BILLING CODE 3510-22-P

DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

RIN 0648-XR023

Takes of Marine Mammals Incidental to Specified Activities; Taking Marine Mammals Incidental to Office of Naval Research Arctic Research Activities

AGENCY: National Marine Fisheries Service (NMFS), National Oceanic and Atmospheric Administration (NOAA), Commerce.

ACTION: Notice; proposed incidental harassment authorization; request for comments on proposed authorization and possible renewal.

SUMMARY: NMFS has received a request from the U.S. Navy's Office of Naval Research (ONR) for authorization to take marine mammals incidental to Arctic Research Activities in the Beaufort and Chukchi Seas. Pursuant to the Marine Mammal Protection Act (MMPA), NMFS is requesting comments on its proposal to issue an incidental harassment authorization (IHA) to incidentally take marine mammals during the specified activities. NMFS is also requesting comments on a possible one-year renewal that could be issued under certain circumstances and if all requirements are met, as described in *Request for Public Comments* at the end of this notice. NMFS will consider public comments prior to making any final decision on the issuance of the requested MMPA authorizations and agency responses will be summarized in the final notice of our decision. ONR's activities are considered military readiness activities pursuant to the Marine Mammal Protection Act (MMPA), as amended by the National Defense Authorization Act for Fiscal Year 2004 (NDAA).

DATES: Comments and information must be received no later than **[INSERT DATE 30 DAYS AFTER DATE OF PUBLICATION IN THE FEDERAL REGISTER]**.

ADDRESSES: Comments should be addressed to Jolie Harrison, Chief, Permits and Conservation Division, Office of Protected Resources, National Marine Fisheries Service. Physical comments should be sent to 1315 East-West Highway, Silver Spring, MD 20910 and electronic comments should be sent to *ITP.Fowler@noaa.gov*.

Instructions: NMFS is not responsible for comments sent by any other method, to any other address or individual, or received after the end of the comment period. Comments received electronically, including all attachments, must not exceed a 25-megabyte file size. Attachments to electronic comments will be accepted in Microsoft Word or Excel or Adobe PDF file formats only. All comments received are a part of the public record and will generally be posted online at *https://www.fisheries.noaa.gov/permit/incidental-take-authorizations-under-marine-mammal-protection*-act without change. All personal identifying information (*e.g.*, name, address) voluntarily submitted by the commenter may be publicly accessible. Do not submit confidential business information or otherwise sensitive or protected information.

FOR FURTHER INFORMATION CONTACT: Amy Fowler, Office of Protected Resources, NMFS, (301) 427-8401. Electronic copies of the application and supporting documents, as well as a list of the references cited in this document, may be obtained online at: *https://www.fisheries.noaa.gov/permit/incidental-take-authorizations-under-marine-mammal-protection-act*. In case of problems accessing these documents, please call the contact listed above.

SUPPLEMENTARY INFORMATION:

Background

The MMPA prohibits the "take" of marine mammals, with certain exceptions. Sections 101(a)(5)(A) and (D) of the MMPA (16 U.S.C. 1361 *et seq*.) direct the Secretary of Commerce (as delegated to NMFS) to allow, upon request, the incidental, but not intentional, taking of small numbers of marine mammals by U.S. citizens who engage in a specified activity (other than commercial fishing) within a specified geographical region if certain findings are made and either regulations are issued or, if the taking is limited to harassment, a notice of a proposed incidental take authorization may be provided to the public for review.

Authorization for incidental takings shall be granted if NMFS finds that the taking will have a negligible impact on the species or stock(s) and will not have an unmitigable adverse impact on the availability of the species or stock(s) for taking for subsistence uses (where relevant). Further, NMFS must prescribe the permissible methods of taking and other "means of effecting the least practicable adverse impact" on the affected species or stocks and their habitat, paying particular attention to rookeries, mating grounds, and areas of similar significance, and on the availability of such species or stocks for taking for certain subsistence uses (referred to in shorthand as "mitigation"); and requirements pertaining to the mitigation, monitoring and reporting of such takings are set forth.

The NDAA (Pub. L. 108–136) removed the "small numbers" and "specified geographical region" limitations indicated above and amended the definition of "harassment" as it applies to a "military readiness activity." The activity for which incidental take of marine mammals is being requested addressed here qualifies as a military readiness activity. The definitions of all applicable MMPA statutory terms cited above are included in the relevant sections below. The proposed action constitutes a military readiness activity because these proposed scientific research activities directly support the adequate and realistic testing of military equipment, vehicles, weapons, and sensors for proper operation and suitability for combat use by providing critical data on the changing natural and physical environment in which such materiel will be assessed and deployed. This proposed scientific research also directly supports fleet training and operations by providing up to date information and data on the natural and physical environment essential to training and operations.

National Environmental Policy Act

To comply with the National Environmental Policy Act of 1969 (NEPA; 42 U.S.C. 4321 *et seq*.) and NOAA Administrative Order (NAO) 216-6A, NMFS must review our proposed action (*i.e.*, the issuance of an incidental harassment authorization) with respect to potential impacts on the human environment.

Accordingly, NMFS plans to adopt the Navy's Environmental Assessment/Overseas Environmental Assessment, provided our independent evaluation of the document finds that it includes adequate information analyzing the effects on the human environment of issuing the IHA. The Navy's OEA is available at *https://www.fisheries.noaa.gov/permit/incidental-take-authorizations-under-marine-mammal-protection-act*.

We will review all comments submitted in response to this notice prior to concluding our NEPA process or making a final decision on the IHA request.

Summary of Request

On April 25, 2019, NMFS received a request from ONR for an IHA to take marine mammals incidental to Arctic Research Activities in the Beaufort and Chukchi Seas. The application was deemed adequate and complete on July 16, 2019. ONR's request is for take of a small number of beluga whales (*Delphinapterus leucas*), bearded seals (*Erignathus barbatus*), and ringed seals (*Pusa hispida hispida*) by Level B harassment only. Neither ONR nor NMFS expects serious injury or mortality to result from this activity and, therefore, an IHA is appropriate.

This proposed IHA would cover the second year of a larger project for which ONR obtained a prior IHA and intends to request take authorization for subsequent facets of the project. This IHA would be valid for a period of one year from the date of issuance. The larger three-year project involves several scientific objectives which support the Arctic and Global Prediction Program, as well as the Ocean Acoustics Program and the Naval Research Laboratory, for which ONR is the parent command. ONR complied with all the requirements (*e.g.*, mitigation, monitoring, and reporting) of the previous IHA (83 FR 48799; September 27, 2019).

Description of Proposed Activity

Overview

ONR's Arctic Research Activities include scientific experiments to be conducted in support of the programs named above. Specifically, the project includes the Stratified Ocean Dynamics of the Arctic (SODA), Arctic Mobile Observing System (AMOS), Ocean Acoustics field work (including the Coordinated Arctic Active Tomography Experiment (CAATEX)), and Naval Research Laboratory experiments in the Beaufort and Chukchi Seas. These experiments involve deployment of moored and ice-tethered active acoustic sources, primarily from the U.S Coast Guard Cutter (CGC) HEALY. CGC HEALY may also be required to perform icebreaking to deploy the acoustic sources in deep water. Underwater sound from the acoustic sources and icebreaking may result in behavioral harassment of marine mammals.

Dates and Duration

ONR's Arctic Research Activities began in August 2018 with deployment of autonomous gliders in the Beaufort and Chukchi Seas and subsequent deployment of moored acoustic sources in September 2018. The activities analyzed in this proposed IHA would begin in September 2019, with a tentative sail date of September 3, 2019. CGC HEALY would perform a research cruise for up to 60 days in September and October 2019 to deploy acoustic sources. If required, a second, non-icebreaking ship would perform a cruise of up to 30 days to deploy any remaining sources in the fall of 2019. A total of eight days of icebreaking within the effective dates of this IHA are anticipated to be required to deploy and/or retrieve the northernmost acoustic sources. CGC HEALY, a similar icebreaking ship, or a non-icebreaking ship would be used for a subsequent research cruise for up to 60 days beginning in August 2020. The initial stages of the August 2020 cruise (*i.e.*, the spiral wave beacon, see *Detailed Description of Specific Activity* below) are included in the activities analyzed in this IHA. The latter stages of the 2020 cruise would be analyzed in a subsequent IHA

Specific Geographic Region

The proposed actions would occur in either the U.S. Exclusive Economic Zone (EEZ) or the high seas north of Alaska (Figure 1). All activities, except for the transit of ships, would take place outside U.S. territorial waters. The total area of the study area is 835,860 square kilometers (km^2) (322,727 square miles (mi^2)). The closest active acoustic source (aside from *de minimis* sources described below) within the study area is approximately 145 miles (mi; 233 kilometers (km)) from land.

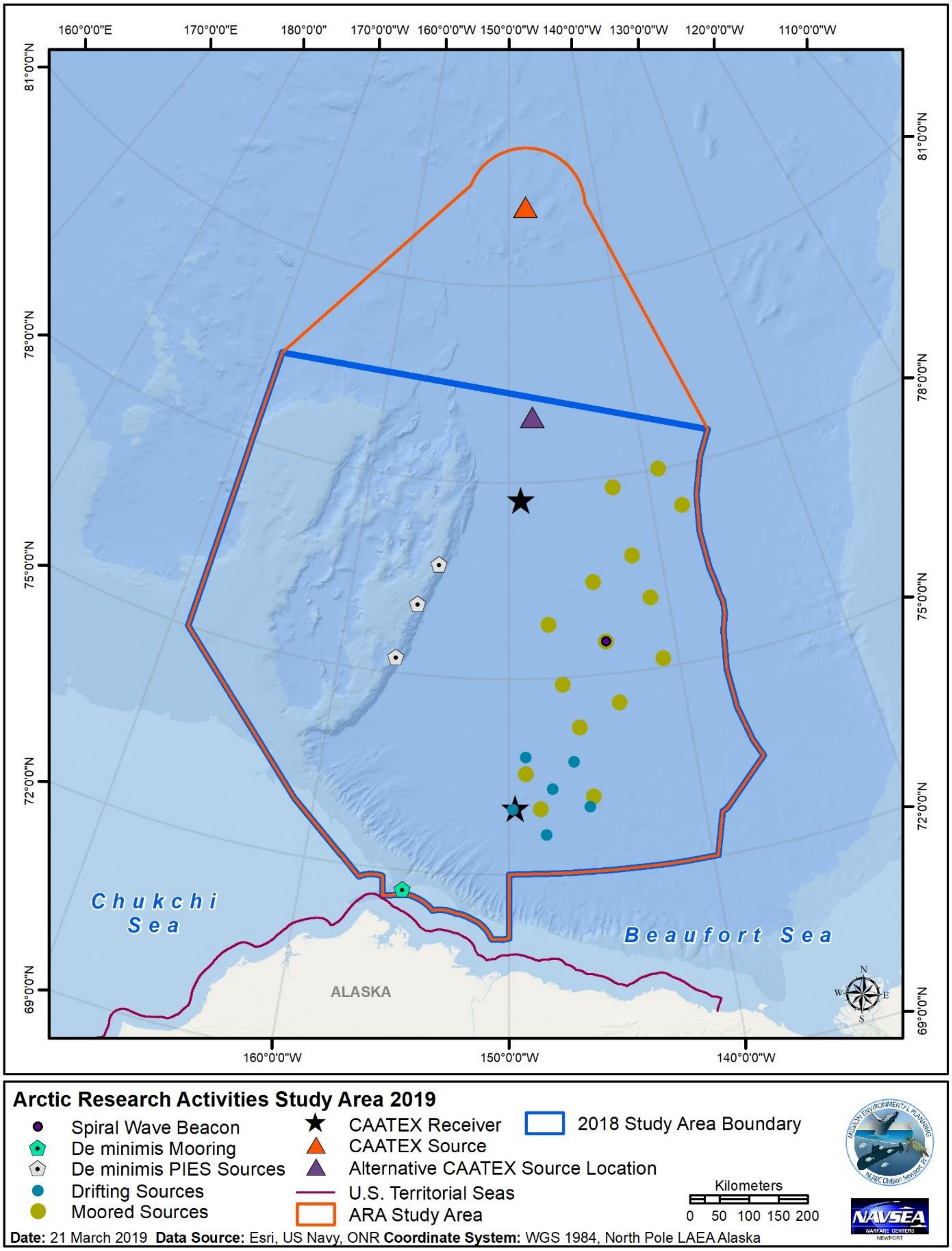

Figure 1. Arctic Research Activities Study Area

Detailed Description of Specific Activity

The ONR Arctic and Global Prediction Program is supporting two major projects (SODA and AMOS), which will both occur during time period covered by this IHA. The SODA project began field work in August 2018, consisting of research cruises and the deployment of autonomous measurement devices for year-round observation of water properties (temperature and salinity) and the associated stratification and circulation. These physical processes are related to the ice cover and as the properties of the ice cover change, the water properties will change as well. Warm water feeding into the Arctic Ocean also plays an important role changing the environment. Observations of these phenomena require geographical sampling of areas of varying ice cover and temperature profile, and year-round temporal sampling to understand what happens during different parts of the year. Unmanned gliders and autonomous platforms are needed for this type of year-round observation of a representative sample of arctic waters. The SODA project also involved the initial deployment of navigation sources for unmanned vehicles. Under the AMOS project, there will be new deployments of navigation sources in September 2019 (Figure 1). Geolocation of autonomous platforms requires the use of acoustic navigation signals, and therefore, year-long use of active acoustic signals.

The ONR Ocean Acoustics Program also supports Arctic field work. The emphasis of the Ocean Acoustics Program field efforts is to understand how the changing environment affects acoustic propagation and the noise environment. The ONR Acoustic Program would be utilizing new technology for year-round observation of the large-scale (range and depth) temperature structure of the ocean at very low frequencies. The use of specialized waveforms and acoustic arrays allows signals to be received over 100 km from a source, while only requiring moderate source levels. The Ocean Acoustics program is planning to perform experiments in conjunction with the Arctic and Global Prediction Program by operating in the same general location and with the same research vessel.

The Naval Research Laboratory would also conduct Arctic research in the same time frame, using drifting buoys with active acoustic sources that are deployed in the ice. The buoys are deployed for real-time environmental characterization to aid in mid-frequency sonar performance predictions. Real-time assimilation of acoustic data into an ocean model is also planned.

Below are descriptions of the equipment and platforms that would be deployed at different times during the proposed action.

Research Vessels

CGC HEALY would be the primary vessel performing the research cruise in September and October 2019. CGC HEALY travels at a maximum speed of 17 knots (kn) with a cruising speed of 12 kn (United States Coast Guard 2013), and a maximum speed of 3 kn when traveling through 3.5 feet (ft; 1.07 meters (m)) of sea ice (Murphy 2010). CGC HEALY may be required to perform icebreaking to deploy the moored and ice tethered acoustic sources in deep water. Icebreaking would only occur during the warm season, presumably in the August through October timeframe. CGC HEALY has proven capable of breaking ice up to 8 ft (2.4 m) thick while backing and ramming (Roth *et al*. 2013). A study in the western Arctic Ocean was conducted while CGC HEALY was mapping the seafloor north of the Chukchi Cap in August 2008. During this study, CGC HEALY icebreaker events generated signals with frequency bands centered near 10, 50, and 100 Hertz (Hz) with maximum source levels of 190 to 200 decibel(s) (dB) referenced to 1 microPascal (μPa) at 1 meter (dB re 1 μPa at 1 m; full octave band) (Roth *et* *al.* 2013). Icebreaking would likely only occur in the northernmost areas of the study area while deploying and/or retrieving sources.

The CGC HEALY or other vessels may perform the following activities during the research cruises (some of these activities may result in take of marine mammals, while others may not, as described further below):

- Deployment of moored and/or ice-tethered passive sensors (*e.g.*, oceanographic measurement devices, acoustic receivers);
- Deployment of moored and/or ice-tethered active acoustic sources to transmit acoustic signals for up to two years after deployment. Transmissions could be terminated during ice-free periods (August-October) each year, if needed;
- Deployment of unmanned surface, underwater, and air vehicles; and
- 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 Integrated 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;

- Surface Wave Instrument Float with Tracking (SWIFTs) buoys are freely drifting buoys measuring winds, waves, and other parameters with deployments spanning from hours to days; and
- A single mooring would be deployed to perform measurements of currents with an ADCP.

Moored and Drifting Acoustic Sources

Up to 15 moored acoustic navigation sources would be deployed during the period September 2019 to September 2020 at the locations shown in Figure 1. Each navigation source transmits for 8 seconds every 4 hours, with the sources transmitting with a five minute offset from each other. The purpose of the navigation sources is to allow autonomous vehicles and gliders to navigate by receiving acoustic signals from multiple locations and triangulating position. This is needed for vehicles that are under ice and cannot communicate with satellites.

A single very low frequency (VLF) source would be deployed in the furthest north part of the study area, shown by the triangle symbols in Figure 1. The northernmost location is the preferred location, but the alternative location may be used. The VLF source provides capability for persistent (year-long) observation of Arctic oceanographic processes and measures oceanographic changes (*e.g.* regional increases in temperature) over long ranges.

All 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.

Up to six drifting sources would be deployed for the purpose of near-real time environmental characterization, which is accomplished by communicating information from the drifting buoys to a satellite. They would be deployed in the ice for purposes of buoy stability, but would eventually drift in open water. The sources would transmit signals to each other to measure oceanographic properties of the water between them. The sources would stop transmitting when this IHA expires in September 2020 or when they leave the Study Area, whichever comes first.

On the fall 2020 cruise, a spiral wave beacon source would be tested for fine-scale navigation. The spiral wave beacon is a mid-frequency source that transmits a 50 millisecond signal at 30 second intervals. The source would be deployed from a ship at a single location and transmit for up to 5 days. It will either be attached to the ship or moored near the ship. The ship will remain for the 5 days of the test, and the source will be recovered at the end of testing.

Table 1. Characteristics of Proposed Acoustic Sources.

Source Name	**Frequency Range (Hz)**	**Sound Pressure Level (dB re 1 µPa at 1 m)**	**Pulse Length (milliseconds)**	**Duty Cycle (Percent)**	**Source Type**	**Usage**
Navigation Sources	900	185	8,000	<1 %	Moored	15 sources transmitting 8 seconds every 4 hours, up to 2 years
Real-Time Sensing Sources	900 to 1000	184	60,000	<1%	Drifting	6 sources transmitting 1 minute every 4 hours, up to 2 years
Spiral Wave Beacon	2,500	183	50	<1%	Moored	5 days
Very Low Frequency (VLF source)	34	185 (peak)	1,800,000	<1%	Moored	One source transmitting 30 minutes every 6 days, up to 2 years

Activities Not Likely to Result in Take

The following in-water activities have been determined to be unlikely to result in take of marine mammals. These activities are described here but their effects are not described further in this document.

De minimis Sources—De minimis sources have the following parameters: low source levels, narrow beams, downward directed transmission, short pulse lengths, frequencies outside known marine mammal hearing ranges, or some combination of these factors (Department of the Navy 2013b). For further detail regarding the de minimis sources planned for use by the Navy, which are not quantitatively analyzed, please see the Navy's application. Descriptions of example sources are provided below and in Table 2.

Table 2. Parameters for *De minimis* Sources.

Source Name	Frequency Range (kHz)	Sound Pressure Level (dB re 1 µPa at 1 m)	Pulse Length (milli-seconds)	Duty Cycle (Percent)	Beamwidth	De minimis Justification
Pressure Inverted Echosounders (PIES)	12	170-180	6	<0.01	45	Extremely low duty cycle, low source level, very short pulse length
ADCP	>200, 150, or 75	190	<1	<0.1	2.2	Very low pulse length, narrow beam, moderate source level
Chirp sonar	2-16	200	20	<1	narrow	Very short pulse length, low duty cycle, narrow beam width
Expendable Mobile Anti-Submarine	700-1100 Hz and 1100-4000	<150	N/A	25-100	Omni	Very low source level

Warfare Training Targets (EMATTs)	Hz					
Coring system	25-200	158-162	< 1	16	Omni	Very low source level[2]
CTD[1] attached Echosounder	5-20	160	4	2	Omni	Very low source level

[1]CTD = Conductivity Temperature Depth
[2]within sediment, not within the water column

Drifting Oceanographic Sensors—Observations of ocean-ice interactions require the use of sensors which are moored and embedded in the 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 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 would have a long temperature string extending down to 656 ft (200 m) depth and would incorporate meteorological sensors, and a temperature string to estimate ice thickness. The Ice Tethered Profilers would collect information on ocean temperature, salinity, and velocity down to 820 ft (250 m) depth.

Fifteen autonomous floats (Air-Launched Autonomous Micro Observers) would be deployed during the proposed action to measure seasonal evolution of the ocean temperature and salinity, as well as currents. They would be deployed on the eastern edge of the Chukchi Sea in water less than 3,280 ft (1,000 m) deep. Three autonomous floats would act as virtual moorings by originating on the seafloor, then moving up the water column to the surface and returning to the seafloor. The other 12 autonomous floats would sit on the sea floor and at intervals begin to move toward the surface. At programmed intervals, a subset of the floats would release anchors and begin their profiling mission. Up to 15 additional floats may be deployed by ships of opportunity in the Beaufort Gyre..

The drifting oceanographic sensors described above use only *de minimis* sources and are therefore not anticipated to have the potential for impacts on marine mammals or their habitat.

Moored Oceanographic Sensors—Moored sensors would capture a range of ice, ocean, and atmospheric conditions on a year-round basis. The location of the bottom-anchored sub-surface moorings are depicted by the purple stars in Figure 1-1 of the IHA application. These would be bottom-anchored, sub-surface moorings measuring velocity, temperature, and salinity in the upper 1,640 ft (500 m) of the water column. The moorings also collect high-resolution acoustic measurements of the ice using the ice profilers described above. Ice velocity and surface waves would be measured by 500 kHz multibeam sonars.

Additionally, Beaufort Gyre Exploration Project moorings BGOS-A and BGOS-B (depicted by the black plus signs in Figure 1-1 of the IHA application) would be augmented with McLane Moored Profilers. BGOS-A and BGOS-B would provide measurements near the Northwind Ridge, with considerable latitudinal distribution. Existing deployments of Nortek Acoustic Wave and Current Profilers on BGOS-A and BGOS-B would also be continued as part of the proposed action.

The moored oceanographic sensors described above use only *de minimis* sources and are therefore not anticipated to have the potential for impacts on marine mammals or their habitat.

Fixed and Towed Receiving Arrays—Horizontal and vertical arrays may be used to receive acoustic signals. Two receiving arrays will be deployed in September-October 2020 to receive signals from the CAATEX source. Other receiving arrays are the Single Hydrophone

Recording Units and Autonomous Multichannel Acoustic Recorder. All these arrays would be moored to the seafloor and remain in place throughout the activity.

These are passive acoustic sensors and therefore are not anticipated to have the potential for impacts on marine mammals or their habitat.

Activities Involving Aircraft and Unmanned Air Vehicles—Naval Research Laboratory would be conducting flights to characterize the ice structure and character, ice edge and wave heights across the open water and marginal ice zone to the ice. Up to 4 flights, lasting approximately 3 hours in duration would be conducted over a 10 day period during February or March for ice structure and character measurements and during late summer/early fall for ice edge and wave height studies. Flights would be conducted with a Twin Otter aircraft over the seafloor mounted acoustic sources and receivers. Most flights would transit at 1,500 ft or 10,000 ft (457 or 3,048 m) above sea level. Twin Otters have a typical survey speed of 90 to 110 kn, 66 ft (20 m) wing span, and a total length of 26 ft (8 m) (U.S. Department of Commerce and NOAA 2015). 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 dB (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). The objective of the flights is to characterize thickness and physical properties of the ice mass overlying the experiment area.

Rotary wing aircraft may also be used during the activity. Helicopter transit would be no longer than two hours to and from the ice location. A twin engine helicopter may be used to transit scientists from land to an offshore floating ice location. Once on the floating ice, the team would drill holes with 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 science team would depart the area and return to land after three hours of data collection and leave the equipment and leave the equipment behind for a later recovery.

The proposed action includes the use of an Unmanned Aerial System (UAS). 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. 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 2.5 lb (1.13 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 used. As stated previously, these systems are small and are similar to a remote control helicopter. It is likely marine mammals would not hear the device since the noise generated would likely not be audible from greater than 5 ft (1.5 m) away (Christiansen *et al.*, 2016).

All aircraft (manned and unmanned) would be required to maintain a minimum separation distance of 1,000 ft (305 m) from any pinnipeds hauled out on the ice. Therefore, no take of marine mammals is anticipated from these activities.

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. The system would consist of an anemometer, humidity sensor, and pressure sensor. 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 would sink to the seafloor as their host ice floes melted.

All personnel conducting experiments on the ice would be required to maintain a minimum separation distance of 1,000 ft (305 m) from any pinnipeds hauled out on the ice. Therefore, no take of marine mammals is anticipated from these activities.

Bottom Interaction Systems—Coring of bottom sediment could occur anywhere within the study area to obtain a more complete understanding of the Arctic environment. Coring equipment would take up to 50 samples of the ocean bottom in the study area annually. The samples would be roughly cylindrical, with a 3.1 in (8 cm) diameter cross-sectional area; the corings would be between 10 and 20 ft (3 and 6 m) long. Coring would only occur during research cruises, during the summer or early fall. The coring equipment moves slowly through the muddy bottom, at a speed of approximately 1 m per hour, and would not create any detectable acoustic signal within the water column, though very low levels of acoustic transmissions may be created in the mud (see parameters listed in Table 2).

Weather Balloons—To support weather observations, up to 40 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 to 6 ft (1.5 – 1.8 m) in diameter and gradually expands as it rises due 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.

The deployment of weather balloons does not include the use of active acoustics and is therefore not anticipated to have the potential for impacts on marine mammals or their habitat.

Proposed mitigation, monitoring, and reporting measures are described in detail later in this document (please see *Proposed Mitigation* and *Proposed Monitoring and Reporting*).

Description of Marine Mammals in the Area of Specified Activities

Sections 3 and 4 of the application summarize available information regarding status and trends, distribution and habitat preferences, and behavior and life history, of the potentially affected species. Additional information regarding population trends and threats may be found in NMFS's Stock Assessment Reports (SARs; *https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-stock-assessments*) and more general information about these species (*e.g.*, physical and behavioral descriptions) may be found on NMFS's website (*https://www.fisheries.noaa.gov/find*-species).

Table 3 lists all species with expected potential for occurrence in the study area and summarizes information related to the population or stock, including regulatory status under the MMPA and ESA and potential biological removal (PBR), where known. For taxonomy, we follow Committee on Taxonomy (2018). PBR is defined by the MMPA as the maximum number of animals, not including natural mortalities, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population (as described in NMFS's SARs). While no mortality is anticipated or authorized here, PBR and annual serious injury and mortality from anthropogenic sources are included here as gross indicators of the status of the species and other threats.

Marine mammal abundance estimates presented in this document represent the total number of individuals that make up a given stock or the total number estimated within a particular study or survey area. NMFS's stock abundance estimates for most species represent the total estimate of individuals within the geographic area, if known, that comprises that stock. For some species, this geographic area may extend beyond U.S. waters. All managed stocks in this region are assessed in NMFS's U.S. 2018 SARs (*e.g.*, Muto *et al.*, 2019, Carretta *et al.*, 2019). All values presented in Table 3 are the most recent available at the time of publication and are available in the 2018 SARs (Muto *et al.*, 2019; Carretta *et al.*, 2019).

Table 3. Marine Mammal Species Potentially Present in the Project Area.

Common name	Scientific name	Stock	ESA/MMPA status; Strategic (Y/N)[1]	Stock abundance (CV, N_{min}, most recent abundance survey)[2]	PBR	Annual M/SI[3]
Order Cetartiodactyla – Cetacea – Superfamily Mysticeti (baleen whales)						
Family Eschrichtiidae						
Gray whale	*Eschrichtius robustus*	Eastern North Pacific	-/- ; N	26960 (0.05, 25,849, 2016)	801	135
Family Balaenidae						
Bowhead whale	*Balaena mysticetus*	Western Arctic	E/D ; Y	16,820 (0.052, 16,100, 2011)	161	46
Superfamily Odontoceti (toothed whales, dolphins, and porpoises)						
Family Delphinidae						
Beluga whale	*Delphinapterus leucas*	Beaufort Sea	-/- ; N	39,258 (0.229, N/A, 1992)	Undet.[4]	139
Beluga whale	*Delphinapterus leucas*	Eastern Chukchi Sea	-/- ; N	20,752 (0.70,	244	67

				12.194, 2012)		
Order Carnivora – Superfamily Pinnipedia						
Family Phocidae (earless seals)						
Bearded seal[5]	*Erignathus barbatus*	Alaska	T/D ; Y	299,174 (-, 273,676, 2013)	8,210	557
Ribbon seal	*Histriophoca fasciata*	Alaska	-/- ; N	184,697 (-, 163,086, 2013)	9,785	3.9
Ringed seal[5]	*Pusa hispida hispida*	Alaska	T/D ; Y	170,000 (-, 170,000, 2013)	5,100	1,054
Spotted seal	*Phoca largha*	Alaska	-/- ; N	461,625 (-, 423,237, 2013)	12,697	329

1 - Endangered Species Act (ESA) status: Endangered (E), Threatened (T)/MMPA status: Depleted (D). A dash (-) indicates that the species is not listed under the ESA or designated as depleted under the MMPA. Under the MMPA, a strategic stock is one for which the level of direct human-caused mortality exceeds PBR or which is determined to be declining and likely to be listed under the ESA within the foreseeable future. Any species or stock listed under the ESA is automatically designated under the MMPA as depleted and as a strategic stock.
2- NMFS marine mammal stock assessment reports online at: https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-stock-assessment-reports-region/. CV is coefficient of variation; Nmin is the minimum estimate of stock abundance. In some cases, CV is not applicable.
3 - These values, found in NMFS's SARs, represent annual levels of human-caused mortality plus serious injury from all sources combined (*e.g.*, commercial fisheries, ship strike). Annual M/SI often cannot be determined precisely and is in some cases presented as a minimum value or range. A CV associated with estimated mortality due to commercial fisheries is presented in some cases.
4 - The 2016 guidelines for preparing SARs state that abundance estimates older than 8 years should not be used to calculate PBR due to a decline in the reliability of an aged estimate. Therefore, the PBR for this stock is considered undetermined.
5 - Abundances and associated values for bearded and ringed seals are for the U.S. population in the Bering Sea only.
NOTE - Italicized species are not expected to be taken or proposed for authorization

All species that could potentially occur in the proposed survey areas are included in Table 3. Activities conducted during the proposed action are expected to cause harassment, as defined by the MMPA as it applies to military readiness, to the beluga whale (of the Beaufort and Eastern Chukchi Sea stocks), bearded seal, and ringed seal. Due to the location of the study area (*i.e.*, northern offshore, deep water), there were no calculated exposures for the bowhead whale, gray whale, spotted seal, and ribbon seal from quantitative modeling of non-impulsive acoustic and icebreaking sources. Bowhead and gray whales remain closely associated with the shallow waters of the continental shelf in the Beaufort Sea and are unlikely to be exposed to acoustic harassment (Carretta *et al.*, 2017; Muto *et al.*, 2018). Similarly, spotted seals tend to prefer pack ice areas with water depths less than 200 m during the spring and move to coastal habitats in the summer and fall, found as far north as 69-72° N (Muto *et al.*, 2018). Although the study area includes waters south of 72º N, the acoustic sources with the potential to result in take of marine mammals are not found below that latitude and spotted seals are not expected to be exposed. Ribbon seals are found year-round in the Bering Sea but may seasonally range into the Chukchi Sea (Muto *et al.*, 2018). The proposed action occurs primarily in the Beaufort Sea, outside of the core range of ribbon seals, thus ribbon seals are not expected to be behaviorally harassed. Narwhals are considered extralimital in the project area and are not expected to be encountered or taken. As no harassment is expected of bowhead whales, gray whales, spotted seals, and ribbon seals, these species will not be discussed further in this IHA.

Beluga Whale

Beluga whales are distributed throughout seasonally ice-covered arctic and subarctic waters of the Northern Hemisphere (Gurevich 1980), and are closely associated with open leads and polynyas in ice-covered regions (Hazard 1988). Belugas are both migratory and residential (non-migratory), depending on the population. Seasonal distribution is affected by ice cover, tidal conditions, access to prey, temperature, and human interaction (Frost *et al.*, 1985).

There are five beluga stocks recognized within U.S. waters: Cook Inlet, Bristol Bay, eastern Bering Sea, eastern Chukchi Sea, and Beaufort Sea. Two stocks, the Beaufort Sea and eastern Chukchi Sea stocks, have the potential to occur in the Study Area.

There are two migration areas used by Beaufort Sea belugas that overlap the Study Area. One, located in the Eastern Chukchi and Alaskan Beaufort Sea, is a migration area in use from April to May. The second, located in the Alaskan Beaufort Sea, is used by migrating belugas from September to October (Calambokidis *et al.*, 2015). During the winter, they can be found foraging in offshore waters associated with pack ice. When the sea ice melts in summer, they move to warmer river estuaries and coastal areas for molting and calving (Muto *et al.*, 2017).

Annual migrations can span over thousands of kilometers. The residential Beaufort Sea populations participate in short distance movements within their range throughout the year. Based on satellite tags (Suydam *et al.*, 2001) there is some overlap in distribution with the eastern Chukchi Sea beluga whale stock.

During the winter, eastern Chukchi Sea belugas occur in offshore waters associated with pack ice. In the spring, they migrate to warmer coastal estuaries, bays, and rivers where they may molt (Finley 1982; Suydam 2009) and give birth to and care for their calves (Sergeant and Brodie 1969). Eastern Chukchi Sea belugas move into coastal areas, including Kasegaluk Lagoon (outside of the Study Area), in late June and animals are sighted in the area until about mid-July (Frost and Lowry 1990; Frost *et al.*, 1993). Satellite tags attached to eastern Chukchi Sea belugas captured in Kaseguluk Lagoon during the summer showed these whales traveled 593 nm (1,100 km) north of the Alaska coastline, into the Canadian Beaufort Sea within three months (Suydam *et al.*, 2001). Satellite telemetry data from 23 whales tagged during 1998-2007 suggest variation in movement patterns for different age and/or sex classes during July-September (Suydam *et al.*, 2005). Adult males used deeper waters and remained there for the duration of the summer; all belugas that moved into the Arctic Ocean (north of 75ºN) were males, and males traveled through 90 percent pack ice cover to reach deeper waters in the Beaufort Sea and Arctic Ocean (79-80ºN) by late July/early August. Adult and immature female belugas remained at or near the shelf break in the south through the eastern Bering Strait into the northern Bering Sea, remaining north of Saint Lawrence Island over the winter. A whale tagged in the eastern Chukchi Sea in 2007 overwintered in the waters north of Saint Lawrence Island during 2007/2008 and moved to near King Island in April and May before moving north through the Bering Strait in late May and early June (Suydam 2009).

Bearded Seal

Bearded seals are a boreoarctic species with circumpolar distribution (Burns 1967; Burns 1981; Burns and Frost 1979; Fedoseev 1965; Johnson *et al.*, 1966; Kelly 1988a; Smith 1981). Their normal range extends from the Arctic Ocean (85º N) south to Sakhalin Island (45º N) in the Pacific and south to Hudson Bay (55º N) in the Atlantic (Allen 1880; King 1983; Ognev 1935). Bearded seals are widely distributed throughout the northern Bering, Chukchi, and Beaufort Seas and are most abundant north of the ice edge zone (MacIntyre *et al.*, 2013). Bearded seals inhabit the seasonally ice-covered seas of the Northern Hemisphere, where they whelp and rear their pups and molt their coats on the ice in the spring and early summer. The overall summer distribution is quite broad, with seals rarely hauled out on land, and some seals, mostly juveniles, may not follow the ice northward but remain near the coasts of Bering and Chukchi seas (Burns 1967; Burns 1981; Heptner *et al.*, Nelson 1981). As the ice forms again in the fall and winter, most seals move south with the advancing ice edge through the Bering Strait into the Bering Sea where they spend the winter (Boveng and Cameron 2013; Burns and Frost 1979; Cameron and Boveng 2007; Cameron and Boveng 2009; Frost *et al.*, 2005; Frost *et al.*, 2008). This southward migration is less noticeable and predictable than the northward movements in late spring and early summer (Burns 1981; Burns and Frost 1979; Kelly 1988a). During winter, the central and northern parts of the Bering Sea shelf have the highest densities of bearded seals (Braham *et al.*, 1981; Burns 1981; Burns and Frost 1979; Fay 1974; Heptner *et al.*, 1976; Nelson *et al.*, 1984). In late winter and early spring, bearded seals are widely but not uniformly distributed in the broken, drifting pack ice ranging from the Chukchi Sea south to the ice front in the Bering Sea. In these areas, they tend to avoid the coasts and areas of fast ice (Burns 1967; Burns and Frost 1979).

Bearded seals along the Alaskan coast tend to prefer areas where sea ice covers 70 to 90 percent of the surface, and are most abundant 20 to 100 nautical miles (nmi) (37 to 185 (km) offshore during the spring season (Bengston *et al.*, 2000; Bengston *et al.*, 2005; Simpkins *et al.*, 2003). In spring, bearded seals may also concentrate in nearshore pack ice habitats, where females give birth on the most stable areas of ice (Reeves *et al.*, 2003) and generally prefer to be near polynyas (areas of open water surrounded by sea ice) and other natural openings in the sea ice for breathing, hauling out, and prey access (Nelson *et al.*, 1984; Stirling 1997). While molting between April and August, bearded seals spend substantially more time hauled out than at other times of the year (Reeves *et al.*, 2002).

In their explorations of the Canada Basin, Harwood *et al.* (2005) observed bearded seals in waters of less than 656 ft (200 m) during the months from August to September. These sightings were east of 140ºW. The Bureau of Ocean Energy Management conducted an aerial survey from June through October that covered the shallow Beaufort and Chukchi Sea shelf waters, and observed bearded seals from Point Barrow to the border of Canada (Clarke *et al.*, 2014). The farthest from shore that bearded seals were observed was the waters of the continental slope.

On December 28, 2012, NMFS listed both the Okhotsk and the Beringia distinct population segments (DPSs) of bearded seals as threatened under the ESA (77 FR 76740). The Alaska stock of bearded seals consists of only Beringia DPS seals.

Ringed Seal

Ringed seals are the most common pinniped in the Study Area and have wide distribution in seasonally and permanently ice-covered waters of the Northern Hemisphere (North Atlantic Marine Mammal Commission 2004). Throughout their range, ringed seals have an affinity for ice-covered waters and are well adapted to occupying both shore-fast and pack ice (Kelly 1988c). Ringed seals can be found further offshore than other pinnipeds since they can maintain breathing holes in ice thickness greater than 6.6 ft (2 m) (Smith and Stirling 1975). Breathing holes are maintained by ringed seals' sharp teeth and claws on their fore flippers. They remain in contact with ice most of the year and use it as a platform for molting in late spring to early summer, for pupping and nursing in late winter to early spring, and for resting at other times of the year (Muto *et al.*, 2017).

Ringed seals have at least two distinct types of subnivean lairs: haulout lairs and birthing lairs (Smith and Stirling 1975). Haulout lairs are typically single-chambered and offer protection from predators and cold weather. Birthing lairs are larger, multi-chambered areas that are used for pupping in addition to protection from predators. Ringed seals pup on both land-fast ice as well as stable pack ice. Lentfer (1972) found that ringed seals north of Barrow, Alaska build their subnivean lairs on the pack ice near pressure ridges. Since subnivean lairs were found north of Barrow, Alaska, in pack ice, they are also assumed to be found within the sea ice in the Study Area. Ringed seals excavate subnivean lairs in drifts over their breathing holes in the ice, in which they rest, give birth, and nurse their pups for 5-9 weeks during late winter and spring (Chapskii 1940; McLaren 1958; Smith and Stirling 1975). Snow depths of at least 20 – 26 in (50 – 65 cm) are required for functional birth lairs (Kelly 1988b; Lydersen 1998; Lydersen and Gjertz 1986; Smith and Stirling 1975), and such depths typically are found only where 8 – 12 in (20 – 30 cm) or more of snow has accumulated on flat ice and then drifted along pressure ridges or ice hummocks (Hammill 2008; Lydersen *et al.*, 1990; Lydersen and Ryg 1991; Smith and Lydersen 1991). Ringed seals are born beginning in March, but the majority of births occur in early April. About a month after parturition, mating begins in late April and early May.

In Alaska waters, during winter and early spring when sea ice is at its maximum extent, ringed seals are abundant in the northern Bering Sea, Norton and Kotzebue Sounds, and throughout the Chukchi and Beaufort seas (Frost 1985; Kelly 1988c). Passive acoustic monitoring of ringed seals from a high frequency recording package deployed at a depth of 787 ft (240 m) in the Chukchi Sea 65 nmi (120 km) north-northwest of Barrow, Alaska detected ringed seals in the area between mid-December and late May over the 4 year study (Jones *et al.*, 2014). With the onset of fall freeze, ringed seal movements become increasingly restricted and seals will either move west and south with the advancing ice pack with many seals dispersing throughout the Chukchi and Bering Seas, or remaining in the Beaufort Sea (Crawford *et al.*, 2012; Frost and Lowry 1984; Harwood *et al.*, 2012). Kelly *et al.* (2010a) tracked home ranges for ringed seals in the subnivean period (using shore-fast ice); the size of the home ranges varied from less than 1 up to 279 km^2 (median is 0.62 km^2 for adult males and 0.65 km^2 for adult females). Most (94 percent) of the home ranges were less than 3 km^2 during the subnivean period (Kelly *et al.*, 2010a). Near large polynyas, ringed seals maintain ranges, up to 7,000 km^2 during winter and 2,100 km^2 during spring (Born *et al.*, 2004). Some adult ringed seals return to the same small home ranges they occupied during the previous winter (Kelly *et al.*, 2010a). The size of winter home ranges can, however, vary by up to a factor of 10 depending on the amount of fast ice; seal movements were more restricted during winters with extensive fast ice, and were much less restricted where fast ice did not form at high levels (Harwood *et al.*, 2015).

Most taxonomists recognize five subspecies of ringed seals. The Arctic ringed seal subspecies occurs in the Arctic Ocean and Bering Sea and is the only stock that occurs in U.S. waters (referred to as the Alaska stock). NMFS listed the Arctic ringed seal subspecies as threatened under the ESA on December 28, 2012 (77 FR 76706), primarily due to anticipated loss of sea ice through the end of the 21st century.

Marine Mammal Hearing

Hearing is the most important sensory modality for marine mammals underwater, and exposure to anthropogenic sound can have deleterious effects. To appropriately assess the potential effects of exposure to sound, it is necessary to understand the frequency ranges marine mammals are able to hear. Current data indicate that not all marine mammal species have equal hearing capabilities (*e.g.*, Richardson *et al.*, 1995; Wartzok and Ketten, 1999; Au and Hastings, 2008). To reflect this, Southall *et al.* (2007) recommended that marine mammals be divided into functional hearing groups based on directly measured or estimated hearing ranges on the basis of available behavioral response data, audiograms derived using auditory evoked potential techniques, anatomical modeling, and other data. Note that no direct measurements of hearing ability have been successfully completed for mysticetes (*i.e.*, low-frequency cetaceans). Subsequently, NMFS (2018) described generalized hearing ranges for these marine mammal hearing groups. Generalized hearing ranges were chosen based on the approximately 65 dB threshold from the normalized composite audiograms, with the exception for lower limits for low-frequency cetaceans where the lower bound was deemed to be biologically implausible and the lower bound from Southall *et al.* (2007) retained. Marine mammal hearing groups and their associated hearing ranges are provided in Table 4.

Table 4. Marine Mammal Hearing Groups (NMFS, 2018).

Hearing Group	Generalized Hearing Range*
Low-frequency (LF) cetaceans (baleen whales)	7 Hz to 35 kHz
Mid-frequency (MF) cetaceans (dolphins, toothed whales, beaked whales, bottlenose whales)	150 Hz to 160 kHz
High-frequency (HF) cetaceans (true porpoises, *Kogia*, river dolphins, cephalorhynchid, *Lagenorhynchus cruciger* & *L. australis*)	275 Hz to 160 kHz
Phocid pinnipeds (PW) (underwater) (true seals)	50 Hz to 86 kHz
Otariid pinnipeds (OW) (underwater) (sea lions and fur seals)	60 Hz to 39 kHz

***** Represents 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 pinniped functional hearing group was modified from Southall *et al.* (2007) on the basis of data indicating that phocid species have consistently demonstrated an extended frequency range of hearing compared to otariids, especially in the higher frequency range (Hemilä *et al.*, 2006; Kastelein *et al.*, 2009; Reichmuth and Holt, 2013).

For more detail concerning these groups and associated frequency ranges, please see NMFS (2018) for a review of available information. Three marine mammal species (one cetacean and two pinniped (both phocid) species) have the reasonable potential to co-occur with the proposed survey activities. Please refer to Table 3. Beluga whales are classified as mid-frequency cetaceans.

Potential Effects of Specified Activities on Marine Mammals and their Habitat

This section includes a summary and discussion of the ways that components of the specified activity may impact marine mammals and their habitat. The *Estimated Take by Incidental Harassment* section later in this document includes a quantitative analysis of the number of individuals that are expected to be taken by this activity. The *Negligible Impact Analysis and Determination* section considers the content of this section, the *Estimated Take by*

Incidental Harassment section, and the *Proposed Mitigation* section, to draw conclusions regarding the likely impacts of these activities on the reproductive success or survivorship of individuals and how those impacts on individuals are likely to impact marine mammal species or stocks.

Description of Sound Sources

Here, we first provide background information on marine mammal hearing before discussing the potential effects of the use of active acoustic sources on marine mammals.

Sound travels in waves, the basic components of which are frequency, wavelength, velocity, and amplitude. Frequency is the number of pressure waves that pass by a reference point per unit of time and is measured in Hz or cycles per second. Wavelength is the distance between two peaks of a sound wave; lower frequency sounds have longer wavelengths than higher frequency sounds and attenuate (decrease) more rapidly in shallower water. Amplitude is the height of the sound pressure wave or the 'loudness' of a sound and is typically measured using the dB scale. A dB is the ratio between a measured pressure (with sound) and a reference pressure (sound at a constant pressure, established by scientific standards). It is a logarithmic unit that accounts for large variations in amplitude; therefore, relatively small changes in dB ratings correspond to large changes in sound pressure. When referring to sound pressure levels (SPLs; the sound force per unit area), sound is referenced in the context of underwater sound pressure to 1 μPa. One pascal is the pressure resulting from a force of one newton exerted over an area of one square meter. The source level (SL) represents the sound level at a distance of 1 m from the source (referenced to 1 μPa). The received level is the sound level at the listener's position. Note that all underwater sound levels in this document are referenced to a pressure of 1 μPa.

Root mean square (rms) is the quadratic mean sound pressure over the duration of an impulse. RMS is calculated by squaring all of the sound amplitudes, averaging the squares, and then taking the square root of the average (Urick 1983). RMS accounts for both positive and negative values; squaring the pressures makes all values positive so that they may be accounted for in the summation of pressure levels (Hastings and Popper 2005). This measurement is often used in the context of discussing behavioral effects, in part because behavioral effects, which often result from auditory cues, may be better expressed through averaged units than by peak pressures.

When underwater objects vibrate or activity occurs, sound-pressure waves are created. These waves alternately compress and decompress the water as the sound wave travels. Underwater sound waves radiate in all directions away from the source (similar to ripples on the surface of a pond), except in cases where the source is directional. The compressions and decompressions associated with sound waves are detected as changes in pressure by aquatic life and man-made sound receptors such as hydrophones.

Even in the absence of sound from the specified activity, the underwater environment is typically loud due to ambient sound. Ambient sound is defined as environmental background sound levels lacking a single source or point (Richardson *et al.*, 1995), and the sound level of a region is defined by the total acoustical energy being generated by known and unknown sources. These sources may include physical (*e.g.*, waves, earthquakes, ice, atmospheric sound), biological (*e.g.*, sounds produced by marine mammals, fish, and invertebrates), and anthropogenic sound (*e.g.*, vessels, dredging, aircraft, construction). A number of sources contribute to ambient sound, including the following (Richardson *et al.*, 1995):

- *Wind and waves*: The complex interactions between wind and water surface, including processes such as breaking waves and wave-induced bubble oscillations and cavitation, are a main source of naturally occurring ambient noise for frequencies between 200 Hz and 50 kHz (Mitson, 1995). Under sea ice, noise generated by ice deformation and ice fracturing may be caused by thermal, wind, drift and current stresses (Roth *et al.*, 2012);
- *Precipitation*: Sound from rain and hail impacting the water surface can become an important component of total noise at frequencies above 500 Hz, and possibly down to 100 Hz during quiet times. In the ice-covered study area, precipitation is unlikely to impact ambient sound;
- *Biological*: Marine mammals can contribute significantly to ambient noise levels, as can some fish and shrimp. The frequency band for biological contributions is from approximately 12 Hz to over 100 kHz; and
- *Anthropogenic*: Sources of ambient noise related to human activity include transportation (surface vessels and aircraft), dredging and construction, oil and gas drilling and production, seismic surveys, sonar, explosions, and ocean acoustic studies. Shipping noise typically dominates the total ambient noise for frequencies between 20 and 300 Hz. In general, the frequencies of anthropogenic sounds are below 1 kHz and, if higher frequency sound levels are created, they attenuate rapidly (Richardson *et al.*, 1995). Sound from identifiable anthropogenic sources other than the activity of interest (*e.g.*, a passing vessel) is sometimes termed background sound, as opposed to ambient sound. Anthropogenic sources are unlikely to significantly contribute to ambient underwater noise during the late

winter and early spring in the study area as most anthropogenic activities will not be active due to ice cover (*e.g*. seismic surveys, shipping) (Roth *et al.,* 2012).

The sum of the various natural and anthropogenic sound sources at any given location and time – which comprise "ambient" or "background" sound – depends not only on the source levels (as determined by current weather conditions and levels of biological and shipping activity) but also on the ability of sound to propagate through the environment. In turn, sound propagation is dependent on the spatially and temporally varying properties of the water column and sea floor, and is frequency-dependent. As a result of the dependence on a large number of varying factors, ambient sound levels can be expected to vary widely over both coarse and fine spatial and temporal scales. Sound levels at a given frequency and location can vary by 10-20 dB from day to day (Richardson *et al.,* 1995). The result is that, depending on the source type and its intensity, sound from the specified activity may be a negligible addition to the local environment or could form a distinctive signal that may affect marine mammals.

Underwater sounds fall into one of two general sound types: impulsive and non-impulsive (defined in the following paragraphs). The distinction between these two sound types is important because they have differing potential to cause physical effects, particularly with regard to hearing (*e.g*., Ward, 1997 in Southall *et al*., 2007). Please see Southall *et al*., (2007) for an in-depth discussion of these concepts.

Impulsive sound sources (*e.g*., explosions, gunshots, sonic booms, impact pile driving) produce signals that are brief (typically considered to be less than one second), broadband, atonal transients (ANSI 1986; Harris 1998; NIOSH 1998; ISO 2003; ANSI 2005) and occur either as isolated events or repeated in some succession. 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.

Non-impulsive sounds can be tonal, narrowband, or broadband, brief or prolonged, and may be either continuous or non-continuous (ANSI 1995; NIOSH 1998). 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, machinery operations such as drilling or dredging, vibratory pile driving, 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. Icebreaking is also considered a non-impulsive sound. The duration of such sounds, as received at a distance, can be greatly extended in a highly reverberant environment.

Acoustic Impacts

Please refer to the information given previously regarding sound, characteristics of sound types, and metrics used in this document. Anthropogenic sounds cover a broad range of frequencies and sound levels and can have a range of highly variable impacts on marine life, from none or minor to potentially severe responses, depending on received levels, duration of exposure, behavioral context, and various other factors. The potential effects of underwater sound from active acoustic sources can potentially result in one or more of the following: temporary or permanent hearing impairment, non-auditory physical or physiological effects, behavioral disturbance, stress, and masking (Richardson *et al*., 1995; Gordon *et al*., 2004;

Nowacek *et al.*, 2007; Southall *et al.*, 2007; Gotz *et al.*, 2009). The degree of effect is intrinsically related to the signal characteristics, received level, distance from the source, and duration of the sound exposure. In general, sudden, high level sounds can cause hearing loss, as can longer exposures to lower level sounds. Temporary or permanent loss of hearing will occur almost exclusively for noise within an animal's hearing range. In this section, we first describe specific manifestations of acoustic effects before providing discussion specific to the proposed activities in the next section.

Permanent Threshold Shift - Marine mammals exposed to high-intensity sound, or to lower-intensity sound for prolonged periods, can experience hearing threshold shift (TS), which is the loss of hearing sensitivity at certain frequency ranges (Finneran 2015). TS can be permanent (PTS), in which case the loss of hearing sensitivity is not fully recoverable, or temporary (TTS), in which case the animal's hearing threshold would recover over time (Southall *et al.*, 2007). Repeated sound exposure that leads to TTS could cause PTS. In severe cases of PTS, there can be total or partial deafness, while in most cases the animal has an impaired ability to hear sounds in specific frequency ranges (Kryter 1985).

When PTS occurs, there is physical damage to the sound receptors in the ear (*i.e.*, tissue damage), whereas TTS represents primarily tissue fatigue and is reversible (Southall *et al.*, 2007). In addition, other investigators have suggested that TTS is within the normal bounds of physiological variability and tolerance and does not represent physical injury (*e.g.*, Ward, 1997). Therefore, NMFS does not consider TTS to constitute auditory injury.

Relationships between TTS and PTS thresholds have not been studied in marine mammals – PTS data exists only for a single harbor seal (Kastak *et al.*, 2008) – but are assumed to be similar to those in humans and other terrestrial mammals. PTS typically occurs at exposure levels at least several decibels above (a 40-dB threshold shift approximates PTS onset; *e.g.*, Kryter *et al.*, 1966; Miller, 1974) that inducing mild TTS (a 6-dB threshold shift approximates TTS onset; *e.g.*, Southall *et al.*, 2007). Based on data from terrestrial mammals, a precautionary assumption is that the PTS thresholds for impulse sounds (such as impact pile driving pulses as received close to the source) are at least six dB higher than the TTS threshold on a peak-pressure basis and PTS cumulative sound exposure level (SEL) thresholds are 15 to 20 dB higher than TTS cumulative SEL thresholds (Southall *et al.*, 2007).

Temporary Threshold Shift – TTS is the mildest form of hearing impairment that can occur during exposure to sound (Kryter, 1985). While experiencing TTS, the hearing threshold rises, and a sound must be at a higher level in order to be heard. In terrestrial and marine mammals, TTS can last from minutes or hours to days (in cases of strong TTS). In many cases, hearing sensitivity recovers rapidly after exposure to the sound ends.

Marine mammal hearing plays a critical role in communication with conspecifics, and interpretation of environmental cues for purposes such as predator avoidance and prey capture. Depending on the degree (elevation of threshold in dB), duration (*i.e.*, recovery time), and frequency range of TTS, and the context in which it is experienced, TTS can have effects on marine mammals ranging from discountable to serious. For example, a marine mammal may be able to readily compensate for a brief, relatively small amount of TTS in a non-critical frequency range that occurs during a time where ambient noise is lower and there are not as many competing sounds present. Alternatively, a larger amount and longer duration of TTS sustained during time when communication is critical for successful mother/calf interactions could have more serious impacts.

Currently, TTS data only exist for four species of cetaceans (bottlenose dolphin (*Tursiops truncatus)*, beluga whale, harbor porpoise, and Yangtze finless porpoise (*Neophocoena asiaeorientalis*)) and three species of pinnipeds (northern elephant seal (*Mirounga angustirostris*), harbor seal, and California sea lion (*Zalophus californianus*)) exposed to a limited number of sound sources (*i.e.*, mostly tones and octave-band noise) in laboratory settings (Finneran 2015). TTS was not observed in trained spotted and ringed seals exposed to impulsive noise at levels matching previous predictions of TTS onset (Reichmuth *et al.*, 2016). In general, harbor seals and harbor porpoises have a lower TTS onset than other measured pinniped or cetacean species. Additionally, the existing marine mammal TTS data come from a limited number of individuals within these species. There are no data available on noise-induced hearing loss for mysticetes. For summaries of data on TTS in marine mammals or for further discussion of TTS onset thresholds, please see Southall *et al.* (2007), Finneran and Jenkins (2012), and Finneran (2015).

Behavioral effects – Behavioral disturbance may include a variety of effects, including subtle changes in behavior (*e.g.*, minor or brief avoidance of an area or changes in vocalizations), more conspicuous changes in similar behavioral activities, and more sustained and/or potentially severe reactions, such as displacement from or abandonment of high-quality habitat. Behavioral responses to sound are highly variable and context-specific and any reactions depend on numerous intrinsic and extrinsic factors (*e.g.*, species, state of maturity, experience, current activity, reproductive state, auditory sensitivity, time of day), as well as the interplay between factors (*e.g.*, Richardson *et al.*, 1995; Wartzok *et al.*, 2003; Southall *et al.*, 2007; Weilgart, 2007; Archer *et al.*, 2010). Behavioral reactions can vary not only among individuals but also within an individual, depending on previous experience with a sound source, context, and numerous other factors (Ellison *et al.*, 2012), and can vary depending on characteristics associated with the sound source (*e.g.*, whether it is moving or stationary, number of sources, distance from the source). Please see Appendices B-C of Southall *et al.* (2007) for a review of studies involving marine mammal behavioral responses to sound.

Habituation can occur when an animal's response to a stimulus wanes with repeated exposure, usually in the absence of unpleasant associated events (Wartzok *et al.*, 2003). Animals are most likely to habituate to sounds that are predictable and unvarying. It is important to note that habituation is appropriately considered as a "progressive reduction in response to stimuli that are perceived as neither aversive nor beneficial," rather than as, more generally, moderation in response to human disturbance (Bejder *et al.*, 2009). The opposite process is sensitization, when an unpleasant experience leads to subsequent responses, often in the form of avoidance, at a lower level of exposure. As noted, behavioral state may affect the type of response. For example, animals that are resting may show greater behavioral change in response to disturbing sound levels than animals that are highly motivated to remain in an area for feeding (Richardson *et al.* 1995; NRC 2003; Wartzok *et al.* 2003). Controlled experiments with captive marine mammals have showed pronounced behavioral reactions, including avoidance of loud sound sources (Ridgway *et al.* 1997; Finneran *et al.* 2003). Observed responses of wild marine mammals to loud impulsive sound sources (typically seismic airguns or acoustic harassment devices) have been varied but often consist of avoidance behavior or other behavioral changes suggesting discomfort (Morton and Symonds 2002; see also Richardson *et al.*, 1995; Nowacek *et al.*, 2007).

Available studies show wide variation in response to underwater sound; therefore, it is difficult to predict specifically how any given sound in a particular instance might affect marine mammals perceiving the signal. If a marine mammal does react briefly to an underwater sound by changing its behavior or moving a small distance, the impacts of the change are unlikely to be significant to the individual, let alone the stock or population. However, if a sound source displaces marine mammals from an important feeding or breeding area for a prolonged period, impacts on individuals and populations could be significant (*e.g.*, Lusseau and Bejder 2007; Weilgart 2007; NRC 2003). However, there are broad categories of potential response, which we describe in greater detail here, that include alteration of dive behavior, alteration of foraging behavior, effects to breathing, interference with or alteration of vocalization, avoidance, and flight.

Changes in dive behavior can vary widely, and may consist of increased or decreased dive times and surface intervals as well as changes in the rates of ascent and descent during a dive (*e.g.*, Frankel and Clark 2000; Costa *et al.*, 2003; Ng and Leung, 2003; Nowacek *et al.*, 2004; Goldbogen *et al.*, 2013). Variations in dive behavior may reflect interruptions in biologically significant activities (*e.g.*, foraging) or they may be of little biological significance. The impact of an alteration to dive behavior resulting from an acoustic exposure depends on what the animal is doing at the time of the exposure and the type and magnitude of the response.

Disruption of feeding behavior can be difficult to correlate with anthropogenic sound exposure, so it is usually inferred by observed displacement from known foraging areas, the appearance of secondary indicators (*e.g.*, bubble nets or sediment plumes), or changes in dive behavior. As for other types of behavioral response, the frequency, duration, and temporal pattern of signal presentation, as well as differences in species sensitivity, are likely contributing factors to differences in response in any given circumstance (*e.g.,* Croll *et al.*, 2001; Nowacek *et al.*; 2004; Madsen *et al.*, 2006; Yazvenko *et al.*, 2007). A determination of whether foraging disruptions incur fitness consequences would require information on or estimates of the energetic requirements of the affected individuals and the relationship between prey availability, foraging effort and success, and the life history stage of the animal.

Variations in respiration naturally vary with different behaviors and alterations to breathing rate as a function of acoustic exposure can be expected to co-occur with other behavioral reactions, such as a flight response or an alteration in diving. However, respiration rates in and of themselves may be representative of annoyance or an acute stress response. Various studies have shown that respiration rates may either be unaffected or could increase, depending on the species and signal characteristics, again highlighting the importance in understanding species differences in the tolerance of underwater noise when determining the potential for impacts resulting from anthropogenic sound exposure (*e.g*., Kastelein *et al*., 2001, 2005b, 2006; Gailey *et al*., 2007).

Marine mammals vocalize for different purposes and across multiple modes, such as whistling, echolocation click production, calling, and singing. Changes in vocalization behavior in response to anthropogenic noise can occur for any of these modes and may result from a need to compete with an increase in background noise or may reflect increased vigilance or a startle response. For example, in the presence of potentially masking signals, humpback whales and killer whales have been observed to increase the length of their songs (Miller *et al*., 2000; Fristrup *et al*., 2003; Foote *et al*., 2004), while right whales have been observed to shift the frequency content of their calls upward while reducing the rate of calling in areas of increased anthropogenic noise (Parks *et al*., 2007b). In some cases, animals may cease sound production during production of aversive signals (Bowles *et al*., 1994).

Avoidance is the displacement of an individual from an area or migration path as a result of the presence of a sound or other stressors, and is one of the most obvious manifestations of disturbance in marine mammals (Richardson *et al.*, 1995). For example, gray whales are known to change direction – deflecting from customary migratory paths – in order to avoid noise from seismic surveys (Malme *et al.*, 1984). Avoidance may be short-term, with animals returning to the area once the noise has ceased (*e.g.*, Bowles *et al.*, 1994; Goold, 1996; Morton and Symonds, 2002; Gailey *et al.*, 2007). Longer-term displacement is possible, however, which may lead to changes in abundance or distribution patterns of the affected species in the affected region if habituation to the presence of the sound does not occur (*e.g.*, Blackwell *et al.*, 2004; Bejder *et al.*, 2006).

A flight response is a dramatic change in normal movement to a directed and rapid movement away from the perceived location of a sound source. The flight response differs from other avoidance responses in the intensity of the response (*e.g.*, directed movement, rate of travel). Relatively little information on flight responses of marine mammals to anthropogenic signals exist, although observations of flight responses to the presence of predators have occurred (Connor and Heithaus 1996). The result of a flight response could range from brief, temporary exertion and displacement from the area where the signal provokes flight to, in extreme cases, marine mammal strandings (Evans and England 2001). However, it should be noted that response to a perceived predator does not necessarily invoke flight (Ford and Reeves 2008), and whether individuals are solitary or in groups may influence the response.

Behavioral disturbance can also impact marine mammals in more subtle ways. Increased vigilance may result in costs related to diversion of focus and attention (*i.e.*, when a response consists of increased vigilance, it may come at the cost of decreased attention to other critical behaviors such as foraging or resting). These effects have generally not been demonstrated for marine mammals, but studies involving fish and terrestrial animals have shown that increased vigilance may substantially reduce feeding rates (*e.g*., Beauchamp and Livoreil,1997; Fritz *et al*., 2002; Purser and Radford 2011). In addition, chronic disturbance can cause population declines through reduction of fitness (*e.g*., decline in body condition) and subsequent reduction in reproductive success, survival, or both (*e.g*., Harrington and Veitch 1992; Daan *et al*., 1996; Bradshaw *et al*., 1998). However, Ridgway *et al*. (2006) reported that increased vigilance in bottlenose dolphins exposed to sound over a five-day period did not cause any sleep deprivation or stress effects.

Many animals perform vital functions, such as feeding, resting, traveling, and socializing, on a diel cycle (24-hour cycle). Disruption of such functions resulting from reactions to stressors such as sound exposure are more likely to be significant if they last more than one diel cycle or recur on subsequent days (Southall *et al*., 2007). Consequently, a behavioral response lasting less than one day and not recurring on subsequent days is not considered particularly severe unless it could directly affect reproduction or survival (Southall *et al*., 2007). Note that there is a difference between multi-day substantive behavioral reactions and multi-day anthropogenic activities. For example, just because an activity lasts for multiple days does not necessarily mean that individual animals are either exposed to activity-related stressors for multiple days or, further, exposed in a manner resulting in sustained multi-day substantive behavioral responses.

For non-impulsive sounds (*i.e*., similar to the sources used during the proposed action), data suggest that exposures of pinnipeds to sources between 90 and 140 dB re 1 μPa do not elicit strong behavioral responses; no data were available for exposures at higher received levels for Southall *et al*. (2007) to include in the severity scale analysis. Reactions of harbor seals were the only available data for which the responses could be ranked on the severity scale. For reactions that were recorded, the majority (17 of 18 individuals/groups) were ranked on the severity scale as a 4 (defined as moderate change in movement, brief shift in group distribution, or moderate change in vocal behavior) or lower; the remaining response was ranked as a 6 (defined as minor or moderate avoidance of the sound source). Additional 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 grey (*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.,* 1992a; Wartzok *et al.*, 1992b). An acoustic tracking system then was installed in the ice to receive the acoustic signals and provide real-time tracking of ice seal movements. Although the frequencies used in this study are at the upper limit of ringed seal hearing, the ringed seals appeared unaffected by the acoustic transmissions, as they were able to maintain normal behaviors (*e.g.*, finding breathing holes).

Seals exposed to non-impulsive sources with a received sound pressure level within the range of calculated exposures (142–193 dB re 1 μPa), have been 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).

Some behavioral response studies have been conducted on odontocete responses to sonar. In studies that examined sperm whales (*Physeter macrocephalus*) and false killer whales (*Pseudorca crassidens*) (both in the mid-frequency cetacean hearing group), the marine mammals showed temporary cessation of calling and avoidance of sonar sources (Akamatsu *et al.*, 1993; Watkins and Schevill 1975). Sperm whales resumed calling and communication approximately two minutes after the pings stopped (Watkins and Schevill 1975). False killer whales moved away from the sound source but returned to the area between 0 and 10 minutes after the end of transmissions (Akamatsu *et al.*, 1993). Many of the contextual factors resulting from the behavioral response studies (*e.g.*, close approaches by multiple vessels or tagging) would not occur during the proposed action. Odontocete behavioral responses to acoustic transmissions from non-impulsive sources used during the proposed action would likely be a result of the animal's behavioral state and prior experience rather than external variables such as ship proximity; thus, if significant behavioral responses occur they would likely be short term. In fact, no significant behavioral responses such as panic, stranding, or other severe reactions have been observed during monitoring of actual training exercises (Department of the Navy 2011, 2014; Smultea and Mobley 2009; Watwood *et al.*, 2012).

Icebreaking noise has the potential to disturb marine mammals and elicit an alerting, avoidance, or other behavioral reaction (Huntington *et al.*, 2015; Pirotta *et al.*, 2015; Williams *et al.*, 2014). Icebreaking in fast ice during the spring can cause behavioral reactions in beluga whales. However, icebreaking associated with the proposed action would only occur from

August through October, which lessens the probability of a whale encountering the vessel (in comparison to other sources in the proposed action that would be active year-round).

Ringed seals and bearded seals on pack ice showed various behaviors when approached by an icebreaking vessel. A majority of seals dove underwater when the ship was within 0.5 nautical miles (0.93 km) while others remained on the ice. However, as icebreaking vessels came closer to the seals, most dove underwater. Ringed seals have also been observed foraging in the wake of an icebreaking vessel (Richardson *et al.*, 1995). In studies by Alliston (1980; 1981), there was no observed change in the density of ringed seals in areas that had been subject to icebreaking. Alternatively, ringed seals may have preferentially established breathing holes in the ship tracks after the icebreaker moved through the area. Due to the time of year of the activity (August through October), ringed seals are not expected to be within the subnivean lairs nor pupping (Chapskii 1940; McLaren 1958; Smith and Stirling 1975).

Adult ringed seals spend up to 20 percent of the time in subnivean lairs during the winter season (Kelly *et al.*, 2010a). Ringed seal pups spend about 50 percent of their time in the lair during the nursing period (Lydersen and Hammill 1993). During the warm season both bearded seals and ringed seals haul out on the ice. In a study of ringed seal haulout activity by Born *et al.* (2002), ringed seals spent 25-57 percent of their time hauled out in June which is during their molting season. Bearded seals also spend a large amount of time hauled out during the molting season between April and August (Reeves *et al.*, 2002). Ringed seal lairs are typically used by individual seals (haulout lairs) or by a mother with a pup (birthing lairs); large lairs used by many seals for hauling out are rare (Smith and Stirling 1975). If the non-impulsive acoustic transmissions are heard and are perceived as a threat, ringed seals within subnivean lairs could react to the sound in a similar fashion to their reaction to other threats, such as polar bears (their primary predators), although the type of sound would be novel to them. Responses of ringed seals to a variety of human-induced sounds (*e.g.*, helicopter noise, snowmobiles, dogs, people, and seismic activity) have been variable; some seals entered the water and some seals remained in the lair. However, in all instances in which observed seals departed lairs in response to noise disturbance, they subsequently reoccupied the lair (Kelly *et al.*, 1988).

Ringed seal mothers have a strong bond with their pups and may physically move their pups from the birth lair to an alternate lair to avoid predation, sometimes risking their lives to defend their pups from potential predators (Smith 1987). If a ringed seal mother perceives the proposed acoustic sources as a threat, the network of multiple birth and haulout lairs allows the mother and pup to move to a new lair (Smith and Hammill 1981; Smith and Stirling 1975). The acoustic sources and icebreaking noise from this proposed action are not likely to impede a ringed seal from finding a breathing hole or lair, as captive seals have been found to primarily use vision to locate breathing holes and no effect to ringed seal vision would occur from the acoustic disturbance (Elsner *et al.*, 1989; Wartzok *et al.*, 1992a). It is anticipated that a ringed seal would be able to relocate to a different breathing hole relatively easily without impacting their normal behavior patterns.

Stress responses – An animal's perception of a threat may be sufficient to trigger stress responses consisting of some combination of behavioral responses, autonomic nervous system responses, neuroendocrine responses, or immune responses (*e.g*., Seyle 1950; Moberg 2000). In many cases, an animal's first and sometimes most economical (in terms of energetic costs) response is behavioral avoidance of the potential stressor. Autonomic nervous system responses to stress typically involve changes in heart rate, blood pressure, and gastrointestinal activity.

These responses have a relatively short duration and may or may not have a significant long-term effect on an animal's fitness.

Neuroendocrine stress responses often involve the hypothalamus-pituitary-adrenal system. Virtually all neuroendocrine functions that are affected by stress – including immune competence, reproduction, metabolism, and behavior – are regulated by pituitary hormones. Stress-induced changes in the secretion of pituitary hormones have been implicated in failed reproduction, altered metabolism, reduced immune competence, and behavioral disturbance (*e.g.*, Moberg, 1987; Blecha, 2000). Increases in the circulation of glucocorticoids are also equated with stress (Romano *et al.*, 2004).

The primary distinction between stress (which is adaptive and does not normally place an animal at risk) and "distress" is the cost of the response. During a stress response, an animal uses glycogen stores that can be quickly replenished once the stress is alleviated. In such circumstances, the cost of the stress response would not pose serious fitness consequences. However, when an animal does not have sufficient energy reserves to satisfy the energetic costs of a stress response, energy resources must be diverted from other functions. This state of distress will last until the animal replenishes its energetic reserves sufficient to restore normal function.

Relationships between these physiological mechanisms, animal behavior, and the costs of stress responses are well-studied through controlled experiments and for both laboratory and free-ranging animals (*e.g.*, Holberton *et al.*, 1996; Hood *et al.*, 1998; Jessop *et al.*, 2003; Krausman *et al.*, 2004; Lankford *et al.*, 2005). Stress responses due to exposure to anthropogenic sounds or other stressors and their effects on marine mammals have also been reviewed (Fair and Becker, 2000; Romano *et al.*, 2002b) and, more rarely, studied in wild populations (*e.g.*, Romano *et al.*, 2002a). These and other studies lead to a reasonable expectation that some marine mammals will experience physiological stress responses upon exposure to acoustic stressors and that it is possible that some of these would be classified as "distress." In addition, any animal experiencing TTS would likely also experience stress responses (NRC, 2003).

Auditory masking – Sound can disrupt behavior through masking, or interfering with, an animal's ability to detect, recognize, or discriminate between acoustic signals of interest (*e.g.*, those used for intraspecific communication and social interactions, prey detection, predator avoidance, navigation) (Richardson *et al.*, 1995). Masking occurs when the receipt of a sound is interfered with by another coincident sound at similar frequencies and at similar or higher intensity, and may occur whether the sound is natural (*e.g.*, snapping shrimp, wind, waves, precipitation) or anthropogenic (*e.g.*, shipping, sonar, seismic exploration) in origin. The ability of a noise source to mask biologically important sounds depends on the characteristics of both the noise source and the signal of interest (*e.g.*, signal-to-noise ratio, temporal variability, direction), in relation to each other and to an animal's hearing abilities (*e.g.*, sensitivity, frequency range, critical ratios, frequency discrimination, directional discrimination, age or TTS hearing loss), and existing ambient noise and propagation conditions.

Under certain circumstances, marine mammals experiencing significant masking could also be impaired from maximizing their performance fitness in survival and reproduction. Therefore, when the coincident (masking) sound is anthropogenic, it may be considered harassment when disrupting or altering critical behaviors. It is important to distinguish TTS and PTS, which persist after the sound exposure, from masking, which occurs during the sound exposure. Because masking (without resulting in TS) is not associated with abnormal physiological function, it is not considered a physiological effect, but rather a potential behavioral effect.

The frequency range of the potentially masking sound is important in determining any potential behavioral impacts. For example, low-frequency signals may have less effect on high-frequency echolocation sounds produced by odontocetes but are more likely to affect detection of mysticete communication calls and other potentially important natural sounds such as those produced by surf and some prey species. The masking of communication signals by anthropogenic noise may be considered as a reduction in the communication space of animals (*e.g.*, Clark *et al*., 2009) and may result in energetic or other costs as animals change their vocalization behavior (*e.g.*, Miller *et al.*, 2000; Foote *et al.*, 2004; Parks *et al.*, 2007b; Di Iorio and Clark, 2009; Holt *et al*., 2009). Masking can be reduced in situations where the signal and noise come from different directions (Richardson *et al*., 1995), through amplitude modulation of the signal, or through other compensatory behaviors (Houser and Moore, 2014). Masking can be tested directly in captive species (*e.g.*, Erbe, 2008), but in wild populations it must be either modeled or inferred from evidence of masking compensation. There are few studies addressing real-world masking sounds likely to be experienced by marine mammals in the wild (*e.g.*, Branstetter *et al*., 2013).

Masking affects both senders and receivers of acoustic signals and can potentially have long-term chronic effects on marine mammals at the population level as well as at the individual level. Low-frequency ambient sound levels have increased by as much as 20 dB (more than three times in terms of SPL) in the world's ocean from pre-industrial periods, with most of the increase from distant commercial shipping (Hildebrand 2009). All anthropogenic sound sources, but especially chronic and lower-frequency signals (*e.g.*, from vessel traffic), contribute to elevated ambient sound levels, thus intensifying masking.

Potential Effects on Prey—The marine mammal species in the study area feed on marine invertebrates and fish. Studies of sound energy effects on invertebrates are few, and primarily identify behavioral responses. It is expected that most marine invertebrates would not sense the frequencies of the acoustic transmissions from the acoustic sources associated with the proposed action. Although acoustic sources used during the proposed action may briefly impact individuals, intermittent exposures to non-impulsive acoustic sources are not expected to impact survival, growth, recruitment, or reproduction of widespread marine invertebrate populations. Impacts to invertebrates from icebreaking noise is unknown, but it is likely that some species including crustaceans and cephalopods would be able to perceive the low frequency sounds generated from icebreaking. Icebreaking associated with the proposed action would be short-term and temporary as the vessel moves through an area, and it is not anticipated that this short-term noise would result in significant harm, nor is it expected to result in more than a temporary behavioral reaction of marine invertebrates in the vicinity of the icebreaking event.

The fish species residing in the study area include those that are closely associated with the deep ocean habitat of the Beaufort Sea. Nearly 250 marine fish species have been described in the Arctic, excluding the larger parts of the sub-Arctic Bering, Barents, and Norwegian Seas (Mecklenburg *et al.*, 2011). However, only about 30 are known to occur in the Arctic waters of the Beaufort Sea (Christiansen and Reist 2013). Although hearing capability data only exist for fewer than 100 of the 32,000 named fish species, current data suggest that most species of fish detect sounds from 50 to 100 Hz, with few fish hearing sounds above 4 kHz (Popper 2008). It is believed that most fish have the best hearing sensitivity from 100 to 400 Hz (Popper 2003). Fish species in the study area are expected to hear the low-frequency sources associated with the proposed action, but most are not expected to detect sound from the mid-frequency sources. Human generated sound could alter the behavior of a fish in a manner than would affect its way of living, such as where it tries to locate food or how well it could find a mate. Behavioral responses to loud noise could include a startle response, such as the fish swimming away from the source, the fish "freezing" and staying in place, or scattering (Popper 2003). Icebreaking noise has the potential to expose fish to both sound and general disturbance, which could result in short-term behavioral or physiological responses (*e.g.*, avoidance, stress, increased heart rate). Misund (1997) found that fish ahead of a ship showed avoidance reactions at ranges of 160 to 489 ft (49 to 149 m). Avoidance behavior of vessels, vertically or horizontally in the water column, has been reported for cod and herring, and was attributed to vessel noise. While acoustic sources and icebreaking associated with the proposed action may influence the behavior of some fish species, other fish species may be equally unresponsive. Overall effects to fish from the proposed action would be localized, temporary, and infrequent.

Effects to Physical and Foraging Habitat—Icebreaking activities include the physical pushing or moving of ice to allow vessels to proceed through ice-covered waters. Breaking of pack ice that contains hauled out seals may result in the animals becoming startled and entering the water, but such effects would be brief. Bearded and ringed seals haul out on pack ice during the spring and summer to molt (Reeves *et al.* 2002; Born *et al.*, 2002). Due to the time of year of the icebreaking activity (August through October), ringed seals are not expected to be within the subnivean lairs nor pupping (Chapskii 1940; McLaren 1958; Smith and Stirling 1975). Additionally, studies by Alliston (Alliston 1980; Alliston 1981) suggested that ringed seals may preferentially establish breathing holes in ship tracks after icebreakers move through the area.

The amount of ice habitat disturbed by icebreaking activities is small relative to the amount of overall habitat available. There will be no permanent loss or modification of physical ice habitat used by bearded or ringed seals. Icebreaking would have no effect on physical beluga habitat as beluga habitat is solely within the water column.

Testing of towed sources and icebreaking noise would be limited in duration and the deployed sources that would remain in use after the vessels have left the survey area have low duty cycles and lower source levels. There would not be any expected habitat-related effects from non-impulsive acoustic sources or icebreaking noise that could impact the in-water habitat of ringed seal, bearded seal, or beluga whale foraging habitat.

Estimated Take

This section provides an estimate of the number of incidental takes proposed for authorization through this IHA, which will inform both NMFS' consideration of "small numbers" and the negligible impact determination.

Harassment is the only type of take expected to result from these activities. For this military readiness activity, the MMPA defines "harassment" as (i) 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 (ii) Any act that 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).

Authorized takes would be by Level B harassment only, in the form of disruption of behavioral patterns and TTS for individual marine mammals resulting from exposure to acoustic transmissions and icebreaking noise. Based on the nature of the activity, Level A harassment is neither anticipated nor proposed to be authorized.

As described previously, no mortality is anticipated or proposed to be authorized for this activity. Below we describe how the take is estimated.

Generally speaking, we estimate 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 area or volume of water that will be ensonified above these levels in a day; (3) the density or occurrence of marine mammals within these ensonified areas; and, (4) and the number of days of activities. We note that while these basic factors can contribute to a basic calculation to provide an initial prediction of takes, additional information that can qualitatively inform take estimates is also sometimes available (e.g., previous monitoring results or average group size). For the proposed IHA, ONR employed a sophisticated model known as the Navy Acoustic Effects Model (NAEMO) for assessing the impacts of underwater sound. Below, we describe the factors considered here in more detail and present the proposed take estimate.

Acoustic Thresholds

Using the best available science, NMFS has developed acoustic thresholds that identify the received level of underwater sound above which exposed marine mammals would be reasonably expected to be behaviorally harassed (equated to Level B harassment) or to incur PTS of some degree (equated to Level A harassment).

Level B Harassment for non-explosive sources—In coordination with NMFS, the Navy developed behavioral thresholds to support environmental analyses for the Navy's testing and training military readiness activities utilizing active sonar sources; these behavioral harassment thresholds are used here to evaluate the potential effects of the active sonar components of the proposed action. 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 also 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). Reviews by Nowacek *et al.* (2007) and 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.

Multi-year research efforts have conducted sonar exposure studies for odontocetes and mysticetes (Miller *et al.* 2012; Sivle *et al.* 2012). Several studies with captive animals have provided data under controlled circumstances for odontocetes and pinnipeds (Houser *et al.* 2013a; Houser *et al.* 2013b). Moretti *et al.* (2014) published a beaked whale dose-response curve based on passive acoustic monitoring of beaked whales during U.S. Navy training activity at Atlantic Underwater Test and Evaluation Center during actual Anti-Submarine Warfare exercises. This new information necessitated the update of the behavioral response criteria for the U.S. Navy's environmental analyses.

Southall *et al.* (2007), and more recently Southall *et al.* (2019), synthesized data from many past behavioral studies and observations to determine the likelihood of behavioral reactions at specific sound levels. While in general, the louder the sound source the more intense the behavioral response, it was clear that the proximity of a sound source and the animal's experience, motivation, and conditioning were also critical factors influencing the response

(Southall *et al.* 2007; Southall *et al.* 2019). After examining all of the available data, the authors felt that the derivation of thresholds for behavioral response based solely on exposure level was not supported because context of the animal at the time of sound exposure was an important factor in estimating response. Nonetheless, in some conditions, consistent avoidance reactions were noted at higher sound levels depending on the marine mammal species or group allowing conclusions to be drawn. Phocid seals showed avoidance reactions at or below 190 dB re 1 μPa at 1m; thus, seals may actually receive levels adequate to produce TTS before avoiding the source.

Odontocete behavioral criteria for non-impulsive sources were updated based on controlled exposure studies for dolphins and sea mammals, sonar, and safety (3S) studies where odontocete behavioral responses were reported after exposure to sonar (Antunes *et al.*, 2014; Houser *et al.*, 2013b); Miller *et al.*, 2011; Miller *et al.*, 2014; Miller *et al.*, 2012). For the 3S study the sonar outputs included 1-2 kHz up- and down-sweeps and 6-7 kHz up-sweeps; source levels were ramped up from 152-158 dB re 1 μPa to a maximum of 198-214 re 1 μPa at 1 m. Sonar signals were ramped up over several pings while the vessel approached the mammals. The study did include some control passes of ships with the sonar off to discern the behavioral responses of the mammals to vessel presence alone versus active sonar.

The controlled exposure studies included exposing the Navy's trained bottlenose dolphins to mid-frequency sonar while they were in a pen. Mid-frequency sonar was played at 6 different exposure levels from 125-185 dB re 1 μPa (rms). The behavioral response function for odontocetes resulting from the studies described above has a 50 percent probability of response at 157 dB re 1 μPa. Additionally, distance cutoffs (20 km for MF cetaceans) were applied to exclude exposures beyond which the potential of significant behavioral responses is considered to be unlikely.

The pinniped behavioral threshold was updated based on controlled exposure experiments on the following captive animals: hooded seal, gray seal, and California sea lion (Götz *et al.* 2010; Houser *et al.* 2013a; Kvadsheim *et al.* 2010). Hooded seals were exposed to increasing levels of sonar until an avoidance response was observed, while the grey seals were exposed first to a single received level multiple times, then an increasing received level. Each individual California sea lion was exposed to the same received level ten times. These exposure sessions were combined into a single response value, with an overall response assumed if an animal responded in any single session. The resulting behavioral response function for pinnipeds has a 50 percent probability of response at 166 dB re 1 μPa. Additionally, distance cutoffs (10 km for pinnipeds) were applied to exclude exposures beyond which the potential of significant behavioral responses is considered to be unlikely.

NMFS is proposing to adopt the Navy's approach to estimating incidental take by Level B harassment from the active acoustic sources for this action, which includes use of these dose response functions. The Navy's dose response functions were developed to estimate take from sonar and similar transducers and are not applicable to icebreaking. NMFS predicts that marine mammals are likely to be behaviorally harassed in a manner we consider Level B harassment when exposed to underwater anthropogenic noise above received levels of 120 dB re 1 μPa (rms) for continuous (*e.g.*, vibratory pile-driving, drilling, icebreaking) and above 160 dB re 1 μPa (rms) for non-explosive impulsive (*e.g.*, seismic airguns) or intermittent (*e.g.*, scientific sonar) sources. Thus, take of marine mammals by Level B harassment due to icebreaking has been calculated using the Navy's NAEMO model with a step-function at 120 dB re 1 µPa (rms) received level for behavioral response.

Level A harassment for non-explosive sources—NMFS' Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0) (Technical Guidance, 2018) identifies dual criteria to assess auditory injury (Level A harassment) to five different marine mammal groups (based on hearing sensitivity) as a result of exposure to noise from two different types of sources (impulsive or non-impulsive). ONR's proposed activities involve only non-impulsive sources.

These thresholds are provided in the table below. The references, analysis, and methodology used in the development of the thresholds are described in NMFS 2018 Technical Guidance, which may be accessed at *https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-acoustic-technical-guidance*.

Table 5. Thresholds identifying the onset of Permanent Threshold Shift

	PTS Onset Acoustic Thresholds* (Received Level)	
Hearing Group	**Impulsive**	**Non-impulsive**
Low-Frequency (LF) Cetaceans	*Cell 1* $L_{pk,flat}$: 219 dB $L_{E,LF,24h}$: 183 dB	*Cell 2* $L_{E,LF,24h}$: 199 dB
Mid-Frequency (MF) Cetaceans	*Cell 3* $L_{pk,flat}$: 230 dB $L_{E,MF,24h}$: 185 dB	*Cell 4* $L_{E,MF,24h}$: 198 dB
High-Frequency (HF) Cetaceans	*Cell 5* $L_{pk,flat}$: 202 dB $L_{E,HF,24h}$: 155 dB	*Cell 6* $L_{E,HF,24h}$: 173 dB
Phocid Pinnipeds (PW) (Underwater)	*Cell 7* $L_{pk,flat}$: 218 dB $L_{E,PW,24h}$: 185 dB	*Cell 8* $L_{E,PW,24h}$: 201 dB
Otariid Pinnipeds (OW) (Underwater)	*Cell 9* $L_{pk,flat}$: 232 dB $L_{E,OW,24h}$: 203 dB	*Cell 10* $L_{E,OW,24h}$: 219 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. In this Table, thresholds are abbreviated to reflect American National Standards Institute standards (ANSI 2013). However, peak sound pressure is defined by ANSI as incorporating frequency weighting, which is not the intent for this Technical Guidance. Hence, 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.

Quantitative Modeling

The Navy performed a quantitative analysis to estimate the number of mammals that could be harassed by the underwater acoustic transmissions during the proposed action. Inputs to the quantitative analysis included marine mammal density estimates, marine mammal depth occurrence distributions (Navy 2017a), 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 and icebreaking, 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 animats exceeds the thresholds for effects.

The Navy developed a set of software tools and compiled data for estimating acoustic effects on marine mammals without consideration of behavioral avoidance or mitigation. These tools and data sets serve as integral components of NAEMO. In NAEMO, animats are distributed non-uniformly based on species-specific density, depth distribution, and group size information and animats record energy received at their location in the water column. A fully three-dimensional environment is used for calculating sound propagation and animat exposure in NAEMO. Site-specific bathymetry, sound speed profiles, wind speed, and bottom properties are incorporated into the propagation modeling process. NAEMO calculates the likely propagation for various levels of energy (sound or pressure) resulting from each source used during the training event.

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 (which NMFS recommends in order to ensure more consistent quantification of take across actions), is independent of all others, and therefore, the same individual marine animal (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 study area, 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).

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.

Because of these inherent model limitations and simplifications, model-estimated results should be further analyzed, considering such factors as the range to specific effects, avoidance, and the likelihood of successfully implementing mitigation measures. This analysis uses a number of factors in addition to the acoustic model results to predict acoustic effects on marine mammals.

The underwater radiated noise signature for icebreaking in the central Arctic Ocean by CGC HEALY during different types of ice-cover was characterized in Roth *et al.* (2013). The radiated noise signatures were characterized for various fractions of ice cover. For modeling, the 8/10 ice cover was used. Each modeled day of icebreaking consisted of 6 hours of 8/10 ice cover. Icebreaking was modeled for eight days for each of the 2019 and 2020 cruises. For each cruise, this includes four days of icebreaking for the deployment (or recovery) of the VLF source and four days of icebreaking for the deployment (or recovery) of the northernmost navigation sources. Since ice forecasting cannot be predicted more than a few weeks in advance it is unknown if icebreaking would be needed to deploy or retrieve the sources after one year of transmitting. Therefore, icebreaking was conservatively analyzed within this IHA. Figure 5a and 5b in Roth *et al*. (2013) depicts the source spectrum level versus frequency for 8/10 ice cover. The sound signature of the ice coverage level was broken into 1-octave bins (Table 6). In the model, each bin was included as a separate source on the modeled vessel. When these independent sources go active concurrently, they simulate the sound signature of CGC HEALY. The modeled source level summed across these bins was 196.2 dB for the 8/10 signature ice signature. These source levels are a good approximation of the icebreaker's observed source level (provided in Figure 4b of (Roth *et al*. 2013)). Each frequency and source level was modeled as an independent source, and applied simultaneously to all of the animats within NAEMO. Each second was summed across frequency to estimate sound pressure level (root mean square (SPL_{RMS})). For PTS and TTS determinations, sound exposure levels were summed over the duration of the test and the transit to the deployment area. The method of quantitative modeling for icebreaking is considered to be a conservative approach; therefore, the number of takes estimated for icebreaking are likely an over-estimate and would not be expected.

Table 6. Modeled Bins for Icebreaking in 8/10 Ice Coverage on CGC HEALY

Frequency (Hz)	Source Level (dB)
25	189

50	188
100	189
200	190
400	188
800	183
1600	177
3200	176
6400	172
12800	167

For the other non-impulsive sources, NAEMO calculates the SPL and SEL for each active emission during an event. This is done by taking the following factors into account over the propagation paths: bathymetric relief and bottom types, sound speed, and attenuation contributors such as absorption, bottom loss, and surface loss. Platforms such as a ship using one or more sound sources are modeled in accordance with relevant vehicle dynamics and time durations by moving them across an area whose size is representative of the testing event's operational area. Table 7 provides range to effects for non-impulsive sources and icebreaking noise proposed for the Arctic research activities to mid-frequency cetacean and pinniped specific criteria. Marine mammals within these ranges would be predicted to receive the associated effect. Range to effects is important information in not only predicting non-impulsive acoustic impacts, but also in verifying the accuracy of model results against real-world situations and determining adequate mitigation ranges to avoid higher level effects, especially physiological effects in marine mammals. Therefore, the ranges in Table 7 provide realistic maximum distances over which the specific effects from the use of non-impulsive sources during the proposed action would be possible.

Table 7. Range to PTS, TTS, and Behavioral Effects in the Study Area

Source	**Range to Behavioral Effects (m)**		**Range to TTS Effects (m)**		**Range to PTS Effects (m)**	
	MF	**Pinniped**	**MF**	**Pinniped**	**MF**	**Pinniped**

	Cetacean		Cetacean		Cetacean	
Navigation and real-time sensing sources	20,000[a]	10,000[a]	0	6	0	0
Spiral Wave Beacon source	20,000[a]	10,000[a]	0	0	0	0
Icebreaking noise	4,275	4,525	3	12	0	0

[a] Cutoff distances applied

A behavioral response study conducted on and around the Navy range in Southern California (SOCAL BRS) observed reactions to sonar and similar sound sources by several marine mammal species, including Risso's dolphins (*Grampus griseus*), a mid-frequency cetacean (DeRuiter *et al.*, 2013; Goldbogen *et al.*, 2013; Southall *et al.*, 2011; Southall *et al.*, 2012; Southall *et al.*, 2013; Southall *et al.*, 2014). In preliminary analysis, none of the Risso's dolphins exposed to simulated or real mid-frequency sonar demonstrated any overt or obvious responses (Southall *et al.*, 2012, Southall *et al.*, 2013). In general, although the responses to the simulated sonar were varied across individuals and species, none of the animals exposed to real Navy sonar responded; these exposures occurred at distances beyond 10 km, and were up to 100 km away (DeRuiter *et al.*, 2013; B. Southall pers. comm.). These data suggest that most odontocetes (not including beaked whales and harbor porpoises) likely do not exhibit significant behavioral reactions to sonar and other transducers beyond approximately 10 km. Therefore, the Navy uses a cutoff distance for odontocetes of 10 km for moderate source level, single platform training and testing events, and 20 km for all other events, including the proposed Arctic Research Activities (Navy 2017a).

Southall *et al.*, (2007) report 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 uses a distance cutoff of 5 km for moderate source level, single platform training and testing events, and 10 km for all other events, including the proposed Arctic Research Activities (Navy 2017a)

NMFS and the Navy conservatively propose a distance cutoff of 10 km for pinnipeds, and 20 km for mid-frequency cetaceans (Navy 2017a). Regardless of the received level at that distance, take is not estimated to occur beyond 10 and 20 km from the source for pinnipeds and cetaceans, respectively. Sources that show a range of zero do not rise to the specified level of effects (*i.e.*, there is no chance of PTS for either MF cetaceans or pinnipeds from any of the sources). No instances of PTS were modeled for any species or stock; as such, no take by Level A harassment is anticipated or proposed to be authorized.

As discussed above, within NAEMO animats do not move horizontally or react in any way to avoid sound. Furthermore, mitigation measures that reduce the likelihood of physiological impacts are not considered in quantitative analysis. Therefore, the model may overestimate 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. 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 quantitative consideration of avoidance and mitigation factors were not included in this analysis.

The marine mammal density numbers utilized for quantitative modeling are from the Navy Marine Species Density Database (Navy 2014). Density estimates are based on habitat-based modeling by Kaschner *et al.*, (2006) and Kaschner (2004). While density estimates for the two stocks of beluga whales are equal (Kaschner *et al.*, 2006; Kaschner 2004), take has been apportioned to each stock proportional to the abundance of each stock. Table 8 shows the exposures expected for the beluga whale, bearded seal, and ringed seal based on NAEMO modeled results.

Table 8. Quantitative Modeling Results of Potential Exposures.

Species	Density Estimate within Study Area (animals per square km)[a]	Level B Harassment from Deployed Sources	Level B Harassment from Icebreaking	Level A Harassment	Total Proposed Take	Percentage of Stock Taken
Beluga Whale (Beaufort Sea Stock)	0.0087	331	32	0	363	0.92
Beluga Whale (Eastern Chukchi Sea stock)	0.0087	178	18	0	196	0.94
Bearded Seal	0.0332	0	0	0	5[b]	< 0.01
Ringed Seal	0.3760	6,773	1,072	0	7,845	2.17

[a] Kaschner *et al.* (2006); Kaschner (2004)
[b] Quantitative modeling yielded zero takes of bearded seals. However, in an abundance of caution, we are proposing to authorize five takes of bearded seals by Level B harassment.

Effects of Specified Activities on Subsistence Uses of Marine Mammals

Subsistence hunting is important for many Alaska Native communities. A study of the North Slope villages of Nuiqsut, Kaktovik, and Barrow identified the primary resources used for subsistence and the locations for harvest (Stephen R. Braund & Associates 2010), including terrestrial mammals (caribou, moose, wolf, and wolverine), birds (geese and eider), fish (Arctic cisco, Arctic char/Dolly Varden trout, and broad whitefish), and marine mammals (bowhead whale, ringed seal, bearded seal, and walrus). Bearded seals, ringed seals, and beluga whales are located within the study area during the proposed action. The permitted sources would be placed outside of the range for subsistence hunting and the study plans have been communicated to the Native communities. The closest active acoustic source within the study area (aside from the *de minimis* sources), is approximately 145 mi (233 km) from land. As stated above, the range to effects for non-impulsive acoustic sources in this experiment is much smaller than the distance from shore. In addition, the proposed action would not remove individuals from the population. Therefore, there would be no impacts caused by this action to the availability of bearded seal, ringed seal, or beluga whale for subsistence hunting. Therefore, subsistence uses of marine mammals are not expected to be impacted by the proposed action.

Proposed Mitigation

In order to issue an IHA under Section 101(a)(5)(D) of the MMPA, NMFS must set forth the permissible methods of taking pursuant to such activity, and other means of effecting the least practicable impact on such species or stock and its habitat, paying particular attention to rookeries, mating grounds, and areas of similar significance, and on the availability of such species or stock for taking for certain subsistence uses. NMFS regulations require applicants for incidental take authorizations to include information about the availability and feasibility (economic and technological) of equipment, methods, and manner of conducting such activity or other means of effecting the least practicable adverse impact upon the affected species or stocks and their habitat (50 CFR 216.104(a)(11)). The NDAA for FY 2004 amended the MMPA as it relates to military readiness activities and the incidental take authorization process such that "least practicable impact" shall include consideration of personnel safety, practicality of implementation, and impact on the effectiveness of the military readiness activity.

In evaluating how mitigation may or may not be appropriate to ensure the least practicable adverse impact on species or stocks and their habitat, as well as subsistence uses where applicable, we carefully consider two primary factors:

(1) The manner in which, and the degree to which, the successful implementation of the measure(s) is expected to reduce impacts to marine mammals, marine mammal species or stocks, and their habitat, as well as subsistence uses. This considers the nature of the potential adverse impact being mitigated (likelihood, scope, range). It further considers the likelihood that the measure will be effective if implemented (probability of accomplishing the mitigating result if implemented as planned), the likelihood of effective implementation (probability implemented as planned), and;

(2) The practicability of the measures for applicant implementation, which may consider such things as cost, impact on operations, and, in the case of a military readiness activity, personnel safety, practicality of implementation, and impact on the effectiveness of the military readiness activity.

Mitigation for Marine Mammals and their Habitat

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 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.

During navigational source deployments, visual observation would start 30 minutes prior to and continue throughout the deployment within an exclusion zone of 55 m (180 ft, roughly one ship length) around the deployed mooring. Deployment will stop if a marine mammal is visually detected within the exclusion zone. Deployment will re-commence if any one of the following conditions are met: (1) the animal is observed exiting the exclusion zone, (2) the animal is thought to have exited the exclusion zone based on its course and speed, or (3) the exclusion zone has been clear from any additional sightings for a period of 15 minutes for pinnipeds and 30 minutes for cetaceans. Visual monitoring will continue through 30 minutes following the deployment of sources.

Once deployed, the spiral wave beacon would transmit for five days. The ship will maintain position near the moored source and will monitor the surrounding area for marine mammals. Transmission will cease if a marine mammal enters a 55-m (180 ft) exclusion zone. Transmission will re-commence if any one of the following conditions are met: (1) the animal is observed exiting the exclusion zone, (2) the animal is thought to have exited the exclusion zone based on its course and speed and relative motion between the animal and the source, or (3) the exclusion zone has been clear from any additional sightings for a period of 15 minutes for pinnipeds and 30 minutes for cetaceans. The spiral wave beacon source will only transmit during daylight hours.

Ships would avoid approaching marine mammals head on and would maneuver to maintain an exclusion zone of 1,500 ft (457 m) around observed mysticete whales, and 600 ft (183 m) around all other marine mammals, provided it is safe to do so in ice free waters.

With the exception of the spiral wave beacon, moored/drifting sources are left in place and cannot be turned off until the following year during ice free months. Once they are programmed they will operate at the specified pulse lengths and duty cycles until they are either turned off the following year or there is failure of the battery and are not able to operate. Due to the ice covered nature of the Arctic is in not possible to recover the sources or interfere with their transmit operations in the middle of the deployment.

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 the vessel after there has already been one maneuver and/or speed change to avoid the animal. Avoidance measures should continue for any observed whale in order to maintain an exclusion zone of 1,500 ft (457 m).

All personnel conducting on-ice experiments, as well as all aircraft operating in the study area, are required to maintain a separation distance of 1,000 ft (305 m) from any sighted marine mammal.

Based on our evaluation of the applicant's proposed measures, NMFS has preliminarily determined that the proposed mitigation measures provide the means effecting the least practicable impact on the affected species or stocks and their habitat, paying particular attention to rookeries, mating grounds, areas of similar significance, and on the availability of such species or stock for subsistence uses.

Proposed Monitoring and Reporting

In order to issue an IHA for an activity, Section 101(a)(5)(D) of the MMPA states that NMFS must set forth requirements pertaining to the monitoring and reporting of such taking.

The MMPA implementing regulations at 50 CFR 216.104 (a)(13) indicate that requests for authorizations must include the suggested means of accomplishing the necessary monitoring and reporting that will result in increased knowledge of the species and of the level of taking or impacts on populations of marine mammals that are expected to be present in the proposed action area. Effective reporting is critical both to compliance as well as ensuring that the most value is obtained from the required monitoring.

Monitoring and reporting requirements prescribed by NMFS should contribute to improved understanding of one or more of the following:

- Occurrence of marine mammal species or stocks in the area in which take is anticipated (*e.g.*, presence, abundance, distribution, density);
- Nature, scope, or context of likely marine mammal exposure to potential stressors/impacts (individual or cumulative, acute or chronic), through better understanding of: (1) action or environment (*e.g.*, source characterization, propagation, ambient noise); (2) affected species (*e.g.*, life history, dive patterns); (3) co-occurrence of marine mammal species with the action; or (4) biological or behavioral context of exposure (*e.g.*, age, calving or feeding areas);
- Individual marine mammal responses (behavioral or physiological) to acoustic stressors (acute, chronic, or cumulative), other stressors, or cumulative impacts from multiple stressors;
- How anticipated responses to stressors impact either: (1) long-term fitness and survival of individual marine mammals; or (2) populations, species, or stocks;
- Effects on marine mammal habitat (*e.g.*, marine mammal prey species, acoustic habitat, or other important physical components of marine mammal habitat); and
- Mitigation and monitoring effectiveness.

While underway, the ships (including non-Navy ships operating on behalf of the Navy) utilizing active acoustics will have at least one watch person during activities. 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). Additionally, watch personnel have taken the Navy's Marine Species Awareness Training. 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.

The U.S. Navy has coordinated with NMFS to develop an overarching program plan in which specific monitoring would occur. This plan is called the Integrated Comprehensive Monitoring Program (ICMP) (Navy 2011). The ICMP has been developed in direct response to Navy permitting requirements established through various environmental compliance efforts. As a framework document, the ICMP applies by regulation to those activities on ranges and operating areas for which the Navy is seeking or has sought incidental take authorizations. The ICMP is intended to coordinate monitoring efforts across all regions and to allocate the most appropriate level and type of effort based on a set of standardized research goals, and in acknowledgement of regional scientific value and resource availability.

The ICMP is focused on Navy training and testing ranges where the majority of Navy activities occur regularly as those areas have the greatest potential for being impacted. ONR's Arctic Research Activities in comparison is a less intensive test with little human activity present in the Arctic. Human presence is limited to a minimal amount of days for source operations and source deployments, in contrast to the large majority (>95%) of time that the sources will be left behind and operate autonomously. Therefore, a dedicated monitoring project is not warranted. However, ONR will record all observations of marine mammals, including the marine mammal's location (latitude and longitude), behavior, and distance from project activities, including icebreaking.

The Navy is committed to documenting and reporting relevant aspects of research and testing activities to verify implementation of mitigation, comply with permits, and improve future environmental assessments. If any injury or death of a marine mammal is observed during the 2019-20 Arctic Research Activities, the Navy will immediately halt the activity and report the incident to the Office of Protected Resources, NMFS, and the Alaska Regional Stranding Coordinator, NMFS. The following information must be provided:

- Time, date, and location of the discovery;
- Species identification (if known) or description of the animal(s) involved;
- Condition of the animal(s) (including carcass condition if the animal is dead);
- Observed behaviors of the animal(s), if alive;
- If available, photographs or video footage of the animal(s); and

- General circumstances under which the animal(s) was discovered (*e.g.*, during use of towed acoustic sources, deployment of moored or drifting sources, during on-ice experiments, or by transiting vessel).

ONR will provide NMFS with a draft exercise monitoring report within 90 days of the conclusion of the proposed activity. The draft exercise monitoring report will include data regarding acoustic source use and any mammal sightings or detection will be documented. The report will include the estimated number of marine mammals taken during the activity. The report will also include information on the number of shutdowns recorded. 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.

Negligible Impact Analysis and Determination

NMFS has defined negligible impact as an impact resulting from the specified activity that cannot be reasonably expected to, and is not reasonably likely to, adversely affect the species or stock through effects on annual rates of recruitment or survival (50 CFR 216.103). A negligible impact finding is based on the lack of likely adverse effects on annual rates of recruitment or survival (*i.e.*, population-level effects). An estimate of the number of takes alone is not enough information on which to base an impact determination. In addition to considering estimates of the number of marine mammals that might be "taken" through harassment, NMFS considers other factors, such as the likely nature of any responses (*e.g.*, intensity, duration), the context of any responses (*e.g.*, critical reproductive time or location, migration), as well as effects on habitat, and the likely effectiveness of the mitigation. We also assess the number, intensity, and context of estimated takes by evaluating this information relative to population status. Consistent with the 1989 preamble for NMFS's implementing regulations (54 FR 40338; September 29, 1989), the impacts from other past and ongoing anthropogenic activities are incorporated into this analysis via their impacts on the environmental baseline (*e.g.*, as reflected in the regulatory status of the species, population size and growth rate where known, ongoing sources of human-caused mortality, or ambient noise levels).

Underwater acoustic transmissions associated with the Arctic Research Activities, as outlined previously, have the potential to result in Level B harassment of beluga whales, ringed seals, and bearded seals in the form of TTS and behavioral disturbance. No serious injury, mortality, or Level A harassment are anticipated to result from this activity.

Minimal takes of marine mammals by Level B harassment would be due to TTS since the range to TTS effects is small at only 12 m or less while the behavioral effects range is significantly larger extending up to 20 km (Table 7). TTS is a temporary impairment of hearing and can last from minutes or hours to days (in cases of strong TTS). In many cases, however, hearing sensitivity recovers rapidly after exposure to the sound ends. No takes from TTS were modeled, but if TTS did occur, the overall fitness of the individual is unlikely to be affected and negative impacts to the relevant stock are not anticipated.

Effects on individuals that are taken by Level B harassment could include alteration of dive behavior, alteration of foraging behavior, effects to breathing rates, interference with or alteration of vocalization, avoidance, and flight. More severe behavioral responses are not anticipated due to the localized, intermittent use of active acoustic sources. Most likely, individuals will simply be temporarily displaced by moving away from the sound source. As described previously in the behavioral effects section, seals exposed to non-impulsive sources with a received sound pressure level within the range of calculated exposures (142-193 dB re 1 µPa), have been 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 sound sources associated with 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). Thus, even repeated Level B harassment of some small subset of the overall stock is unlikely to result in any significant realized decrease in fitness for the affected individuals, and would not result in any adverse impact to the stock as a whole.

The project is not expected to have significant adverse effects on marine mammal habitat. While the activities may cause some fish to leave the area of disturbance, temporarily impacting marine mammals' foraging opportunities, this would encompass a relatively small area of habitat leaving large areas of existing fish and marine mammal foraging habitat unaffected. Icebreaking may temporarily affect the availability of pack ice for seals to haul out but the proportion of ice disturbed is small relative to the overall amount of available ice habitat. Icebreaking will not occur during the time of year when ringed seals are expected to be within subnivean lairs or pupping (Chapskii 1940; McLaren 1958; Smith and Stirling 1975). As such, the impacts to marine mammal habitat are not expected to cause significant or long-term negative consequences.

In summary and as described above, the following factors primarily support our preliminary determination that the impacts resulting from this activity are not expected to adversely affect the species or stock through effects on annual rates of recruitment or survival:

- No mortality is anticipated or authorized;
- Impacts will be limited to Level B harassment;

- Takes by Level B harassment will primarily be in the form of behavioral disturbance; and
- There will be no permanent or significant loss or modification of marine mammal prey or habitat.

Based on the analysis contained herein of the likely effects of the specified activity on marine mammals and their habitat, and taking into consideration the implementation of the proposed monitoring and mitigation measures, NMFS preliminarily finds that the total marine mammal take from the proposed activity will have a negligible impact on all affected marine mammal species or stocks.

Unmitigable Adverse Impact Analysis and Determination

Impacts to subsistence uses of marine mammals resulting from the proposed action are not anticipated. The closest active acoustic source within the study area is approximately 145 mi (233 km) from land, outside of known subsistence use areas. Based on this information, NMFS has preliminarily determined that there will be no unmitigable adverse impact on subsistence uses from ONR's proposed activities.

Endangered Species Act (ESA)

Section 7(a)(2) of the Endangered Species Act of 1973 (16 U.S.C. 1531 *et seq*.) requires that each Federal agency insure that any action it authorizes, funds, or carries out is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of designated critical habitat. To ensure ESA compliance for the issuance of IHAs, NMFS consults internally, in this case with the NMFS Alaska Regional Office (AKR), whenever we propose to authorize take for endangered or threatened species.

NMFS is proposing to authorize take of ringed seals and bearded seals, which are listed under the ESA. The Permits and Conservation Division has requested initiation of section 7 consultation with the Protected Resources Division of AKR for the issuance of this IHA. NMFS will conclude the ESA consultation prior to reaching a determination regarding the proposed issuance of the authorization.

Proposed Authorization

As a result of these preliminary determinations, NMFS proposes to issue an IHA to ONR for conducting Arctic Research Activities in the Beaufort and Chukchi Seas, provided the previously mentioned mitigation, monitoring, and reporting requirements are incorporated. A draft of the proposed IHA can be found at *https://www.fisheries.noaa.gov/permit/incidental-take-authorizations-under-marine-mammal-protection-act*.

Request for Public Comments

We request comment on our analyses, the proposed authorization, and any other aspect of this Notice of Proposed IHA for the proposed action. We also request at this time comment on the potential renewal of this proposed IHA as described in the paragraph below. Please include with your comments any supporting data or literature citations to help inform decisions on the request for this IHA or a subsequent Renewal.

On a case-by-case basis, NMFS may issue a one-year IHA renewal with an additional 15 days for public comments when (1) another year of identical or nearly identical activities as described in the Specified Activities section of this notice is planned or (2) the activities as described in the Specified Activities section of this notice would not be completed by the time the IHA expires and a second IHA would allow for completion of the activities beyond that described in the Dates and Duration section of this notice, provided all of the following conditions are met:

- A request for renewal is received no later than 60 days prior to expiration of the current IHA;

- The request for renewal must include the following:

(1) An explanation that the activities to be conducted under the requested Renewal are identical to the activities analyzed under the initial IHA, are a subset of the activities, or include changes so minor (e.g., reduction in pile size) that the changes do not affect the previous analyses, mitigation and monitoring requirements, or take estimates (with the exception of reducing the type or amount of take because only a subset of the initially analyzed activities remain to be completed under the Renewal); and

(2) A preliminary monitoring report showing the results of the required monitoring to date and an explanation showing that the monitoring results do not indicate impacts of a scale or nature not previously analyzed or authorized.

- Upon review of the request for Renewal, the status of the affected species or stocks, and any other pertinent information, NMFS determines that there are no more than minor changes in the activities, the mitigation and monitoring measures will remain the same and appropriate, and the findings in the initial IHA remain valid.

Dated: July 26, 2019.

Catherine Marzin,

Acting Director, Office of Protected Resources,

National Marine Fisheries Service.

[FR Doc. 2019-16318 Filed: 7/30/2019 8:45 am; Publication Date: 7/31/2019]