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DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

RIN 0648-XG909

Takes of Marine Mammals Incidental to Specified Activities; Taking Marine Mammals Incidental to Site Characterization Surveys of Lease Areas OCS-A 0486, OCS-A 0487, and OCS-A 0500

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

ACTION: Notice; proposed incidental harassment authorization; request for comments.

SUMMARY: NMFS has received an application from Orsted Wind Power LLC (Orsted) for an Incidental Harassment Authorization (IHA) to take marine mammals, by harassment, incidental to high-resolution geophysical (HRG) survey investigations associated with marine site characterization activities off the coast of Massachusetts and Rhode Island in the areas of Commercial Lease of Submerged Lands for Renewable Energy Development on the Outer Continental Shelf (OCS) currently being leased by the Applicant's affiliates Deepwater Wind New England, LLC and Bay State Wind LLC, respectively. These are identified as OCS-A 0486, OCS-A 0487, and OCS-A 0500 (collectively referred to as the Lease Areas). Orsted is also proposing to conduct marine site characterization surveys along one or more export cable route corridors (ECRs) originating from the Lease Areas and landing along the shoreline at locations from New York to Massachusetts, between Raritan Bay (part of the New York Bight) to Falmouth, Massachusetts (see Figure 1). Pursuant to the Marine Mammal Protection Act (MMPA), NMFS is requesting comments on its proposal to issue an IHA to Orsted to incidentally take, by Level B harassment only, small numbers of marine mammals during the

specified activities. 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.

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.Pauline@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/national/marine-mammal-protection/incidental-take-authorizations-other-energy-activities-renewable* 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: Rob Pauline, 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.

National Environmental Policy Act (NEPA)

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 is preparing an Environmental Assessment (EA) to consider the environmental impacts associated with the issuance of the proposed IHA. NMFS' [EIS or EA] [was or will be] made 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 March 8, 2019, NMFS received an application from Orsted for the taking of marine mammals incidental to HRG and geotechnical survey investigations in the OCS-A 0486, OCS-A 0487, and OCS-A 0500 Lease Areas, designated and offered by the Bureau of Ocean Energy Management (BOEM) as well as along one or more ECRs between the southern portions of the Lease Areas and shoreline locations from New York to Massachusetts, to support the development of an offshore wind project. Orsted's request is for take, by Level B harassment, of small numbers of 15 species or stocks of marine mammals. The application was considered adequate and complete on May 23, 2019. Neither Orsted nor NMFS expects serious injury or mortality to result from this activity and, therefore, an IHA is appropriate.

NMFS previously issued two IHAs to both Bay State Wind (81 FR 56589, August 22, 2016; 83 FR 36539, July 30, 2018) and Deepwater Wind (82 FR 32230, July 13, 2017; 83 FR 28808, June 21, 2018) for similar activities. Orsted has complied with all the requirements (*e.g.*, mitigation, monitoring, and reporting) of the issued IHAs.

Description of the Specified Activity

Overview

Orsted proposes to conduct HRG surveys in the Lease Area and ECRs to support the characterization of the existing seabed and subsurface geological conditions. This information is necessary to support the final siting, design, and installation of offshore project facilities, turbines and subsea cables within the project area as well as to collect the data necessary to support the review requirements associated with Section 106 of the National Historic Preservation Act of 1966, as amended. Underwater sound resulting from Orsted's proposed site characterization surveys has the potential to result in incidental take of marine mammals. This take of marine mammals is anticipated to be in the form of harassment and no serious injury or mortality is anticipated, nor is any authorized in this IHA.

Dates and Duration

HRG surveys are anticipated to commence in August, 2019. Orsted is proposing to conduct continuous HRG survey operations 24-hours per day (Lease Area and ECR Corridors) using multiple vessels. Based on the planned 24-hour operations, the survey activities for all survey segments would require 666 vessel days total if one vessel were surveying the entire survey line continuously. However, an estimated 5 vessels may be used simultaneously with a maximum of no more than 9 vessels. Therefore, all of the survey will be completed within one year. See Table 1 for the estimated number of vessel days for each survey segment. This is considered the total number of vessel days required, regardless of the number of vessels used. While actual survey duration would shorten given the use of multiple vessels, total vessel days provides an equivalent estimate of exposure for a given area. The estimated durations to complete survey activities do not include weather downtime. Surveys are anticipated to commence upon issuance of the requested IHA, if appropriate.

Table 1. Summary of Proposed HRG Survey Segments.

Survey Segment	Total Line km Per Day	Total Duration (Vessel Days)*
Lease Area OCS-A 0486	70	79
Lease Area OCS-A 0487		140
Lease Area OCS-A 0500		94
ECR Corridor(s)		353
Total		666

*Estimate is based on total time for one (1) vessel to complete survey activities

Specified Geographic Region

Orsted's survey activities will occur in the Lease Areas designated and offered by BOEM, located approximately 14 miles (mi) south of Martha's Vineyard, Massachusetts at its closest point, as well as within potential export cable route corridors off the coast of New York, Connecticut, Rhode Island, and Massachusetts shown in Figure 1. Water depth in these areas for the majority of the survey area is 1-55 m. However south of Long Island in the area we are surveying for cable routes, the maximum depth reaches 77 m in some locations. Also there is a very small area in the area north of the eastern end of Long Island that reaches a depth of 123 m.

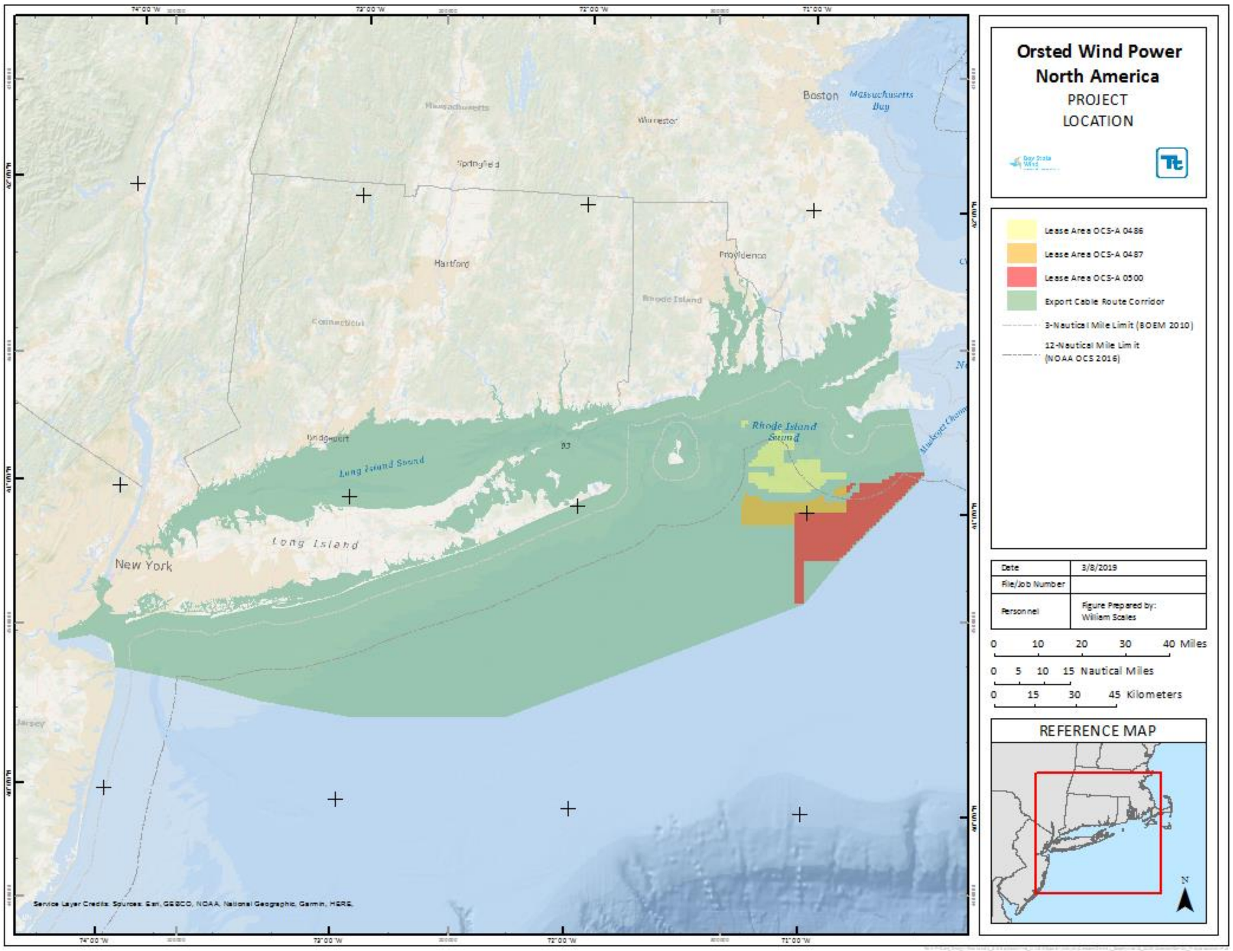

Figure 1. Survey Area Location

Detailed Description of Specified Activities

Marine site characterization surveys will include the following HRG survey activities:

- Depth sounding (multibeam depth sounder) to determine water depths and general bottom topography (currently estimated to range from approximately 3 to 180 feet (ft), 1 to 55 m, in depth below mean lower low water);
- Magnetic intensity measurements for detecting local variations in regional magnetic field from geological strata and potential ferrous objects on and below the seabed;
- Seafloor imaging (sidescan sonar survey) for seabed sediment classification purposes, to identify natural and man-made acoustic targets resting on the bottom as well as any anomalous features;
- Sub-bottom profiler to map the near surface stratigraphy; and
- Ultra High Resolution Seismic (UHRS) equipment to map deeper subsurface stratigraphy as needed

Table 2 identifies the representative survey equipment that is being considered in support of the HRG survey activities. The make and model of the HRG equipment will vary depending on availability. The primary operating frequency is oftentimes defined by the HRG equipment manufacturer or HRG contractor. The pulse duration provided represents best engineering estimates of the RMS_{90} values based on anticipated operator and sound source verification (SSV) reports of similar equipment (see Appendix E in Application). Orsted SSV reports also provide relevant information on anticipated settings. For most HRG sources, the midrange frequency is typically deemed appropriate for hydroacoustic assessment purposes. The SSV reports have also reasonably assumed that the HRG equipment were being operated at configurations deemed appropriate for the Survey Area. None of the proposed HRG survey activities will result in the disturbance of bottom habitat in the Survey Area.

Table 2. Summary of Proposed HRG Survey Data Acquisition Equipment.

Representative HRG Survey Equipment	Range of Operating Frequencies (kHz)	Baseline Source Level [a/]	Representative RMS90 Pulse Duration (millisec)	Pulse Repetition Rate (Hz)	Primary Operating Frequency (kHz)
USBL & Global Acoustic Positioning System (GAPS) Transceiver					
Sonardyne Ranger 2 transponder [b/]	19-34	200 dB_{RMS}	300	1	26
Sonardyne Ranger 2 USBL HPT 5/7000 transceiver [b/]	19 to 34	200 dB_{RMS}	300	1	26
Sonardyne Ranger 2 USBL HPT 3000 transceiver [b/]	19 to 34	194 dB_{RMS}	300	3	26.5
Sonardyne Scout Pro transponder [b/]	35 to 50	188 dB_{RMS}	300	1	42.5
Easytrak Nexus 2 USBL transceiver [b/]	18 to 32	192 dB_{RMS}	300	1	26
IxSea GAPS transponder [b/]	20 to 32	188 dB_{RMS}	20	10	26
Kongsberg HiPAP 501/502 USBL transceiver [b/]	21 to 31	190 dB_{RMS}	300	1	26
Edgetech BATS II transponder [b/]	17 to30	204 dB_{RMS}	300	3	23.5
Shallow Sub-Bottom Profiler (Chirp)					
Edgetech 3200 [c/]	2 to 16	212 dB_{RMS}	150	5	9
EdgeTech 216 [b/]	2 to 16	174 dB_{RMS}	22	2	6
EdgeTech 424 [b/]	4 to 24	176 dB_{RMS}	3.4	2	12
EdgeTech 512 [b/]	0.5 to 12	177 dB_{RMS}	2.2	2	3
Teledyne Benthos Chirp III - TTV 170 [b/]	2 to 7	197 dB_{RMS}	5 to 60	4	3.5
GeoPulse 5430 A Sub-bottom Profiler [b/, e/]	1.5 to 18	214 dB_{RMS}	25	10	4.5
PanGeo LF Chirp [b/]	2 to 6.5	195 dB_{RMS}	481.5	0.06	3

PanGeo HF Chirp b/	4.5 to 12.5	190 dB_{RMS}	481.5	0.06	5
Parametric Sub-Bottom Profiler					
Innomar SES-2000 Medium 100 c/	85 to 115	247 dB_{RMS}	0.07 to 2	40	85
Innomar SES-2000 Standard & Plus b/	85 to 115	236 dB_{RMS}	0.07 to 2	60	85
Innomar SES-2000 Medium 70 b/	60 to 80	241 dB_{RMS}	0.1 to 2.5	40	70
Innomar SES-2000 Quattro b/	85 to 115	245 dB_{RMS}	0.07 to 1	60	85
PanGeo 2i Parametric b/	90-115	239 dB_{RMS}	0.33	40	102
Medium Penetration Sub-Bottom Profiler (Sparker)					
GeoMarine Geo-Source 400tip d/	0.2 to 5	212 dB_{Peak} 201 dB_{RMS}	55	2	2
GeoMarine Geo-Source 600tip d/	0.2 to 5	214 dB_{Peak} 205 dB_{RMS}	55	2	2
GeoMarine Geo-Source 800tip d/	0.2 to 5	215 dB_{Peak} 206 dB_{RMS}	55	2	2
Applied Acoustics Dura-Spark 400 System d/	0.3 to 1.2	225dB_{Peak} 214 dB_{RMS}	55	0.4	1
GeoResources Sparker 800 System d/	0.05 to 5	215 dB_{Peak} 206 dB_{RMS}	55	2.5	1.9
Medium Penetration Sub-Bottom Profiler (Boomer)					
Applied Acoustics S-Boom 1000J b/	0.250 to 8	228 dB_{Peak} 208 dB_{RMS}	0.6	3	0.6
Applied Acoustics S-Boom 700J b/	0.1 to 5	211 dB_{Peak} 205 dB_{RMS}	5	3	0.6

Notes:
[a/] Baseline source levels were derived from manufacturer-reported source levels (SL) when available either in the manufacturer specification sheet or from the SSV report. When manufacturer specifications were unavailable or unclear, Crocker and Fratantonio (2016) SLs were utilized as the baseline:
[b/] source level obtained from manufacturer specifications
[c/] source level obtained from SSV-reported manufacturer SL
[d/] source level obtained from Crocker and Fratantonio (2016)
[e/] unclear from manufacturer specifications and SSV whether SL is reported in peak or rms; however, based on SLpk source level reported in SSV, assumption is SLrms is reported in specifications.
The transmit frequencies of sidescan and multibeam sonars for the 2019 marine site characterization surveys operate outside of marine mammal functional hearing frequency range.

The deployment of HRG survey equipment, including the use of intermittent, impulsive sound-producing equipment operating below 200 kilohertz (kHz), has the potential to cause acoustic harassment to marine mammals. Based on the frequency ranges of the equipment to be used in support of the HRG survey activities (Table 2) and the hearing ranges of the marine mammals that have the potential to occur in the Survey Area during survey activities (Table 3), the noise produced by the ultrashort baseline (USBL) and global acoustic positioning system (GAPS) transceiver systems; sub-bottom profilers (parametric and chirp); sparkers; and boomers fall within the established marine mammal hearing ranges and have the potential to result in harassment of marine mammals. All HRG equipment proposed for use is shown in Table 2.

Assuming a maximum survey track line to fully cover the Survey Area, the survey activities will be supported by vessels sufficient in size to accomplish the survey goals in specific survey areas and capable of maintaining both the required course and a survey speed to cover approximately 70.0 kilometers (km) per day at a speed of 4 knots (7.4 km per hour) while acquiring survey lines. While survey tracks could shorten, the maximum survey track scenario has been selected to provide operational flexibility and to cover the possibility of multiple landfall locations and associated cable routes. Survey segments represent a maximum extent, and distances may vary depending on contractor used.

Orsted has proposed to reduce the total duration of survey activities and minimize cost by conducting continuous HRG survey operations 24-hours per day for all survey segments. Total survey effort has been conservatively estimated to require up to a full year to provide survey flexibility on specific locations and vessel numbers to be utilized (likely between 5-9), which will be determined at the time of contractor selection.

Orsted also proposes to complete the proposed survey quickly and efficiently by using multiple vessels of varying size depending on survey segment location. To reduce the total survey duration, simultaneous survey activities will occur across multiple vessels in respective survey segments, where appropriate. Additionally, Orsted may elect to use an autonomous surface vehicle (ASV) to support survey operations. Use of an ASV in combination with a mother vessel allows the project team to double the survey daily production. The ASV will capture data in water depths shallower than 26 ft (8 m), increasing the shallow end reach of the larger vessel. The ASV can be used for nearshore operations and shallow work (20 ft (6 m) and less) in a "manned" configuration. The ASV and mother vessel will acquire survey data in tandem and the ASV will be kept within sight of the mother vessel at all times. The ASV will operate autonomously along a parallel track to, and slightly ahead of, the mother vessel at a distance set to prevent crossed signaling of survey equipment (within 2,625 ft (800 m)) During data acquisition surveyors have full control of the data being acquired and have the ability to make changes to settings such as power, gain, range scale etc. in real time

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 the Specified Activity

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' Stock Assessment Reports (SAR; *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' website (*https://www.fisheries.noaa.gov/find-species*).

We expect that the species listed in Table 3 will potentially occur in the project area and will potentially be taken as a result of the proposed project. Table 3 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' SARs). While no mortality is anticipated or authorized here, PBR is included here as a gross indicator 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’ stock abundance estimates for most species represent the total estimate of individuals within the geographic area, if known, that comprise that stock. For some species, this geographic area may extend beyond U.S. waters. All managed stocks in this region are assessed in NMFS' U.S. Atlantic Ocean SARs (*e.g.*, Hayes *et al.*, 2018). All values presented in Table 3 are the most recent available at the time of publication and are available in the 2017 SARs (Hayes *et al.*, 2018) and draft 2018 SARs (available online at: *https://www.fisheries.noaa.gov/national/marine-mammal-protection/draft-marine-mammal-stock-assessment-reports*).

Table 3. Marine Mammal known to occur in Survey Area Waters.

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 Balaenidae						
North Atlantic Right whale	*Eubalaena glacialis*	Western North Atlantic (WNA)	E/D; Y	451 (0; 445; 2017)	0.9	5.56
Family Balaenopteridae (rorquals)						
Humpback whale	*Megaptera novaeangliae*	Gulf of Maine	-/ -; N	896 (0; 896; 2012)	14.6	9.7
Fin whale	*Balaenoptera physalus*	WNA	E/D; Y	1,618 (0.33; 1,234; 2011)	2.5	2.5
Sei whale	*Balaenoptera borealis*	Nova Scotia	E/D; Y	357 (0.52; 236	0.5	0.8
Minke whale	*Balaenoptera acutorostrata*	Canadian East Coast	-/-; N	2,591 (0.81; 1,425	14	7.7
Superfamily Odontoceti (toothed whales, dolphins, and porpoises)						
Family Physeteridae						
Sperm whale	*Physeter macrocephalus*	E; Y	2,288 (0.28; 1,815)	North Atlantic	3.6	0.8
Family Delphinidae						
Long-finned pilot whale	*Globicephala melas*	WNA	-/-; Y	5,636 (0.63; 3,464)	35	38
Bottlenose dolphin	*Tursiops spp.*	WNA Offshore	-/-; N	77,532 (0.40; 56053; 2016)	561	39.4
Short beaked common dolphin	*Delphinus delphis*	WNA	-/-; N	70,184 (0.28; 55,690;2011)	557	406
Atlantic white-sided dolphin	*Lagenorhynchus acutus*	WNA	-/-; N	48,819 (0.61; 30,403; 2011)	304	30
Atlantic spotted dolphin	*Stenella frontalis*	WNA	-/-: N	44,715 (0.43; 31,610; 2013)	316	0

Risso's dolphin	*Grampus griseus*	WNA	-/-; N	18,250 (0.5; 12,619; 2011)	126	49.7
Family Phocoenidae (porpoises)						
Harbor porpoise	*Phocoena phocoena*	Gulf of Maine/Bay of Fundy	-/-; N	79,833 (0.32; 61,415; 2011)	706	256
Order Carnivora – Superfamily Pinnipedia						
Family Phocidae (earless seals)						
Gray seal	*Halichoerus grypus*	-; N	27,131 (0.19; 23,158)	W. North Atlantic	1,389	5,688
Harbor seal	*Phoca vitulina*	-; N	75,834 (0.15; 66,884)	W. North Atlantic	345	333

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.

As described below, 15 species (with 15 managed stocks) temporally and spatially co-occur with the activity to the degree that take is reasonably likely to occur, and we have proposed authorizing it.

The following subsections provide additional information on the biology, habitat use, abundance, distribution, and the existing threats to the non-ESA-listed and ESA-listed marine mammals that are both common in the waters of the outer continental shelf (OCS) of Southern New England and have the likelihood of occurring, at least seasonally, in the Survey Area. These species include the North Atlantic right, humpback, fin, sei, minke, sperm, and long finned pilot whale, bottlenose, short-beaked common, Atlantic white-sided, Atlantic spotted, and Risso's dolphins, harbor porpoise, and gray and harbor seals (BOEM 2014). Although the potential for interactions with long-finned pilot whales and Atlantic spotted and Risso's dolphins is minimal, small numbers of these species may transit the Survey Area and are included in this analysis.

Cetaceans

North Atlantic Right Whale

The North Atlantic right whale ranges from the calving grounds in the southeastern United States to feeding grounds in New England waters and into Canadian waters (Waring *et al.*, 2017). Right whales have been observed in or near southern New England during all four seasons; however, they are most common in the spring when they are migrating north and in the fall during their southbound migration (Kenney and Vigness-Raposa 2009). Surveys have demonstrated the existence of seven areas where North Atlantic right whales congregate seasonally, including north and east of the proposed survey area in Georges Bank, off Cape Cod, and in Massachusetts Bay (Waring *et al.*, 2017). In addition modest late winter use of a region south of Martha's Vineyard and Nantucket Islands was recently described (Stone *et al.* 2017). A large increase in aerial surveys of the Gulf of St. Lawrence documented at least 36 and 117 unique individuals using the region, respectively, during the summers of 2015 and 2017 (NMFS unpublished data). In the late fall months (*e.g.* October), right whales are generally thought to depart from the feeding grounds in the North Atlantic and move south to their calving grounds off Florida. However, recent research indicates our understanding of their movement patterns remains incomplete (Davis *et al.* 2017). A review of passive acoustic monitoring data from 2004 to 2014 throughout the western North Atlantic Ocean demonstrated nearly continuous year-round right whale presence across their entire habitat range, including in locations previously thought of as migratory corridors, suggesting that not all of the population undergoes a consistent annual migration (Davis *et al.* 2017). The number of North Atlantic right whale vocalizations detected in the proposed survey area were relatively constant throughout the year, with the exception of August through October when detected vocalizations showed an apparent decline

(Davis *et al.* 2017). North Atlantic right whales are expected to be present in the proposed survey area during the proposed survey, especially during the summer months, with numbers possibly lower in the fall. The proposed survey area is part of a migratory Biologically Important Area (BIA) for North Atlantic right whales; this important migratory area is comprised of the waters of the continental shelf offshore the East Coast of the United States and extends from Florida through Massachusetts. A map showing designated BIAs is available at: *https://cetsound.noaa.gov/biologically-important-area-map.*

NMFS' regulations at 50 CFR part 224.105 designated nearshore waters of the Mid-Atlantic Bight as Mid-Atlantic U.S. Seasonal Management Areas (SMA) for right whales in 2008. SMAs were developed to reduce the threat of collisions between ships and right whales around their migratory route and calving grounds. A portion of one SMA, overlaps spatially with a section of the proposed survey area. The SMA is active from November 1 through April 30 of each year.

The western North Atlantic population demonstrated overall growth of 2.8 percent per year between 1990 to 2010, despite a decline in 1993, and no growth between 1997 and 2000 (Pace *et al.* 2017). However, since 2010 the population has been in decline, with a 99.99 percent probability of a decline of just under 1 percent per year (Pace *et al.* 2017). Between 1990 and 2015, calving rates varied substantially, with low calving rates coinciding with all three periods of decline or no growth (Pace *et al.* 2017). In 2018, no new North Atlantic right whale calves were documented in their calving grounds; this represented the first time since annual NOAA aerial surveys began in 1989 that no new right whale calves were observed. However, in 2019 at least seven right whale calves have been identified (Savio 2019). Data indicates that the number of adult females fell from 200 in 2010 to 186 in 2015 while males fell from 283 to 272 in the same time frame (Pace *et al.*, 2017). In addition, elevated North Atlantic right whale mortalities have occurred since June 7, 2017. A total of 26 confirmed dead stranded whales (18 in Canada; 8 in the United States), have been documented to date. This event has been declared an Unusual Mortality Event (UME), with human interactions (*i.e.*, fishery-related entanglements and vessel strikes) identified as the most likely cause. More information is available online at: *https://www.fisheries.noaa.gov/national/marine-life-distress/2017-2018-north-atlantic-right-whale-unusual-mortality-event*.

Humpback Whale

Humpback whales are found worldwide in all oceans. Humpback whales were listed as endangered under the Endangered Species Conservation Act (ESCA) in June 1970. In 1973, the ESA replaced the ESCA, and humpbacks continued to be listed as endangered. NMFS recently evaluated the status of the species, and on September 8, 2016, NMFS divided the species into 14 distinct population segments (DPS), removed the current species-level listing, and in its place listed four DPSs as endangered and one DPS as threatened (81 FR 62259; September 8, 2016). The remaining nine DPSs were not listed. The West Indies DPS, which is not listed under the ESA, is the only DPS of humpback whale that is expected to occur in the survey area. The best estimate of population abundance for the West Indies DPS is 12,312 individuals, as described in the NMFS Status Review of the Humpback Whale under the Endangered Species Act (Bettridge *et al.*, 2015).

In New England waters, feeding is the principal activity of humpback whales, and their distribution in this region has been largely correlated to abundance of prey species, although behavior and bathymetry are factors influencing foraging strategy (Payne *et al.* 1986, 1990). Humpback whales are frequently piscivorous when in New England waters, feeding on herring

(*Clupea harengus*), sand lance (*Ammodytes* spp.), and other small fishes, as well as euphausiids in the northern Gulf of Maine (Paquet *et al.* 1997). During winter, the majority of humpback whales from North Atlantic feeding areas (including the Gulf of Maine) mate and calve in the West Indies, where spatial and genetic mixing among feeding groups occurs, though significant numbers of animals are found in mid- and high-latitude regions at this time and some individuals have been sighted repeatedly within the same winter season, indicating that not all humpback whales migrate south every winter (Waring *et al.,* 2017). Other sightings of note include 46 sightings of humpbacks in the New York- New Jersey Harbor Estuary documented between 2011 and 2016 (Brown *et al.* 2017). Multiple humpbacks were observed feeding off Long Island during July of 2016 (*https://www.greateratlantic.fisheries.noaa.gov/mediacenter/2016/july/26_humpback_whales_visit_new_york.html*, accessed 31 December, 2018) and there were sightings during November–-December 2016 near New York City (*https://www.greateratlantic.fisheries.noaa.gov/mediacenter/2016/december/09_humans_and_humpbacks_of_new_york_2.html*, accessed 31 December 2018).

Since January 2016, elevated humpback whale mortalities have occurred along the Atlantic coast from Maine through Florida. The event has been declared a UME. Partial or full necropsy examinations have been conducted on approximately half of the 93 known cases. A portion of the whales have shown evidence of pre-mortem vessel strike; however, this finding is not consistent across all of the whales examined so more research is needed. NOAA is consulting with researchers that are conducting studies on the humpback whale populations, and these efforts may provide information on changes in whale distribution and habitat use that could provide additional insight into how these vessel interactions occurred. More detailed information is available at*: https://www.fisheries.noaa.gov/national/marine-life-distress/2016-2018-humpback-whale-unusual-mortality-event-along-atlantic-coast#causes-of-the-humpback-whale-ume* (accessed June 3, 2019). Three previous UMEs involving humpback whales have occurred since 2000, in 2003, 2005, and 2006.

Fin Whale

Fin whales are common in waters of the U. S. Atlantic Exclusive Economic Zone (EEZ), principally from Cape Hatteras northward (Waring *et al.,* 2017). Fin whales are present north of 35-degree latitude in every season and are broadly distributed throughout the western North Atlantic for most of the year, though densities vary seasonally (Waring *et al.,* 2017). The main threats to fin whales are fishery interactions and vessel collisions (Waring *et al.,* 2017). New England waters represent a major feeding ground for fin whales. The proposed survey area would overlap spatially and temporally with a feeding BIA for fin whales. The important fin whale feeding area occurs from March through October and stretches from an area south of Montauk Point to south of Martha's Vineyard.

Sei Whale

The Nova Scotia stock of sei whales can be found in deeper waters of the continental shelf edge waters of the northeastern United States and northeastward to south of Newfoundland. NOAA Fisheries considers sei whales occurring from the U.S. East Coast to Cape Breton, Nova Scotia, and east to 42° W as the Nova Scotia stock of sei whales (Waring *et al.* 2016; Hayes *et al.* 2018). In the Northwest Atlantic, it is speculated that the whales migrate from south of Cape Cod along the eastern Canadian coast in June and July, and return on a southward migration again in September and October (Waring *et al.* 2014; 2017). Spring is the period of greatest abundance in U.S. waters, with sightings concentrated along the eastern margin of Georges Bank and into the Northeast Channel area, and along the southwestern edge of Georges Bank in the area of Hydrographer Canyon (Waring *et al.,* 2015).

Minke Whale

Minke whales can be found in temperate, tropical, and high-latitude waters. The Canadian East Coast stock can be found in the area from the western half of the Davis Strait (45 °W) to the Gulf of Mexico (Waring *et al.,* 2017). This species generally occupies waters less than 100 m deep on the continental shelf. There appears to be a strong seasonal component to minke whale distribution in which spring to fall are times of relatively widespread and common occurrence, and when the whales are most abundant in New England waters, while during winter the species appears to be largely absent (Waring *et al.,* 2017).

Since January 2017, elevated minke whale strandings have occurred along the Atlantic coast from Maine through South Carolina, with highest numbers in Massachusetts, Maine, and New York. Partial or full necropsy examinations have been conducted on more than 60 percent of the 59 known cases. Preliminary findings in several of the whales have shown evidence of human interactions or infectious disease. These findings are not consistent across all of the whales examined, so more research is needed. As part of the UME investigation process, NOAA is assembling an independent team of scientists to coordinate with the Working Group on Marine Mammal Unusual Mortality Events to review the data collected, sample stranded whales, and determine the next steps for the investigation. More information is available at: *www.fisheries.noaa.gov/national/marine-life-distress/2017-2018-minke-whale-unusual-mortality-event-along-atlantic-coast* (accessed June 3, 2019).

Sperm Whale

The distribution of the sperm whale in the U.S. EEZ occurs on the continental shelf edge, over the continental slope, and into mid-ocean regions (Waring *et al.* 2014). The basic social unit of the sperm whale appears to be the mixed school of adult females plus their calves and some juveniles of both sexes, normally numbering 20-40 animals in all. Sperm whales are somewhat migratory; however, their migrations are not as specific as seen in most of the baleen whale species. In the North Atlantic, there appears to be a general shift northward during the summer, but there is no clear migration in some temperate areas (Rice 1989). In summer, the distribution of sperm whales includes the area east and north of Georges Bank and into the Northeast Channel region, as well as the continental shelf (inshore of the 100-m isobath) south of New England. In the fall, sperm whale occurrence south of New England on the continental shelf is at its highest level, and there remains a continental shelf edge occurrence in the mid-Atlantic bight. In winter, sperm whales are concentrated east and northeast of Cape Hatteras. Their distribution is typically associated with waters over the continental shelf break and the continental slope and into deeper waters (Whitehead *et al*. 1991). Sperm whale concentrations near drop-offs and areas with strong currents and steep topography are correlated with high productivity. These whales occur almost exclusively found at the shelf break, regardless of season.

Long-Finned Pilot Whale

Long-finned pilot whales are found from North Carolina and north to Iceland, Greenland and the Barents Sea (Waring *et al.*, 2016). They are generally found along the edge of the continental shelf (a depth of 330 to 3,300 feet (100 to 1,000 meters)), choosing areas of high relief or submerged banks in cold or temperate shoreline waters. In the western North Atlantic, long-finned pilot whales are pelagic, occurring in especially high densities in winter and spring over the continental slope, then moving inshore and onto the shelf in summer and autumn following squid and mackerel populations (Reeves *et al*. 2002). They frequently travel into the central and northern Georges Bank, Great South Channel, and Gulf of Maine areas during the late spring and remain through early fall (May and October) (Payne and Heinemann 1993).

Atlantic White-Sided Dolphin

White-sided dolphins are found in temperate and sub-polar waters of the North Atlantic, primarily in continental shelf waters to the 100-m depth contour from central West Greenland to North Carolina (Waring *et al.,* 2017). The Gulf of Maine stock is most common in continental shelf waters from Hudson Canyon to Georges Bank, and in the Gulf of Maine and lower Bay of Fundy. Sighting data indicate seasonal shifts in distribution (Northridge *et al.,* 1997). During January to May, low numbers of white-sided dolphins are found from Georges Bank to Jeffreys Ledge (off New Hampshire), with even lower numbers south of Georges Bank, as documented by a few strandings collected on beaches of Virginia to South Carolina. From June through September, large numbers of white-sided dolphins are found from Georges Bank to the lower Bay of Fundy. From October to December, white-sided dolphins occur at intermediate densities from southern Georges Bank to southern Gulf of Maine (Payne and Heinemann 1990). Sightings south of Georges Bank, particularly around Hudson Canyon, occur year round but at low densities.

Atlantic Spotted Dolphin

Atlantic spotted dolphins are found in tropical and warm temperate waters ranging from southern New England, south to Gulf of Mexico and the Caribbean to Venezuela (Waring *et al.,* 2014). This stock regularly occurs in continental shelf waters south of Cape Hatteras and in continental shelf edge and continental slope waters north of this region (Waring *et al.,* 2014). There are two forms of this species, with the larger ecotype inhabiting the continental shelf and is usually found inside or near the 200 m isobaths (Waring *et al.,* 2014). The smaller ecotype has less spots and occurs in the Atlantic Ocean, but is not known to occur in the Gulf of Mexico. Atlantic spotted dolphins are not listed under the ESA and the stock is not considered depleted or strategic under the MMPA.

Common Dolphin

The short-beaked common dolphin is found world-wide in temperate to subtropical seas. In the North Atlantic, short-beaked common dolphins are commonly found over the continental shelf between the 100-m and 2,000-m isobaths and over prominent underwater topography and east to the mid-Atlantic Ridge (Waring *et al.*, 2016). This species is found between Cape Hatteras and Georges Bank from mid-January to May, although they migrate onto the northeast edge of Georges Bank in the fall where large aggregations occur (Kenney and Vigness-Raposa 2009), where large aggregations occur on Georges Bank in fall (Waring *et al.* 2007). Only the western North Atlantic stock may be present in the Survey Area.

Bottlenose Dolphin

There are two distinct bottlenose dolphin ecotypes in the western North Atlantic: the coastal and offshore forms (Waring *et al.,* 2015). The migratory coastal morphotype resides in waters typically less than 65.6 ft (20 m) deep, along the inner continental shelf (within 7.5 km (4.6 miles) of shore), around islands, and is continuously distributed south of Long Island, New York into the Gulf of Mexico. This migratory coastal population is subdivided into 7 stocks based largely upon spatial distribution (Waring *et al.* 2015). Of these 7 coastal stocks, the Western North Atlantic migratory coastal stock is common in the coastal continental shelf waters off the coast of New Jersey (Waring *et al.* 2017). Generally, the offshore migratory morphotype is found exclusively seaward of 34 km (21 miles) and in waters deeper than 34 m (111.5 feet).

This morphotype is most expected in waters north of Long Island, New York (Waring *et al.* 2017; Hayes *et al.* 2017; 2018). The offshore form is distributed primarily along the outer continental shelf and continental slope in the Northwest Atlantic Ocean from Georges Bank to the Florida Keys and is the only type that may be present in the survey area as the survey area is north of the northern extent of the range of the Western North Atlantic Northern Migratory Coastal Stock.

Risso's Dolphins

Risso's dolphins are distributed worldwide in tropical and temperate seas (Jefferson *et al.* 2008, 2014), and in the Northwest Atlantic occur from Florida to eastern Newfoundland (Leatherwood *et al.* 1976; Baird and Stacey 1991). Off the northeastern U.S. coast, Risso's dolphins are distributed along the continental shelf edge from Cape Hatteras northward to Georges Bank during spring, summer, and autumn (CETAP 1982; Payne *et al.* 1984) (Figure 1). In winter, the range is in the mid-Atlantic Bight and extends outward into oceanic waters (Payne *et al.* 1984).

Harbor Porpoise

In the Survey Area, only the Gulf of Maine/Bay of Fundy stock may be present. This stock is found in U.S. and Canadian Atlantic waters and is concentrated in the northern Gulf of Maine and southern Bay of Fundy region, generally in waters less than 150 m deep (Waring *et al.*, 2017). During fall (October–December) and spring (April–June) harbor porpoises are widely dispersed from New Jersey to Maine. During winter (January to March), intermediate densities of harbor porpoises can be found in waters off New Jersey to North Carolina, and lower densities are found in waters off New York to New Brunswick, Canada They are seen from the coastline to deep waters (>1800 m; Westgate *et al.* 1998), although the majority of the population is found over the continental shelf (Waring *et al.*, 2017).

Harbor Seal

Harbor seals are year-round inhabitants of the coastal waters of eastern Canada and Maine (Katona *et al.* 1993), and occur seasonally along the coasts from southern New England to New Jersey from September through late May. While harbor seals occur year-round north of Cape Cod, they only occur during winter migration, typically September through May, south of Cape Cod (Southern New England to New Jersey) (Waring *et al.* 2015; Kenney and Vigness-Raposa 2009). *Gray Seal*

There are three major populations of gray seals found in the world; eastern Canada (western North Atlantic stock), northwestern Europe and the Baltic Sea. Gray seals in the survey area belong to the western North Atlantic stock. The range for this stock is thought to be from New Jersey to Labrador. Current population trends show that gray seal abundance is likely increasing in the U.S. Atlantic EEZ (Waring *et al.*, 2017). Although the rate of increase is unknown, surveys conducted since their arrival in the 1980s indicate a steady increase in abundance in both Maine and Massachusetts (Waring *et al.*, 2017). It is believed that recolonization by Canadian gray seals is the source of the U.S. population (Waring *et al.*, 2017).

Since July 2018, elevated numbers of harbor seal and gray seal mortalities have occurred across Maine, New Hampshire and Massachusetts. This event has been declared a UME. Additionally, seals showing clinical signs of stranding have occurred as far south as Virginia, although not in elevated numbers. Therefore the UME investigation now encompasses all seal strandings from Maine to Virginia. Between July 1, 2018 and June 26, 2019, a total of 2,593 seal strandings have been recorded as part of this designated Northeast Pinniped UME. Based on tests conducted so far, the main pathogen found in the seals is phocine distemper virus. Additional testing to identify other factors that may be involved in this UME are underway.

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. The functional groups and the associated frequencies are indicated below (note that these frequency ranges correspond to the range for the composite group, with the entire range not necessarily reflecting the capabilities of every species within that group):

- Low-frequency cetaceans (mysticetes): generalized hearing is estimated to occur between approximately 7 Hertz (Hz) and 35 kHz;

- Mid-frequency cetaceans (larger toothed whales, beaked whales, and most delphinids): generalized hearing is estimated to occur between approximately 150 Hz and 160 kHz;

- High-frequency cetaceans (porpoises, river dolphins, and members of the genera Kogia and Cephalorhynchus; including two members of the genus Lagenorhynchus, on the basis of recent echolocation data and genetic data): generalized hearing is estimated to occur between approximately 275 Hz and 160 kHz.

- Pinnipeds in water; Phocidae (true seals): generalized hearing is estimated to occur between approximately 50 Hz to 86 kHz;

- Pinnipeds in water; Otariidae (eared seals): generalized hearing is estimated to occur between 60 Hz and 39 kHz.

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. Fifteen marine mammal species (thirteen cetacean and two pinniped (both phocid) species) have the reasonable potential to co-occur with the proposed survey activities. Please refer to Table 2. Of the cetacean species that may be present, five are classified as low-frequency cetaceans (*i.e.*, all mysticete species), seven are classified as mid-frequency cetaceans (*i.e.*, all delphinid species and the sperm whale), and one is classified as high-frequency cetacean (*i.e.*, harbor porpoise).

Potential Effects of the Specified Activity 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.

Background on Sound

Sound is a physical phenomenon consisting of minute vibrations that travel through a medium, such as air or water, and is generally characterized by several variables. Frequency describes the sound’s pitch and is measured in Hz or kHz, while sound level describes the sound’s intensity and is measured in dB. Sound level increases or decreases exponentially with each dB of change. The logarithmic nature of the scale means that each 10-dB increase is a 10-fold increase in acoustic power (and a 20-dB increase is then a 100-fold increase in power). A 10-fold increase in acoustic power does not mean that the sound is perceived as being 10 times louder, however. Sound levels are compared to a reference sound pressure (micro-Pascal) to identify the medium. For air and water, these reference pressures are “re: 20 micro pascals (μPa)” and “re: 1 μPa,” respectively. 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, 1975). 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. 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 rather than by peak pressures.

Acoustic Impacts

HRG survey equipment use during the geophysical surveys may temporarily impact marine mammals in the area due to elevated in-water sound levels. Marine mammals are continually exposed to many sources of sound. Naturally occurring sounds such as lightning, rain, sub-sea earthquakes, and biological sounds (*e.g.*, snapping shrimp, whale songs) are widespread throughout the world's oceans. Marine mammals produce sounds in various contexts and use sound for various biological functions including, but not limited to: (1) social interactions; (2) foraging; (3) orientation; and (4) predator detection. Interference with producing or receiving these sounds may result in adverse impacts. Audible distance, or received levels of sound depend on the nature of the sound source, ambient noise conditions, and the sensitivity of the receptor to the sound (Richardson *et al.*, 1995). Type and significance of marine mammal reactions to sound are likely dependent on a variety of factors including, but not limited to, (1) the behavioral state of the animal (*e.g.*, feeding, traveling, etc.); (2) frequency of the sound; (3) distance between the animal and the source; and (4) the level of the sound relative to ambient conditions (Southall *et al.*, 2007).

When sound travels (propagates) from its source, its loudness decreases as the distance traveled by the sound increases. Thus, the loudness of a sound at its source is higher than the loudness of that same sound a kilometer away. Acousticians often refer to the loudness of a sound at its source (typically referenced to one meter from the source) as the source level and the loudness of sound elsewhere as the received level (*i.e.*, typically the receiver). For example, a humpback whale 3 km from a device that has a source level of 230 dB may only be exposed to sound that is 160 dB loud, depending on how the sound travels through water (*e.g.*, spherical spreading (6 dB reduction with doubling of distance) was used in this example). As a result, it is important to understand the difference between source levels and received levels when discussing the loudness of sound in the ocean or its impacts on the marine environment.

As sound travels from a source, its propagation in water is influenced by various physical characteristics, including water temperature, depth, salinity, and surface and bottom properties that cause refraction, reflection, absorption, and scattering of sound waves. Oceans are not homogeneous and the contribution of each of these individual factors is extremely complex and interrelated. The physical characteristics that determine the sound's speed through the water will change with depth, season, geographic location, and with time of day (as a result, in actual active sonar operations, crews will measure oceanic conditions, such as sea water temperature and depth, to calibrate models that determine the path the sonar signal will take as it travels through the ocean and how strong the sound signal will be at a given range along a particular transmission path). As sound travels through the ocean, the intensity associated with the wavefront diminishes, or attenuates. This decrease in intensity is referred to as propagation loss, also commonly called transmission loss.

Hearing Impairment

Marine mammals may experience temporary or permanent hearing impairment when exposed to loud sounds. Hearing impairment is classified by temporary threshold shift (TTS) and permanent threshold shift (PTS). There are no empirical data for onset of PTS in any marine mammal; therefore, PTS-onset must be estimated from TTS-onset measurements and from the rate of TTS growth with increasing exposure levels above the level eliciting TTS-onset. PTS is considered auditory injury (Southall *et al.*, 2007) and occurs in a specific frequency range and amount. Irreparable damage to the inner or outer cochlear hair cells may cause PTS; however, other mechanisms are also involved, such as exceeding the elastic limits of certain tissues and membranes in the middle and inner ears and resultant changes in the chemical composition of the inner ear fluids (Southall *et al.*, 2007). Given the higher level of sound, longer durations of exposure necessary to cause PTS as compared with TTS, and the small zone within which sound levels would exceed criteria for onset of PTS, it is unlikely that PTS would occur during the proposed HRG surveys.

Temporary Threshold Shift

TTS is the mildest form of hearing impairment that can occur during exposure to a loud sound (Kryter, 1985). While experiencing TTS, the hearing threshold rises and a sound must be stronger in order to be heard. At least in terrestrial mammals, TTS can last from minutes or hours to (in cases of strong TTS) days, can be limited to a particular frequency range, and can occur to varying degrees (*i.e.*, a loss of a certain number of dBs of sensitivity). For sound exposures at or somewhat above the TTS threshold, hearing sensitivity in both terrestrial and marine mammals recovers rapidly after exposure to the noise ends.

Marine mammal hearing plays a critical role in communication with conspecifics and in 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 takes place during a time when the animals is traveling through the open ocean, 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 a time when communication is critical for successful mother/calf interactions could have more serious impacts if it were in the same frequency band as the necessary vocalizations and of a severity that it impeded communication. The fact that animals exposed to levels and durations of sound that would be expected to result in this physiological response would also be expected to have behavioral responses of a comparatively more severe or sustained nature is also notable and potentially of more importance than the simple existence of a TTS.

Currently, TTS data only exist for four species of cetaceans (bottlenose dolphin, beluga whale, harbor porpoise, and Yangtze finless porpoise) and three species of pinnipeds (northern elephant seal, harbor seal, and California sea lion) exposed to a limited number of sound sources (*i.e.*, mostly tones and octave-band noise) in laboratory settings (*e.g.*, Finneran *et al.*, 2002 and 2010; Nachtigall *et al.*, 2004; Kastak *et al.*, 2005; Lucke *et al.*, 2009; Mooney *et al.*, 2009; Popov *et al.*, 2011; Finneran and Schlundt, 2010). In general, harbor seals (Kastak *et al.*, 2005; Kastelein *et al.*, 2012a) and harbor porpoises (Lucke *et al.*, 2009; Kastelein *et al.*, 2012b) have a lower TTS onset than other measured pinniped or cetacean species. However, even for these animals, which are better able to hear higher frequencies and may be more sensitive to higher frequencies, exposures on the order of approximately 170 dB_{RMS} or higher for brief transient signals are likely required for even temporary (recoverable) changes in hearing sensitivity that would likely not be categorized as physiologically damaging (Lucke *et al.*, 2009). 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 (of note, the source operating characteristics of some of Orsted's proposed HRG survey equipment—*i.e.*, the equipment positioning systems—are unlikely to be audible to mysticetes). For summaries of data on TTS in marine mammals or for further discussion of TTS onset thresholds, please see NMFS (2018), Southall *et al.* (2007), Finneran and Jenkins (2012), and Finneran (2015).

Scientific literature highlights the inherent complexity of predicting TTS onset in marine mammals, as well as the importance of considering exposure duration when assessing potential impacts (Mooney *et al.*, 2009a, 2009b; Kastak *et al.*, 2007). Generally, with sound exposures of equal energy, quieter sounds (lower sound pressure level (SPL)) of longer duration were found to induce TTS onset more than louder sounds (higher SPL) of shorter duration (more similar to sub-bottom profilers). For intermittent sounds, less threshold shift will occur than from a continuous exposure with the same energy (some recovery will occur between intermittent exposures) (Kryter *et al.*, 1966; Ward, 1997). For sound exposures at or somewhat above the TTS-onset threshold, hearing sensitivity recovers rapidly after exposure to the sound ends; intermittent exposures recover faster in comparison with continuous exposures of the same duration (Finneran *et al.*, 2010). NMFS considers TTS as Level B harassment that is mediated by physiological effects on the auditory system.

Marine mammals in the Survey Area during the HRG survey are unlikely to incur TTS hearing impairment due to the characteristics of the sound sources, which include low source levels (208 to 221 dB re 1 μPa-m) and generally very short pulses and duration of the sound. Even for high-frequency cetacean species (*e.g.*, harbor porpoises), which may have increased sensitivity to TTS (Lucke *et al.*, 2009; Kastelein *et al.*, 2012b), individuals would have to make a very close approach and also remain very close to vessels operating these sources in order to receive multiple exposures at relatively high levels, as would be necessary to cause TTS.

Intermittent exposures—as would occur due to the brief, transient signals produced by these sources—require a higher cumulative SEL to induce TTS than would continuous exposures of the same duration (*i.e.*, intermittent exposure results in lower levels of TTS) (Mooney *et al.*, 2009a; Finneran *et al.*, 2010). Moreover, most marine mammals would more likely avoid a loud sound source rather than swim in such close proximity as to result in TTS. Kremser *et al.* (2005) noted that the probability of a cetacean swimming through the area of exposure when a sub-bottom profiler emits a pulse is small—because if the animal was in the area, it would have to pass the transducer at close range in order to be subjected to sound levels that could cause temporary threshold shift and would likely exhibit avoidance behavior to the area near the transducer rather than swim through at such a close range. Further, the restricted beam shape of the sub-bottom profiler and other HRG survey equipment makes it unlikely that an animal would be exposed more than briefly during the passage of the vessel. Boebel *et al.* (2005) concluded similarly for single and multibeam echosounders, and more recently, Lurton (2016) conducted a modeling exercise and concluded similarly that likely potential for acoustic injury from these types of systems is negligible, but that behavioral response cannot be ruled out. Animals may avoid the area around the survey vessels, thereby reducing exposure. Any disturbance to marine mammals is likely to be in the form of temporary avoidance or alteration of opportunistic foraging behavior near the survey location.

Masking

Masking is the obscuring of sounds of interest to an animal by other sounds, typically at similar frequencies. Marine mammals are highly dependent on sound, and their ability to recognize sound signals amid other sound is important in communication and detection of both predators and prey (Tyack, 2000). Background ambient sound may interfere with or mask the ability of an animal to detect a sound signal even when that signal is above its absolute hearing threshold. Even in the absence of anthropogenic sound, the marine environment is often loud. Natural ambient sound includes contributions from wind, waves, precipitation, other animals, and (at frequencies above 30 kHz) thermal sound resulting from molecular agitation (Richardson *et al.*, 1995).

Background sound may also include anthropogenic sound, and masking of natural sounds can result when human activities produce high levels of background sound. Conversely, if the background level of underwater sound is high (*e.g.*, on a day with strong wind and high waves), an anthropogenic sound source would not be detectable as far away as would be possible under quieter conditions and would itself be masked. Ambient sound is highly variable on continental shelves (Thompson, 1965; Myrberg, 1978; Desharnais *et al.*, 1999). This results in a high degree of variability in the range at which marine mammals can detect anthropogenic sounds.

Although masking is a phenomenon which may occur naturally, the introduction of loud anthropogenic sounds into the marine environment at frequencies important to marine mammals increases the severity and frequency of occurrence of masking. For example, if a baleen whale is exposed to continuous low-frequency sound from an industrial source, this would reduce the size of the area around that whale within which it can hear the calls of another whale. The components of background noise that are similar in frequency to the signal in question primarily determine the degree of masking of that signal. In general, little is known about the degree to which marine mammals rely upon detection of sounds from conspecifics, predators, prey, or other natural sources. In the absence of specific information about the importance of detecting these natural sounds, it is not possible to predict the impact of masking on marine mammals (Richardson *et al.,* 1995). In general, masking effects are expected to be less severe when sounds are transient than when they are continuous. Masking is typically of greater concern for those marine mammals that utilize low-frequency communications, such as baleen whales, and from sources of lower frequency, because of how far low-frequency sounds propagate.

Marine mammal species, including ESA-listed species, that may be exposed to survey noise are widely dispersed. As such, only a very small percentage of the population is likely to be within the radius of masking at any given time. Richardson *et al*. (1995) concludes broadly that, although further data are needed, localized or temporary increases in masking probably cause few problems for marine mammals, with the possible exception of populations highly concentrated in an ensonified area. While some number of marine mammals may be subject to occasional masking as a result of survey activity, temporary shifts in calling behavior to reduce the effects of masking, on the scale of no more than a few minutes, are not likely to result in failure of an animal to feed successfully, breed successfully, or complete its life history.

Furthermore, marine mammal communications would not likely be masked appreciably by sound from most HRG survey equipment given the narrow beam widths, directionality of the signal, relatively small ensonified area, and the brief period when an individual mammal is likely to be exposed to sound from the HRG survey equipment..

Marine mammal communications would not likely be masked appreciably by the sub-profiler or pingers' signals given the directionality of the signal and the brief period when an individual mammal is likely to be within its beam, as well as the higher frequencies.

Non-auditory Physical Effects (Stress)

Classic stress responses begin when an animal's central nervous system perceives a potential threat to its homeostasis. That perception triggers stress responses regardless of whether a stimulus actually threatens the animal; the mere perception of a threat is sufficient to trigger a stress response (Moberg, 2000; Seyle, 1950). Once an animal's central nervous system perceives a threat, it mounts a biological response or defense that consists of a combination of the four general biological defense responses: behavioral responses, autonomic nervous system responses, neuroendocrine responses, or immune responses.

In the case of many stressors, an animal's first and sometimes most economical (in terms of biotic costs) response is behavioral avoidance of the potential stressor or avoidance of continued exposure to a stressor. An animal's second line of defense to stressors involves the sympathetic part of the autonomic nervous system and the classical "fight or flight" response which includes the cardiovascular system, the gastrointestinal system, the exocrine glands, and the adrenal medulla to produce changes in heart rate, blood pressure, and gastrointestinal activity that humans commonly associate with "stress." These responses have a relatively short duration and may or may not have significant long-term effect on an animal's welfare.

An animal's third line of defense to stressors involves its neuroendocrine systems; the system that has received the most study has been the hypothalamus-pituitary-adrenal system (also known as the HPA axis in mammals or the hypothalamus-pituitary-interrenal axis in fish and some reptiles). Unlike stress responses associated with the autonomic nervous system, virtually all neuro-endocrine 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 (Moberg, 1987; Rivier, 1995), altered metabolism (Elasser *et al.*, 2000), reduced immune competence (Blecha, 2000), and behavioral disturbance. Increases in the circulation of glucocorticosteroids (cortisol, corticosterone, and aldosterone in marine mammals; see Romano *et al.*, 2004) have been equated with stress for many years.

The primary distinction between stress (which is adaptive and does not normally place an animal at risk) and distress is the biotic 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 a risk to the animal's welfare. 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 biotic function, which impairs those functions that experience the diversion. For example, when mounting a stress response diverts energy away from growth in young animals, those animals may experience stunted growth. When mounting a stress response diverts energy from a fetus, an animal's reproductive success and its fitness will suffer. In these cases, the animals will have entered a pre-pathological or pathological state which is called "distress" (Seyle, 1950) or "allostatic loading" (McEwen and Wingfield, 2003). This pathological state will last until the animal replenishes its biotic reserves sufficient to restore normal function. Note that these examples involved a long-term (days or weeks) stress response exposure to stimuli.

Relationships between these physiological mechanisms, animal behavior, and the costs of stress responses have also been documented fairly well through controlled experiments; because this physiology exists in every vertebrate that has been studied, it is not surprising that stress responses and their costs have been documented in both laboratory and free-living animals (for examples see, Holberton *et al.*, 1996; Hood *et al.*, 1998; Jessop *et al.*, 2003; Krausman *et al.*, 2004; Lankford *et al.*, 2005; Reneerkens *et al.*, 2002; Thompson and Hamer, 2000). Information has also been collected on the physiological responses of marine mammals to exposure to anthropogenic sounds (Fair and Becker, 2000; Romano *et al.*, 2002). For example, Rolland *et al.* (2012) found that noise reduction from reduced ship traffic in the Bay of Fundy was associated with decreased stress in North Atlantic right whales. In a conceptual model developed by the Population Consequences of Acoustic Disturbance (PCAD) working group, serum hormones were identified as possible indicators of behavioral effects that are translated into altered rates of reproduction and mortality.

Studies of other marine animals and terrestrial animals would also lead us to expect some marine mammals to experience physiological stress responses and, perhaps, physiological responses that would be classified as "distress" upon exposure to high frequency, mid-frequency and low-frequency sounds. For example, Jansen (1998) reported on the relationship between acoustic exposures and physiological responses that are indicative of stress responses in humans (for example, elevated respiration and increased heart rates). Jones (1998) reported on reductions in human performance when faced with acute, repetitive exposures to acoustic disturbance. Trimper *et al.* (1998) reported on the physiological stress responses of osprey to low-level aircraft noise while Krausman *et al.* (2004) reported on the auditory and physiology stress responses of endangered Sonoran pronghorn to military overflights. Smith *et al.* (2004a, 2004b), for example, identified noise-induced physiological transient stress responses in hearing-specialist fish (*i.e.*, goldfish) that accompanied short- and long-term hearing losses. Welch and Welch (1970) reported physiological and behavioral stress responses that accompanied damage to the inner ears of fish and several mammals.

Hearing is one of the primary senses marine mammals use to gather information about their environment and to communicate with conspecifics. Although empirical information on the relationship between sensory impairment (TTS, PTS, and acoustic masking) on marine mammals remains limited, it seems reasonable to assume that reducing an animal's ability to gather information about its environment and to communicate with other members of its species would be stressful for animals that use hearing as their primary sensory mechanism. Therefore, we assume that acoustic exposures sufficient to trigger onset PTS or TTS would be accompanied by physiological stress responses because terrestrial animals exhibit those responses under similar conditions (NRC, 2003). More importantly, marine mammals might experience stress responses at received levels lower than those necessary to trigger onset TTS. Based on empirical studies of the time required to recover from stress responses (Moberg, 2000), we also assume that stress responses are likely to persist beyond the time interval required for animals to recover from TTS and might result in pathological and pre-pathological states that would be as significant as behavioral responses to TTS.

In general, there are few data on the potential for strong, anthropogenic underwater sounds to cause non-auditory physical effects in marine mammals. Such effects, if they occur at all, would presumably be limited to short distances and to activities that extend over a prolonged period. The available data do not allow identification of a specific exposure level above which non-auditory effects can be expected (Southall *et al.*, 2007). There is no definitive evidence that any of these effects occur even for marine mammals in close proximity to an anthropogenic sound source. In addition, marine mammals that show behavioral avoidance of survey vessels and related sound sources, are unlikely to incur non-auditory impairment or other physical effects. NMFS does not expect that the generally short-term, intermittent, and transitory HRG surveys would create conditions of long-term, continuous noise and chronic acoustic exposure leading to long-term physiological stress responses in marine mammals.

Behavioral Disturbance

Behavioral responses to sound are highly variable and context-specific. Many different variables can influence an animal's perception of and response to (nature and magnitude) an acoustic event. An animal's prior experience with a sound or sound source affects whether it is less likely (habituation) or more likely (sensitization) to respond to certain sounds in the future (animals can also be innately pre-disposed to respond to certain sounds in certain ways) (Southall *et al.,* 2007). Related to the sound itself, the perceived nearness of the sound, bearing of the sound (approaching vs. retreating), similarity of a sound to biologically relevant sounds in the animal's environment (*i.e.,* calls of predators, prey, or conspecifics), and familiarity of the sound may affect the way an animal responds to the sound (Southall *et al.,* 2007, DeRuiter *et al.,* 2013). Individuals (of different age, gender, reproductive status, etc.) among most populations will have variable hearing capabilities, and differing behavioral sensitivities to sounds that will be affected by prior conditioning, experience, and current activities of those individuals. Often, specific acoustic features of the sound and contextual variables (*i.e.,* proximity, duration, or recurrence of the sound or the current behavior that the marine mammal is engaged in or its prior experience), as well as entirely separate factors such as the physical presence of a nearby vessel, may be more relevant to the animal's response than the received level alone. Studies by DeRuiter *et al.* (2012) indicate that variability of responses to acoustic stimuli depends not only on the species receiving the sound and the sound source, but also on the social, behavioral, or environmental contexts of exposure.

Ellison *et al.* (2012) outlined an approach to assessing the effects of sound on marine mammals that incorporates contextual-based factors. The authors recommend considering not just the received level of sound, but also the activity the animal is engaged in at the time the sound is received, the nature and novelty of the sound (*i.e.,* is this a new sound from the animal's perspective), and the distance between the sound source and the animal. They submit that this "exposure context," as described, greatly influences the type of behavioral response exhibited by the animal. This sort of contextual information is challenging to predict with accuracy for ongoing activities that occur over large spatial and temporal expanses. However, distance is one contextual factor for which data exist to quantitatively inform a take estimate. Other factors are often considered qualitatively in the analysis of the likely consequences of sound exposure, where supporting information is available.

Exposure of marine mammals to sound sources can result in, but is not limited to, no response or any of the following observable response: Increased alertness; orientation or attraction to a sound source; vocal modifications; cessation of feeding; cessation of social interaction; alteration of movement or diving behavior; habitat abandonment (temporary or permanent); and, in severe cases, panic, flight, stranding, potentially resulting in death (Southall *et al.*, 2007). A review of marine mammal responses to anthropogenic sound was first conducted by Richardson (1995). More recent reviews (Nowacek *et al.*,2007; DeRuiter *et al.*, 2012 and 2013; Ellison *et al.*, 2012) address studies conducted since 1995 and focused on observations where the received sound level of the exposed marine mammal(s) was known or could be estimated. Southall *et al.* (2016) states that results demonstrate that some individuals of different species display clear yet varied responses, some of which have negative implications, while others appear to tolerate high levels, and that responses may not be fully predicable with simple acoustic exposure metrics (*e.g.*, received sound level). Rather, the authors state that differences among species and individuals along with contextual aspects of exposure (*e.g.*, behavioral state) appear to affect response probability.

Changes in dive behavior can vary widely. They 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. Variations in dive behavior may reflect interruptions in biologically significant activities (*e.g.,* foraging) or they may be of little biological significance. Variations in dive behavior may also expose an animal to potentially harmful conditions (*e.g.,* increasing the chance of ship-strike) or may serve as an avoidance response that enhances survivorship. The impact of a variation in diving 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.

Avoidance is the displacement of an individual from an area as a result of the presence of a sound. Richardson *et al.* (1995) noted that avoidance reactions are the most obvious manifestations of disturbance in marine mammals. Avoidance is qualitatively different from the flight response, but also differs in the magnitude of the response (*i.e.,* directed movement, rate of travel, etc.). Oftentimes avoidance is temporary, and animals return to the area once the noise has ceased. However, longer term displacement is possible and can lead to changes in abundance or distribution patterns of the species in the affected region if they do not become acclimated to the presence of the sound (Blackwell *et al.,* 2004; Bejder *et al.,* 2006; Teilmann *et al.,* 2006). Acute avoidance responses have been observed in captive porpoises and pinnipeds exposed to a number of different sound sources (Kastelein *et al.,* 2001; Finneran *et al.,* 2003; Kastelein *et al.,* 2006a; Kastelein *et al.,* 2006b)

Southall *et al.* (2007) reviewed the available literature on marine mammal hearing and behavioral and physiological responses to human-made sound with the goal of proposing exposure criteria for certain effects. This peer-reviewed compilation of literature is very valuable, though Southall *et al.* (2007) note that not all data are equal, some have poor statistical power, insufficient controls, and/or limited information on received levels, background noise, and other potentially important contextual variables – such data were reviewed and sometimes used for qualitative illustration but were not included in the quantitative analysis for the criteria recommendations. All of the studies considered, however, contain an estimate of the received sound level when the animal exhibited the indicated response.

For purposes of analyzing responses of marine mammals to anthropogenic sound and developing criteria, NMFS (2018) differentiates between pulse (impulsive) sounds (single and multiple) and non-pulse sounds. For purposes of evaluating the potential for take of marine mammals resulting from underwater noise due to the conduct of the proposed HRG surveys (operation of USBL positioning system and the sub-bottom profilers), the criteria for Level A harassment (PTS onset) from impulsive noise was used as prescribed in NMFS (2018) and the threshold level for Level B harassment (160 dB_{RMS} re 1 µPa) was used to evaluate takes from behavioral harassment.

Studies that address responses of low-frequency cetaceans to sounds include data gathered in the field and related to several types of sound sources, including: vessel noise, drilling and machinery playback, low-frequency M-sequences (sine wave with multiple phase reversals) playback, tactical low-frequency active sonar playback, drill ships, and non-pulse playbacks. These studies generally indicate no (or very limited) responses to received levels in the 90 to 120 dB re: 1µPa range and an increasing likelihood of avoidance and other behavioral effects in the 120 to 160 dB range. As mentioned earlier, though, contextual variables play a very important role in the reported responses and the severity of effects do not increase linearly with received levels. Also, few of the laboratory or field datasets had common conditions, behavioral contexts, or sound sources, so it is not surprising that responses differ.

The studies that address responses of mid-frequency cetaceans to sounds include data gathered both in the field and the laboratory and related to several different sound sources, including: pingers, drilling playbacks, ship and ice-breaking noise, vessel noise, Acoustic harassment devices (AHDs), Acoustic Deterrent Devices (ADDs), mid-frequency active sonar, and non-pulse bands and tones. Southall *et al.* (2007) were unable to come to a clear conclusion regarding the results of these studies. In some cases animals in the field showed significant responses to received levels between 90 and 120 dB, while in other cases these responses were not seen in the 120 to 150 dB range. The disparity in results was likely due to contextual variation and the differences between the results in the field and laboratory data (animals typically responded at lower levels in the field). The studies that address the responses of mid-frequency cetaceans to impulse sounds include data gathered both in the field and the laboratory and related to several different sound sources, including: small explosives, airgun arrays, pulse sequences, and natural and artificial pulses. The data show no clear indication of increasing probability and severity of response with increasing received level. Behavioral responses seem to vary depending on species and stimuli.

The studies that address responses of high-frequency cetaceans to sounds include data gathered both in the field and the laboratory and related to several different sound sources, including: pingers, AHDs, and various laboratory non-pulse sounds. All of these data were collected from harbor porpoises. Southall *et al.* (2007) concluded that the existing data indicate that harbor porpoises are likely sensitive to a wide range of anthropogenic sounds at low received levels (around 90 to 120 dB), at least for initial exposures. All recorded exposures above 140 dB induced profound and sustained avoidance behavior in wild harbor porpoises (Southall *et al.*, 2007). Rapid habituation was noted in some but not all studies.

The studies that address the responses of pinnipeds in water to sounds include data gathered both in the field and the laboratory and related to several different sound sources, including: AHDs, various non-pulse sounds used in underwater data communication, underwater drilling, and construction noise. Few studies exist with enough information to include them in the analysis. The limited data suggest that exposures to non-pulse sounds between 90 and 140 dB generally do not result in strong behavioral responses of pinnipeds in water, but no data exist at higher received levels (Southall *et al.,* 2007). The studies that address the responses of pinnipeds in water to impulse sounds include data gathered in the field and related to several different sources, including: small explosives, impact pile driving, and airgun arrays. Quantitative data on reactions of pinnipeds to impulse sounds is limited, but a general finding is that exposures in the 150 to 180 dB range generally have limited potential to induce avoidance behavior (Southall *et al.,* 2007).

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; Erbe and Farmer, 2000; Tyack, 2000; Erbe *et al.,* 2016). 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. Masking these acoustic signals can disturb the behavior of individual animals, groups of animals, or entire populations. 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 man-made, it may be considered harassment when disrupting or altering critical behaviors. 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; Matthews *et al.,* 2016) 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.,* 2007; Di Iorio and Clark, 2009; Holt *et al.,* 2009).

Marine mammals are likely to avoid the HRG survey activity, especially harbor porpoises, while the harbor seals might be attracted to them out of curiosity. However, because the sub-bottom profilers and other HRG survey equipment operate from a moving vessel, and the predicted maximum distance to the 160 dB_{RMS} re 1μPa isopleth (Level B harassment criteria) is 178 m, the area and time that this equipment would be affecting a given location is very small. Further, once an area has been surveyed, it is not likely that it will be surveyed again, therefore reducing the likelihood of repeated HRG-related impacts within the survey area.

A number of cetacean mass stranding events have been linked to use of military active sonar. We considered the potential for HRG equipment to result in standings or indirect injury or mortality based on the 2008 mass stranding of approximately one hundred melon-headed whales in a Madagascar lagoon system. An investigation of the event indicated that use of a high-frequency mapping system (12-kHz multibeam echosounder) was the most plausible and likely initial behavioral trigger of the event, while providing the caveat that there is no unequivocal and easily identifiable single cause (Southall *et al.*, 2013). The investigatory panel's conclusion was based on (1) very close temporal and spatial association and directed movement of the survey with the stranding event; (2) the unusual nature of such an event coupled with previously documented apparent behavioral sensitivity of the species to other sound types (Southall *et al.*, 2006; Brownell *et al.*, 2009); and (3) the fact that all other possible factors considered were determined to be unlikely causes. Specifically, regarding survey patterns prior to the event and in relation to bathymetry, the vessel transited in a north-south direction on the shelf break parallel to the shore, ensonifying large areas of deep-water habitat prior to operating intermittently in a concentrated area offshore from the stranding site; this may have trapped the animals between the sound source and the shore, thus driving them towards the lagoon system. The investigatory panel systematically excluded or deemed highly unlikely nearly all potential reasons for these animals leaving their typical pelagic habitat for an area extremely atypical for the species (*i.e.*, a shallow lagoon system). Notably, this was the first time that such a system has been associated with a stranding event. The panel also noted several site- and situation-specific secondary factors that may have contributed to the avoidance responses that led to the eventual entrapment and mortality of the whales. Specifically, shoreward-directed surface currents and elevated chlorophyll levels in the area preceding the event may have played a role (Southall *et al.*, 2013). The report also notes that prior use of a similar system in the general area may have sensitized the animals and also concluded that, for odontocete cetaceans that hear well in higher frequency ranges where ambient noise is typically quite low, high-power active sonars operating in this range may be more easily audible and have potential effects over larger areas than low frequency systems that have more typically been considered in terms of anthropogenic noise impacts. It is, however, important to note that the relatively lower output frequency, higher output power, and complex nature of the system implicated in this event, in context of the other factors noted here, likely produced a fairly unusual set of circumstances that indicate that such events would likely remain rare and are not necessarily relevant to use of lower-power, higher-frequency systems more commonly used for HRG survey applications. The risk of similar events recurring may be very low, given the extensive use of active acoustic systems used for scientific and navigational purposes worldwide on a daily basis and the lack of direct evidence of such responses previously reported.

Tolerance

Numerous studies have shown that underwater sounds from industrial activities are often readily detectable by marine mammals in the water at distances of many kilometers. However, other studies have shown that marine mammals at distances more than a few kilometers away often show no apparent response to industrial activities of various types (Miller *et al*., 2005). This is often true even in cases when the sounds must be readily audible to the animals based on measured received levels and the hearing sensitivity of that mammal group. Although various baleen whales, toothed whales, and (less frequently) pinnipeds have been shown to react behaviorally to underwater sound from sources such as airgun pulses or vessels under some conditions, at other times, mammals of all three types have shown no overt reactions (*e.g*., Malme *et al*., 1986; Richardson *et al*., 1995; Madsen and Mohl, 2000; Croll *et al*., 2001; Jacobs and Terhune, 2002; Madsen *et al*., 2002; Miller *et al*., 2005). In general, pinnipeds seem to be more tolerant of exposure to some types of underwater sound than are baleen whales. Richardson *et al*. (1995) found that vessel sound does not seem to strongly affect pinnipeds that are already in the water. Richardson *et al.* (1995) went on to explain that seals on haulouts sometimes respond strongly to the presence of vessels and at other times appear to show considerable tolerance of vessels, and Brueggeman *et al.* (1992) observed ringed seals (*Pusa hispida*) hauled out on ice pans displaying short-term escape reactions when a ship approached within 0.16-0.31 mi (0.25-0.5 km). Due to the relatively high vessel traffic in the Survey Area it is possible that marine mammals are habituated to noise from project vessels in the area.

Vessel Strike

Ship strikes of marine mammals can cause major wounds, which may lead to the death of the animal. An animal at the surface could be struck directly by a vessel, a surfacing animal could hit the bottom of a vessel, or a vessel's propeller could injure an animal just below the surface. The severity of injuries typically depends on the size and speed of the vessel (Knowlton and Kraus, 2001; Laist *et al.*, 2001).

The most vulnerable marine mammals are those that spend extended periods of time at the surface in order to restore oxygen levels within their tissues after deep dives (*e.g.*, the sperm whale). In addition, some baleen whales, such as the North Atlantic right whale, seem generally unresponsive to vessel sound, making them more susceptible to vessel collisions (Nowacek *et al.*, 2004). These species are primarily large, slow moving whales. Smaller marine mammals (*e.g.*, bottlenose dolphin) move quickly through the water column and are often seen riding the bow wave of large ships. Marine mammal responses to vessels may include avoidance and changes in dive pattern (NRC, 2003).

An examination of all known ship strikes from all shipping sources (civilian and military) indicates vessel speed is a principal factor in whether a vessel strike results in death (Knowlton and Kraus, 2001; Laist *et al.*, 2001; Jensen and Silber, 2003; Vanderlaan and Taggart, 2007). In assessing records with known vessel speeds, Laist *et al*. (2001) found a direct relationship between the occurrence of a whale strike and the speed of the vessel involved in the collision. The authors concluded that most deaths occurred when a vessel was traveling in excess of 24.1 km/h (14.9 mph; 13 knots). Given the slow vessel speeds and predictable course necessary for data acquisition, ship strike is unlikely to occur during the geophysical and geotechnical surveys. Most marine mammals would be able to easily avoid vessels and are likely already habituated to the presence of numerous vessels in the area. Further, Orsted shall implement measures (*e.g.*, vessel speed restrictions and separation distances; see *Proposed Mitigation Measures*) set forth in the BOEM Lease to reduce the risk of a vessel strike to marine mammal species in the Survey Area. Finally, survey vessels will travel at slow speeds (approximately 4 knots) during the survey, which reduces the risk of injury in the unlikely the event a survey vessel strikes a marine mammal.

Effects on Marine Mammal Habitat

Bottom disturbance associated with the HRG activities may include grab sampling to validate the seabed classification obtained from the multibeam echosounder/sidescan sonar data. This will typically be accomplished using a Mini-Harmon Grab with 0.1 m^2 sample area or the slightly larger Harmon Grab with a 0.2 m^2 sample area. This limited and highly localized impact to habitat in relation to the comparatively vast area of surrounding open ocean, would not be expected to result in any effects to prey availability. The HRG survey equipment itself will not disturb the seafloor.

There are no feeding areas, rookeries, or mating grounds known to be biologically important to marine mammals within the proposed project area with the exception of a feeding BIA for fin whales and migratory BIA for North Atlantic right whales which were described previously. There is also no designated critical habitat for any ESA-listed marine mammals. NMFS' regulations at 50 CFR part 224 designated the nearshore waters of the Mid-Atlantic Bight as the Mid-Atlantic U.S. Seasonal Management Area (SMA) for right whales in 2008. Mandatory vessel speed restrictions are in place in that SMA from November 1 through April 30 to reduce the threat of collisions between ships and right whales around their migratory route and calving grounds.

We are not aware of any available literature on impacts to marine mammal prey species from HRG survey equipment. However, because the HRG survey equipment introduces noise to the marine environment, there is the potential for avoidance of the area around the HRG survey activities by marine mammal prey species. Any avoidance of the area on the part of marine mammal prey species would be expected to be short term and temporary. Because of the temporary nature of the disturbance, the availability of similar habitat and resources (*e.g.*,prey species) in the surrounding area, and the lack of important or unique marine mammal habitat, the impacts to marine mammals and the food sources that they utilize are not expected to cause significant or long-term consequences for individual marine mammals or their populations. Impacts on marine mammal habitat from the proposed activities will be temporary, insignificant, and discountable.

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. Except with respect to certain activities not pertinent here, the MMPA defines "harassment" as: any act of pursuit, torment, or annoyance which (i) has the potential to injure a marine mammal or marine mammal stock in the wild (Level A harassment); or (ii) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering (Level B harassment).

Authorized takes would be by Level B harassment only, in the form of disruption of behavioral patterns for individual marine mammals resulting from exposure to sound from HRG equipment. Based on the nature of the activity and the anticipated effectiveness of the mitigation measures (*i.e.*, shutdown – discussed in detail below in Proposed Mitigation section), 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). 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 – Though significantly driven by received level, the onset of behavioral disturbance from anthropogenic noise exposure is also informed to varying degrees by other factors related to the source (*e.g.*, frequency, predictability, duty cycle), the environment (*e.g.*, bathymetry), and the receiving animals (hearing, motivation, experience, demography, behavioral context) and can be difficult to predict (Southall *et al.*, 2007, Ellison *et al.*, 2011). Based on what the available science indicates and the practical need to use a threshold based on a factor that is both predictable and measurable for most activities, NMFS uses a generalized acoustic threshold based on received level to estimate the onset of behavioral harassment. 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) and above 160 dB re 1 μPa (rms) for non-explosive impulsive (*e.g.*, seismic airguns) or intermittent (*e.g.*, scientific sonar) sources. Orsted's proposed activities include the use of intermittent impulsive (HRG Equipment) sources, and therefore the 160 dB re 1 μPa (rms) threshold is applicable.

Level A harassment for non-explosive sources - NMFS' Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (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).

These thresholds are provided in Table 4 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: *http://www.nmfs.noaa.gov/pr/acoustics/guidelines.htm*.

Table 4. 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 $1\mu Pa^2s$. 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.

Ensonified Area

Here, we describe operational and environmental parameters of the activity that will feed into identifying the area ensonified above the acoustic thresholds, which include source levels and transmission loss coefficient.

When NMFS' Acoustic Technical Guidance (2016) was published, in recognition of the fact that ensonified area/volume could be more technically challenging to predict because of the duration component of the new thresholds, NMFS developed an optional User Spreadsheet that includes tools to help predict takes. We note that because of some of the assumptions included in the methods used for these tools, we anticipate that isopleths produced are typically going to be overestimates of some degree, which will result in some degree of overestimate of Level A take. However, these tools offer the best way to predict appropriate isopleths when more sophisticated 3D modeling methods are not available, and NMFS continues to develop ways to quantitatively refine these tools, and will qualitatively address the output where appropriate. For mobile sources such as the HRG survey equipment proposed for use in Orsted's activity, the User Spreadsheet predicts the closest distance at which a stationary animal would not incur PTS if the sound source traveled by the animal in a straight line at a constant speed.

Orsted conducted field verification tests on different types of HRG equipment within the proposed Lease Areas during previous site characterization survey activities. NMFS is proposing to authorize take in these same three Lease Areas listed below.

- *OCS-A 0486 & OCS-A 0487*: Marine Acoustics, Inc. (MAI), under contract to Oceaneering International completed an underwater noise monitoring program for the field verification for equipment to be used to survey the Skipjack Windfarm Project (MAI 2018a; 2018b).

- *OCS-A 0500 Lease Area*: The Gardline Group (Gardline), under contract to Alpine Ocean Seismic Survey, Inc., completed an underwater noise monitoring program for the field verification within the Lease Area prior to the commencement of the HRG survey which took place between August 14 and October 6, 2016 (Gardline 2016a, 2016b, 2017). Additional field verifications were completed by the RPS Group, under contract to Terrasond prior to commencement of the 2018 HRG field survey campaign (RPS 2018).

Field Verification results are shown in Table 5. The purpose of the field verification programs was to determine distances to the regulatory thresholds for injury/mortality and behavior disturbance of marine mammals that were established during the permitting process.

As part of their application, Orsted collected field verified source levels and calculated the differential between the averaged measured field verified source levels versus manufacturers' reported source levels for each tested piece of HRG equipment. The results of the field verification studies were used to derive the variability in source levels based on the extrapolated values resulting from regression analysis. These values were used to further calibrate calculations for a specific suite of HRG equipment of similar type. Orsted stated that the calculated differential accounts for both the site specific environmental conditions and directional beam width patterns and can be applied to similar HRG equipment within one of the specified equipment categories (*e.g*. USBL & GAPS Transceivers, Shallow Sub-Bottom Profilers (SBP), Parametric SBP, Medium Penetration SBP (Sparker), and Medium Penetration SBP (Boomer)). For example, the manufacturer of the Geosource 800J medium penetration SBP reported a source level of 206 dB RMS. The field verification study measured a source level of 189 dB RMS (Gardline 2016a, 2017). Therefore, the differential between the manufacturer and field verified SL is -17 dB RMS. Orsted proposed to apply this differential (-17 dB) to other

HRG equipment in the medium penetration SBP (sparker) category with an output of approximately 800 joules. Orsted employed this methodology for all non-field verified equipment within a specific equipment category. These new differential-based proxy SLs were inserted into the User Spreadsheet and used to calculate the Level A and Level B harassment isopleths for the various hearing groups. Table 5 shows the field verified equipment SSV results as well as applicable non-verified equipment broken out by equipment category.

Table 5. Summary of Field Verified HRG Equipment SSV results and Applicable HRG Devices Grouped by Category Type.

Representative HRG Survey Equipment	Operating Frequencies	Baseline Source Level (dB re 1 µPa)	Source Level Measured During Ørsted FV Surveys (dB re 1 µPa)	2019 HRG Survey Data Acquisition Equipment
USBL & GAPS Transponder and Transceiver [a/]				
Sonardyne Ranger 2	19 to 34 kHz	200 dB_{RMS}	166 dB_{RMS}	Sonardyne Ranger 2 USBL HPT 5/7000 Sonardyne Ranger 2 USBL HPT 3000 Sonardyne Scout Pro Easytrak Nexus 2 USBL IxSea GAPS System Kongsberg HiPAP 501/502 USBL Edgetech BATS II
Shallow Sub-Bottom Profilers (Chirp) [a/c/]				
GeoPulse 5430 A Sub-bottom Profiler	1.5 to 18 kHz	214 dB_{RMS}	173 dB_{RMS}	Edgetech 3200 Teledyne Benthos Chirp III - TTV 170
EdgeTech 512	0.5 to 12 kHz	177 dB_{RMS}	166 dB_{RMS}	PanGeo LF Chirp PanGeo HF Chirp EdgeTech 216 EdgeTech 424
Parametric Sub-Bottom Profiler [d/]				
Innomar SES-2000 Medium 100	85 to 115	247 dB_{RMS}	187 dB_{RMS}	Innomar SES-2000 Standard & Plus Innomar SES-2000 Medium 70 Innomar SES-2000 Quattro PanGeo 2i Parametric
Medium Penetration Sub-Bottom Profiler (Sparker) [a/]				
Geo-Resources Geo-Source 600 J	0.05 to 5 kHz	214 dB_{Peak} 205 dB_{RMS}	206 dB_{Peak} 183 dB_{RMS}	GeoMarine Geo-Source 400tip Applied Acoustics Dura-Spark 400 System

Geo-Resources Geo-Source 800 J	0.05 to 5 kHz	215 dB_{Peak} 206 dB_{RMS}	212 dB_{Peak} 189 dB_{RMS}	GeoMarine Geo-Source 800
Medium Penetration Sub-Bottom Profiler (Boomer) [b/c]				
Applied Acoustics S-Boom Triple Plate Boomer (700J)	0.1 to 5	211 dB_{Peak} 205 dB_{RMS}	195 dB_{Peak} 173 dB_{RMS}	Not used for any other equipment
Applied Acoustics S-Boom Triple Plate Boomer (1000J)	0.250 to 8 kHz	228 dB_{Peak} 208 dB_{RMS}	215 dB_{Peak} 198 dB_{RMS}	Not used for any other equipment
Note: Sources: a/ Gardline 2016a, 2017; b/ RPS 2018; c/ MAI 2018a; d/ Subacoustech 2018				

After careful consideration, NMFS concluded that the use of differentials to derive proxy SLs is not appropriate or acceptable. NMFS determined that when field verified measurements are compared to the source levels measured in a controlled experimental setting (*i.e.*, Crocker and Fratantonio, 2016), there are significant discrepancies in isopleth distances for the same equipment that cannot be explained solely by absorption and scattering of acoustic energy. There are a number of variables, including potential differences in propagation rate, operating frequency, beam width, and pulse width that make us question whether SL differential values can be universally applied across different pieces of equipment, even if they fall within the same equipment category. Therefore, NMFS did not employ Orsted's proposed use of differentials to determine Level A and Level B harassment isopleths or proposed take estimates.

As noted above, much of the HRG equipment proposed for use during Orsted's survey has not been field-verified. NMFS employed an alternate approach in which data reported by Crocker and Fratantonio (2016) was used to establish injury and behavioral harassment zones. If Crocker and Fratantonio (2016) did not provide data on a specific piece of equipment within a given equipment category, the SLs reported in the study for measured equipment are used to represent all the other equipment within that category, regardless of whether any of the devices has been field verified. If SSV data from Crocker and Fratantonio (2016) is not available across an entire equipment category, NMFS instead adopted the field verified results from equipment that had been tested. Here, the largest field verified SL was used to represent the entire equipment category. These values were applied to the User Spreadsheet to calculate distances for each of the proposed HRG equipment categories that might result in harassment of marine mammals. Inputs to the User Spreadsheet are shown in Table 6. The source levels used in Table 6 are from field verified values shown in Table 5. However, source levels for the EdgeTech 512 (177 dB RMS) and Applied Acoustics S-Boom Triple Plate Boomer (1,000j) (203 dB RMS) were derived from Crocker and Fratantonio (2016). Table 7 depicts isopleths that could result in injury to a specific hearing group.

Table 6. Inputs to the User Spreadsheet.

	USBL	**Shallow Penetration SBP-Chirp**	**Shallow Penetration SBP-Chirp**	**Parametric SBP**	**Medium Penetration SBP - Sparker**	**Medium Penetration SBP - Boomer**
Spreadsheet Tab Used	D: MOBILE SOURCE: Non-Impulsive, Intermittent	D: MOBILE SOURCE: Non-Impulsive, Intermittent	D: MOBILE SOURCE: Non-Impulsive, Intermittent	D: MOBILE SOURCE: Non-Impulsive, Intermittent	F: MOBILE SOURCE: Impulsive, Intermittent	F: MOBILE SOURCE: Impulsive, Intermittent
HRG Equipment	Sonardyne Ranger 2	GeoPulse 5430 A Sub-bottom Profiler	EdgeTech 512	Innomar SES 2000 Medium 100	GeoMarine Geo-Source 800 J	Applied Acoustics S-Boom Triple Plate Boomer (1,000j)
Source Level (dB RMS SPL)	166	173	177*	187	212 Pk 189 RMS	209 Pk 203 RMS*
Weighting Factor Adjustment (kHz)	26	4.5	3	42	2	0.6
Source Velocity (m/s)	2.045	2.045	2.045	2.045	2.045	2.045
Pulse Duration (seconds)	0.3	0.025	0.0022	0.001	0.055	0.0006
1/Repetition rate^ (seconds)	1	0.1	0.50	0.025	0.5	0.333
Source Level (PK SPL)	---	---	---	--	212	215
Propagation (xLogR)	20	20	20	20	20	20

* Crocker and Fratantonio (2016)

Table 7. Maximum Distances to Level A Harassment Isopleths Based on Data from Field Verification studies and Crocker and Fratantonio (2016) (where available).

Representative HRG Survey Equipment	Marine Mammal Group	PTS Onset	Lateral Distance (m)
USBL/GAPS Positioning Systems			
Sonardyne Ranger 2	LF cetaceans	199 dB SEL_{cum}	---
	MF cetaceans	198 dB SEL_{cum}	---
	HF cetaceans	173 dB SEL_{cum}	< 1
	Phocid pinnipeds	201 dB SEL_{cum}	---
Shallow Sub-Bottom Profiler (Chirp)			
Edgetech 512	LF cetaceans	199 dB SEL_{cum}	---
	MF cetaceans	198 dB SEL_{cum}	---
	HF cetaceans	173 dB SEL_{cum}	---
	Phocid pinnipeds	201 dB SEL_{cum}	---
GeoPulse 5430 A Sub-bottom Profiler	LF cetaceans	199 dB SEL_{cum}	---
	MF cetaceans	198 dB SEL_{cum}	---
	HF cetaceans	173 dB SEL_{cum}	---
	Phocid pinnipeds	201 dB SEL_{cum}	---
Parametric Sub-bottom Profiler			
Innomar SES-2000 Medium 100	LF cetaceans	199 dB SEL_{cum}	---
	MF cetaceans	198 dB SEL_{cum}	---
	HF cetaceans	173 dB SEL_{cum}	<2
	Phocid pinnipeds	201 dB SEL_{cum}	---
Medium Penetration Sub-Bottom Profiler (Sparker)			
GeoMarine Geo-Source 800tip	LF cetaceans	219 dBpeak, 183 dB SEL_{cum}	---, < 1
	MF cetaceans	230 dBpeak, 185 dB SEL_{cum}	---,---
	HF cetaceans	202 dBpeak, 155 dB	<4, <1

		SEL_{cum}	
	Phocid pinnipeds	218 dBpeak, 185 dB SEL_{cum}	---, <1
Medium Penetration Sub-Bottom Profiler (Boomer)			
Applied Acoustics S-Boom Triple Plate Boomer (1000j)	LF cetaceans	219 dBpeak, 183 dB SELcum	---, < 1
	MF cetaceans	230 dBpeak, 185 dB SELcum	---, ---
	HF cetaceans	202 dBpeak, 155 dB SELcum	< 3, --
	Phocid pinnipeds	218 dBpeak, 185 dB SELcum	---, ---

In the absence of Crocker and Fratantonio (2016) data, as noted above, NMFS determined that field verified SLs could be used to delineate Level A harassment isopleths which can be used to represent all of the HRG equipment within that specific category. While there is some uncertainty given that the SLs associated with assorted HRG equipment are variable within a given category, all of the predicted distances based on the field-verified source level are small enough to support a prediction that Level A harassment is unlikely to occur. While it is possible that Level A harassment isopleths of non-verified equipment would be larger than those shown in Table 7, it is unlikely that such zones would be substantially greater in size such that take by Level A harassment would be expected. Therefore, NMFS is not proposing to authorize any take from Level A harassment.

The methodology described above was also applied to calculate Level B harassment isopleths as shown in Table 8. Note that the spherical spreading propagation model (20logR) was used to derive behavioral harassment isopleths for equipment measured by Crocker and Fratantonio (2016) data. However, the practical spreading model (15logR) was used to conservatively assess distances to Level B harassment thresholds for equipment not tested by Crocker and Fratantonio (2016). Table 8 shows calculated Level B harassment isopleths for specific equipment tested by Crocker and Fratantonio (2016) which is applied to all devices within a given category. In cases where Crocker and Fratantonio (2016) collected measurement on more than one device, the largest calculated isopleth is used to represent the entire category. Table 8 also shows field-verified SLs and associated Level B harassment isopleths for equipment categories that lack relevant Crocker & Fratantonio (2016) measurements. Additionally, Table 8 also references the specific field verification studies that were used to develop the isopleths. For these categories, the largest calculated isopleth in each category was also used to represent all equipment within that category.

Further information depicting how Level B harassment isopleths were derived for each equipment category is described below:

USBL and GAPS: There are no relevant information sources or measurement data within the Crocker and Fratantonio (2016) report. However, SSV tests were conducted on the Sonardyne Ranger 2 (Gardline 2016a, 2017) and the IxSea GAPS System (MAI 2018b). Of the two devices, the IxSea GAPS System had the larger Level B harassment isopleth calculated at a distance of 6 m. It is assumed that all equipment within this category will have the same Level B harassment isopleth.

Parametric SBP: There are no relevant data contained in Crocker and Fratantonio (2016) report for parametric SBPs. However, results from an SSV study showed a Level B harassment isopleth of 63 m for the Innomar-2000 SES Medium 100 system (Subacoustech 2018). Therefore, 63 m will serve as the Level B harassment isopleth for all parametric SBP devices.

SBP (Chirp): Crocker and Fratantonio (2016) tested two chirpers, the Edge Tech (ET) models 424 and 512. The largest calculated isopleth is 7 m associated with the Edgetech 512. This distance will be applied to all other HRD equipment within this category.

SBP (sparkers): The Applied Acoustics Dura-Spark 400 was the only sparker tested by Crocker and Fratantonio (2016). The Level B harassment isopleth calculated for this devise is 141 m and represents all equipment within this category.

SBP (Boomers): The Crocker and Fratantonio report (2016) included data on the Applied Acoustics S-Boom Triple Plate Boomer (1,000J) and the Applied Acoustics S-Boom Boomer (700J). The results showed respective Level B harassment isopleths of 141 m and 178 m. Therefore, the Level B harassment isopleth for both boomers will be established at a distance of 178 m.

Table 8: Distances to Level B harassment Isopleths.

HRG Survey Equipment	Lateral Distance to Level B (m)	Measured SSV Level at Closest Point of Approach Single Pulse $SPL_{rms,90\%}$ (dB re $1\mu Pa^2$)
USBL & GAPS Transceiver		
Sonardyne Ranger 2[a/]	2	126 to 132 @ 40 m
Sonardyne Scout Pro	--	N/A
Easytrak Nexus 2 USBL	--	N/A
IxSea GAPS System[e/]	6	144 @ 35 m
Kongsberg HiPAP 501/502 USBL	--	N/A
Edgetech BATS II	--	N/A
Shallow Sub-Bottom Profiler (Chirp)		
Edgetech 3200[f/]	5	153 @ 30 m
EdgeTech 216[e/]	2	142 @ 35 m
EdgeTech 424	6	Crocker and Fratantonio (2016): SL = 176
EdgeTech 512 c/	2.4	141 dB @ 40 m 130 dB @ 200 m
	7	Crocker and Fratantonio (2016): SL = 177
Teledyne Benthos Chirp III - TTV 170	--	N/A
GeoPulse 5430 A Sub-Bottom Profiler[a/]	4	145 @ 20 m
PanGeo LF Chirp (Corer)	--	N/A
PanGeo HF Chirp (Corer)	--	N/A
Parametric Sub-Bottom Profiler		
Innomar SES-2000 Medium 100 Parametric Sub-Bottom Profiler[b/]	63	129 to 133 @ 100 m
Innomar SES-2000 Medium 70 Parametric Sub-Bottom Profiler	--	N/A
Innomar SES-2000 Standard & Plus Parametric Sub-Bottom Profiler	--	N/A
Innomar SES-2000 Quattro	--	N/A
PanGeo 2i Parametric (Corer)	--	N/A
Medium Penetration Sub-Bottom Profiler (Sparker)		
GeoMarine Geo-Source 400tip	--	N/A
GeoMarine Geo-Source 600tip[a/]	34	155 @ 20 m
GeoMarine Geo-Source 800tip[a/]	86	144 @ 200 m

Applied Acoustics Dura-Spark 400 System g/	141	Crocker and Fratantonio (2016); SL = 203
GeoResources Sparker 800 System	--	N/A
Medium Penetration Sub-Bottom Profiler (Boomer)		
Applied Acoustics S-Boom Boomer 1000 J operation [d,g/]	20	146@144
	141	Crocker and Fratantonio (2016); SL = 203
Applied Acoustics S-Boom Boomer/ 700 J operation [d,g/]	14	142 @ 38 m
	178	Crocker and Fratantonio (2016); SL = 205

Sources:
[a/] Gardline 2016a, 2017
[b/] Subacoustech 2018,
[c/] MAI 2018a,
[d/] NCE, 2018 e/ MAI 2018b,
[f/] Subacoustech 2017,
[g/] Crocker and Fratantonio, 2016.

For the purposes of estimated take and implementing proposed mitigation measure, it is assumed that all HRG equipment will operate concurrently. Therefore, NMFS conservatively utilized the largest isopleth of 178 m, derived from the Applied Acoustics S-Boom Boomer medium SBP, to establish the Level B harassment zone for all HRG categories and devices.

Take Calculation and Estimation

Here we describe how the information provided above is brought together to produce a quantitative take estimate. In order to estimate the number of marine mammals predicted to be exposed to sound levels that would result in harassment, radial distances to predicted isopleths corresponding to harassment thresholds are calculated, as described above. Those distances are then used to calculate the area(s) around the HRG survey equipment predicted to be ensonified to sound levels that exceed harassment thresholds. The area estimated to be ensonified to relevant thresholds by a single vessel in a single day of the survey is then calculated, based on areas predicted to be ensonified around the HRG survey equipment and the estimated trackline distance traveled per day by the survey vessel. The daily area is multiplied by the marine mammal density of a given species. This value is then multiplied by the number of proposed vessel days (666).

HRG survey equipment has the potential to cause harassment as defined by the MMPA (160 dB_{RMS} re 1 µPa). As noted previously, all noise producing survey equipment/sources are assumed to be operated concurrently by each survey vessel on every vessel day. The greatest distance to the Level B harassment threshold of 160 $dB_{RMS90\%}$ re 1 µPa level B for impulsive sources is 178 m associated with the Applied Acoustics S-Boom Boomer (700J) (Crocker &

Fratantonio, 2016). Therefore, this distance is conservatively used to estimate take by Level B harassment.

The estimated distance of the daily vessel trackline was determined using the estimated average speed of the vessel and the 24-hour operational period within each of the corresponding survey segments. Estimates of incidental take by HRG survey equipment are calculated using the 178 m Level B harassment isopleth, estimated daily vessel track of approximately 70 km, and the daily ensonified area of 25.022 km^2 for 24-hour operations as shown in Table 9, multiplied by 666 days.

Table 9. Survey Segment Distances and Level B harassment Isopleth and Zone.

Survey Segment	Number of Active Survey Vessel Days	Estimated distances per day (km)	Level Harassment Isopeth (m)	Calculated ZOI per day (km^2)
Lease Area OCS-A 0486	79	70.000	178	25.022
Lease Area OCS-A 0487	140			
Lease Area OCS-A 0500	94			
ECR Corridor(s)	353			

The data used as the basis for estimating species density for the Lease Area are derived from data provided by Duke Universities' Marine Geospatial Ecology Lab and the Marine-life Data and Analysis Team. This data set is a compilation of the best available marine mammal data (1994-2018) and was prepared in a collaboration between Duke University, Northeast Regional Planning Body, University of Carolina, the Virginia Aquarium and Marine Science Center, and NOAA (Roberts *et al.* 2016a; Curtice *et al.* 2018). Recently, these data have been updated with new modeling results and have included density estimates for pinnipeds (Roberts *et al.* 2016b; 2017; 2018). Because the seasonality of, and habitat use by, gray seals roughly overlaps with harbor seals, the same abundance estimate is applicable. Pinniped density data (as presented in Roberts *et al*. 2016b; 2017; 2018) were used to estimate pinniped densities for the Lease Area Survey segment and ECR Corridor Survey segment(s). Density data from Roberts *et al*. (2016b; 2017; 2018) were mapped within the boundary of the Survey Area for each segment using geographic information systems. For all Survey Area locations, the maximum densities as reported by Roberts *et al.* (2016b; 2017; 2018), were averaged over the survey duration (for spring, summer, fall and winter) for the entire HRG survey area based on the proposed HRG survey schedule as depicted in Table 7. The Level B ensonified area and the projected duration of each respective survey segment was used to produce the estimated take calculations provided in Table 10.

Table 10. Marine Mammal Density and Estimated Level B Harassment Take Numbers at 178 m Isopleth.

Species	Lease Area OCS-A 0500		Lease Area OCS-A 0486		Lease Area OCS-A 0487		ECR Corridor(s)		Adjusted Totals	
	Average Seasonal Density [a/] (No./100 km²)	Calculated Take (No.)	Average Seasonal Density [a/] (No./100 km²)	Calculated Take (No.)	Average Seasonal Density [a/] (No./100 km²)	Calculated Take (No.)	Average Seasonal Density [a/] (No./100 km²)	Calculated Take (No.)	Take Authorization (No.)	Percent of Population
North Atlantic right whale	0.502	11.798	0.383	7.570	0.379	13.262	0.759	67.029	10[c/]	2.2
Humpback whale	0.290	6.814	0.271	5.354	0.277	9.717	0.402	35.537	58	6.4
Fin whale	0.350	8.221	0.210	4.157	0.283	9.929	0.339	29.905	52	3.2
Sei whale	0.014	0.327	0.005	0.106	0.009	0.306	0.011	0.946	2	0.5
Sperm whale	0.018	0.416	0.014	0.272	0.017	0.581	0.047	4.118	5	0.2
Minke whale	0.122	2.866	0.075	1.487	0.094	3.275	0.126	11.146	19	0.7
Long-finned pilot whale	1.895	44.571	0.504	9.969	1.012	35.449	1.637	144.590	235	4.2
Bottlenose dolphin	1.992	46.844	1.492	57.800	1.478	43.874	25.002	2,208.314	2,357	3.0
Short beaked common dolphin	22.499	529.176	7.943	157.012	14.546	509.559	19.198	1,695.655	2,892	4.1
Atlantic white-sided dolphin	7.349	172.857	2.006	39.656	3.366	117.896	7.634	674.282	1,005	2.1
Spotted dolphin	0.105	2.477	2.924	0.313	1.252	1.119	0.109	9.611	50[d/]	0.1
Risso's dolphin	0.037	0.859	0.016	0.120	0.032	0.498	0.037	3.291	30[d/]	0.2
Harbor porpoise	5.389	126.757	5.868	115.997	4.546	159.253	20.098	1,775.180	2,177	<0.1
Harbor seal[b/]	7.633	179.522	6.757	133.558	3.966	138.918	45.934	4,057.192	4,509	5.9
Gray Seal[b/]	7.633	179.522	6.757	133.558	3.966	138.918	45.934	4,057.192	4,509	16.6

Notes:
a/ Cetacean density values from Duke University (Roberts *et al*. 2016b, 2017, 2018)
b/ Pinniped density values from Duke University (Roberts *et al*. 2016, 2017, 2018) reported as "seals" and not species-specific
c/ Exclusion zone exceeds Level B isopleth; take adjusted to 10 given duration of survey
d/ The number of authorized takes (Level B harassment only) for these species has been increased from the estimated take to mean group size. Source for Atlantic spotted dolphin group size estimate is: Jefferson *et al*. (2008). Source for Risso's dolphin group size estimate is: Baird and Stacey (1991).

For the North Atlantic right whale, NMFS proposes to establish a 500-m exclusion zone which substantially exceeds the distance to the level B harassment isopleth (178 m). However, Orsted will be operating 24 hours per day for a total of 666 vessel days. Even with the implementation of mitigation measures (including night-vision goggles and thermal clip-ons) it is reasonable to assume that night time operations for an extended period could result in a limited number of right whales being exposed to underwater sound at Level B harassment levels. . Given the fact that take has been conservatively calculated based on the largest source, which will not be operating at all times, and is thereby likely over-estimated to some degree, the fact that Orsted will implement a shutdown zone at 2.5 times the predicted Level B threshold distance for that largest source (and more than that for the smaller sources), and the fact that night vision goggles with thermal clips will be used for nighttime operations, NMFS predicts that 10 right whales may be taken by Level B harassment.

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 (latter not applicable for this action). 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)).

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. 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) and 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.

With NMFS' input during the application process, Orsted is requesting the following mitigation measures during site characterization surveys utilizing HRG survey equipment. The mitigation measures outlined in this section are based on protocols and procedures that have been successfully implemented and previously approved by NMFS (DONG Energy, 2016, ESS, 2013; Dominion, 2013 and 2014).

Orsted will develop an environmental training program that will be provided to all vessel crew prior to the start of survey and during any changes in crew such that all survey personnel are fully aware and understand the mitigation, monitoring and reporting requirements. Prior to implementation, the training program will be provided to NOAA Fisheries for review and approval. Confirmation of the training and understanding of the requirements will be documented on a training course log sheet. Signing the log sheet will certify that the crew members understand and will comply with the necessary requirements throughout the survey event.

Marine Mammal Monitoring zone, Harassment Zone and Exclusion Zone

Protected species observers (PSOs) will observe the following monitoring and exclusion zones for the presence of marine mammals:

- 500-m exclusion zone for North Atlantic right whales;
- 100-m exclusion zone for large whales (except North Atlantic right whales); and
- 180-m Level B harassment zone for all marine mammals except for North

Atlantic right whales. This represents the largest Level B harassment isopleth applicable to all hearing groups.

If a marine mammal is detected approaching or entering the exclusion zones during the HRG survey, the vessel operator would adhere to the shutdown procedures described below to minimize noise impacts on the animals.

At all times, the vessel operator will maintain a separation distance of 500 m from any sighted North Atlantic right whale as stipulated in the *Vessel Strike Avoidance* procedures described below. These stated requirements will be included in the site-specific training to be provided to the survey team.

Pre-Clearance of the Exclusion Zones

Orsted will implement a 30-minute clearance period of the exclusion zones prior to the initiation of ramp-up. During this period the exclusion zones will be monitored by the PSOs, using the appropriate visual technology for a 30-minute period. Ramp up may not be initiated if any marine mammal(s) is within its respective exclusion zone. If a marine mammal is observed within an exclusion zone during the pre-clearance period, ramp-up may not begin until the animal(s) has been observed exiting its respective exclusion zone or until an additional time period has elapsed with no further sighting (*i.e.*, 15 minutes for small odontocetes and 30 minutes for all other species).

Ramp-Up

A ramp-up procedure will be used for HRG survey equipment capable of adjusting energy levels at the start or re-start of HRG survey activities. A ramp-up procedure will be used at the beginning of HRG survey activities in order to provide additional protection to marine mammals near the Survey Area by allowing them to vacate the area prior to the commencement of survey equipment use. The ramp-up procedure will not be initiated during periods of inclement conditions or if the exclusion zones cannot be adequately monitored by the PSOs, using the appropriate visual technology for a 30-minute period

A ramp-up would begin with the powering up of the smallest acoustic HRG equipment at its lowest practical power output appropriate for the survey. When technically feasible the power would then be gradually turned up and other acoustic sources would be added.

Ramp-up activities will be delayed if a marine mammal(s) enters its respective exclusion zone. Ramp-up will continue if the animal has been observed exiting its respective exclusion zone or until an additional time period has elapsed with no further sighting (*i.e.*, 15 minutes for small odontocetes and 30 minutes for all other species).

Shutdown Procedures

An immediate shut-down of the HRG survey equipment will be required if a marine mammal is sighted at or within its respective exclusion zone. The vessel operator must comply immediately with any call for shut-down by the Lead PSO. Any disagreement between the Lead PSO and vessel operator should be discussed only after shut-down has occurred. Subsequent restart of the survey equipment can be initiated if the animal has been observed exiting its respective exclusion zone with 30 minutes of the shut-down or until an additional time period has elapsed with no further sighting (*i.e*., 15 minutes for small odontocetes and 30 minutes for all other species).

If a species for which authorization has not been granted, or, a species for which authorization has been granted but the authorized number of takes have been met, approaches or is observed within the 180 m Level B harassment zone, shutdown must occur.

If the acoustic source is shut down for reasons other than mitigation (*e.g.,* mechanical difficulty) for less than 30 minutes, it may be activated again without ramp-up, if PSOs have maintained constant observation and no detections of any marine mammal have occurred within the respective exclusion zones. If the acoustic source is shut down for a period longer than 30 minutes and PSOs have maintained constant observation then ramp-up procedures will be initiated as described in previous section.

The shutdown requirement is waived for small delphinids of the following genera: *Delphinus, Lagenodelphis, Lagenorhynchus, Lissodelphis, Stenella, Steno, and Tursiops*. If a delphinid (individual belonging to the indicated genera of the Family Delphinidae), is visually detected within the exclusion zone, no shutdown is required unless the visual PSO confirms the individual to be of a genus other than those listed, in which case a shutdown is required.

Vessel Strike Avoidance

Orsted will ensure that vessel operators and crew maintain a vigilant watch for cetaceans and pinnipeds and slow down or stop their vessels to avoid striking these species. Survey vessel crew members responsible for navigation duties will receive site-specific training on marine mammal and sea turtle sighting/reporting and vessel strike avoidance measures. Vessel strike avoidance measures will include the following, except under extraordinary circumstances when complying with these requirements would put the safety of the vessel or crew at risk:

- All vessel operators will comply with 10 knot (<18.5 km per hour [km/h]) speed restrictions in any Dynamic Management Area (DMA) when in effect and in .Mid-Atlantic Seasonal Management Areas (SMA) from November 1 through April 30;

- All vessel operators will reduce vessel speed to 10 knots or less when mother/calf pairs, pods, or larger assemblages of non-delphinoid cetaceans are observed near an underway vessel;

- All survey vessels will maintain a separation distance of 1,640 ft (500 m) or greater from any sighted North Atlantic right whale;

- If underway, vessels must steer a course away from any sighted North Atlantic right whale at 10 knots (<18.5 km/h) or less until the 1,640-ft (500-m) minimum separation distance has been established. If a North Atlantic right whale is sighted in a vessel's path, or within 330 ft (100 m) to an underway vessel, the underway vessel must reduce speed and shift the engine to neutral. Engines will not be engaged until the North Atlantic right whale has moved outside of the vessel's path and beyond 330 ft (100 m). If stationary, the vessel must not engage engines until the North Atlantic right whale has moved beyond 330 ft (100 m);

- All vessels will maintain a separation distance of 330 ft (100 m) or greater from any sighted non-delphinoid (*i.e.*, mysticetes and sperm whales) cetaceans. If sighted, the vessel underway must reduce speed and shift the engine to neutral, and must not engage the engines until the non-delphinoid cetacean has moved outside of the vessel's path and beyond 330 ft (100 m). If a survey vessel is stationary, the vessel will not engage engines until the non-delphinoid cetacean has moved out of the vessel's path and beyond 330 ft (100 m);

- All vessels will maintain a separation distance of 164 ft (50 m) or greater from any sighted delphinid cetacean. Any vessel underway remain parallel to a sighted delphinid cetacean's course whenever possible, and avoid excessive speed or abrupt changes in direction. Any vessel underway reduces vessel speed to 10 knots or less when pods (including mother/calf pairs) or large assemblages of delphinid cetaceans are observed. Vessels may not adjust course and speed until the delphinid cetaceans have moved beyond 164 ft (50 m) and/or the abeam of the underway vessel;
- All vessels underway will not divert to approach any delphinid cetacean or pinniped. Any vessel underway will avoid excessive speed or abrupt changes in direction to avoid injury to the sighted delphinid cetacean or pinniped; and
- All vessels will maintain a separation distance of 164 ft (50 m) or greater from any sighted pinniped.

Seasonal Operating Requirements

Between watch shifts members of the monitoring team will consult NOAA Fisheries North Atlantic right whale reporting systems for the presence of North Atlantic right whales throughout survey operations. Survey vessels may transit the SMA located off the coast of Rhode Island (Block Island Sound SMA) and at the entrance to New York Harbor (New York Bight SMA). The seasonal mandatory speed restriction period for this SMA is November 1 through April 30.

Throughout all survey operations, Orsted will monitor NOAA Fisheries North Atlantic right whale reporting systems for the establishment of a DMA. If NOAA Fisheries should establish a DMA in the Lease Area under survey, the vessels will abide by speed restrictions in the DMA per the lease condition.

Based on our evaluation of the applicant's proposed measures, as well as other measures considered by NMFS, NMFS has preliminarily determined that the proposed mitigation measures provide the means of effecting the least practicable impact on marine mammals species or stocks and their habitat, paying particular attention to rookeries, mating grounds, and areas of similar significance.

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.

Proposed Monitoring Measures

Visual monitoring of the established monitoring and exclusion zone(s) for the HRG surveys will be performed by qualified, NMFS-approved PSOs, the resumes of whom will be provided to NMFS for review and approval prior to the start of survey activities. During these observations, the following guidelines shall be followed:

Other than brief alerts to bridge personnel of maritime hazards and the collection of ancillary wildlife data, no additional duties may be assigned to the PSO during his/her visual observation watch. For all HRG survey segments, an observer team comprising a minimum of four NOAA Fisheries-approved PSOs, operating in shifts, will be stationed aboard respective survey vessels. Should the ASV be utilized, at least one PSO will be stationed aboard the mother vessel to monitor the ASV exclusively. PSOs will work in shifts such that no one monitor will work more than 4 consecutive hours without a 2-hour break or longer than 12 hours during any 24-hour period. Any time that an ASV is in operation, PSOs will work in pairs. During daylight hours without ASV operations, a single PSO will be required. PSOs will rotate in shifts of 1 on and 3 off during daylight hours when an ASV is not operating and work in pairs during all nighttime operations.

The PSOs will begin observation of the monitoring and exclusion zones during all HRG survey operations. Observations of the zones will continue throughout the survey activity and/or while equipment operating below 200 kHz are in use. The PSOs will be responsible for visually monitoring and identifying marine mammals approaching or entering the established zones during survey activities. It will be the responsibility of the Lead PSO on duty to communicate the presence of marine mammals as well as to communicate and enforce the action(s) that are necessary to ensure mitigation and monitoring requirements are implemented as appropriate.

PSOs will be equipped with binoculars and will have the ability to estimate distances to marine mammals located in proximity to their respective exclusion zones and monitoring zone using range finders. Reticulated binoculars will also be available to PSOs for use as appropriate based on conditions and visibility to support the siting and monitoring of marine species. Camera equipment capable of recording sightings and verifing species identification will be utilized. During night operations, night-vision equipment (night-vision goggles with thermal clip-ons) and infrared technology will be used. Position data will be recorded using hand-held or vessel global positioning system (GPS) units for each sighting.

Observations will take place from the highest available vantage point on all the survey vessels. General 360-degree scanning will occur during the monitoring periods, and target scanning by the PSOs will occur when alerted of a marine mammal presence.

For monitoring around the ASV, a dual thermal/HD camera will be installed on the mother vessel, facing forward, angled in a direction so as to provide a field of view ahead of the vessel and around the ASV. One PSO will be assigned to monitor the ASV exclusively at all times during both day and night when in use. The ASV will be kept in sight of the mother vessel at all times (within 800 m). This dedicated PSO will have a clear, unobstructed view of the ASV's exclusion and monitoring zones. While conducting survey operations, PSOs will adjust their positions appropriately to ensure adequate coverage of the entire exclusion and monitoring zones around the respective sound sources. PSOs will also be able to monitor the real time output of the camera on hand-held iPads. Images from the cameras can be captured for review and to assist in verifying species identification. A monitor will also be installed on the bridge displaying the real-time picture from the thermal/HD camera installed on the front of the ASV itself, providing a further forward field of view of the craft. In addition, night-vision goggles with thermal clip-ons, as mentioned above, and a hand-held spotlight will be provided such that PSOs can focus observations in any direction, around the mother vessel and/or the ASV. The ASV camera is only utilized at night as part of the reduced visibility program, during which one PSO monitors the ASV camera and the forward-facing camera mounted on mothership. The second PSO would use the hand held devices to cover the areas around the mothership that the forward-facing camera could not cover.

Observers will maintain 360° coverage surrounding the mothership vessel and the ASV when in operation, which will travel ahead and slightly offset to the mothership on the survey line. PSOs will adjust their positions appropriately to ensure adequate coverage of the entire exclusion zone around the mothership and the ASV.

As part of the monitoring program, PSOs will record all sightings beyond the established monitoring and exclusion zones, as far as they can see. Data on all PSO observations will be recorded based on standard PSO collection requirements.

Proposed Reporting Measures

Orsted will provide the following reports as necessary during survey activities:

Notification of Injured or Dead Marine Mammals

In the unanticipated event that the specified HRG and geotechnical activities lead to an unauthorized injury of a marine mammal (Level A harassment) or mortality (*e.g.*, ship-strike, gear interaction, and/or entanglement), Orsted would immediately cease the specified activities and report the incident to the Chief of the Permits and Conservation Division, Office of Protected Resources and the NOAA Greater Atlantic Regional Fisheries Office (GARFO) Stranding Coordinator. The report would include the following information:

- Time, date, and location (latitude/longitude) of the incident;
- Name and type of vessel involved;
- Vessel's speed during and leading up to the incident;
- Description of the incident;
- Status of all sound source use in the 24 hours preceding the incident;
- Water depth;
- Environmental conditions (*e.g.*, wind speed and direction, Beaufort sea state, cloud cover, and visibility);
- Description of all marine mammal observations in the 24 hours preceding the incident;
- Species identification or description of the animal(s) involved;
- Fate of the animal(s); and
- Photographs or video footage of the animal(s) (if equipment is available).

Activities would not resume until NMFS is able to review the circumstances of the event. NMFS would work with Orsted to minimize reoccurrence of such an event in the future. Orsted would not resume activities until notified by NMFS.

In the event that Orsted discovers an injured or dead marine mammal and determines that the cause of the injury or death is unknown and the death is relatively recent (*i.e.*, in less than a moderate state of decomposition), Orsted would immediately report the incident to the Chief of the Permits and Conservation Division, Office of Protected Resources and the GARFO Stranding Coordinator. The report would include the same information identified in the paragraph above. Activities would be allowed to continue while NMFS reviews the circumstances of the incident. NMFS would work with the Applicant to determine if modifications in the activities are appropriate.

In the event that Orsted discovers an injured or dead marine mammal and determines that the injury or death is not associated with or related to the activities authorized in the IHA (*e.g.*, previously wounded animal, carcass with moderate to advanced decomposition, or scavenger damage), Orsted would report the incident to the Chief of the Permits and Conservation Division, Office of Protected Resources, NMFS, and the GARFO Stranding Coordinator, within 24 hours of the discovery. Orsted would provide photographs or video footage (if available) or other documentation of the stranded animal sighting to NMFS. Orsted can continue its operations in such a case.

Within 90 days after completion of the marine site characterization survey activities, a draft technical report will be provided to NMFS that fully documents the methods and monitoring protocols, summarizes the data recorded during monitoring, estimates the number of marine mammals that may have been taken during survey activities, and provides an interpretation of the results and effectiveness of all monitoring tasks. Any recommendations made by NMFS must be addressed in the final report prior to acceptance by NMFS.

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).

To avoid repetition, this introductory discussion of our analyses applies to all the species listed in Table 8, given that many of the anticipated effects of this project on different marine mammal stocks are expected to be relatively similar in nature. Where there are meaningful differences between species or stocks, or groups of species, in anticipated individual responses to activities, impact of expected take on the population due to differences in population status, or impacts on habitat, they are described independently in the analysis below.

As discussed in the "Potential Effects of the Specified Activity on Marine Mammals and Their Habitat" section, PTS, TTS, masking, non-auditory physical effects, and vessel strike are not expected to occur. Marine mammal habitat may experience limited physical impacts in the form of grab samples taken from the sea floor. This highly localized habitat impact is negligible in relation to the comparatively vast area of surrounding open ocean, and would not be expected to result in any effects to prey availability. The HRG survey equipment itself will not result in physical habitat disturbance. Avoidance of the area around the HRG survey activities by marine mammal prey species is possible. However, any avoidance by prey species would be expected to be short term and temporary. Marine mammal feeding behavior is not likely to be significantly impacted. Prey species are mobile, and are broadly distributed throughout the Survey Area; therefore, marine mammals that may be temporarily displaced during survey activities are expected to be able to resume foraging once they have moved away from areas with disturbing levels of underwater noise. Because of the availability of similar habitat and resources in the surrounding area the impacts to marine mammals and the food sources that they utilize are not expected to cause significant or long-term consequences for individual marine mammals or their populations.

ESA-Listed Marine Mammal Species

ESA-listed species for which takes are proposed are right, fin, sei, and sperm whales, and these effects are anticipated to be limited to lower level behavioral effects. NMFS does not anticipate that serious injury or mortality would occur to ESA-listed species, even in the absence of proposed mitigation and the proposed authorization does not authorize any serious injury or mortality. As discussed in the *Potential Effects* section, non-auditory physical effects and vessel strike are not expected to occur. We expect that most potential takes would be in the form of short-term Level B behavioral harassment in the form of temporary avoidance of the area or decreased foraging (if such activity were occurring), reactions that are considered to be of low severity and with no lasting biological consequences (*e.g.*, Southall *et al.*, 2007). The proposed survey is not anticipated to affect the fitness or reproductive success of individual animals. Since impacts to individual survivorship and fecundity are unlikely, the proposed survey is not expected to result in population-level effects for any ESA-listed species or alter current population trends of any ESA-listed species.

There is no designated critical habitat for any ESA-listed marine mammals within the Survey Area.

Biologically Important Areas (BIA)

The proposed Survey Area includes a fin whale feeding BIA effective between March and October. The fin whale feeding area is sufficiently large (2,933 km^2), and the acoustic footprint of the proposed survey is sufficiently small (<20 km^2 ensonified per day to the Level B harassment threshold assuming simultaneous operation of two survey ships) that whale feeding habitat would not be reduced appreciably. Any fin whales temporarily displaced from the proposed survey area would be expected to have sufficient remaining feeding habitat available to them, and would not be prevented from feeding in other areas within the biologically important feeding habitat. In addition, any displacement of fin whales from the BIA would be expected to be temporary in nature. Therefore, we do not expect fin whale feeding to be negatively impacted by the proposed survey.

The proposed survey area includes a biologically important migratory area for North Atlantic right whales (effective March-April and November-December) that extends from Massachusetts to Florida (LaBrecque, *et al.,* 2015). Off the south coast of Massachusetts and Rhode Island, this biologically important migratory area extends from the coast to beyond the shelf break. The fact that the spatial acoustic footprint of the proposed survey is very small relative to the spatial extent of the available migratory habitat means that right whale migration is not expected to be impacted by the proposed survey. Required vessel strike avoidance measures will also decrease risk of ship strike during migration. Additionally, only very limited take by Level B harassment of North Atlantic right whales has been proposed as HRG survey operations are required to shut down at 500 m to minimize the potential for behavioral harassment of this species.

Unusual Mortality Events (UME)

A UME is defined under the MMPA as "a stranding that is unexpected; involves a significant die-off of any marine mammal population; and demands immediate response." Four UMEs are ongoing and under investigation relevant to HRG survey area. These involve humpback whales, North Atlantic right whales, minke whales, and pinnipeds. Specific information for each ongoing UME is provided below. There is currently no direct connection between the four UMEs, as there is no evident cause of stranding or death that is common across the species involved in the different UMEs. Additionally, strandings across these species are not clustering in space or time.

As noted previously, elevated humpback whale mortalities have occurred along the Atlantic coast from Maine through Florida since January 2016 Of the cases examined, approximately half had evidence of human interaction (ship strike or entanglement). Beginning in January 2017, elevated minke whale strandings have occurred along the Atlantic coast from Maine through South Carolina, with highest numbers in Massachusetts, Maine, and New York. Preliminary findings in several of the whales have shown evidence of human interactions or infectious disease. Elevated North Atlantic right whale mortalities began in June 2017, primarily in Canada. Overall, preliminary findings support human interactions, specifically vessel strikes or rope entanglements, as the cause of death for the majority of the right whales. Elevated numbers of harbor seal and gray seal mortalities were first observed in July, 2018 and have occurred across Maine, New Hampshire and Massachusetts. Based on tests conducted so far, the main pathogen found in the seals is phocine distemper virus although additional testing to identify other factors that may be involved in this UME are underway.

Direct physical interactions (ship strikes and entanglements) appear to be responsible for many of the UME humpback and right whale mortalities recorded. The proposed HRG survey will require ship strike avoidance measures which would minimize the risk of ship strikes while fishing gear and in-water lines will not be employed as part of the survey. Furthermore, the proposed activities are not expected to promote the transmission of infectious disease among marine mammals.The survey is not expected to result in the deaths of any marine mammals or combine with the effects of the ongoing UMEs to result in any additional impacts not analyzed here.

The required mitigation measures are expected to reduce the number and/or severity of takes by giving animals the opportunity to move away from the sound source before HRG survey equipment reaches full energy and preventing animals from being exposed to sound levels that have the potential to cause injury (Level A harassment) and more severe Level B harassment during HRG survey activities, even in the biologically important areas described above.

Accordingly, Orsted did not request, and NMFS is not proposing to authorize, take of marine mammals by serious injury, or mortality. NMFS expects that most takes would primarily be in the form of short-term Level B behavioral harassment in the form of brief startling reaction and/or temporary vacating of the area, or decreased foraging (if such activity were occurring)—reactions that are considered to be of low severity and with no lasting biological consequences (*e.g.*, Southall *et al.*, 2007). Since the source is mobile, a specified area would be ensonified by sound levels that could result in take for only a short period. Additionally, required mitigation measures would reduce exposure to sound that could result in harassment.

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 or serious injury is anticipated or authorized;
- No Level A harassment (PTS) is anticipated;
- Foraging success is not likely to be significantly impacted as effects on species that serve as prey species for marine mammals from the survey are expected to be minimal;
- The availability of alternate areas of similar habitat value for marine mammals to temporarily vacate the survey area during the planned survey to avoid exposure to sounds from the activity;
- Take is anticipated to be primarily Level B behavioral harassment consisting of brief startling reactions and/or temporary avoidance of the Survey Area;
- While the Survey Area is within areas noted as biologically important for north Atlantic right whale migration, the activities would occur in such a comparatively small area such that any avoidance of the survey area due to activities would not affect migration. In

addition, mitigation measures to shut down at 500 m to minimize potential for Level B behavioral harassment would limit any take of the species. Similarly, due to the small footprint of the survey activities in relation to the size of a biologically important area for fin whales foraging, the survey activities would not affect foraging behavior of this species; and

- The proposed mitigation measures, including visual monitoring and shutdowns, are expected to minimize potential impacts to marine mammals.

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 Orsted's proposed HRG survey activities will have a negligible impact on the affected marine mammal species or stocks.

Small Numbers

As noted above, only small numbers of incidental take may be authorized under Section 101(a)(5)(D) of the MMPA for specified activities other than military readiness activities. The MMPA does not define small numbers and so, in practice, where estimated numbers are available, NMFS compares the number of individuals taken to the most appropriate estimation of abundance of the relevant species or stock in our determination of whether an authorization is limited to small numbers of marine mammals. Additionally, other qualitative factors may be considered in the analysis, such as the temporal or spatial scale of the activities.

The numbers of marine mammals that we propose for authorization to be taken, for all species and stocks, would be considered small relative to the relevant stocks or populations (less than 17 percent for all authorized species).

Based on the analysis contained herein of the proposed activity (including the proposed mitigation and monitoring measures) and the anticipated take of marine mammals, NMFS preliminarily finds that small numbers of marine mammals will be taken relative to the population size of the affected species or stocks.

Impact on Availability of Affected Species for Taking for Subsistence Uses

There are no relevant subsistence uses of marine mammals implicated by this action. Therefore, NMFS has determined that the total taking of affected species or stocks would not have an unmitigable adverse impact on the availability of such species or stocks for taking for subsistence purposes.

Endangered Species Act

Section 7(a)(2) of the Endangered Species Act of 1973 (ESA: 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 Greater Atlantic Regional Field Office (GARFO), whenever we propose to authorize take for endangered or threatened species.

Within the project area, fin, Sei, humpback, North Atlantic right, and sperm whale are listed as endangered under the ESA. Under section 7 of the ESA, BOEM consulted with NMFS on commercial wind lease issuance and site assessment activities on the Atlantic Outer Continental Shelf in Massachusetts, Rhode Island, New York and New Jersey Wind Energy Areas. NOAA’s GARFO issued a Biological Opinion concluding that these activities may adversely affect but are not likely to jeopardize the continued existence of fin whale or North

Atlantic right whale. NMFS is also consulting internally on the issuance of an IHA under section 101(a)(5)(D) of the MMPA for this activity and the existing Biological Opinion may be amended to include an incidental take exemption for these marine mammal species, as appropriate.

Proposed Authorization

As a result of these preliminary determinations, NMFS proposes to issue an IHA to Orsted for HRG survey activities effective one year from the date of issuance, provided the previously mentioned mitigation, monitoring, and reporting requirements are incorporated. A draft of the IHA itself is available for review in conjunction with this notice at *https://www.fisheries.noaa.gov/national/marine-mammal-protection/incidental-take-authorizations-other-energy-activities-renewable.*

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 survey. 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).

(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 19, 2019.

Donna S. Wieting,

Director, Office of Protected Resources,

National Marine Fisheries Service.

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