) known marine mammal hearing ranges factors (see Table 3; Department of the Navy 2013). For example, any sources 200 kHz or above in frequency are considered by ONR to be *de minimis* because they are outside the range of marine mammal hearing. Although ONR did not include these sources in their NAEMO modeling, we calculated the distance to the 120 dB isopleth for these sources. We consider these calculations of the area of affected marine waters to be conservative for the following reasons: 1) narrow beam and downwardly-directed sources will propagate outside of the source signal's cone at much reduced intensity; 2) pulses of very short durations are less audible than longer pulses at the same sound source levels (Kastelein et al. 2010; Plomp and Bouman 1959; Terhune 1988); 3) sounds with a very low duty cycle are less likely to elicit responses from marine mammals than the equivalent sounds with high duty cycles; and 4) sounds outside of a species' hearing ranges are not likely to be perceived by individuals of that species at all (Southall et al. 2007).

Although an active source when the research vessels are in the Beaufort Sea because of its regular use, the WHOI micromodem is considered *de minimis* during the leave behind period. During the leave behind period it just acts as an on-off switch for the moored systems, activating only five times. Because of the very short interval of usage it is considered *de minimis*.

The Acoustic Doppler Current Profilers (ADCPs) will be moored or deployed on unmanned underwater vehicles. One of the three types of ADCPs used in this project produces signals above 200 kHz; sound that is out of the hearing range of listed marine mammals in Alaska. The other two types of ADCP produce signals from 75-150 kHz; sound that is within the hearing range of ringed seals. NMFS calculated that sound from these devices will produce received levels above 120 dB within 3,000 m of the source. However, the pulse length is extremely short (<1 ms), and the ADCPs have a very narrow beam (2.2 radians), so that only a very small cone of water within 3,000 m of these devices will actually contain sounds in excess of 120 dB. Responses of seals to these sounds are expected to be brief, with animals near the devices expected to quickly habituate to the sounds, therefore these devices are unlikely to cause significant disruptions to normal behavioral patterns.

6.1.1.5. Vessel strike

Behavioral reactions from vessels can vary depending on the type and speed of the vessel, the spatial relationship between the animal and the vessel, the species, and the behavior of the animal prior to the disturbance from the vessel. Response also varies between individuals of the same species. Individual animals' past experiences with vessels appear to be important in determining an individual's response. Vessels moving at slow speeds and avoiding rapid changes in direction or engine power may be tolerated by some species, and seals may even investigate vessels. Other individuals may deflect around vessels and continue on their migratory path.

Various efforts have investigated the impact of vessels on seals (both whale-watching and general vessel traffic noise). Jansen et al. (2015) found disturbance rates (i.e., numbers of harbor seals flushed into the water) from cruise ships as high as 14 percent in Disenchantment Bay, Alaska. In another study on harbor seals in Tracy and Endicott Arms, Alaska, Karpovich et al. (2015) found increases in heart rate in seals disturbed by vessels. This effect persisted through the subsequent haul out period and could have energetic impacts on individual animals.

The project's seagliders are small and slow moving (0.25 meters per second). The Unmanned Underwater Vehicle (UUV) are larger and can travel at a faster speed (5 knots) which is about equal to the average swimming speed of a ringed seal. Both devices are bright yellow, will be traveling in a predictable manner without major changes in speed or direction and seals will likely be able to visually detect and easily avoid the devices. While they may investigate the devices, we have no information that would cause us to expect they would display a significant disruption of normal behavior patterns.

Ringed seals will likely be able to hear the research vessels from many kilometers away, and if disturbed, would likely move away from the vessel noise before it comes in close proximity. Although Sternfeld (2004) documented a single spotted seal stranding in Bristol Bay, Alaska that may have resulted from a propeller strike, there have been no incidents of ship strike with bearded or ringed seals documented in Alaska (BOEM 2015a). In addition, ringed seals are extremely agile and capable of moving quickly in the water greatly reducing the probability of being struck by a vessel traveling at 10 knots. Finally, personnel will be watching for marine mammals during marine operations, further reducing the possibility of ship strike. Therefore, we conclude that the probability of project vessels or equipment striking a ringed seal is very small, and adverse effects to these seals are extremely unlikely to occur.

6.1.1.6. Entanglement and ingestion of trash and debris

The project activities require a variety of lines and cables (Table 12). The longest ones will anchor moorings and these will be retrieved. However, there will be a variety of cables and debris jettisoned as a consequence of the project activities. While functional, the lines will be kept taut from their anchor attachments, reducing the risk of entanglement. During deployment, the likelihood of entanglement will be further reduced because personnel will be monitoring for the presence of marine mammals and should be aware of their presence in the area.

Table 12. Cable length, material, and fate for ONR's Arctic Research Activity instruments.

Device Name	Deployed 2021	Cable Length	Cable Material	Bottom-tethered or Floating	Will Device be Retrieved	If not recovered, sink or float
Moorings (AMOS Project (ONR)) 900Hz	7	4000	5/16" Technora Line and ½" chain	Bottom-tethered	Yes	NA
Ice Tethered Profilers (ITP)	2	500-800 m	0.635-cm diameter plastic-jacketed wire rope	Floating	No	Sink

Device Name	**Deployed 2021**	**Cable Length**	**Cable Material**	**Bottom-tethered or Floating**	**Will Device be Retrieved**	**If not recovered, sink or float**
WIMBO	2	200 m	1 cm diameter plastic-jacketed wire with sensors integrated into the wire and jacket	Floating	No	Sink
Autonomous Ocean Flux Buoy (AOFB)	2	4 m	Stainless steel poles	Floating	No	Sink
Argo float site	1	3 m	0.5 cm diameter plastic jacketed wire rope	Floating	No	Sink
NRL Real Time Sensing 900-1000Hz	10	150 m	Polyurethane coated, polypropylene insulated stainless steel wire	Floating	No	Sink
VLF source	1	100 m	2 electrical cables up to 0.7”in diameter	Tethered to ship	Yes	N/A
Weather balloons	40	55 m	Polypropylene lines	N/A	No	Float

The weather balloons being released could introduce the potential for entanglement following their descent; these balloons would consist of shredded debris from bursting balloons, a parachute used to slow the descent of the radiosonde, and all of the ropes and twine used to keep all of the components together (the radiosonde would be suspended 82-115 ft [25-55 m] below the balloon). Balloon fragments would temporarily be deposited on the ice, until the ice melts. Components would likely float until becoming so weathered and degraded that they eventually sink to the seafloor. Balloon and parachute fragments that remain suspended in the water column could be ingested if encountered and mistaken for a prey item. However, ringed seals primarily eat fish, reducing the likelihood that an individual would consume a piece of plastic which would neither look, nor move, like a fish.

Although there is a potential for entanglement from an expended material, the amount of materials expended will be low compared to the size of the Beaufort Sea. All of the cables/lines except those from the weather balloons are metal coated with plastic. We assume that the weight of the metal will cause these cables to sink to the sea floor. The water depth in the area of deployment is 1,000 to over 3,000 m deep, greater than ringed seals dive. Therefore, it is extremely unlikely that ringed seals would be exposed to this expended material. In addition, a recent stranding report found that out of the 21 reported seal strandings that occurred from human interaction in the Arctic regions, none were documented to be from entanglement (Savage 2018). We note that jettisoning this material adds to the plastic debris and ultimately to the mircoplastics found in the Arctic Ocean.

6.1.1.7. Pollution

Increased vessel activity in the action area will temporarily increase the risk of accidental fuel and lubricant spills from the research vessels. Accidental spills may occur from a spilled container, vessel leak, or hull breach. Spilled oil tends to concentrate in ice leads and in breathing holes, and will be held closer to the surface against ice edges where seals tend to travel (Engelhardt 1987). Floating sea ice also reduces wave action and surface exchange, thus delaying the weathering and dispersion of oil (or other contaminants) and increasing the level and duration of exposure to seals. Sea ice impedes response efforts. Low temperatures make oil more viscous and thus increase the hazards associated with fouling of animals. They also reduce evaporation of volatile hydrocarbons, lessening the acute levels of toxins in the air but lengthening the period of exposure (Engelhardt 1987). To date there have been no major oil spills in the Arctic, so real-world data from which to develop a specific response or predict environmental impacts are lacking.

The greatest threat to Arctic marine mammals from small spills is likely from the inhalation of the volatile toxic hydrocarbon fractions of fresh oil, which can damage the respiratory system (Hansen 1985; Neff 2010) and cause neurological disorders or liver damage (Geraci 2012). Freshly spilled oil contains high levels of toxic aromatic compounds that, if inhaled, could cause serious health effects or death in ringed seals, as occurred with an estimated 300 harbor seals following the Exxon Valdez oil spill in Prince William Sound, Alaska (Frost et al. 1994a; Frost et al. 1994b; Lowry et al. 1994; Spraker et al. 1994). Oil that disperses from a spill site may still have high levels of toxic aromatic compounds, depending on the temperature and whether the oil becomes frozen into ice (St. Aubin 1990). Pinnipeds stressed by parasitism or other metabolic disorders may be susceptible to injury or death from even brief exposure to low concentrations of hydrocarbon vapors (St. Aubin 1990). For example, parasitized lungs—common in pinnipeds—can exacerbate the effects of even mild irritation of respiratory tissues (St. Aubin 1990). Toxicity of oil is generally greater in younger animals, so exposure to oil contamination during the breeding season would likely cause higher mortality among pups (Jenssen 1996; Jenssen et al. 1996) .

Direct ingestion of oil, ingestion of contaminated prey, or inhalation of volatile hydrocarbons transfers toxins to body fluids, muscle, liver, and blubber, causing effects that may lead to death, as suspected in dead gray and harbor seals found with oil in their stomachs (Engelhardt 1987; Engelhardt et al. 1977; Frost et al. 1994a; Jenssen 1996; Lowry et al. 1994; Spraker et al. 1994; St. Aubin 1990). Furthermore, ingestion of hydrocarbons irritates and destroys epithelial cells in the stomach and intestine, affecting motility, digestion, and absorption, which can result in death or reproductive failure (St. Aubin 1990).

Other acute effects of oil exposure, which have been shown to reduce both ringed and bearded seal health and possibly survival include skin irritation, disorientation, lethargy, conjunctivitis, corneal ulcers, and liver legions (Geraci and Smith 1976b; St. Aubin 1988).

Project vessels will not be in the region during pupping season but will be in the region after pups have developed their pelage and insulating blubber layer. Energetic costs associated with exposure to contaminants such as oil would occur if mothers and pups spend more time in the water by swimming out of the affected area. Adults, juveniles, and weaned young of the year rely on blubber for insulation, so effects on their thermoregulation are expected to be minimal (Jenssen 1996).

While the potential effects of pollution, particularly oil pollution, can be severe, the vessels associated with this action will be carrying relatively small volumes of refined fuel and other petroleum products such as lubricating oils and solvents. Refined fuel will contain a higher proportion of lower molecular weight toxic aromatic compounds, which pose a greater risk for lung damage if vapors are inhaled, but which also evaporate more rapidly. Given the small volumes of petroleum products carried by these project vessels, their ability to operate in icy waters safely, their ability to clean up spilled petroleum products before it reaches marine waters, their ability to coordinate rapid oil spill response should spilled petroleum products reach marine waters, and their brief time spent in the project area, the probability of project related pollution occurring is very small. Adverse impacts to ringed seals are therefore extremely unlikely to occur.

6.1.2. Major Stressors on ESA-Listed Species and Critical Habitat

The following sections analyze the stressors likely to adversely affect the ringed seal due to underwater sounds created by the scientific instruments. First, we provide a brief explanation of the sound measurements and acoustic thresholds used in the discussions of acoustic effects in this opinion.

For the proposed action, the activities which could result in underwater acoustic disturbance to ringed seals include: 1) active acoustic sources from moored, drifting, and vessel-based devices (Tables 1). Although noise will also be created by the research vessels that stressor is discussed in section 6.1.1. The proposed action involves the use of low-(35 Hz), mid-(850-1050 Hz), and high-(8-14 kHz) frequency sources in the deep ocean area (Figure 1). The 35 Hz sources are below ringed seal hearing ability. The mid and high frequency sources are within their hearing range. Decibel source levels range from 180 to 190 re 1 μPa at 1 m and have various duty cycles and pulse lengths (Table 1). The total amount of active source testing for ship-deployed sources used during the cruise would be 120 hours. Acoustic stressors are responsible for all instances of ringed seal take expected to result from this project.

Impulsive sound sources (e.g., explosions, sonic booms, impact pile driving) produce signals that are brief (typically considered to be less than one second), broadband, and occur either as isolated events or repeated in some succession (86 FR 47065). Impulsive sounds are all characterized by a relatively rapid rise from ambient pressure to a maximal pressure value followed by a rapid decay period that may include a period of diminishing, oscillating maximal and minimal pressures, and generally have an increased capacity to induce physical injury as compared with sounds that lack these features. No impulsive acoustic sources will be used during ONR's proposed action.

Non-impulsive sounds can be tonal, narrowband, or broadband, brief or prolonged, and may be either continuous or non-continuous (86 FR 47065). Some of these non-impulsive sounds can be transient signals of short duration but without the essential properties of pulses (e.g., rapid rise time). Examples of non-impulsive sounds include those produced by vessels, aircraft, and active sonar sources that intentionally direct a sound signal at a target that is reflected back in order to discern physical details about the target. These active sources are used in navigation, military training and testing, and other research activities such as the activities planned by ONR as part of the proposed action.

6.1.2.1. Acoustic Thresholds

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, 1872; January 11, 2005). NMFS revised the comprehensive guidance on sound levels likely to cause injury to marine mammals through onset of permanent and temporary threshold shifts (PTS and TTS; Level A harassment) (83 FR 28824; June 21, 2018) (NMFS 2018b). NMFS is in the process of developing guidance for behavioral disruption (Level B harassment). However, until such guidance is available, NMFS uses the following conservative thresholds of underwater sound pressure levels[18], expressed in rms[19] from broadband sounds that cause behavioral disturbance, and referred to as Level B harassment under section 3(18)(A)(ii) of the MMPA (16 U.S.C § 1362(18)(A)(ii)):

- impulsive sound: 160 dB re 1 μPa_{rms}
- non-impulsive sound: 120 dB re 1μPa_{rms}

Under the PTS/TTS Technical Guidance, NMFS uses the following thresholds for underwater sounds that cause injury, referred to as Level A harassment under section 3(18)(A)(i) of the MMPA (16 U.S.C § 1362(18)(A)(i)). Different thresholds and auditory weighting functions are provided for different marine mammal hearing groups, which are defined in the Technical Guidance (NMFS 2018b). The generalized hearing range for each hearing group is in Table 13.

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[18] Sound pressure is the sound force per unit micropascals (μPa), where 1 pascal (Pa) is the pressure resulting from a force of one newton exerted over an area of one square meter. Sound pressure level is expressed as the ratio of a measured sound pressure and a reference level. The commonly used reference pressure level in acoustics is 1 μPa, and the units for underwater sound pressure levels are decibels (dB) re 1 μPa.

[19] Root mean square (rms) is the square root of the arithmetic average of the squared instantaneous pressure values.

Table 13. Underwater marine mammal hearing groups (NMFS 2018b).

Hearing Group	**Generalized Hearing Range**[1]
Low-frequency (LF) cetaceans *(Baleen whales)*	7 Hz to 35 kHz
Mid-frequency (MF) cetaceans *(dolphins, toothed whales, beaked whales)*	150 Hz to 160 kHz
High-frequency (HF) cetaceans *(true porpoises)*	275 Hz to 160 kHz
Phocid pinnipeds (PW) *(true seals)*	50 Hz to 86 kHz
Otariid pinnipeds (OW) *(sea lions and fur seals)*	60 Hz to 39 kHz

[1] Respresents the generalized hearing range for the entire group as a composite (i.e., all species within the group), where individual species' hearing ranges are typically not as broad. Generalized hearing range chosen based on ~65 dB threshold from normalized composite audiogram, with the exception for lower limits for LF cetaceans (Southall et al. 2007) and PW pinniped (approximation).

The PTS onset acoustic thresholds for ringed seals are presented in Table 14, using dual metrics of cumulative sound exposure level (L_E) and peak sound level (PK) for impulsive sounds and L_E for non-impulsive sounds. Level A harassment radii can be calculated using the optional user spreadsheet[20] associated with NMFS Technical Guidance, or through modeling.

Table 14. PTS Onset Acoustic Thresholds (NMFS 2018b).

Hearing Group	**PTS Onset Acoustic Thresholds*** **(Received Level)**	
	Impulsive	**Non-impulsive**
Phocid Pinnipeds (PW) (Underwater)	$L_{\text{pk,flat}}$: 218 dB $L_{\text{E,PW,24h}}$: 185 dB	$L_{\text{E,PW,24h}}$: 201 dB

* Dual metric acoustic thresholds for impulsive sounds: Use whichever results in the largest isopleth for calculating PTS onset. If a non-impulsive sound has the potential of exceeding the peak sound pressure level thresholds associated with impulsive sounds, these thresholds should also be considered.

Note: Peak sound pressure (L_{pk}) has a reference value of 1 µPa, and cumulative sound exposure level (L_E) has a reference value of 1µPa²s. The subscript "flat" is being included to indicate peak sound pressure should be flat weighted or unweighted within the generalized hearing range. The subscript associated with cumulative sound exposure level thresholds indicates the designated marine mammal auditory weighting function (LF, MF, and HF cetaceans, and PW and OW pinnipeds) and that the recommended accumulation period is 24 hours. The cumulative sound exposure level thresholds could be exceeded in a multitude of ways (i.e., varying exposure levels and durations, duty cycle). When possible, it is valuable for action proponents to indicate the conditions under which these acoustic thresholds will be exceeded.

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[20] The Optional User Spreadsheet can be downloaded from the following website: http://www.nmfs.noaa.gov/pr/acoustics/guidelines.htm

In addition, NMFS uses the following thresholds for in-air sound pressure levels from broadband sounds that cause Level B behavioral disturbance under section 3(18)(A)(ii) of the MMPA (16 U.S.C § 1362(18)(A)(ii)):

- 90 dB re 20µPa$_{rms}$ for harbor seals
- 100 dB re 20µPa$_{rms}$ for non-harbor seal pinnipeds

There is no established in-air acoustic threshold for Level A injury. For the proposed action, in-air acoustic disturbance could be caused by aircraft or ice auguring. These affects are discussed in sections 6.1.1.2and 6.1.1.3, respectively.

The National Defense Authorization Act of Fiscal Year 2004 (PL 108-136) amended the definition of "harassment" under the MMPA, specifically as it applies to military readiness activities or scientific research activities conducted by or on behalf of the federal government (16 U.S.C. §1362 (18)(B)). The Fiscal Year 2004 National Defense Authorization Act adopted the definition of "military readiness activity" as set forth in the Fiscal Year 2003 National Defense Authorization Act (PL 107-314). Research activities within the study area are composed of military readiness activities, as that term is defined in PL 107-314, because activities constitute realistic testing of military equipment, vehicles, and sensors for proper operation and suitability for combat use. For military readiness activities, the relevant definition of harassment under the MMPA is any act that:

- Injures or has the significant potential to injure a marine mammal or marine mammal stock in the wild ("Level A harassment"); or
- Disturbs or is likely to disturb a marine mammal or marine mammal stock in the wild by causing disruption of natural behavioral patterns including, but not limited to, migration, surfacing, nursing, breeding, feeding, or sheltering to a point where such behavioral patterns are abandoned or significantly altered ("Level B harassment") (16 U.S.C. § 1362(18)(B)(i) and (ii)).

While the ESA does not define "harass," NMFS issued guidance interpreting the term "harass" under the ESA to mean: "create the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering" (Wieting 2016). For the purposes of this consultation, any action that amounts to incidental harassment under the MMPA—whether Level A or Level B—constitutes an incidental "take" under the ESA, including any exposure to Level A or Level B disturbance sound thresholds described below, which must be authorized by the ITS (Section 10 of this opinion) (except that take is not prohibited for threatened species that do not have ESA section 4(d) regulations).

6.2 Exposure Analysis

As discussed in the *Approach to the Assessment* section of this opinion, exposure analyses are designed to identify the listed resources that are likely to co-occur with these effects in space and time and the nature of that co-occurrence. In this step of our analysis, we try to identify the number, age (or life stage), and gender of the individuals that are likely to be exposed to an action's effects and the populations or subpopulations those individuals represent. As discussed in Section 2.2 above, the Navy proposed mitigation measures to avoid or minimize exposure of ringed seals to one or more stressors from the proposed action.

For our exposure analyses, NMFS generally relies on an action agency's estimates of the number of marine mammals that might be "taken." A quantitative exposure analysis was provided in the original Biological Evaluation (ONR 2018) and IHA application (ONR 2018b) for the 4 year project. The take presented in this biological opinion used analysis provide in the Biological Evaluation, the new application for an IHA (ONR 2021) and the Federal Register notice for this project (86 FR 47065). Because of the remote location and because several of the active sound sources are left drifting in the Beaufort Sea when direct observation is not possible, modeling is the best way to estimate exposure of ringed seals to the sound sources.

The ONR's quantitative exposure analysis is based on the Navy Acoustic Effects Model (NAEMO) and estimates the number of marine mammals that could be harassed by the underwater non-impulsive acoustic sources during the proposed action (ONR 2018). Inputs to the quantitative analysis included marine mammal density estimates obtained from the Navy Marine Species Density Database, marine mammal depth occurrence distributions, oceanographic and environmental data, marine mammal hearing data, and criteria and thresholds for levels of potential effects. The quantitative analysis consists of computer modeled estimates and a post-model analysis to determine the number of potential animal exposures. The model calculates sound energy propagation from the proposed non-impulsive acoustic sources, the sound received by animat (virtual animal) dosimeters representing marine mammals distributed in the area around the modeled activity, and whether the sound received by a marine mammal exceeds the thresholds for effects. More information on the details of the NAEMO modelling can be found in (ONR 2021) and 83 FR 40234.

There are limitations to the data used in the acoustic effects model, and the results must be interpreted within this context. While the best available data and appropriate input assumptions have been used in the modeling, when there is a lack of definitive data to support an aspect of the modeling, conservative modeling assumptions have been chosen (i.e., assumptions that may result in an overestimate of acoustic exposures):

- Animats are modeled as being underwater, stationary, and facing the source and therefore always predicted to receive the maximum potential sound level at a given location (i.e., no porpoising or pinnipeds' heads above water);

- Animats do not move horizontally (but change their position vertically within the water column), which may overestimate physiological effects such as hearing loss, especially for slow moving or stationary sound sources in the model;

- Animats are stationary horizontally and therefore do not avoid the sound source, unlike in the wild where animals would most often avoid exposures at higher sound levels, especially those exposures that may result in PTS;

- Multiple exposures within any 24-hour period are considered one continuous exposure for the purposes of calculating potential threshold shift, because there are not sufficient data to estimate a hearing recovery function for the time between exposures; and

- Mitigation measures were not considered in the model. In reality, sound-producing activities would be reduced, stopped, or delayed if marine mammals are detected by visual monitoring.

NAEMO then records the energy received by each animat within the energy footprint of the event and calculates the number of animats having received levels of energy exposures that fall within defined impact thresholds. Predicted effects on the animats within a scenario are then tallied and the highest order effect (based on severity of criteria; e.g., PTS over TTS) predicted for a given animat is assumed. Each scenario, or each 24-hour period for scenarios lasting greater than 24 hours is independent of all others, and therefore, the same individual marine mammal (as represented by an animat in the model environment) could be impacted during each independent scenario or 24-hour period. In few instances, although the activities themselves all occur within the proposed study location, sound may propagate beyond the boundary of the study area. Any exposures occurring outside the boundary of the study area are counted as if they occurred within the study area boundary. NAEMO provides the initial estimated impacts on marine species with a static horizontal distribution (i.e., animats in the model environment do not move horizontally).

As discussed above, within NAEMO, animats do not move horizontally or react in any way to avoid sound. Furthermore, mitigation measures that are implemented during testing activities that reduce the likelihood of physiological impacts are not considered in quantitative analysis. Therefore, the current model overestimates non-impulsive acoustic impacts, especially physiological impacts near the sound source. The behavioral criteria used as a part of this analysis acknowledges that a behavioral reaction is likely to occur at levels below those required to cause hearing loss (TTS or PTS). At close ranges and high sound levels approaching those that could cause PTS, avoidance of the area immediately around the sound source is the assumed behavioral response for most cases.

In previous environmental analyses the Navy has implemented analytical factors to account for avoidance behavior and the implementation of mitigation measures. The application of avoidance and mitigation factors has only been applied to model-estimated PTS exposures given the short distance over which PTS is estimated. Given that no PTS exposures were estimated during the modeling process for this proposed action, the implementation of avoidance and mitigation factors were not included in this analysis.

Table 15 provides a range to effects for noise produced through use of the proposed sources to pinniped-specific criteria. Range to effects is important information in predicting non-impulsive acoustic impacts. Therefore, the ranges in Table 15 provide realistic maximum distances over which the specific effects from the use of non-impulsive active sources during the proposed action would be possible.

Table 15. Range to PTS, TTS, and Behavioral Effects in the Project Area based on Cutoff Distances for Non-Impulsive Active Acoustic Sources

Source Type	**Range to Behavioral Effects (meters)**	**Range to TTS Effects (meters)**[c]	**Range to PTS Effects (meters)**[c]
	Ringed seal	**Ringed seal**	**Ringed seal**
On-site drifting sources [b]	10,000[a]	0	0
Fixed sources	5,000[a]	0	0
a – Cutoff distance applied (U.S. Department of the Navy, 2017a) *b* – Assessed under the assumption that some of the on-site drifting sources would become closer together. *c* – No effect (and therefore, no distance from source) is anticipated based on the NAEMO modeling.			

Southall et al. (2007) reported that pinnipeds do not exhibit strong reactions to SPLs up to 140 dB re 1 μPa from non-impulsive sources. While there are limited data on pinniped behavioral responses beyond about 3 km in the water, the Navy used a conservative distance cutoff of 2.7 nm (5 km) for moderate source level, single platform training and testing events, and 5.4 nm (10 km) for all other events, including the proposed Arctic Research Activities (U.S. Department of the Navy, 2017a). The Permits Division and AKR have also adopted this approach in support of their proposed IHA and biological opinion, respectively.

Regardless of the received level at the cutoff distances described above, take is not estimated to occur beyond 10 km from the source for pinnipeds. No instances of PTS or TTS were modeled and thus, no take by Level A harassment is anticipated or proposed to be authorized. Further information on cutoff distances can be found in (ONR 2021).

The marine mammal density numbers utilized for quantitative modeling of take are from the Navy Marine Species Density Database (U.S. Department of the Navy, 2014). Density estimates are based on habitat-based modeling by Kaschner et al. (2006) and Kaschner (2004). Table 16 shows the exposures expected for the ringed seal based on NAEMO modeled results.

Table 16. Quantitative Modeling Results of Potential Exposures

Species	**Density Estimate within Study Area (animals per square km)**[1]	**Level B Harassment (behavioral)**	**Level B Harassment (TTS)**
Ringed Seal	0.3958	6,050	0
[1] Kaschner (2004); Kaschner et al. (2006)			

6.3 Response Analysis

6.3.1 Threshold Shifts

Exposure of marine mammals to very loud noise can result in physical effects, such as changes to sensory hairs in the auditory system, which may temporarily or permanently impair hearing. Temporary threshold shift (TTS) is a temporary hearing change, and its severity is dependent upon the duration, frequency, sound pressure, and rise time of a sound (Finneran and Schlundt

2013). TTSs can last minutes to days. Full recovery is expected, and this condition is not considered a physical injury. At higher received levels, or in frequency ranges where animals are more sensitive, permanent threshold shift (PTS) can occur. When PTS occurs, auditory sensitivity is unrecoverable (i.e., permanent hearing loss). The effect of noise exposure generally depends on a number of factors relating to the physical and spectral characteristics of the sound (e.g., the intensity, peak pressure, frequency, duration, duty cycle), and relating to the animal under consideration (e.g., hearing sensitivity, age, gender, behavioral status, prior exposures). Both TTS and PTS can result from a single pulse or from accumulated effects of multiple pulses from an impulsive sound source or from accumulated effects of non-pulsed sound from a continuous sound source. In the case of exposure to multiple pulses, each pulse need not be as loud as a single pulse to have the same accumulated effect.

As it is a permanent auditory injury, the onset of PTS may be considered an example of "Level A harassment" as defined in the MMPA. TTS is by definition recoverable rather than permanent, and has historically has been treated as "Level B harassment" under the MMPA. Behavioral effects may also constitute Level B harassment and are expected to occur at even lower noise levels than would generate TTS.

Based on the modeling done by the Navy and in agreement with the Permits Division we do not expect ringed seals to be exposed to sound levels that would cause either PTS or TTS. If exposure to the acoustic sources occurs, ringed seals could exhibit behavioral responses which are discussed in more detail below.

6.3.2 Auditory Interference (masking)

Auditory interference, or masking, occurs when an interfering noise is similar in frequency and loudness to (or louder than) the auditory signal received by an animal while it is processing echolocation signals or listening for acoustic information from other animals (Francis and Barber 2013). Masking can interfere with an animal's ability to gather acoustic information about its environment, such as predators, prey, conspecifics, and other environmental cues (Francis and Barber 2013).

Critical ratios, a measure of the relative ability of an animal to extract signals from noise, have been determined for pinnipeds (Southall et al. 2000; Southall et al. 2003) and bottlenose dolphins (Johnson 1967). These studies provide baseline information from which the probability of masking can be estimated.

Clark et al. (2009) developed a methodology for estimating masking effects on communication signals for low frequency cetaceans, including calculating the cumulative impact of multiple noise sources. They found that two commercial vessels passing through a North Atlantic right whale's optimal communication space decreased the size of that space by 84 percent. Subsequent research for the same species and location estimated that an average of 63 to 67 percent of North Atlantic right whale's communication space has been reduced by an increase in background noise levels, and that noise associated with transiting vessels is a major contributor to the increase in background noise (Hatch et al. 2012).

Vocal changes in response to anthropogenic noise can occur across sounds produced by marine mammals, such as whistling, echolocation click production, calling, and singing. Changes to vocal behavior and call structure may result from a need to compensate for an increase in background noise. In cetaceans, vocalization changes have been reported from exposure to anthropogenic noise sources such as sonar, vessel noise, and seismic surveying. Vocalizations may also change in response to variation in the natural acoustic environment (e.g., from variation in sea surface motion) (Dunlop et al. 2014).

Ringed seals 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 vessel noise (Gordon et al. 2003). However, as explained in Section 6.1.1.1, vessel noise from this project is expected to have a very temporary and minor effect on ringed seals.

Evidence suggests that at least some marine mammals have the ability to acoustically identify predators. For example, harbor seals that reside in the coastal waters off British Columbia are frequently targeted by certain groups of killer whales, but not others. The seals discriminate between the calls of threatening and non-threatening killer whales (Deecke et al. 2002), a capability that should increase survivorship while reducing the energy required for responding to all killer whale calls. Auditory masking may prevent marine mammals from responding to the acoustic cues produced by their predators. The effects of auditory masking on the predator-prey relationship depends on the duration of the masking and the likelihood of encountering a predator.

Although ringed seals vocalize, there is no evidence that they use sound to find prey or evade predators. Ringed seals are prey for polar bears and killer whales. The seals are susceptible to attack by polar bears when basking on ice, not when they are in the water. Because ringed seals do not rely on sound in water to evade polar bears, auditory masking of a polar bear approach is not a potential effect of this project. Killer whales are not present in the deep waters of the Beaufort Sea. Ringed seal calls are primarily barks in winter and yelps in spring (Jones et al. 2014). (Stirling et al. 1983) hypothesized that the calls are involved in intraspecific competition to maintain social structure around breathing holes and that they may also serve a purpose during reproduction. Because ringed seals breed in the spring and the project activities are concentrated in the fall, the potential for masking of communication related to breeding is greatly decreased. Given the nature of the ringed seal calls and the fact that all the active acoustic sources except for one have either a very short pulse time (less than one minute) and/or a very short duty cycle (less than 10%) (Table 1), it is highly unlikely that they would cause significant level of masking as there will be much more time without sound production than with sound production. The one source that has a significantly longer pulse length is the AMOS VLF Navigation Source. However, it will use a frequency of 35 Hz which is below the hearing range of ringed seals.

6.3.3 Behavioral Response

NMFS expects that ringed seals may have a behavioral response to the sounds created by the research devices. Marine mammals may exhibit a variety of behavioral changes in response to underwater sound and the general presence of project activities and equipment, which can be generally summarized as:

- Modifying or stopping vocalizations

- Changing from one behavioral state to another
- Movement out of feeding, breeding, or migratory areas

The response of a marine mammal to an anthropogenic sound will depend on the frequency, duration, temporal pattern, and amplitude of the sound as well as the animal's prior experience with the sound and the context in which the sound is encountered (i.e., what the animal is doing at the time of the exposure). The distance from the sound source and whether it is perceived as approaching or moving away can affect the way an animal responds to a sound (Wartzok et al. 2003). For marine mammals, a review of responses to anthropogenic sound was first conducted by Richardson et al. (1995). More recent reviews (e.g., Ellison et al. 2012; Nowacek et al. 2007; Southall et al. 2009; Southall et al. 2007) address studies conducted since 1995 and focus on observations where the received sound level of the exposed marine mammal(s) was known or could be estimated.

Except for some vocalization changes that may be compensating for auditory masking, all behavioral reactions are assumed to occur due to a preceding stress or cueing response; however, stress responses cannot be predicted directly due to a lack of scientific data (see following section). Responses can overlap; for example, a flight response is likely to be coupled with an increased respiration rate. Differential responses are expected among and within species since hearing ranges vary across species and individuals, the behavioral ecology of individual species is unlikely to completely overlap, and individuals of the same species may react differently to the same, or similar, stressor.

A review of behavioral reactions by pinnipeds to impulsive noise can be found in Richardson et al. (1995) and Southall et al. (2007). Blackwell et al. (2004a) observed that ringed seals exhibited little or no reaction to drilling noise with mean underwater levels of 157 dB re 1 μPa rms and in air levels of 112 dB re 20 μPa, suggesting the seals had habituated to the noise. In contrast, captive California sea lions avoided sounds from an impulsive source at levels of 165 to 170 dB re 1 μPa (Finneran et al. 2003).

Experimentally, (Götz and Janik 2011) tested underwater responses to a startling sound (sound with a rapid rise time and a 93 dB sensation level [the level above the animal's threshold at that frequency) and a non-startling sound (sound with the same level, but with a slower rise time) in wild-captured gray seals. The animals exposed to the startling treatment avoided a known food source, whereas animals exposed to the non-startling treatment did not react or habituate during the exposure period. The results of this study highlight the importance of the characteristics of the acoustic signal in an animal's habituation.

In cases where the seal response is brief (i.e., changing from one behavior to another, relocating a short distance, or ceasing vocalization), effects could rise to the level of take of individuals but are not likely to be significant at the population level.

Marine mammal responses to anthropogenic sound vary by species, state of maturity, prior exposure, current activity, reproductive state, time of day, and other factors (Ellison et al. 2012). Southall et al. (2007) reported that pinnipeds do not exhibit strong reactions to SPLs up to 140 dB re 1 μPa from non-impulsive sources. Data on hooded seals (*Cystophora cristata*) indicate avoidance responses to signals above 160–170 dB re 1 μPa (Kvadsheim et al. 2010), and data on gray (*Halichoerus grypus*) and harbor seals indicate avoidance response at received levels of 135–144 dB re 1 µPa (Götz et al. 2010). In each instance where food was available, which provided the seals motivation to remain near the source, habituation to the signals occurred rapidly. In the same study, it was noted that habituation was not apparent in wild seals where no food source was available (Götz et al. 2010). This implies that the motivation of the animal is necessary to consider in determining the potential for a reaction.

In one study aimed to investigate the under-ice movements and sensory cues associated with under-ice navigation of ice seals, acoustic transmitters (60–69 kHz at 159 dB re 1 µPa at 1 m) were attached to ringed seals (Wartzok et al. 1992). An acoustic tracking system then was installed in the ice to receive the non-impulsive acoustic signals and provide real-time tracking of ice seal movements. Although the frequencies used in the study are at the upper limit of ringed seal hearing, the ringed seals appeared unaffected by the non-impulsive acoustic sources, as they were able to maintain normal behaviors (e.g., finding breathing holes).

In studies by Götz et al. (2010), and Kvadsheim et al. (2010), seals that were exposed to non-impulsive acoustic sources with a received sound pressure level between 142–193 dB re 1 µPa, were shown to change their behavior by modifying diving activity and avoidance of the sound source (Götz et al. 2010; Kvadsheim et al. 2010). Although a minor change to a behavior may occur as a result of exposure to the sources in the proposed action, these changes would be within the normal range of behaviors for the animal (e.g., the use of a breathing hole further from the source, rather than one closer to the source, would be within the normal range of behavior) (Kelly et al. 1988).

These studies indicate that depending on a variety of factors including availability of food, past experiences with anthropogenic sound, and distance from the source, ringed seals may avoid the sounds created by the scientific instruments used in this project or they may have very little reaction to them.

6.3.4 Non-Auditory Physical or Physiological Effects

Individuals exposed to noise can experience stress and distress, where stress is an adaptive response that does not normally place an animal at risk, and distress is a stress response resulting in a biological consequence to the individual. Both stress and distress can affect survival and productivity (Cowan and Curry 2008; Cowan and Curry 2002; Curry and Edwards 1998; Herráez et al. 2007). Mammalian stress levels can vary by age, sex, season, and health status (Gardiner and Hall 1997; Hunt et al. 2006; Romero et al. 2008; St. Aubin et al. 1996).

Anthropogenic activities have the potential to provide additional stressors above and beyond those that occur naturally. For example, various efforts have investigated the impact of vessels on marine mammals (both whale-watching and general vessel traffic noise) and demonstrated that impacts do occur (Bain et al. 2006; Erbe 2002; Noren et al. 2009; Pirotta et al. 2015; Williams et al. 2002). In an analysis of energy costs to killer whales, Williams and Noren (2009) suggested that whale-watching in the Johnstone Strait resulted in lost feeding opportunities due to vessel disturbance. During the time following September 11, 2001, shipping traffic and associated ocean noise decreased along the northeastern U.S. This decrease in ocean noise was associated with a significant decline in fecal stress hormones in North Atlantic right whales, suggesting that chronic exposure to increased noise levels, although not acutely injurious, can produce stress

(Rolland et al. 2012). These levels returned to their previous level within 24 hours after the resumption of shipping traffic. Exposure to loud noise can also adversely affect reproductive and metabolic physiology (Kight and Swaddle 2011). In a variety of factors, including behavioral and physiological responses, females appear to be more sensitive or respond more strongly than males (Kight and Swaddle 2011).

If a sound is detected by a marine mammal, a stress response (e.g., startle or annoyance) or a cueing response (based on a past stressful experience) can occur. Although preliminary because of the small numbers of samples collected, different types of sounds have been shown to produce variable stress responses in marine mammals. Whales and seals use hearing as a primary way to gather information about their environment and for communication; therefore, we assume that limiting these abilities is stressful. Stress responses may also occur at levels lower than those required for TTS (NMFS 2006). Therefore, exposure to levels sufficient to trigger onset of PTS or TTS are expected to be accompanied by physiological stress responses (NRC 2003, NMFS 2006).

We expect that project activities from the proposed action may result in ringed seals temporarily exhibiting behavioral responses from project activities. Therefore, we expect ringed seals may experience stress responses. If ringed seals are not displaced and remain in a stressful environment (i.e., within the behavioral harassment zone), we expect the stress response will dissipate shortly after the individual leaves the area or after the cessation of the acoustic stressor.

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, per section 7 of the ESA.

We searched for information on non-Federal actions reasonably certain to occur in the action area. We did not find any information about non-Federal actions other than what has already been described in the Environmental Baseline (Section 5 of this Opinion). We expect subsistence harvest of ringed seal to continue. We expect bans on commercial sealing and whaling will remain in place. We also expect that with commercial and private vessels operating in the Bering, Chukchi, and Beaufort Seas, the risk of non-permitted oil and pollutant discharges will continue.

As discussed in section 5.4, continued expansion of the duration and extent of seasonal ice-free waters in the Chukchi and Beaufort seas is anticipated over the coming decades, likely resulting in increased vessel traffic and increased duration of the navigation season. As seasonal ice-free waters expand, the international commercial transport of goods and people in the area is projected to increase 100-500 percent in some Arctic areas by 2025 (Adams and Silber 2017). The U.S. Committee on the Marine Transportation System (CMTS) reported that the number of vessels operating in the Chukchi and Beaufort seas has increased 128% from 2008 to 2018. The length of the navigation season has been growing by as much as 7-10 days annually, which, extrapolated over the next decade, could result in 2.5 months of additional navigation season over what was currently seen in 2019 (U.S. Committee on the Marine Transportation System

2019). Although some vessels are related to federal actions, vessels related to commercial shipping and tourism, which have no federal nexus, are expected to increase substantially.

Some continuing non-Federal activities are reasonably certain to contribute to climate change within the action area. However, it is difficult if not impossible to distinguish between the action area's future environmental conditions caused by global climate change that are properly part of the environmental baseline *vs.* cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described in the environmental baseline (Section 5.1).

There are currently no other known state or private activities reasonably certain to occur in the action area that may affect listed species and are not subject to section 7 consultation.

8. Integration and Synthesis

The Integration and Synthesis section is the final step of NMFS's assessment of the risk posed to species and critical habitat as a result of implementing 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 the survival or recovery of the species in the wild by reducing its numbers, reproduction, or distribution; or (2) result in the adverse modification or destruction of critical habitat as measured through direct or indirect alterations that appreciably diminish the value of designated critical habitat as a whole for the conservation of the species. 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 (Anderson 2000; Brandon 1978; Mills and Beatty 1979; Stearns 1992). 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 effects of the action to affect the performance of the populations those individuals represent or the species those population comprise. If, however, we conclude that 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 all of 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.

We assume that existing regulations or similar regulatory requirements will apply over the life of the ONR's Arctic Research Activities from October 2021 to October 2022. Regulatory changes may require reinitiation of consultation per 50 CFR 402.16. In addition, we assume that all required mitigation measures will be implemented. If required mitigation measures and are not incorporated into the proposed action, ONR will need to reinitiate consultation per 50 CFR 402.16.

As discussed in Section 4.1, we concluded that the proposed activities may affect but will not adversely affect Western North Pacific DPS humpback whale, Mexico DPS humpback whale, fin whales, Western DPS gray whales, North Pacific right whales, bowhead whales, and bearded seals. We came to this conclusion for the sub-Arctic species of whales because it is unlikely that they will present in the area transited by the research vessels in the fall, the implementation of protective mitigation measures, and the low number of transits through potentially occupied habitat. Bowhead whales and bearded seals are more likely to overlap spatially and temporally with the research vessel transit but with the implementation of the mitigation measures, the low number of transits through potentially occupied habitat, and the limited amount of time the vessels would overlap temporally with occupied habitat we concluded that effects of the vessel transit are extremely unlikely to occur and thus effects due to vessel transit are extremely unlikely.

8.1. Ringed Seal Risk Analysis

Based on the results of the exposure analysis (see Section 6), we expect ringed seals may be exposed to underwater noise from vessels in transit, towed, drifting, and moored acoustic sources, and fixed winged aircraft. Exposure to noise from moored and drifting acoustic sources may result in Level B harassment (and therefore takes) due to project sounds (Table 16).

The exposure of ringed seals to aircraft sound is likely to occur, but such exposure will be very brief and of sufficiently low intensity that we conclude the effects will be insignificant.

Ringed seals may also be struck by project vessels or project equipment, or entangled in lines, cables, or expended materials associated with this project. However, the probability of a project vessel striking a ringed seal is extremely small, as is the probability of a ringed seal becoming entangled in project-related marine debris, lines, cables or in-water devices. Thus, adverse effects to these species from strikes or entanglement are extremely unlikely to occur.

There is the potential of exposure to vessel noise, aircraft noise, ice auguring, *de minimis* sources, and small oil spill discharge as part of the proposed action, but the effects are considered minor or extremely unlikely to occur, and would not rise to the level of take. Similarly, entanglement due to lines, cables and debris is extremely unlikely to occur.

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 pregnancy, estrus, and lactation (Kelly et al. 2010b). Fall and early winter overlap with the time period when a vessel will be present in the study area. However, the individual and cumulative energy costs of the behavioral responses we have discussed are not likely to reduce the energy budgets of ringed seals. As a result, the ringed seal's probable responses (tolerance, avoidance, short-term masking, and short-term vigilance behavior) to close approaches by a vessel or other in-water devices and their probable exposure to noise or human disturbance are not likely to reduce the fitness or 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. During the timeframe when the vessels are present in the action area, ringed seals will not have begun constructing lairs. While individual ringed seals may be impacted by behavioral responses to vessels, these impacts are not likely to reduce the abundance, reproductive rates, or growth rates of the populations those individuals represent.

We concluded in the Effects of the Action (Section 6 of this Opinion) that ringed seals may be harassed by the proposed activities. NMFS relied upon ONR's NAEMO modeled exposures to calculate all takes. All of the exposures are expected to constitute Level B takes in the form of acoustic harassment. Table 17 shows the number of takes based on the exposure analysis associated with the moored acoustic sources.

Table 17. Take of Ringed Seals for Moored Acoustic Sources.

Species	**Density Estimate within Study Area (animals per square km)**[1]	**Level B Harassment (behavioral)**	**Level B Harassment (TTS)**
Ringed Seal	0.3958	6,050	0
[1] Kaschner (2004); Kaschner et al. (2006)			

These estimates represent the total number of take events (instances) that will occur, not necessarily the number of individual seals taken, as an individual seal may be "taken" multiple times over the course of the proposed action. These exposure estimates are likely to be overestimates because they do not account for avoidance of noise fields by seals or the effectiveness of mitigation measures in reducing take.

No reduction in the distribution of Arctic subspecies of ringed seals from the Arctic Ocean is expected because of ONR's Arctic Research Activities and the NMFS Permits and Conservation Division's issuance of an incidental harassment authorization and possible renewal.

The Arctic subspecies of ringed seal is threatened due to climate change especially from the expected loss of sea ice and snow cover over the ensuing decades. Ringed seals are an important species for Alaska Native subsistence hunters. The current level of subsistence harvest is not known and there are no efforts to quantify statewide harvest numbers. The highest number of ringed seals taken in a year was 1,306 in 2014. Additional threats to the species which may increase over time with the loss of sea ice include fisheries interactions (including entanglement), disturbance from vessels, sound from seismic exploration, and oil spills.

The Arctic subspecies of ringed seal has an apparently large population, making it resilient to immediate perturbations. However, threatened by climate change in the long-term, the species is likely to become endangered in the future.

There are no precise population estimates for the entire Arctic subspecies of ringed seal population due to the species' widespread distribution across political boundaries. In the status review (Kelley et al. 2010a), the population was estimated at approximately 2,000,000 individuals; however, NMFS considers this a rough estimate, as it relies on old data collected in a variety of ways and does not include all areas of its range. In the status review, the population of ringed seals in Alaska waters of the Chukchi and Beaufort seas was estimated to be at least 300,000 individuals. This is most likely an underestimate of the true abundance because surveys in the Beaufort Sea were limited to within 40 kilometers (21.6 nautical miles) of the shore (Kelly et al. 2010a).

Due to insufficient data, population trends for the Arctic subspecies of ringed seal cannot be calculated. It is unknown if the population is stable or fluctuating. The genetic population structure of the Arctic subspecies of ringed seal is poorly understood. It is likely that population structuring exists in the species, but the extent to which it occurs is unknown.

No reduction in numbers is anticipated as part of the proposed actions. Therefore, no reduction in reproduction is expected as a result of the proposed actions. We expect that 6,050 individuals will be harassed from the proposed research activities. Because we do not anticipate a reduction in numbers or reproduction of Arctic subspecies of ringed seals as a result of the proposed research activities and the NMFS Permits and Conservation Division's issuance of an incidental harassment authorization and possible renewal, a reduction in the species' likelihood of survival is not expected.

Because no mortalities or effects on the abundance, distribution, and reproduction of Arctic subspecies of ringed seal populations are expected as a result of the proposed actions, we do not anticipate the proposed Arctic Research Activities and the NMFS Permits and Conservation Division's issuance of an incidental harassment authorization and possible renewal will impede the recovery objectives for Arctic subspecies of ringed seals. In conclusion, we believe the effects associated with the proposed actions are not likely to appreciably reduce the likelihood of survival or recovery of Arctic subspecies of ringed seals in the wild, when considered along with the environmental baseline and cumulative effects.

9. Conclusion

After reviewing the current status of the listed species, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is NMFS's biological opinion that ONR's proposed Arctic Research Activities in the Beaufort Sea, Alaska and the Permits Division's proposed issuance of an IHA to ONR are not likely to jeopardize the continued existence of the Arctic ringed seal.

In addition, the proposed action is not likely to adversely affect Western North Pacific DPS humpback whale, Mexico DPS humpback whale, fin whales, Western DPS gray whales, North Pacific right whales, bowhead whales and bearded seals. We expect no effects to critical habitat for any species under NMFS jurisdiction.

10. Incidental Take Statement

Section 9 of the ESA prohibits the take of endangered species unless there is 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 (16 U.S.C. § 1532(19)). "Incidental take" is defined as take that results from, but is not the purpose of, the carrying out of an otherwise lawful activity conducted by the action agency or applicant (50 CFR § 402.02). Based on NMFS guidance, the term "harass" under the ESA means to: "create the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering" (Wieting 2016). The National Defense Authorization Act of Fiscal Year 2004 (PL 108-136) amended the definition of "harassment" under the MMPA, specifically as it applies to military readiness activities or scientific research activities conducted by or on behalf of the federal government (16 U.S.C. §1362 (18)(B)). The Fiscal Year 2004 National Defense Authorization Act adopted the definition of "military readiness activity" as set forth in the Fiscal Year 2003 National Defense Authorization Act (PL 107-314). Research activities within the study area are composed of military readiness activities, as that term is defined in PL 107-314, because activities constitute realistic testing of military equipment, vehicles, and sensors for proper operation and suitability for combat use. For military readiness activities, the relevant definition of harassment under the MMPA is any act that:

- Injures or has the significant potential to injure a marine mammal or marine mammal stock in the wild ("Level A harassment"); or
- Disturbs or is likely to disturb a marine mammal or marine mammal stock in the wild by causing disruption of natural behavioral patterns including, but not limited to, migration, surfacing, nursing, breeding, feeding, or sheltering to a point where such behavioral patterns are abandoned or significantly altered ("Level B harassment") (16 U.S.C. § 1362(18)(B)(i) and (ii)).

For this consultation, the Permits Division anticipates that any take will be by harassment only. No Level A takes are contemplated or authorized.

The ESA does not prohibit the taking of threatened species unless special regulations have been promulgated, pursuant to ESA Section 4(d), to promote the conservation of the species. ESA Section 4(d) rules have not been promulgated for Arctic ringed seals; therefore, ESA section 9 take prohibitions do not apply. This ITS includes numeric limits on the take of this species because specific amounts of take were analyzed in our jeopardy analysis. These numeric limits provide guidance to the action agencies on their requirement to re-initiate consultation if the amount of take estimated in the jeopardy analysis of this biological opinion is exceeded. This ITS includes reasonable and prudent measures and terms and conditions designed to minimize and monitor take of this threatened species.

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 under section 101(a)(5) of the MMPA. Accordingly, the reasonable and prudent measures and terms and conditions of this Incidental Take Statement become effective only upon the issuance of MMPA authorization to take the marine mammals identified here. Absent such authorization, this Incidental Take Statement is inoperative.

The Terms and Conditions described below are nondiscretionary. ONR and the Permits Division have a continuing duty to regulate the activities covered by this ITS. In order to monitor the impact of incidental take, ONR and the Permits Division must monitor the progress of the action and its impact on the species as specified in the ITS (50 CFR 402.14(i)(3)).

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 use a surrogate (e.g., other species, habitat, or ecological conditions) 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 80 FR 26832 (May 11, 2015)).

NMFS anticipates the proposed ONR project in the Beaufort Sea, Alaska, between October 2021 and October 2022, is likely to result in the incidental take of ringed seals by harassment. The Permits Division estimated take by considering: 1) acoustic thresholds above which NMFS believes the best available science indicates marine mammals will be behaviorally harassed or incur some degree of permanent hearing impairment; 2) the range to which behavioral effects were anticipated to reach; and 3) the density or occurrence of marine mammals within these ensonified areas. AKR and the Permits Division relied heavily on the NAEMO model developed by the Navy for assessing the impacts of underwater sound (ONR 2021)

The proposed action is expected to take, by Level B harassment, 6,050 Arctic ringed seals.

Harassment of these individuals will occur by exposure to sound from acoustic sources with received sound levels of at least 120 dB_{rms} re 1 µPa within the ensonified area but less than 190 dB_{rms} re 1 µPa. NAEMO modelling indicated that ringed seals would have to be within 10 km from the source to elicit any behavioral reaction (e.g., flushing from a lair) (86 FR 47065). If exposure were to occur, ringed seals may exhibit behavioral responses such as avoidance, increased swimming speeds, increased surfacing time, or decreased foraging or on-ice resting time.

Any incidental take of ringed seals considered in this consultation is restricted to the permitted action as proposed. If the actual incidental take exceeds the estimated level or type of take, ONR and the Permits Division may be required to reinitiate consultation. Likewise, if the action deviates from what is described in Section 2 of this biological opinion, ONR and the Permits Division may be required to reinitiate consultation. All anticipated takes will be by harassment, as described previously, involving temporary changes in behavior.

10.2 Effect of the Take

In section 9 of this Opinion, NMFS determined that the level of anticipated incidental take, coupled with other effects of the proposed action, is not likely to result in jeopardy to the ESA-listed species.

The takes from the proposed action are associated with behavioral harassment from acoustic noise. Although the biological significance of behavioral responses remains unknown, this consultation has assumed that exposure to noise sources might disrupt one or more behavioral patterns that are essential to an individual animal's life history. However, any behavioral responses of these pinnipeds to noise sources and any associated disruptions are not expected to affect the fitness of any individuals of these species, the viability of the population, or the species' survival or recovery.

10.3 Reasonable and Prudent Measures

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

RPMs are distinct from the mitigation measures that are included in the proposed action (described in Section 2.2). We presume that the mitigation measures will be implemented as described in this opinion. The failure to do so will constitute a change to the action that may require reinitiation of consultation pursuant to 50 CFR § 402.16.

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 Arctic ringed seals resulting from the proposed action.

1. ONR and the Permits Division will monitor for take and the effects of their action on listed marine mammals, document, and report relevant aspects of its research and testing activities to verify implementation of the mitigation measures, compliance with permits, and improve future environmental assessments.

10.4 Terms and Conditions

These terms and conditions are in addition to the mitigation measures included in the proposed action, as set forth in Section 2.2 of this opinion. The Navy and the Permits Division has a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this incidental take statement (50 CFR § 402.14(i)(3))).

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 the RPM 1 listed in Section 10.3, the following must occur:

1. ONR and the Permits Division must provide NMFS AKR with written and photographic (if applicable) documentation of any effects of the proposed actions on listed marine mammals and implementation of the mitigation measures specified in section 2.2 of the Biological Opinion.

Table 18. NMFS Contact Information

Reason for Contact	**Contact Information**
Consultation Questions & Unauthorized Take	Greg Balogh: greg.balogh@noaa.gov Marilyn Myers: Marilyn.myers@noaa.gov and Jon Kurland: jon.kurland@noaa.gov
Reports & Data Submittal	AKR.section7@noaa.gov (please include NMFS consultation number AKRO 2021-09126)
Stranded, Injured, or Dead Marine Mammal *(not related to project activities)*	Stranding Hotline (24/7 coverage) 877-925-7773
Oil Spill & Hazardous Materials Response	U.S. Coast Guard National Response Center: 1-800-424-8802 (or U.S. Coast Guard 17th District Command Center: 907-463-2000) & NMFS AKR Protected Resources Oil Spill Response Coordinator: 907-586-7630 AKRNMFSSpillResponse@noaa.gov and/or Sadie.wright@noaa.gov

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. ONR should review all new and relevant marine mammal population and density data from the Arctic to ensure that inputs into NAEMO are updated with the most current available information.
2. NMFS encourages ONR to add passive acoustic monitors to their existing equipment when possible or to deploy passive acoustic monitors in the Beaufort Sea as part of their mission so that we can get a better understanding of the marine mammal presence in the area.
3. ONR should consider design modifications for its research equipment in order to reduce the amount of plastic and debris added to the Arctic Ocean.
4. We suggest that ONR utilize standardized monitoring forms to record the pertinent information for marine mammal observations.

In order to keep NMFS's Protected Resources Division, Alaska Region informed of actions minimizing or avoiding adverse effects or benefiting ESA-listed species or their habitats, ONR and the Permits Division should notify NMFS of any conservation recommendations those agencies implement.

12. Reinitiation of Consultation

As provided in 50 CFR § 402.16, reinitiation of 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 or designated critical habitat 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 of incidental take is exceeded, section 7 consultation must be reinitiated immediately (50 CFR § 402.14(i)(4)).

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 NOAA, the Navy, 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

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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