Bay State Wind
An Ørsted & Eversource Initiative

Ørsted Wind Power North America LLC

Request for the Taking of Marine Mammals Incidental to the Site Characterization of Lease Areas OCS-A 0486, OCS-A 0487, and OCS-A 0500

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Acronyms and Abbreviations

ASV	autonomous surface vehicle
BOEM	Bureau of Ocean Energy Management
CeTAP	Cetacean and Turtles Assessment Program
CFR	Code of Federal Regulations
CPA	closest point of approach
dB	decibel
DMA	Dynamic Management Area
DoN	U.S. Department of the Navy
ECR	Export Cable Route
ESA	Endangered Species Act
ft	foot
GAPS	global acoustic positioning system
GPS	global positioning system
HF	high-frequency
HRG	high-resolution geophysical
Hz	hertz
IAC	Inter-Array Cable
IHA	Incidental Harassment Authorization
IR	infrared (thermal)
IUCN	World Conservation Union
IWC	International Whaling Commission
kHz	kilohertz
km	kilometer
knot	nautical mile per hour
kph	kilometers per hour
LF	low-frequency
m	meter
MF	mid-frequency
mi	mile
MMPA	Marine Mammal Protection Act
nm	nautical mile
NOAA	National Oceanic and Atmospheric Administration
NOAA Fisheries	National Marine Fisheries Service
OCS	Outer Continental Shelf
OPAREA	Operations Area
OSS	offshore substation
PSO	Protected Species Observer
PTS	permanent threshold shift
RAM	Range-dependent Acoustic Model
RMS	root mean square
SBP	sub bottom profiler
SEL	sound exposure level
SELcum	cumulative SEL
SL	source level
SMA	Seasonal Management Area

SSV	sound source verification
The Applicant	Bay State Wind LLC
The Lease Area	OCS-A 0500
TTS	temporary threshold shift
UHRS	Ultra-High Resolution Seismic
USBL	Ultra-Short Base Line
WTG	wind turbine generator
ZOI	Zone of Influence
µPa	microPascal

1. Description of Specified Activity

Ørsted Wind Power North America LLC (the Applicant) is proposing to conduct marine site characterization surveys 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: OCS-A 0486, OCS-A 0487, and OCS-A 0500 (collectively referred to as the Lease Areas). The Applicant is also proposing to conduct marine site characterization surveys along one or more cable route corridors 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 1-1). The Survey Area is defined as the Lease Areas and cable route corridors to be investigated (Figure 1-1).

The Applicant submits this request for Incidental Harassment Authorization (IHA) pursuant to Section 101(a)(5) of the Marine Mammal Protection Act (MMPA) and 50 Code of Federal Regulations (CFR) § 216 Subpart I to allow for the incidental harassment of small numbers of marine mammals resulting from the execution of marine site characterization surveys in the Survey Area specifically associated with the operation of high-resolution geophysical (HRG) survey equipment during upcoming field activities. The objective of the surveys are to acquire geophysical data within the Lease Areas and associated footprints of proposed ancillary locations for development (i.e., export and inter array cable construction corridors, wind turbine generator [WTG] foundation and installation areas, the offshore substation [OSS] foundation and installation area) within both the Lease Areas and future potential cable routes to shore in accordance with the following Bureau of Ocean Energy Management (BOEM) guidelines:

1. Guidelines for Providing Archaeological and Historic Property Information Pursuant to 30 CFR Part 585 (March 2017)
2. Guidelines for Providing Geophysical, Geotechnical, and Geohazard Information Pursuant to 30 CFR Part 585 (July 2015)

Both the National Oceanic and Atmospheric Administration (NOAA) and BOEM have advised that sound-producing survey equipment operating below 200 kilohertz (kHz) (e.g., sub-bottom profilers) has the potential to cause acoustic harassment to marine species, in particular marine mammals. This request is being submitted to NOAA to specifically address survey sound-producing data acquisition equipment that operates below 200 kHz.

The regulations set forth in Section 101(a)(5) of the MMPA and 50 CFR § 216 Subpart I allow for the incidental taking of marine mammals by a specific activity if the activity is found to have a negligible impact on the species or stock(s) of marine mammals and will not result in immitigable adverse impact on the availability of the marine mammal species or stock(s) for certain subsistence uses. In order for the NOAA National Marine Fisheries Service (NOAA Fisheries) to consider authorizing the taking by U.S. citizens of small numbers of marine mammals incidental to a specified activity (other than commercial fishing), or to make a finding that incidental take is unlikely to occur, a written request must be submitted to the Assistant Administrator. Such a request is detailed in the following sections.

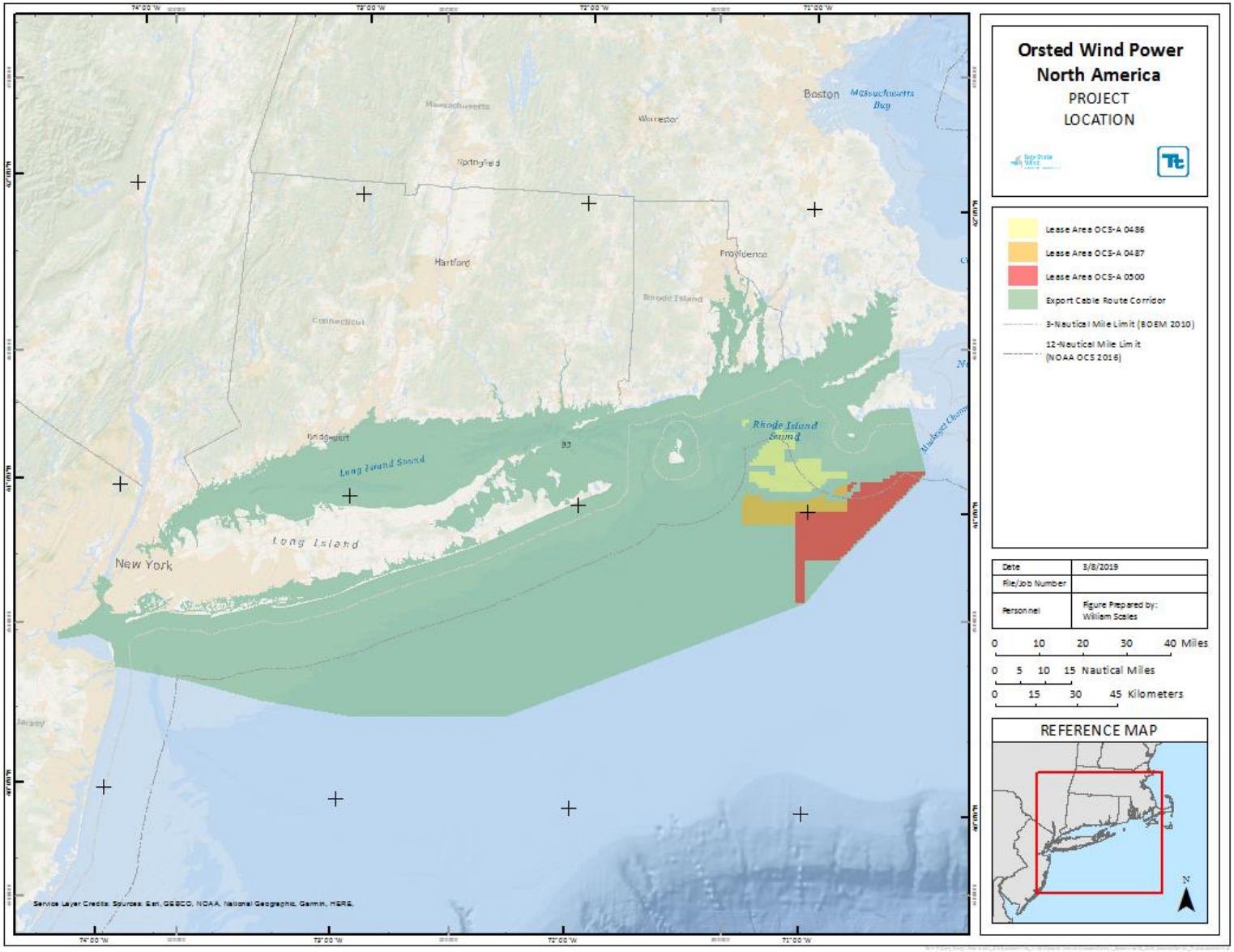

Figure 1-1 Survey Area Location

1.1 Survey Activities

The Applicant will conduct marine site characterization surveys within the Lease Areas, and within areas were potential future Export Cable Corridors to shore could be located (Figure 1-1). Marine site characterization surveys will consist of HRG survey activities. The purpose of the marine site characterization surveys is to:

- Support the siting, design, and installation of offshore project facilities, turbines and subsea cables within the project areas; and
- Collect the data necessary to support Project review requirements associated with Section 106 of the National Historic Preservation Act of 1966, as amended.

The HRG survey activities will include the following:

- 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 meters [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

The HRG surveys are scheduled to begin no earlier than May 1, 2019. The survey equipment to be employed will be equivalent to the equipment utilized during the HRG survey campaigns associated with Lease Area OCS-A 0500 conducted in 2016, 2017, and 2018 and with Lease Area OCS-A 0486 conducted in 2018. Table 1-1 identifies the HRG survey equipment and relevant acoustic parameters used in the hydroacoustic assessment. The make and model of the listed HRG equipment are currently being finalized as part of the survey preparations and contract negotiations with the survey contractor(s). 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). Ørsted 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 1-1 Summary of Proposed HRG Survey Data Acquisition Equipment

Representative HRG Survey Equipment	Range of Operating Frequencies (kHz)	Baseline Source Level a/	Representative RMS_{90} 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 400J d/	0.2 to 5	212 dB_{Peak} 201 dB_{RMS}	55	2	2
GeoMarine Geo-Source 600J d/	0.2 to 5	215 dB_{Peak} 205 dB_{RMS}	55	2	2
GeoMarine Geo-Source 800J 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	225 dB_{Peak} 214 dB_{RMS}	1.1	0.4	1
GeoResources Sparker 800 System d/	0.05 to 5	215 dB_{Peak} 206 dB_{RMS}	55	2.5	1.9

Table 1-1 Summary of Proposed HRG Survey Data Acquisition Equipment

Representative HRG Survey Equipment	Range of Operating Frequencies (kHz)	Baseline Source Level a/	Representative RMS_{90} Pulse Duration (millisec)	Pulse Repetition Rate (Hz)	Primary Operating Frequency (kHz)
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.

It is important to note that neither Crocker and Farantino (2016), nor HRG manufacturer technical specifications report source levels in terms of the RMS_{90}, which is the metric required in assessment to the distance of NOAA Fisheries Level B harassment thresholds. Therefore, careful consideration should be made when attempting to make such direct comparisons. As shown in Crocker and Farantino, the pulse duration may also be a function of HRG operator settings.

Assuming a maximum survey track line to fully cover the Lease Areas, 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 while acquiring survey lines. Vessel survey speed is anticipated to be approximately 4 knots (7.4 kph). Survey activities will occur in discrete segments corresponding to the following general areas:

- **Lease Area OCS-A 0486 –** inclusive of potential WTG locations, OSS locations and Inter-Array Cable (IAC) corridors, outside of the proposed South Fork Project Area;
- **Lease Area OCS-A 0487 –** inclusive of potential WTG locations, OSS locations and Inter-Array Cable (IAC) corridors;
- **Lease Area OCS-A 0500** - inclusive of potential WTG locations, OSS locations and Inter-Array Cable (IAC) corridors, and
- **Export Cable Route (ECR) Corridor(s)** – Potential ECR corridors through federal and state waters located within a general survey area as indicated in Figure 1-1.

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. These vessels will be assigned their respective survey segments (see Figure 1-1). Survey segments represent a maximum extent, and distances may vary depending on contractor used.

To minimize cost, the actual duration of survey activities, and the period of potential impact on marine species, the Applicant has proposed conducting continuous HRG survey operations 24-hours per day for

both survey segments (Lease Areas and ECR Corridor[s]). Based on 24-hour operations, the estimated duration of the survey activities for each survey segment is provided in Table 1-2. Total days are estimated assuming one vessel surveys the entire survey line continuously for a given survey segment and 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. Total survey effort for the Lease Areas and the ECR Corridor(s) survey segments have been conservatively estimated to require up to a full year to provide survey flexibility on specific locations and vessel numbers to be utilized, which will be determined at the time of contractor selection.

To complete the proposed survey quickly and efficiently, the Applicant proposes to use 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. See Table 1-2 for the estimated number of vessels for each survey segment. The Applicant may elect to use an autonomous surface vehicle (ASV) to support survey operations as was described in the previously approved Bay State Wind IHA (2018). Using an ASV in combination with a “mother ship” allows the project team to double the survey daily production.

Table 1-2 Summary of Proposed HRG Survey Segments

Survey Segment	Anticipated Start Date	Total Line km Per Day	Total Duration (Vessel Days) a/
Lease Area OCS-A 0486	May 1, 2019	70	79
Lease Area OCS-A 0487			140
Lease Area OCS-A 0500			94
ECR Corridor(s)			353

Notes:
a/ Estimate is based on total time for one (1) vessel to complete survey activities.

Should an ASV be employed, the ASV will operate autonomously along a parallel track to 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. Surveyors will also be able to monitor the data as it is acquired by the ASV utilizing a real-time IP radio link. For each 12-hour shift, an ASV technician will be assigned to manage the vessel during his or her shift to ensure the vehicle is operating properly and to take over control of the vehicle should the need arise. The ASV will be outfitted with an array of cameras, radars, thermal equipment and an automatic identification system, all of which is monitored in real time by the ASV technician. This includes a forward-facing dual thermal/HD camera installed on the mother vessel to provide a field of view ahead of the vessel and around the ASV, forward-facing thermal camera on the ASV itself with a real-time monitor display installed on the mother vessel bridge and use of night-vision goggles with thermal clip-ons for monitoring around the mother vessel and ASV.

All data-acquiring survey vessels will utilize an assemblage of HRG survey equipment from those represented in Table 1-1 and will be in operation simultaneously in their respective survey segments. As noted previously, both NOAA and BOEM have advised that the deployment of HRG survey equipment including the use of sound-producing equipment operating below 200 kHz (e.g., sub-bottom profilers) has the potential to cause acoustic harassment to marine species, in particular marine mammals. Based on the

frequency ranges of the potential equipment to be used in support of the HRG survey activities (Table 1-1) and the hearing ranges of the marine mammals that have the potential to occur in the Survey Area during survey activities (Table 1-3), the Ultra-Short Base Line (USBL) positioning 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 Level A and B Harassment of marine mammals.

1.2 Survey Activities Resulting in the Potential Incidental Taking of Marine Mammals

The potential effects of underwater noise resulting in takes on marine mammals are federally managed by NOAA under the MMPA to minimize the potential for both harm and harassment. Under the MMPA, Level A harassment is statutorily defined as any act of pursuit, torment, or annoyance that has the potential to injure a marine mammal or marine mammal stock in the wild; however, the actionable sound pressure level is not identified in the statute. Level B harassment is defined as any act of pursuit, torment, or annoyance that 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.

In July of 2016, NOAA Fisheries finalized the *Technical Guidance for Assessing the Effect of Anthropogenic Sound on Marine Mammals* and reaffirmed in the April of 2018 Revision to the Technical Guidance (NOAA Fisheries 2018). Under this new NOAA Fisheries guidance, Level A harassment is said to occur as a result of exposure to high noise levels and the onset of permanent hearing sensitivity loss, known as a permanent threshold shift (PTS). This revision to earlier NOAA Fisheries guidelines is based on findings published by the Noise Criteria Group (Southall et al., 2007). For transient and continuous sounds, it was concluded that the potential for injury is not just related to the level of the underwater sound and the hearing bandwidth of the animal but is also influenced by the duration of exposure. The evaluation of the onset of PTS and temporary threshold shift (TTS) provides additional species-specific insight on the potential for affect that is not captured by evaluations completed using the previous NOAA Fisheries thresholds for Level A and Level B harassment alone.

Frequency weighting provides a sound level referenced to an animal's hearing ability either for individual species or classes of species, and therefore a measure of the potential of the sound to cause an effect. The measure that is obtained represents the perceived level of the sound for that animal. This is an important consideration because even apparently loud underwater sound may not effect an animal if it is at frequencies outside the animal's hearing range. In the NOAA Fisheries final Guidance document, there are five hearing groups: Low-frequency (LF) cetaceans (baleen whales), Mid-frequency (MF) cetaceans (dolphins, toothed whales, beaked whales, bottlenose whales), High-frequency (HF) cetaceans (true porpoises, Kogia, river dolphins, cephalorhynchid [*Lagenorhynchus cruciger* and *L. australis*]), Phocid pinnipeds (true seals), and Otariid pinnipeds (sea lions and fur seals). It should be noted that Otariid pinnipeds do not occur within the Lease Area.

There are specific hearing criteria thresholds provided by NOAA Fisheries for each of group. These criteria apply hearing adjustment curves for each animal group known as M-weighting (see Table 1-3).

Table 1-3 M-Weighted PTS Criteria and Functional Hearing Range for Maine Mammals (NOAA Fisheries, 2018)

Functional Hearing Group	PTS Onset Impulsive	PTS Onset Non-Impulsive	Functional Hearing Range
LF cetaceans	219 dB_{peak} & 183 dB SEL_{cum}	199 dB SEL_{cum}	7 Hz to 35 kHz
MF cetaceans	230 dB_{peak} & 185 dB SEL_{cum}	198 dB SEL_{cum}	150 Hz to 160 kHz
HF cetaceans	202 dB_{peak} & 155 dB SEL_{cum}	173 dB SEL_{cum}	275 Hz to 160 kHz
Phocid pinnipeds	218 dB_{peak} & 185 dB SEL_{cum}	201 dB SEL_{cum}	50 Hz to 86 kHz
Otariid pinnipeds	232 dB_{peak} & 203 dB SEL_{cum}	219 dB SEL_{cum}	60 Hz to 39 kHz

NOAA has defined the threshold level for Level B harassment at 120 decibels (dB) root mean squared (RMS, dB_{RMS}) at a reference pressure of 1 micropascal (re 1 µPa) for non-impulsive and continuous noise and 160 $dB_{RMS90\%}$ re 1 µPa for impulsive noise. Within this zone, the sound produced by the proposed HRG survey equipment may approach or exceed ambient sound levels (i.e., threshold of perception or zone of audibility); however, actual perceptibility will be dependent on the hearing thresholds of the species under consideration and the inherent masking effects of ambient sound levels.

PTS criteria thresholds were assigned as prescribed in the Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammals (NOAA Fisheries 2016; Table 1-2) and reaffirmed in the 2018 Revision to the Technical Guidance (NOAA Fisheries 2018). NOAA's threshold level for Level B harassment remains 160 $dB_{RMS90\%}$ re 1 µPa. As discussed further in Section 5.0, non-impulsive PTS Level A harassment thresholds were applied for parametric subbottom profilers (SBPs), USBL pingers and shallow SBP (chirps), while the impulsive PTS Level A harassment threshold was applied to the medium SBPs which include sparkers, boomers, and bubble pulsars. An important distinction between electromechanical and other acoustic sources employed in HRG survey systems is the determinism of the transmitted signal. Whereas electromechanical sources (i.e. chirpers and pingers) employ deterministic signals generated by piezoelectric transducers, non-electromechanical sources typically employ impulsive physical processes including the release of high-pressure air or electric field discharge at high voltage (i.e., boomers, sparkers, and bubble pulsars) to generate high-intensity acoustic fields (Crocker and Farantino 2016). While classified as non-impulsive, given the short pulse duration and transient nature of a frequency modulated signal of the USBL and shallow penetration SBP pinger, the use of the continuous Level B criteria has been deemed inappropriate for assessing masking effects or predicting adverse auditory effects on marine mammals.

2. Dates, Duration, and Specific Geographic Region

2.1 Dates and Duration

The surveys are anticipated to commence no earlier than May 1, 2019. Survey start and anticipated durations are provided in Table 1-2.

2.2 Specific Geographic Region

The Applicant's survey activities will occur within both federal waters as well as state waters of, potentially, New York, Connecticut, Rhode Island, and Massachusetts as depicted in Figure 1-1.

3. Species and Numbers of Marine Mammals

The BOEM Environmental Assessment (2014) reports 38 species of marine mammals (whales, dolphins, porpoise, and seals) in the Northwest Atlantic Outer Continental Shelf (OCS) region of the Mid-Atlantic that are protected by the MMPA, 5 of which are listed under the Endangered Species Act (ESA) and are known to be present, at least seasonally, in the Lease Area (see Table 3-1). A description of the status and distribution of these species is discussed in detail in Section 4.0.

Table 3-1 Marine Mammals Known to Occur in the Marine Waters of Southern New England

Common Name	Scientific Name	Regulatory Status	Estimated Population	Stock
Toothed Whales (Odontoceti)				
Atlantic white-sided dolphin	*Lagenorhynchus acutus*	MMPA	48,819	W. North Atlantic
Atlantic spotted dolphin	*Stenella frontalis*	MMPA	44,715	W. North Atlantic
Bottlenose dolphin	*Tursiops truncatus*	MMPA; Northern coastal stock: Strategic a/	77,532	W. North Atlantic
Clymene Dolphin	*Stenella clymene*	MMPA	Unknown	W. North Atlantic
Fraser's Dolphin	*Lagenodelphis hosei*	MMPA	Unknown	W. North Atlantic
Pan-Tropical Spotted Dolphin	*Stenella attenuata*	MMPA	3,333	W. North Atlantic
Risso's dolphin	*Grampus griseus*	MMPA	18,250	W. North Atlantic
Rough-Toothed Dolphin	*Steno bredanensis*	MMPA	271	W. North Atlantic
Common dolphin	*Delphinus delphis*	MMPA	70,184	W. North Atlantic
Striped dolphin	*Stenella coeruleoalba*	MMPA	54,807	W. North Atlantic
Spinner Dolphin	*Stenella longirostris*	MMPA	Unknown	W. North Atlantic
White-beaked dolphin	*Lagenorhynchus albirostris*	MMPA	2,003	W. North Atlantic
Harbor porpoise	*Phocoena*	MMPA	79,833	Gulf of Maine/Bay of Fundy
Killer whale	*Orcinus orca*	MMPA	Unknown	W. North Atlantic
Pygmy Killer Whale	*Feresa attenuata*	MMPA	Unknown	W. North Atlantic
False killer whale	*Pseudorca crassidens*	MMPA; Strategic	442	W. North Atlantic
Long-finned pilot whale	*Globicephala malaena*	MMPA	5,636	W. North Atlantic
Short-finned pilot whale	*Globicephala macrorhynchus*	MMPA	21,515	W. North Atlantic
Sperm whale	*Physeter macrocephalus*	ESA; Endangered	2,288	North Atlantic
Pigmy sperm whale	*Kogia breviceps*	MMPA	3,785 b/	W. North Atlantic
Dwarf sperm whale	*Kogia sima*	MMPA	3,785 b/	W. North Atlantic
Cuvier's beaked whale	*Ziphius cavirostris*	MMPA	6,532	W. North Atlantic
Blainville's beaked whale	*Mesoplodon densirostris*	MMPA	7,092 c/	W. North Atlantic
Gervais' beaked whale	*Mesoplodon europaeus*	MMPA	7,092 c/	W. North Atlantic
True's beaked whale	*Mesoplodon mirus*	MMPA	7,092 c/	W. North Atlantic
Sowerby's Beaked Whale	*Mesoplodon bidens*	MMPA	7,092 c/	W. North Atlantic
Northern bottlenose whale	*Hyperoodon ampullatus*	MMPA	Unknown	W. North Atlantic
Melon-headed whale	*Peponocephala electra*	MMPA	Unknown	W. North Atlantic

Table 3-1 Marine Mammals Known to Occur in the Marine Waters of Southern New England

Common Name	Scientific Name	Regulatory Status	Estimated Population	Stock
Baleen Whales (Mysticeti)				
Minke whale	*Balaenoptera acutorostrata*	MMPA	2,591	Canadian East Coast
Blue whale	*Balaenoptera musculus*	ESA; Endangered	Unknown	W. North Atlantic
Fin whale	*Balaenoptera physalus*	ESA; Endangered	1,618	W. North Atlantic
Humpback whale	*Megaptera novaeangliae*	MMPA	335	Gulf of Maine
North Atlantic right whale	*Eubalaena glacialis*	ESA; Endangered	458	W. North Atlantic
Sei whale	*Balaenoptera borealis*	ESA; Endangered	357	Nova Scotia
Earless Seals (Phocidae)				
Gray seals	*Halichoerus grypus*	MMPA	27,131	W. North Atlantic
Harbor seals	*Phoca vitulina*	MMPA	75,834	W. North Atlantic
Hooded seals	*Cystophora cristata*	MMPA	Unknown	W. North Atlantic
Harp seal	*Phoca groenlandica*	MMPA	Unknown	W. North Atlantic

Notes:
a/ A strategic stock is defined as any marine mammal stock: 1) for which the level of direct human-caused mortality exceeds the potential biological removal level; 2) which is declining and likely to be listed as threatened under the ESA; or 3) which is listed as threatened or endangered under the ESA or as depleted under the MMPA (http://www.ncseonline. org/nle/crsreports/biodiversity/biodv-11.cfm).

b/ This estimate may include both the dwarf and pygmy sperm whales.

c/ This estimate includes Gervais' and Blainville's beaked whales and undifferentiated Mesoplodon spp. beaked whales.

Sources: Hayes et al. 2018; Hayes et al. 2017; Waring et al. 2015; Waring et al 2013; Waring et al 2011; Warring et al 2010; NOAA Fisheries 2012; RI Ocean SAMP 2011; Kenney and Vigness-Raposa 2009

4. Affected Species Status and Distribution

As described in Section 3.0, there are up to 38 marine mammal species (whales, dolphins, porpoise, and seals) which are known to be present (some year–round, and some seasonally) in the Northwest Atlantic OCS region. The marine mammal species with the greatest likelihood of occurring in the Survey Area are listed in Table 3-1. All 38 marine mammal species identified in Table 3-1 are protected by the MMPA and some are also listed under the ESA. The 5 ESA-listed marine mammal species known to be present year-round or seasonally in the waters of Southern New England are the sperm whale, right whale, fin whale, blue whale, and sei whale. The humpback whale, which may occur year-round, was recently delisted as an endangered species. These large whale species are generally migratory and typically do not spend extended periods of time in a localized area. The waters of Southern New England (including the Survey Area) are primarily used as areas where animals occur seasonally to feed, or as habitat during seasonal movements between the more northward feeding areas and southern hemisphere breeding grounds typically used by some of the large whale species (though some winter breeding areas exist further offshore vs. in the southerly latitudes). The mid-sized whale species (minke) and large baleen whales, and the sperm whale are present year-round in the continental shelf and slope waters and may occur in the waters of the Survey Area though movements will vary with prey availability and other habitat factors. The fin and right whales have the greater potential to occur within the offshore portions of the Survey Area however, the

sperm, blue, sei and humpback whales can also occur. In particular, while sperm whales are known to occur occasionally in the region, their sightings are considered rare and thus their presence in the Survey Area at the time of the proposed activities is considered unlikely. However, based on a recent increase in sightings, they are included in the discussion below. Because the potential for the blue whale to occur within the Survey Area during the marine survey period is the least likely, this species will not be described further in this analysis.

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 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 whales, bottlenose, short-beaked common, Atlantic white-sided, Atlantic spotted, and Risso's dolphins, harbor porpoise, and gray and harbor seals (BOEM 2014). White-beaked dolphins are likely to occur in the nearby waters surrounding the Survey Area (i.e., within 40 nautical miles [nm, 74 km]), but not in the Survey Area, and beaked whales are likely to occur in the region to the south of the Survey Area, but not within 40 nm (74 km) (Right Whale Consortium 2014). While 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. In general, the remaining non-ESA mammal species listed in Table 3-1 range outside the Survey Area, usually in more pelagic waters, or are so rarely sighted that their presence in the Survey Area is unlikely.

4.1 Toothed Whales (Odontoceti)

4.1.1 Sperm Whale (*Physeter macrocephalus*) – Endangered

Currently, there is no reliable estimate for the total number of sperm whales worldwide. The best estimate is that there are between 300,000 and 450,000 sperm whales, based on extrapolations from only a few areas that have useful estimates (NOAA Fisheries 2015). Estimates show about 1,665 in the northern Gulf of Mexico, 14,000 in the North Atlantic, 80,000 in the North Pacific, and 9,500 in the Antarctic (NOAA Fisheries 2006; Waring et al. 2009). For the North Atlantic, the minimum population size has been estimated at 1,815 individuals (Hayes et al. 2017).

Sperm whales are highly social, with a basic social unit consisting of 20 to 40 adult females, calves, and some juveniles (Rice 1989; Whitehead 2008). During their prime breeding period and old age, male sperm whales are essentially solitary. Males rejoin or find nursery groups during prime breeding season. While foraging, the whales typically gather in small clusters. Between diving bouts, sperm whales are known to raft together at the surface. Adult males often forage alone. Groups of females may spread out over distances greater than 0.5 nm when foraging. When socializing, they generally gather into larger surface-active groups (Jefferson et al. 2008; Whitehead 2003). In the Northern Hemisphere, the peak breeding season for sperm whales occurs between March and June, and in the Southern Hemisphere, the peak breeding season occurs between October and December (NOAA Fisheries 2009).

This species primarily preys on squid and octopus and are also known to prey on fish, such as lumpsuckers and redfish. Although sperm whales are generalists in terms of prey, specialization does appear to occur in a few places. The main sperm whale feeding grounds are correlated with increased primary productivity caused by upwelling.

The sperm whale is thought to have a more extensive distribution than any other marine mammal, except possibly the killer whale. This species is found in polar to tropical waters in all oceans, from approximately 70° N to 70° S (Rice 1989; Whitehead 2003). It ranges throughout all deep oceans of the world, essentially from equatorial zones to the edges of the polar pack ice. In the Atlantic, sperm whales are found throughout the Gulf Stream and North Central Atlantic Gyre. The current abundance estimate for this species in the North Atlantic is 2,288 individuals. The species is listed as Endangered (Hayes et al. 2017).

Sperm whales show a strong preference for deep waters (Rice 1989; Whitehead 2003). Their distribution is typically associated with waters over the continental shelf break and the continental slope and into deeper waters (Jefferson et al. 2008; Whitehead et al. 1992). 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 (NYDOS 2013). 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; Whitehead 2003).

4.1.2 Long-Finned Pilot Whale (*Globicephala melas*) – Non-Strategic

The long-finned pilot whale is more 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. This species is split between two subspecies: the Northern and Southern subspecies. The Southern subspecies is circumpolar with northern limits of Brazil and South Africa. The Northern subspecies, which could be encountered during survey operations, ranges from North Carolina to Greenland (Reeves et al. 2002; Wilson and Ruff 1999). 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) (CETAP 1982; Payne and Heinemann 1993). The best population estimate for long-finned pilot whales in the western North Atlantic is 5,636 individuals (Hayes et al. 2017; Waring et al. 2016).

They feed preferentially on squid but will eat fish (e.g., herring) and invertebrates (e.g., octopus, cuttlefish) if squid are not available. They also ingest shrimp (particularly younger whales) and various other fish species occasionally. These whales probably take most of their prey at depths of 600 to 1,650 feet (200 to 500 meters), although they can forage deeper if necessary (Reeves et al. 2002). A very social species, long-finned pilot whales travel in pods of roughly 20 individuals while following prey. These small pods are thought to be formed around adult females and their offspring. Behaviors of long-finned pilot whales range from quiet rafting or milling on the surface, to purposeful diving, to bouts of playfulness.

The long-finned pilot whales are subject to bycatch during sink gillnet fishing, pelagic trawling, and pelagic longline fishing. Approximately 215 pilot whales were killed or seriously injured each year by human activities during 1997 to 2001 (Waring et al. 2010). From 2007 through 2011, the total observed fishery-related mortality was 44 individuals (Waring et al. 2014). From 2009 through 2013, the total observed fishery-related mortality was 31 individuals (Waring et al. 2016). From 2010 to 2014, the total annual observed average fishery-related mortality or serious injury is 38 pilot whales (Hayes et al. 2017). Strandings involving hundreds of individuals are not unusual and demonstrate that these large schools have a high degree of social cohesion (Reeves et al. 2002). From 2010 through 2014, 27 long-finned pilot

whales, and 5 unspecified pilot whales were reported as stranded between Maine and Florida (Hayes et al. 2017). The species is considered "strategic" under the MMPA by NOAA Fisheries because the mean annual human-cause mortality and serious injury exceeds the Potential Biological Removal (Hayes et al. 2017).

4.1.3 Harbor Porpoise (*Phocoena phocoena*) – Non-Strategic

The harbor porpoise inhabits shallow, coastal waters, often found in bays, estuaries, and harbors. In the western Atlantic, they are found from Cape Hatteras north to Greenland. They are likely to occur frequently in southern New England waters within all seasons but are most likely to reach their highest densities in spring when migration brings them toward the Gulf of Maine feeding grounds from their wintering areas offshore and in the mid-Atlantic (Kenney and Vigness-Raposa 2009). After April, they migrate north towards the Gulf of Maine and Bay of Fundy. Kenney and Vigness-Raposa (2009) report that harbor porpoises are among the most abundant cetaceans in southern New England coastal waters. Harbor porpoises are the smallest North Atlantic cetacean, measuring at only 1.4 to 1.9 m, and feed primarily on fish, but also prey on squid and crustaceans (Reeves and Read 2003; Kenney and Vigness-Raposa 2009). Sighting records from the 1978 to 1981 Cetacean and Turtle Assessment Program (CeTAP) surveys showed porpoises in spring exhibited highest densities in the southwestern Gulf of Maine in proximity to the Nantucket Shoals and western Georges Bank, with presence throughout the southern New England shelf and Gulf of Maine (CeTAP 1982). It has been noted that harbor porpoises display avoidance behavior to sound greater than 140 dB re 1 µPa and tend to avoid vessels at sea (Barlow 1988; Palka and Hammond, 2001; Dyndo et al. 2015). While strandings have occurred throughout the south shore of Long Island and coastal Rhode Island, many sightings have occurred offshore in the OCS area (Kenney and Vigness-Raposa 2009). The North Atlantic harbor porpoise population is likely to be over 500,000 (Kenney and Vigness-Raposa 2009). The current population estimate for harbor porpoise in the Gulf of Maine/Bay of Fundy is 79,833 (Hayes et al. 2017; 2018).

The most common threat to the harbor porpoise is from incidental mortality from fishing activities, especially from bottom-set gillnets. It has been demonstrated that the porpoise echolocation system is capable of detecting net fibers, but they either must not have the "system activated" or else they fail to recognize the nets (Reeves et al. 2002). Roughly 307 harbor porpoises are killed by human-related activities in U.S. and Canadian waters each year (Hayes et al. 2018). In 1999, a Take Reduction Plan to reduce harbor porpoise bycatch in U.S. Atlantic gillnets was implemented. The plan that pertains to the Gulf of Maine focuses on sink gillnets and other gillnets that can catch groundfish in New England waters. The ruling implements time and area closures, some of which are complete closures, as well as requiring pingers on multispecies gillnets. In 2001, the harbor porpoise was removed from the candidate species list for the ESA; a review of the biological status of the stock indicated that a classification of "Threatened" was not warranted (Waring et al. 2009). This species has been listed as "non-strategic" because average annual human-related mortality and injury does not exceed the potential biological removal (Waring et al. 2015; Hayes et al. 2018).

4.1.4 Bottlenose Dolphin (*Tursiops truncatus*) – Non-Strategic

The bottlenose dolphin is a light- to slate-gray dolphin, roughly 8 to 12 ft (2.4 to 3.7 m) long with a short, stubby beak. Because this species occupies a wide variety of habitats, it is regarded as possibly the most adaptable cetacean (Reeves et al. 2002). It occurs in oceans and peripheral seas at both tropical and temperate latitudes. In North America, bottlenose dolphins are found in surface waters with temperatures ranging from 10 to 32°C (50 to 90°F). Its hearing is in the mid-frequency range (Southall et al. 2007).

There are two distinct bottlenose dolphin morphotypes: migratory coastal and offshore. 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. 2016). 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. 2016). These animals often move into or reside in bays, estuaries, the lower reaches of rivers, and coastal waters within the approximate 25 m depth isobath north of Cape Hatteras (Reeves et al. 2002; Waring et al. 2016).

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. 2016; Hayes et al. 2017; 2018). The offshore population extends along the entire continental shelf-break from Georges Bank to Florida during the spring and summer months, and has been observed in the Gulf of Maine during the late summer and fall. However, the range of the offshore morphotype south of Cape Hatteras has recently been found to overlap with that of the migratory coastal morphotype, sampled as close as 7.3 km (4.5 miles) from the shore in water depths of 13 m (42.7 feet) (Waring et al. 2016; Hayes et al. 2017). While bottlenose dolphins have the potential to occur in the waters off southern New England, most sightings have been during summer months and in waters deeper than 40 to 50 m (131 to 164 ft; Kenney 2013). NOAA Fisheries species stock assessment report estimates the population of Western North Atlantic offshore bottlenose dolphin stock at approximately 77,532 individuals and the Western North Atlantic migratory coastal stock at approximately 6,639 individuals (Waring et al. 2016; Hayes et al. 2017; 2018).

Bottlenose dolphins feed on a large variety of organisms, depending on their habitat. The coastal, shallow population tends to feed on benthic fish and invertebrates, while deepwater populations consume pelagic or mesopelagic fish such as croakers, sea trout, mackerel, mullet, and squid (Reeves et al. 2002). Bottlenose dolphins appear to be active both during the day and night. Their activities are influenced by the seasons, time of day, tidal state, and physiological factors such as reproductive seasonality (Wells and Scott 2002).

The biggest threat to the population is bycatch because they are frequently caught in fishing gear, gillnets, purse seines, and shrimp trawls (Waring et al. 2016). They have also been adversely impacted by pollution, habitat alteration, boat collisions, human disturbance, and are subject to bioaccumulation of toxins. Scientists have found a strong correlation between dolphins with elevated levels of PCBs and illness, indicating certain pollutants may weaken their immune system (ACSonline 2004). Total U.S. fishery related mortality and serious injury for this stock is less than 10 percent of the calculated potential biological removal and, therefore, can be considered to be insignificant and approaching the zero mortality and serious injury rate. NOAA Fisheries considers this species as “non-strategic” (Hayes et al. 2018).

4.1.5 Atlantic White-Sided Dolphin (*Lagenorhynchus acutus*) – Non-Strategic

The Atlantic white-sided dolphin is typically found at a depth of 330 ft (100 m) in the cool temperate and subpolar waters of the North Atlantic, generally along the continental shelf between the Gulf Stream and the Labrador current to as far south as North Carolina (Bulloch 1993; Reeves et al. 2002; Jefferson et al. 2008). They are the most abundant dolphin in the Gulf of Maine and the Gulf of St. Lawrence but seem relatively rare along the North Atlantic coast of Nova Scotia (Kenney and Vigness-Raposa 2009).

Atlantic white-sided dolphins range between 8 and 9 ft (2.5 and 2.8 m) in length, with females being approximately 20 centimeters shorter than males (Kenney and Vigness-Raposa 2009). This species is highly social and is commonly seen feeding with fin whales (NOAA 1993). White-sided dolphins feed on a variety of small species, such as herring, hake, smelt, capelin, cod, and squid, with regional and seasonal changes in the species consumed (Kenney and Vigness-Raposa 2009). Sand lance is an important prey species for these dolphins in the Gulf of Maine during the spring. Other fish prey include mackerel, silver hake, herring, smelt, and several other varieties of gadoids (Kenney and Vigness-Raposa 2009). There are seasonal shifts in the distribution of Atlantic white-sided dolphins off the northeastern U.S. coast, with low abundance in winter between Georges Basin and Jeffrey's Ledge and very high abundance in the Gulf of Maine during spring. During the summer, Atlantic white-sided dolphins are most abundant between Cape Cod and the lower Bay of Fundy. During the fall, the distribution of Atlantic white-sided dolphins is similar to that in the summer, although they are less abundant (DoN 2005). Recent population estimates for Atlantic white-sided dolphins in the Western North Atlantic Ocean places this species at 48,819 individuals (Hayes et al. 2017). This species can be found off the coast of southern New England during all seasons of the year but is usually most numerous in areas farther offshore at depth range of 330 ft (100 m) (Kenney and Vigness-Raposa 2009; Bulloch 1993; Reeves et al. 2002).

The biggest human-induced threat to the Atlantic white-sided dolphin is bycatch, because they are occasionally caught in fishing gillnets and trawling equipment. An estimated average of 328 dolphins each year were killed by fishery-related activities during 2003 to 2007 (Waring et al. 2010). From 2008 through 2012, an estimated annual average of 116 dolphins per year were killed (Waring et al. 2015), and from 2011 through 2015, the estimate decreased to 56 individuals annually (Hayes et al. 2018). Average annual fishery-related mortality and serious injury does not exceed the potential biological removal for this species; therefore, NOAA Fisheries considers this species as "non-strategic" (Waring et al. 2011; 2015; Hayes et al. 2018).

4.1.6 Short-Beaked Common Dolphin (*Delphinus delphis*) – Non-Strategic

The short-beaked dolphin is one of the most widely distributed cetaceans and occurs in temperate, tropical, and subtropical regions (Jefferson et al. 2008). Short-beaked dolphins feed on squids and small fish, including species that school in proximity to surface waters as well as mesopelagic species found near the surface at night (World Conservation Union [IUCN] 2010; NatureServe 2010). They have been known to feed on fish escaping from fishermen's nets or fish that are discarded from boats (NOAA 1993). This species is found between Cape Hatteras and Georges Bank from mid-January to May, although they migrate onto Georges Bank and the Scotian Shelf between mid-summer and fall, where large aggregations occur on Georges Bank in fall (Waring et al. 2007). These dolphins can gather in schools of hundreds or thousands, although the schools generally consist of smaller groups of 30 or fewer. They are eager bow riders and are active at the surface (Reeves et al. 2002). The short-beaked common dolphin feeds on small schooling fish and squid. While this dolphin species can occupy a variety of habitats, short-beaked common dolphins occur in greatest abundance within a broad band of the northeast edge of Georges Bank in the fall (Kenney and Vigness-Raposa 2009). According to the species stock report, the best population estimate for the western North Atlantic common dolphin is approximately 70,184 individuals (Hayes et al. 2017; 2018).

Short-beaked common dolphins can be found either along the 650- to 6,500-ft (200- to 2,000-m) isobaths over the continental shelf and in pelagic waters of the Atlantic and Pacific Oceans. They are present in the western Atlantic from Newfoundland to Florida. The short-beaked common dolphin is especially common along shelf edges and in areas with sharp bottom relief such as seamounts and escarpments (Reeves et

al. 2002). They show a strong affinity for areas with warm, saline surface waters. Off the coast of the eastern United States, they are particularly abundant in continental slope waters from Georges Bank southward to about 35 degrees north (Reeves et al. 2002) and usually inhabit tropical, subtropical, and warm-temperate waters (Waring et al. 2009).

The short-beaked common dolphin is also subject to bycatch. It has been caught in gillnets, pelagic trawls, and during longline fishery activities. During 2008 to 2012, it was estimated that on average approximately 289 dolphins were killed each year by human activities (Waring et al. 2015). This number increased to 437 dolphins during 2011 to 2015 (Hayes et al. 2018). This species is also the most common dolphin species to be stranded along the southern New England Coast (Kenney and Vigness-Raposa 2009). Average annual fishery-related mortality and serious injury does not exceed the potential biological removal for this species; therefore, NOAA Fisheries considers this species as “non-strategic” (Waring et al. 2009; 2010; 2015; Hayes et al. 2018).

4.1.7 Atlantic Spotted Dolphin (*Stenella frontalis*) – Non-Strategic

There are two species of spotted dolphin in the Atlantic Ocean, the Atlantic spotted dolphin (*Stenella frontalis*) and the pantropical spotted dolphin (*S. attenuata*) (Perrin et al. 1987). In addition, two forms of the Atlantic spotted dolphin exist: one that is large and heavily spotted and usually inhabits the continental shelf, and the other is smaller in size with less spots and occurs in the Atlantic Ocean but is not known to occur in the Gulf of Mexico (Fulling et al. 2003; Mullin and Fulling 2003; Mullin and Fulling 2004; Viricel and Rosel 2014). Where they co-occur, the offshore form of the Atlantic spotted dolphin and the pantropical spotted dolphin can be difficult to differentiate (Waring et al. 2016).

The Atlantic spotted dolphin prefers tropical to warm temperate waters along the continental shelf 10 to 200 meters (33 to 650 feet) deep to slope waters greater than 500 meters (1640 feet) deep. It has been suggested that the species may move inshore seasonally during the spring, but data to support this theory is limited (Caldwell and Caldwell 1966; Fritts et al. 1983). The Atlantic spotted dolphin diet consists of a wide variety of fish and squid, as well as benthic invertebrates (Herzing 1997). Its hearing is in the mid-frequency range (Southall et al. 2007). According to the species stock report, the best population estimate for the Atlantic spotted dolphin is approximately 44,715 individuals (Hayes et al. 2017).

No fishing-related mortality of spotted dolphin was reported for 1998 through 2003 (Yeung, 1999; Yeung 2001; Garrison 2003; Garrison and Richards 2004). From 2007 through 2011, the estimated mean annual fishery-related mortality and serious injury for this story was 42 Atlantic spotted dolphins (Waring et. al 2016). More recent observer data are not available. The commercial fisheries that interact or potentially interact with the Atlantic spotted dolphin are the pelagic longline fishery and the shrimp trawl fishery (Waring et. al 2016). A total of 16 Atlantic spotted dolphins were reported stranded in the Gulf of Mexico between 2009 and 2013. NOAA Fisheries considers this species as “non-strategic” (Waring et al. 2016).

4.1.8 Risso’s Dolphin (*Grampus griseus*) – Non-Strategic

Risso’s dolphins are commonly found in the deeper waters of the U.S. east coast continental shelf edge and oceanic waters ranging from Cape Hateras to Georges Bank, mainly during spring, summer and autumn (Cetacean and Turtles Assessment Program [CETAP] 1982; Payne et al. 1984). There is currently no information on stock structure of this species for western North Atlantic; therefore, it is not possible to determine if separate stocks exist in the Gulf of Mexico and Atlantic (Hayes et al. 2018). The best estimate

of abundance for the stock of Risso's dolphins is 18,250 animals (Hayes et al. 2018; Waring et al. 2014; 2016). There are insufficient data to determine the population trend for this stock.

Risso's dolphins have been subject to bycatch during squid and mackerel trawl activities, pelagic drift gillnet activities, pelagic pair trawl fishery, and mid-Atlantic gillnet fishery (Hayes et al. 2018). Average annual fishery-related mortality and serious injury between 2007 and 2011 was 62 dolphins (Waring et al. 2014). From 2009 to 2013, the average annual fishery-related mortality and serious injury was 54 dolphins (Waring et al. 2016). From 2011 to 2015, the estimated annual average fishery-related mortality or serious injury was 43.2 Risso's dolphins (Hayes et al. 2018). Risso's dolphin strandings have also been observed, and between 2010 and 2014 30 strandings were recorded along the U.S. Atlantic coast. NOAA Fisheries does not consider this species as "strategic."

4.2 Baleen Whales (Mysticeti)

4.2.1 North Atlantic Right Whale (*Eubalaena glacialis*) – Endangered

The North Atlantic right whale was listed as a federal endangered species in 1970. The North Atlantic right whale has seen a nominal 2 percent recovery rate since it was listed as a protected species (NOAA 2015). This is a drastic difference from the stock found in the Southern Hemisphere, which has increased at a rate of 7 to 8 percent (Knowlton and Kraus 2001). Right whales are considered grazers as they swim slowly with their mouths open. They are the slowest swimming whales and can only reach speeds up to 10 miles (mi) (16 km) per hour. They can dive at least 1,000 ft (300 m) and stay submerged for typically 10 to 15 minutes, feeding on their prey below the surface (ACSonline 2004). Right whales' hearing is in the low-frequency range (Southall et al. 2007).

The right whale is a strongly migratory species that moves annually between high-latitude feeding grounds and low-latitude calving and breeding grounds. The present range of the western North Atlantic right whale population extends from the southeastern United States, which is utilized for wintering and calving, to summer feeding and nursery grounds between New England and the Bay of Fundy and the Gulf of St. Lawrence (Kenney 2002; Waring et al. 2011). The winter distribution of North Atlantic right whales is largely unknown, although offshore surveys have reported 1 to 13 detections annually in northeastern Florida and southeastern Georgia (Waring et al. 2013). A few events of right whale calving have been documented from shallow coastal areas and bays (Kenney 2002). Some evidence provided through acoustic monitoring suggests that not all individuals of the population participate in annual migrations, with a continuous presence of right whales occupying their entire habitat range throughout the year, particularly north of Cape Hatteras (Davis et al. 2017). These data also recognize changes in population distribution throughout the right whale habitat range that could be due to environmental or anthropogenic effects, a response to short-term changes in the environment, or a longer-term shift in the right whale distribution cycle (Davis et al. 2017).

Observations in December 2008 noted congregations of more than 40 individual right whales in the Jordan Basin area of the Gulf of Maine, leading researchers to believe this may be a wintering ground (NOAA 2008). A right whale satellite tracking study within the northeast Atlantic (Baumgartner and Mate 2005) reported that this species often visited waters exhibiting low bottom water temperatures, high surface salinity, and high surface stratification, most likely for higher food densities. The winter distribution of North Atlantic right whales is largely unknown, although offshore surveys have reported between one and 13 detections annually in northeastern Florida and southeastern Georgia (Waring et al. 2007). A few documented events of right whale calving have been from shallow coastal areas and bays (Kenney 2002).

North Atlantic right whales may be found in feeding grounds within New England waters between February and May, with peak abundance in late March (NOAA 2005). While in New England, right whales feed mostly on copepods belonging to the *Calanus* and *Pseudocalanus* genus (Waring et al. 2015).

The North Atlantic right whale was the first species targeted during commercial whaling operations and was the first species to be greatly depleted as a result of whaling operations (Kenney 2002). North Atlantic right whales were hunted in southern New England until the early twentieth century. Shore-based whaling in Long Island involved catches of right whales year-round, with peak catches in spring during the northbound migration from calving grounds off the southeastern United States to feeding grounds in the Gulf of Maine (Kenney and Vigness-Raposa 2009). Abundance estimates for the North Atlantic right whale population vary. From the 2003 United States Atlantic and Gulf of Mexico Marine Mammal Stock Assessments, there were only 291 North Atlantic right whales in existence, which is less than what was reported in the Northern Right Whale Recovery Plan written in 1991 (NOAA Fisheries 1991a; Waring et al. 2004). This is a tremendous difference from pre-exploitation numbers, which are thought to be more than 1,000 individuals. When the right whale was finally protected in the 1930s, it is believed that the North Atlantic right whale population was roughly 100 individuals (Waring et al. 2004). In 2015, the Western North Atlantic population size was estimated to be at least 476 individuals (Waring et al. 2016). That population size estimate decreased to 458 individuals in 2017 (Hayes et al. 2018). Additional information provided by Pace et al. (2017), confirms that the probability that the North Atlantic right whale population has declined since 2010 is 99.99 percent. Data indicates that the number of adult females dropped from 200 in 2010 down to 186 in 2015 while males dropped from 283 to 272 in the same timeframe. Also cause for concern is the confirmed mortality of 17 individuals so far in 2017 alone (NOAA 2017; Pace et al. 2017).

Contemporary anthropogenic threats to right whale populations include fishery entanglements and vessel strikes, although habitat loss, pollution, anthropogenic noise, and intense commercial fishing may also negatively impact their populations (Kenney 2002). Entanglements can represent a significant energy expenditure for large whales, leading to injury or death if disentanglement efforts are not successful within a critical time period (van der Hoop et al. 2017; van der Hoop et al. 2016). Such energy expenditures can have significant sub-lethal impacts to right whales, particularly reproductive females where time for reproduction could be delayed for months or years (van der Hoop et al. 2016). Recovery from entanglements and subsequent energy losses resulting in physiological stress could limit reproductive success and contribute to fluctuations in population growth (van der Hoop et al. 2016). Unfortunately, evidence suggests that recent efforts to reduce entanglement through fishing gear modification have not resulted in decline of frequencies of entanglement or serious injury due to entanglement (Pace et al. 2014). Between 2002 and 2006, a study of marine mammal stranding and human-induced interactions reported that right whales in the western Atlantic were subject to the highest proportion of entanglements (25 of 145 confirmed events) and ship strikes (16 of 43 confirmed occurrences) of any marine mammal studied (Glass et al. 2008). Bycatch of North Atlantic right whale has also been reported in pelagic drift gillnet operations by the Northeast Fisheries Observer Program, however, no mortalities have been reported (Glass et al. 2008). From 2011 through 2015, the minimum rate of annual human-caused mortality and serious injury to this species averaged 5.36 per year (Hayes et al. 2018). Environmental fluctuations and anthropogenic disturbance may be contributing to a decline in overall health of individual North Atlantic right whales that has been occurring for the last 3 decades (Rolland et al. 2016). The NOAA marine mammal stock assessment for 2014 reports that the low annual reproductive rate of right whales, coupled with small population size, suggests anthropogenic mortality may have a greater impact on population growth rates for the species than for other whales (Waring et al. 2016).

Ship strikes of individuals can impact northern right whales on a population level due to the intrinsically small remnant population that persists in the North Atlantic (Laist et al. 2001). Most ship strikes are fatal to the North Atlantic right whales (Jensen and Silber 2004). Right whales have difficulty maneuvering around boats and spend most of their time at the surface, feeding, resting, mating, and nursing, increasing their vulnerability to collisions. Mariners should assume that North Atlantic right whales will not move out of their way nor will they be easy to detect from the bow of a ship for they are dark in color and maintain a low profile while swimming (World Wildlife Fund 2005). To address potential for ship strike, NOAA Fisheries designated the nearshore waters of the Mid-Atlantic Bight as the Mid-Atlantic U.S. Seasonal Management Area (SMA) for right whales. NOAA Fisheries requires that all vessels 65 ft (19.8 m) or longer must travel at 10 knots or less within the right whale SMA from November 1 through April 30 when right whales are most likely to pass through these waters (NOAA 2010). The most recent stock assessment report noted that studies by van der Hoop et al. (2015) have concluded large whale vessel strike mortalities decreased inside active SMAs but have increased outside inactive SMAs. The proposed survey area has components located both within and outside of the right whale Block Island SMA located in the waters between Long Island, New York, and Martha's Vineyard, Massachusetts and the New York Bight SMA located at the entrance to New York Harbor, in the waters between New Jersey and New York.

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).

4.2.2 Humpback Whale (*Megaptera novaeangliae*) – Non-Strategic

The humpback whale was listed as endangered in 1970 due to population decrease resulting from overharvesting; however, this species was delisted as threatened or endangered as of September 8, 2016 (81 FR 62259). Humpback whales feed on small prey that is often found in large concentrations, including krill and fish such as herring and sand lance (Waring et al. 2007; Kenney and Vigness-Raposa 2009). Humpback whales are thought to feed mainly while migrating and in summer feeding areas; little feeding is known to occur in their wintering grounds. Humpbacks feed over the continental shelf in the North Atlantic between New Jersey and Greenland, consuming roughly 95 percent small schooling fish and 5 percent zooplankton (i.e., krill), and they will migrate throughout their summer habitat to locate prey (Kenney and Winn 1986). They swim below the thermocline to pursue their prey, so even though the surface temperatures might be warm, they are frequently swimming in cold water (NOAA Fisheries 1991b). Humpback whales from all of the North Atlantic migrate to the Caribbean in winter, where calves are born between January and March (Blaylock et al. 1995).

Humpback whales exhibit consistent fidelity to feeding areas within the northern hemisphere (Stevick et al. 2006). There are six subpopulations of humpback whales that feed in six different areas during spring, summer, and fall. These feeding populations can be found in the Gulf of Maine, the Gulf of St. Lawrence, Newfoundland/Labrador, western Greenland, Iceland, and Norway (Waring et al. 2015). The highest abundance for humpback whales is distributed primarily along a relatively narrow corridor following the 328-ft (100-m) isobath across the southern Gulf of Maine from the northwestern slope of Georges Bank, south to the Great South Channel, and northward alongside Cape Cod to Stellwagen Bank and Jeffreys Ledge. In winter, whales from waters off New England, Canada, Greenland, Iceland, and Norway migrate to mate and calve primarily in the West Indies (including the Antilles, the Dominican Republic, the Virgin Islands and Puerto Rico), where spatial and genetic mixing among these groups occurs (Waring et al. 2015). While migrating, humpback whales utilize the mid-Atlantic as a migration pathway between

calving/mating grounds to the south and feeding grounds in the north (Waring et al. 2007). Since 1989, observations of juvenile humpbacks in the Mid-Atlantic have been increasing during the winter months, peaking January through March (Swingle et al. 1993). Biologists theorize that non-reproductive animals may be establishing a winter feeding range in the Mid-Atlantic since they are not participating in reproductive behavior in the Caribbean. Swingle et al. (1993) identified a shift in distribution of juvenile humpback whales in the nearshore waters of Virginia, primarily in winter months.

Humpback whales were hunted as early as the seventeenth century, with most whaling operations having occurred in the nineteenth century (Kenney and Vigness-Raposa 2009). Before whaling activities, it was thought that the abundance of whales in the North Atlantic stock was in excess of 15,000 (Nowak 2002). By 1932, commercial hunting within the North Atlantic may have reduced the humpback whale population to as little as 700 individuals (Breiwick et al. 1983). Humpback whales were commercially exploited by whalers throughout their whole range until they were protected in the North Atlantic in 1955 by the International Whaling Commission (IWC) ban. Humpback whaling ended worldwide in 1966 (NatureServe 2010). Contemporary anthropogenic threats to humpback whales include fishery entanglements and vessel strikes. Glass et al. (2008) reported that between 2002 and 2006, humpback whales belonging to the Gulf of Maine population were involved in 77 confirmed entanglements with fishery equipment and nine confirmed ship strikes. Humpback whales that were entangled exhibited the highest number of serious injury events of the six species of whale studied by Glass et al. (2008). A whale mortality and serious injury study conducted by Nelson et al. (2007) reported that the minimum annual rate of anthropogenic mortality and serious injury to humpback whales occupying the Gulf of Maine was 4.2 individuals per year. During this study period, humpback whales were involved in 70 reported entanglements and 12 vessel strikes, and were the most common dead species reported. This number has increased to 8.25 animals per year between 2011 and 2015 (Hayes et al. 2018). Entanglements can represent a significant energy expenditure for large whales, leading to injury or death if disentanglement efforts are not successful within a critical time period (van der Hoop et al. 2017; van der Hoop et al. 2016). Such energy expenditures can have significant sub-lethal impacts, particularly to reproductive females where time for reproduction could be delayed for months or years (van der Hoop et al. 2016). Recovery from entanglements and subsequent energy losses resulting in physiological stress could limit reproductive success and contribute to fluctuations in population growth (van der Hoop et al. 2016). Unfortunately, evidence suggests that recent efforts to reduce large whale entanglement through fishing gear modification have not resulted in decline of frequencies of entanglement or serious injury due to entanglement (Pace et al. 2014). The humpback whale population within the North Atlantic has been estimated to include approximately 11,570 individuals (Waring et al. 2015). Through photographic population estimates, humpback whales within the Gulf of Maine (the only region where these whales summer in the United States) have been estimated to consist of 600 individuals in 1979 (NOAA Fisheries 1991b). According to the species stock assessment report, the best estimate of abundance for the Gulf of Maine stock of humpback whales is, at a minimum, 335 individuals (Hayes et al. 2018).

Humpbacks occur off southern New England in all four seasons, with peak abundance in spring and summer.

4.2.3 Fin Whale (*Balaenoptera physalus*) – Endangered

The fin whale was listed as federally endangered in 1970. Fin whales' range in the North Atlantic extends from the Gulf of Mexico, Caribbean Sea, and Mediterranean Sea in the south to Greenland, Iceland, and Norway in the north (Jonsgård 1966; Gambell 1985). They are the most commonly sighted large whales in

continental shelf waters from the Mid-Atlantic coast of the United States to Nova Scotia (Sergeant 1977; Sutcliffe and Brodie 1977; CETAP 1982; Hain et al. 1992; Waring et al. 2008). Fin whales, much like humpback whales, seem to exhibit habitat fidelity (Waring et al. 2007; Kenney and Vigness-Raposa 2009). However, fin whales habitat use has shifted in the southern Gulf of Maine, most likely due to changes in the abundance of sand lance and herring, both of which are major prey species along with squid, krill, and copepods (Kenney and Vigness-Raposa 2009). While fin whales typically feed in the Gulf of Maine and the waters surrounding New England, mating and calving (and general wintering) areas are largely unknown (Waring et al. 2007). The overall pattern of fin whale movement is complex, consisting of a less obvious north-south pattern of migration than that of right and humpback whales. Based on acoustic recordings from hydrophone arrays, Clark (1995) reported a general southward flow pattern of fin whales in the fall from the Labrador/Newfoundland region, past Bermuda, and into the West Indies. The overall distribution may be based on prey availability, as this species preys opportunistically on both invertebrates and fish (Watkins et al. 1984). Fin whale abundance off the coast of the northeastern United States is highest between spring and fall, with some individuals remaining during the winter (Hain et al. 1992). A recent estimate of fin whale abundance conducted between Georges Bank and the Gulf of St. Lawrence during the feeding season in August 2006 places the western North Atlantic fin whale populations at 2,269 individuals (Waring et al. 2007). Fin whales are the second largest living whale species on the planet (Kenney and Vigness-Raposa 2009). The gestation period for fin whales is approximately 11 months and calve births occur between late fall and winter. Females can give birth every two to three years.

Present threats to fin whales are similar to other whale species, namely fishery entanglements and vessel strikes. Fin whales seem less likely to become entangled than other whale species. Glass et al. (2008) reported that between 2002 and 2006, fin whales belonging to the Gulf of Maine population were involved in only eight confirmed entanglements with fishery equipment. Furthermore, Nelson et al. (2007) reported that fin whales exhibited a low proportion of entanglements (eight reported events) during their 2001 to 2005 study along the western Atlantic. On the other hand, vessel strikes may be a more serious threat to fin whales. Eight and 10 confirmed vessel strikes with fin whales were reported by Glass et al. (2008) and Nelson et al. (2007), respectively. This level of incidence was similar to that exhibited by the other whales studied. Conversely, a study compiling whale/vessel strike reports from historical accounts, recent whale strandings, and anecdotal records by Laist et al. (2001) reported that of the 11 great whale species studied, fin whales were involved in collisions most frequently (31 in the United States and 16 in France). From 2008 to 2012, the minimum annual rate of mortality for the North Atlantic stock from anthropogenic causes was approximately 3.35 per year (Waring et al. 2015) while from 2011 to 2015, this number has decreased to 2.65 per year (Hayes et al. 2018). Increase in ambient noise has also impacted fin whales, for whales in the Mediterranean have demonstrated at least two different avoidance strategies after being disturbed by tracking vessels (Jahoda et al. 2003). The best abundance estimate available for the western North Atlantic fin whale stock is 1,618 (Hayes et al. 2017; 2018).

Fin whales are present in southern New England waters during all four seasons. In spring, summer, and fall, the main center of their distribution is in the Great South Channel area to the east of Cape Cod, which is a well-known feeding ground (Kenney and Winn 1986). Winter is the season of lowest overall abundance, but they do not depart the area entirely. Fin whales are the most common large whale encountered in continental shelf waters south of New England and into the Gulf of Maine. They are the whales most often encountered by local whale-watching operations in most years and are likely to occur in the Lease Area. The species is listed as Endangered due to the depletion of its population from whaling (Reeves et al.

1998). A recovery plan has been written and is available from the NOAA Fisheries for review (Waring et al. 2010; 2011).

4.2.4 Sei Whale (*Balaenoptera borealis*) – Endangered

The sei whale is a widespread species in the world's temperate, subpolar, subtropical, and tropical marine waters. 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. 2017). Sei whales occur in deep water characteristic of the continental shelf edge throughout their range (Hain et al. 1985). 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; 2016). The sei whale is most common on Georges Bank and into the Gulf of Maine/Bay of Fundy region during spring and summer, primarily in deeper waters.

Although sei whales may prey upon small schooling fish and squid, available information suggests that calanoid copepods and euphausiids are the primary prey of this species (Flinn et al. 2002). Sei whales are occasionally seen feeding in association with right whales in the southern Gulf of Maine and in the Bay of Fundy. However, there is no evidence to demonstrate interspecies competition between these species for food resources. Sei whales reach sexual maturity at 5-15 years of age. The calving interval is believed to be two to three years (Perry et al. 1999).

There is limited information on the stock identity of sei whales in the North Atlantic (Hayes et al. 2017). The best abundance estimate for the Nova Scotia stock of sei whales is 357; however, this estimate must be considered low and limited given the known range of the sei whale (Hayes et al. 2017; Waring et al. 2014; 2016). There are insufficient data to determine trends of the Nova Scotian sei whale population. From 2007 to 2011, the minimum annual rate of confirmed human-caused serious injury and mortality to Nova Scotian sei whales was 1.0 (Waring et al. 2014). From 2009 to 2013, this mortality rate was estimated 0.4 (Waring et al. 2016). From 2010 through 2014, the minimum annual rate of human-caused mortality and serious injury was 0.8 (Hayes et al. 2017). This species is listed as endangered under the ESA and is designated as depleted under the MMPA. A final recovery plan for the sei whale was published in 2011 (NOAA Fisheries 2011).

4.2.5 Minke Whale (*Balaenoptera acutorostrata*) – Non-Strategic

Minke whales are among the most widely distributed of all the baleen whales. They occur in the North Atlantic and North Pacific, from tropical to polar waters. Common minke whales range between 20 and 30 ft (6 and 9 m, with maximum lengths of 30 to 33 ft [9 to 10 m]) and are the smallest of the North Atlantic baleen whales (Jefferson et al. 1993; Wynne and Schwartz 1999; Kenney and Vigness-Raposa 2009). The primary prey species for minke whales are most likely sand lance, clupeids, gadoids, and mackerel (Kenney and Vigness-Raposa 2009). These whales basically feed below the surface of the water, and calves are usually not seen in adult feeding areas. Minke whales are almost absent from OCS waters off the western Atlantic in winter; however, they are common in the fall and abundant in spring and summer (CeTAP 1982; Kenney and Vigness-Raposa 2009). In the 2015 stock assessment, the estimate for minke whales in the Canadian East Coast stock was 20,741 (Waring et al. 2015). This population estimate substantially decreased to 2,591 individuals in the most recent stock assessment because estimates older than eight years were excluded from the newest estimate (Hayes et al., 2017; 2018). This new estimate should not be interpreted as a decline in abundance of this stock, as previous estimates are not directly comparable

(Hayes et al., 2018). Minke whales have been observed in southern New England waters during all four seasons.

As is typical of the baleen whales, minke whales are usually seen either alone or in small groups, although large aggregations sometimes occur in feeding areas (Reeves et al. 2002). Minke populations are often segregated by sex, age, or reproductive condition. Known for their curiosity, minke whales often approach boats.

Minke whales are impacted by ship strikes and bycatch from bottom trawls, lobster trap/pot, gillnet, and purse seine fisheries. From 2008 to 2012, the minimum annual rate of mortality for the North Atlantic stock from anthropogenic causes was approximately 9.9 per year (Waring et al. 2015), while from 2011 to 2015 this decreased to 9.15 per year (Hayes et al. 2018). In addition, hunting for Minke whales continues today, by Norway in the northeastern North Atlantic and by Japan in the North Pacific and Antarctic (Reeves et al. 2002). International trade in the species is currently banned. The best recent abundance estimate for this stock is 8,987 (Waring et al. 2011). Average annual fishery-related mortality and serious injury does not exceed the potential biological removal for this species; therefore, NOAA Fisheries considers this species as “non-strategic” (Waring et al. 2010; 2011; 2015; Hayes et al. 2018).

4.3 Earless Seals (Phocidae)

4.3.1 Harbor Seal (*Phoca vitulina*) – Non-Strategic

Harbor seals are the most abundant seals in eastern United States waters and are commonly found in all nearshore waters of the Atlantic Ocean and adjoining seas above northern Florida; however, their “normal” range is probably only south to New Jersey. 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). During the summer, most harbor seals can be found north of New York, within the coastal waters of central and northern Maine, as well as the Bay of Fundy (DoN 2005). Harbor seals are relatively small pinnipeds, with adults ranging between 5.6 and 6.2 ft (1.7 and 1.9 m) in length, with females being slightly smaller than males (Jefferson et al. 1993; Wynne and Schwartz 1999; Kenney and Vigness-Raposa 2009).

Harbor seals prey upon small to medium-sized fish, followed by octopus and squid, and lastly by shrimp and crabs (Kenney and Vigness-Raposa 2009). Fish eaten by harbor seals include commercially important species such as mackerel, herring, cod, hake, smelt, shad, sardines, anchovy, capelin, salmon, rockfish, sculpins, sand lance, trout, and flounders (Kenney and Vigness-Raposa 2009). They spend about 85 percent of the day diving, and much of the diving is presumed to be active foraging in the water column or on the seabed. They dive to depths of about 30 to 500 feet (10 to 150 meters), depending on location. Harbor seals forage in a variety of marine habitats, including deep fjords, coastal lagoons and estuaries, and high-energy, rocky coastal areas. They may also forage at the mouths of freshwater rivers and streams, occasionally traveling several hundred miles upstream (Reeves et al. 2002). They haul out on sandy and pebble beaches, intertidal rocks and ledges, and sandbars, and occasionally on ice floes in bays near calving glaciers.

Except for a strong bond between mothers and pups, harbor seals are generally intolerant of close contact with other seals. Nonetheless, they are gregarious, especially during the molting season, which occurs between spring and autumn, depending on geographic location. They may haul out to molt at a tide bar, sandy or cobble beach, or exposed intertidal reef. During this haulout period, they spend most of their time

sleeping, scratching, yawning, and scanning for potential predators such as humans, foxes, coyotes, bears, and raptors (Reeves et al. 2002). In late autumn and winter, harbor seals may be at sea continuously for several weeks or more, presumably feeding to recover body mass lost during the reproductive and molting seasons and to fatten up for the next breeding season (Reeves et al. 2002).

Historically, these seals have been hunted for several hundred to several thousand years. Harbor seals are still killed legally in Canada, Norway, and the United Kingdom to protect fish farms or local fisheries (Reeves et al. 2002). From 2011 to 2015, the average rate of mortality for the Western North Atlantic harbor seal stock from anthropogenic causes was approximately 368 per year (Hayes et al. 2018). Average annual fishery-related mortality and serious injury does not exceed the potential biological removal for this species; therefore, NOAA Fisheries considers this species as “non-strategic” (Waring et al. 2013; Hayes et al. 2018).

4.3.2 Gray Seal (*Halichoerus grypus*) – Non-Strategic

The gray seal occurs in cold temperate to sub-arctic waters in the North Atlantic, and is partitioned into three major populations occurring in eastern Canada, northwestern Europe, and the Baltic Sea (Jefferson et al. 2008; Kenney and Vigness-Raposa 2009). The western North Atlantic stock is considered to be the same population as the one found in eastern Canada, and ranges between New England and Labrador (Waring et al. 2007). As exhibited in harbor seal populations, gray seals occur most often in the waters off of Maine during winter and spring, and spend summer and fall off northern Maine and in Canadian waters (DoN 2005). Gray seals exhibit sexual dimorphism, with adult males reaching 7.5 ft (2.3 m) long and females reaching 6.6 ft (2.0 m) (Jefferson et al. 1993; Wynne and Schwartz 1999; Kenney and Vigness-Raposa 2009). The gray seal is primarily found in coastal waters and forages in OCS regions (Lesage and Hammill 2001).

Gray seals are gregarious, gathering to breed, molt, and rest in groups of several hundred or more at island coasts and beaches or on land-fast ice and pack-ice floes. They are thought to be solitary when feeding and telemetry data indicates that some seals may forage seasonally in waters close to colonies, while others may migrate long distances from their breeding areas to feed in pelagic waters between the breeding and molting seasons (Reeves et al. 2002). Gray seals molt in late spring or early summer and may spend several weeks ashore during this time. When feeding, most seals remain within 45 mi (72 km) of their haulout sites. Gray seals feed on numerous fish species and cephalopods (Kenney and Vigness-Raposa 2009). Gray seal scat samples from Muskeget Island, Massachusetts, included species such as sand lance, skates, flounder, silver hake, and gadids (Kenney and Vigness-Raposa 2009).

Gray seals form colonies on rocky island or mainland beaches, though some seals give birth in sea caves or on sea ice, especially in the Baltic Sea. Gray seals prefer haulout and breeding sites that are surrounded by rough seas and riptides where boating is hazardous. Pupping colonies have been identified at Muskeget Island (Nantucket Sound), Monomoy National Wildlife Refuge, and in eastern Maine (Rough 1995). Total western Atlantic gray seal population estimates are not currently available (Hayes et al. 2017). However, the gray seal colony of Massachusetts has more than 5,600 seals total and there are more than 1,700 individuals in Maine (Waring et al. 2007). This species has been reported with greater frequency in waters south of Cape Cod in recent years, likely due to a population rebound in southern New England and the mid-Atlantic (Kenney and Vigness-Raposa 2009); however, most gray seals present are juveniles dispersing in the spring. The only consistent haul-out locations within the vicinity of the Lease Area are along the sandy shoals around Monomoy and Nantucket in Massachusetts (Kenney and Vigness-Raposa 2009).

The biggest threats to gray seals are entanglements in gillnets or plastic debris (Waring et al. 2004). From 2006 to 2010, the total estimated human-caused mortality to gray seals was approximately 5,253 per year, which includes the removal of nuisance animals in Canada (Waring et al. 2015). For the period 2011 through 2015, the average annual mortality estimate decreased to 5,207 gray seals per year (Hayes et al. 2018). Average annual fishery-related mortality and serious injury does not exceed the potential biological removal for this species; therefore, NOAA Fisheries considers this species as “non-strategic” (Waring et al. 2015; Hayes et al. 2018).

5. Type of Incidental Taking Requested

The Applicant is requesting the authorization for potential non-lethal “taking” of small numbers of marine mammals to allow for incidental harassment resulting from the HRG survey activities. The request is based upon projected HRG survey activities during the anticipated survey schedule as stated in Section 2.1.

The potential underwater noise impacts of HRG survey equipment were evaluated under the criteria prescribed for PTS Onset in the Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammals (NOAA Fisheries 2016) to determine the potential for take by Level A harassment. To determine the potential for Level B harassment, the take criteria for impulsive noise (160 $dB_{RMS90\%}$ re 1 µPa) was applied.

5.1 HRG Survey Equipment Field Verification Results

Field verifications were completed within the Lease Areas during previous offshore site characterization survey activities:

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 within the 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).

As required by the Applicant’s regulatory permits, the purpose of the field verification programs was to determine the apparent sound source levels of several HRG activities. Far field measurement data were analyzed by linear regression. A key assumption of the linear regression method is that the acoustic propagation environment does not substantially change between measurement positions. The environment is characterized by the water depth, geoacoustic seabed properties, and sound speed profile in the water column. This method may also be used to extrapolate the apparent sound source.

High-resolution geophysical transducers have outputs that are a function of direction and are typically designed to produce an acoustic wave of a specific frequency. For different types of transducers, the beamwidths can vary from 180° (hemispherical) to a single degree swath. Typically, this directional capability increases with increasing operating frequency. For example, the 61 dB differential for the parametric sub-bottom profiler can be readily explained by the directional pattern and the very narrow sound beam pattern produced. For further clarification, the figure below presents the directivity pattern at the mean

primary frequency (100 kHz). In essence, the 'apparent' source level becomes a function of azimuthal angle off broadside.

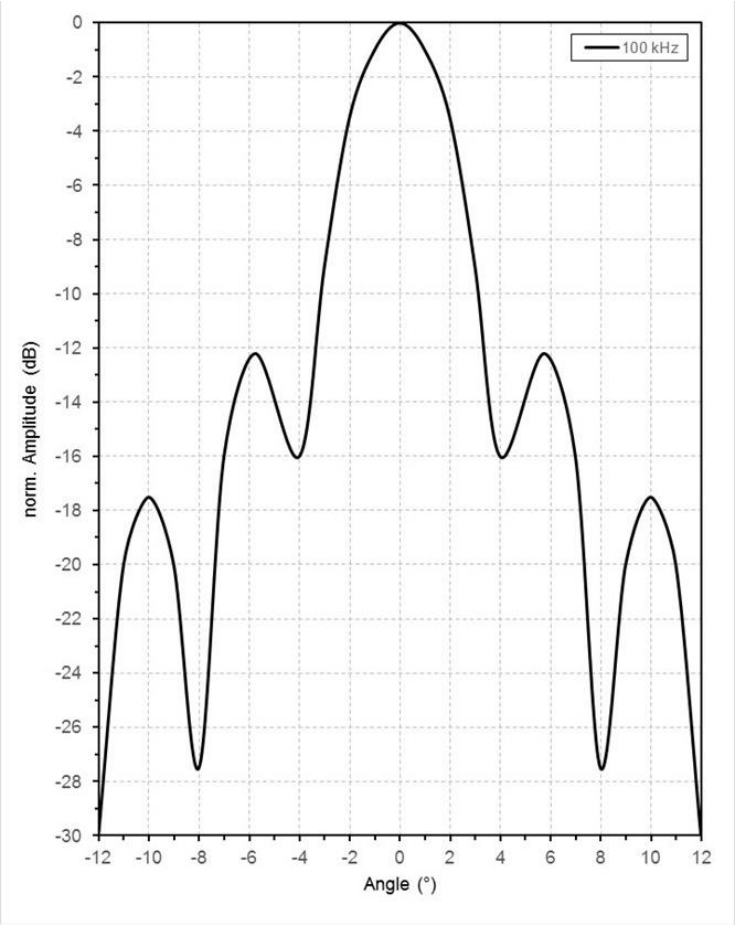

Figure 5-1 Directivity Pattern at the Mean Primary Frequency (100 kHz)

Additionally, there are other considerations such as seasonal effects, HRG operator settings, sound scattering and 'time stretching' of the RMS pulse duration of the signal that will occur with increased distance from the source, which combined will have an effect on received levels. Furthermore, in shallow waters such as at the proposed HRG survey area, the area of ensonification is influenced by the beam interactions with both the seafloor and water surface. These losses are defined by the ratio between incident and reflected sound energy which is dependent on the acoustic impedances of the seafloor as well as surface roughness conditions which are effectively included in the HRG equipment adjustment factors. To account for variation, an additional level of conservatism has been applied in calculations to the Level B harassment thresholds by applying the practical spreading methodology to account for potential variation in propagation loss over varying water depths and bottom conditions.

In addition to identifying the apparent source levels associated with the HRG activities, the field verification programs were also designed to confirm distances to the regulatory thresholds for injury/mortality and behavior disturbance of marine mammals that were established during the permitting process. Of particular importance was confirming the adequacy of the exclusion and monitoring zones used to support the active protection of marine mammals during HRG activities. All impact ranges measured for marine fauna during these field verifications were within the thresholds as prescribed by BOEM in the Lease stipulations.

Apparent source levels and differential between the averaged measured apparent source levels versus manufacturers' levels for each HRG equipment type are summarized in Table 5-1. The results of the field verification studies (see Appendix E) 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 the current suite of HRG equipment of similar type, as the differential accounts for both the site specific environmental conditions and directional beam width patterns for similar HRG equipment proposed (e.g. USBL, SBP, and UHRS Sparker systems). The differentials were applied for the current survey HRG source terms as provided in Table 1-1 and the resulting differential source levels are presented in Table 5-2.

Table 5-1 Summary of Field Verified HRG Survey Equipment Results and Representative Proxy Sources

Representative HRG Survey Equipment	Operating Frequencies	Baseline Source Level (dB re 1 µPa)	Source Level Measured During Ørsted FV Surveys (dB re 1 µPa)	Differential (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}	-34	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}	-41	Edgetech 3200 Teledyne Benthos Chirp III - TTV 170
EdgeTech 512	0.5 to 12 kHz	177 dB_{RMS}	166 dB_{RMS}	--11	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}	-60	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	215 dB_{Peak} 205 dB_{RMS}	206 dB_{Peak} 183 dB_{RMS}	-9 -22	GeoMarine Geo-Source 400J Applied Acoustics Dura-Spark 400 System

Table 5-1 Summary of Field Verified HRG Survey Equipment Results and Representative Proxy Sources

Representative HRG Survey Equipment	Operating Frequencies	Baseline Source Level (dB re 1 µPa)	Source Level Measured During Ørsted FV Surveys (dB re 1 µPa)	Differential (dB re 1 µPa)	2019 HRG Survey Data Acquisition Equipment
Geo-Resources Geo-Source 800 J	0.05 to 5 kHz	215 dB_{Peak} 206 dB_{RMS}	212 dB_{Peak} 189 dB_{RMS}	-3 -17	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}	-16 -32	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}	-13 -10	Not used for any other equipment

Note:
Proxy sources may have similar names although are often different manufacturer and model types, but are expected to provide a valid representation for the HRG equipment with similar operational characteristics.
Sources: a/ Gardline 2016a, 2017; b/ RPS 2018; c/ MAI 2018a; d/ Subacoustech 2018

Table 5-2 Differential source levels for HRG equipment calculated from field verified sources (in bold) and applied to sources within the same equipment category.

Representative HRG Survey Equipment	Baseline Source Level Reported as SPL_{rms} unless noted (dB re 1 µPa m)	Differential Applied (dB)	Differential Source Level Reported as SPL_{rms} unless noted (dB re 1 µPa m)
USBL & GAPS Transponder and Transceiver			
Sonardyne Ranger 2 transponder	**200**	**0**	**166**
Sonardyne Ranger 2 USBL HPT 5/7000 transceiver	200	-34	166
Sonardyne Ranger 2 USBL HPT 3000 transceiver	194	-34	160
Sonardyne Scout Pro transponder	188	-34	154
Easytrak Nexus 2 USBL transceiver	192	-34	158
IxSea GAPS transponder	**188**	**0**	**188**
Kongsberg HiPAP 501/502 USBL transceiver	190	-34	156
Edgetech BATS II transponder	204	-34	170
Shallow Sub-Bottom Profilers (Chirp)			
Edgetech 3200	212	-41	171
EdgeTech 216	**174**	**0**	**159**
EdgeTech 424	176	-11	165
EdgeTech 512	**177**	**0**	**166**
Teledyne Benthos Chirp III - TTV 170	197	-41	156

Table 5-2 Differential source levels for HRG equipment calculated from field verified sources (in bold) and applied to sources within the same equipment category.

Representative HRG Survey Equipment	Baseline Source Level Reported as SPL_{rms} unless noted (dB re 1 µPa m)	Differential Applied (dB)	Differential Source Level Reported as SPL_{rms} unless noted (dB re 1 µPa m)
GeoPulse 5430 A Sub-bottom Profiler	**214**	**0**	**173**
PanGeo LF Chirp	195	-11	184
PanGeo HF Chirp	190	-11	179
Parametric Sub-Bottom Profiler			
Innomar SES-2000 Medium 100	**247**	**0**	**187**
Innomar SES-2000 Standard & Plus	236	- 60	176
Innomar SES-2000 Medium 70	241	- 60	181
Innomar SES-2000 Quattro	245	- 60	185
PanGeo 2i Parametric	239	- 60	179
Medium Penetration Sub-Bottom Profiler (Sparker)			
GeoMarine Geo-Source 400J	212 (pk)	- 9	203 (pk)
	201	- 22	179
GeoMarine Geo-Source 600J	**215 (pk)**	**0**	**206 (pk)**
	205	**0**	**183**
GeoMarine Geo-Source 800J	**215 (pk)**	**0**	**212 (pk)**
	206	**0**	**189**
Applied Acoustics Dura-Spark 400 System	225 (pk)	- 9	216 (pk)
	214	- 22	192
GeoResources Sparker 800 System	215 (pk)	- 3	212 (pk)
	206	-17	189
Medium Penetration Sub-Bottom Profiler (Boomer)			
Applied Acoustics S-Boom 1000J	**228 (pk)**	**0**	**215 (pk)**
	208	**0**	**198**
Applied Acoustics S-Boom 700J	**211 (pk)**	**0**	**195 (pk)**
	205	**0**	**173**

Note:
Proxy sources may have similar names although are often different manufacturer and model types, but are expected to provide a valid representation for the HRG equipment with similar operational characteristics.

The process for utilizing the SSV and differential source level (SL) to calculate distances to regulatory isopleths produced by each source was as follows:

- For equipment that has a valid SSV; establish a differential SL by subtracting the apparent SL reported in the SSV from the baseline SL (typically the manufacturer-reported SL). This provides the differential correction factor to apply to equipment within the same category;
- For equipment that does not have a valid SSV, subtract the correction factor from the baseline SL to obtain the differential SL for that equipment;
- For Level A distance calculation, input the differential SLs into the user spreadsheet for each piece of equipment; and
- For Level B distance calculation, use the practical spreading model applied to the differential SL.

5.2 Calculation of Disturbance Zones of Influence

The zones of influence (ZOIs) for Level A harassment were calculated following the NOAA Fisheries 2018 guidance and the accompanying Optional User Spreadsheet for previously field verified equipment (see Appendix A). The Optional User Spreadsheet requires estimates of the sound produced by the source and the manufacturer source level which were adjusted per Table 5-1. This adjustment is necessary as the Optional User Spreadsheet does not consider the beam width or directivity of HRG sound sources, or the variable characteristics of the ocean environment. The use of previous field verification results with the same type of HRG equipment as a comparison helps reduce this level of uncertainty while allowing continued use of the Optional User Spreadsheet approach.

The HRG equipment types in Table 5-1 have been previously field verified. For different HRG transducers, the beamwidth varies from 180° (almost omnidirectional) to a few degrees. The source directivity is specified as a function of both azimuthal angle and depression angle. It is important to note that the Innomar SES-2000 and PanGeo sub-bottom profilers use the principle of “parametric” or “nonlinear” acoustics to generate short narrow-beam sound pulses. Directionality is generally measured in decibels relative to the maximum radiation level along the central axis perpendicular to the transducer surface. In the case of the Innomar Medium-100 projects at a very narrow beamwidth of 1 to 2° and was described numerically from technical specifications. The directional sound source levels were applied to the field verified results to determine nearfield received noise levels. HRG source directional characteristics are inherently included in the acoustic far field measurement results, as reported in currently accepted Ørsted SSV reports (see Appendix E). Also, the maximum duty cycle was provided, which accounts for the pulse shape and duration, and used for the SEL cumulative exposure calculations.

Table 5-3 shows maximum distances to the level A regulatory thresholds for each major HRG equipment category proposed. For equipment categories with multiple devices (see Table 1-1), only the device with maximum distances to regulatory thresholds is provided as a worst case. Results calculated using the NOAA Fisheries 2018 guidance and the accompanying Optional User Spreadsheets for survey equipment is provided in Appendix A. The distances to Level B disturbance thresholds for all equipment types are summarized in Table 5-4.

Table 5-3 Maximum Distances to Regulatory Thresholds by Equipment Category – Level A

Representative HRG Survey Equipment	Marine Mammal Group	PTS Onset a/	Lateral Distance (m) b/, c/
USBL/GAPS Positioning Systems			
Edgetech BATS II	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 3200 XS 216	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}	---
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

Table 5-3 Maximum Distances to Regulatory Thresholds by Equipment Category – Level A

Representative HRG Survey Equipment	Marine Mammal Group	PTS Onset a/	Lateral Distance (m) b/, c/
	Phocid pinnipeds	201 dB SEL_{cum}	---
Medium Penetration Sub-Bottom Profiler (Sparker)			
GeoMarine Geo-Source 800J	LF cetaceans	219 dBpeak, 183 dB SEL_{cum}	---, <1
	MF cetaceans	230 dBpeak, 185 dB SEL_{cum}	---, ---
	HF cetaceans	202 dBpeak, 155 dB SEL_{cum}	< 4, <1
	Phocid pinnipeds	218 dBpeak, 185 dB SEL_{cum}	---, < 1
Medium Penetration Sub-Bottom Profiler (Boomer)			
Applied Acoustics S-Boom Triple Plate Boomer	LF cetaceans	219 dBpeak, 183 dB SEL_{cum}	---, < 1
	MF cetaceans	230 dBpeak, 185 dB SEL_{cum}	---, ---
	HF cetaceans	202 dBpeak, 155 dB SEL_{cum}	<5, --
	Phocid pinnipeds	218 dBpeak, 185 dB SEL_{cum}	---, ---

Notes:
a/ The peak SPL criterion is un-weighted (i.e., flat weighted), whereas the cumulative SEL criterion is weighted for the given marine mammal functional hearing group. The calculated sound levels and results are based on NOAA Fisheries Technical Guidance's companion User Spreadsheet except as indicated in this IHA application.
b/ --- indicates that no injury was predicted for the given noise profile from the HRG equipment at any appreciable distance.
c/ N/A indicates the HRG source emit frequency is outside of given marine mammal hearing range.

The purpose of the SSV field programs were to confirm distances to the regulatory thresholds for injury/mortality and behavior disturbance of marine mammals that were established during the permitting process of several HRG activities. This method was also used to extrapolate the apparent sound source levels as well as report the received sound level at closest point of approach (CPA). These values were used to further calibrate calculations for the current suite of HRG equipment of similar type, as the differential accounts for both the site specific environmental conditions and directional beam width patterns for similar HRG equipment proposed (e.g. USBL, SBP, and UHRS Sparker systems). For HRG equipment with SSVs, these measurements were calculated using the manufacturer stated values and the practical spreading model of 15Log(R) applied to assess distances to Level B thresholds.

Table 5-4 includes the validly measured noise level at the CPA as reported in the SSVs. Reliance on the SSV CPA measurement data points, completed at several different separation distances, appear to provide consistent results, as a whole, for specific grouping of HRG equipment. And when further comparisons are made to the calculated distances to Level B thresholds, results also appear reasonable. Table 5-4 also includes the Crocker and Fratantonio (2016) HRG equipment that are proposed for the 2019 survey activities (not all HRG equipment types were documented) and applied the spherical spreading model of 20Log(R) to calculate distances to Level B. Except for the Edge Tech 512, all results are orders of magnitude higher, which suggests that this approach may be overly conservative. This has the potential to result in the overstatement of take. Further information by HRG equipment type is as follows:

- **USBL and GAPS**: There are no relevant information sources or measurement data within the Crocker and Fratantonio (2016) reference for USBLs, however there are 2 SSVs for the Sonardyne Ranger 2 (similar model to the Ranger 2 proposed for the 2019 survey) and the IxSea GAPS System. Since USBL and Gap transceivers all have the same operating principals, the application of the SSV to calculate distance to thresholds is a reasonable approach. Due

to the calculated distances, the potential to for Level B take is unlikely to occur.

- **Parametric SBP**: There are no relevant information sources or measurement data within the Crocker and Fratantonio (2016) reference for parametric SBPs, however an SSV was completed Innomar-2000 SES Medium 100. At the closest point of approach, the measured SPL was 133 dB. It is important to note that the Innomar SBPs use the principle of "parametric" or "nonlinear" acoustics to generate short narrow-beam sound pulses. Directionality is generally measured in decibels relative to the maximum radiation level along the central axis perpendicular to the transducer surface. In the case of the Innomar Medium-100, this source projects at a very narrow beamwidth of 1 to 20 and was described numerically from technical specifications. The directional sound source levels were applied to the SSV results to estimate distance to the Level B threshold and is not expected to produce Level B take.
- **Pangeo Chirp/Pangeo Parametric**: Unlike the other HRG sources which are mobile source, acoustic corers are stationary and made up of three distinct sound sources comprised of a high-frequency parametric sonar, a high-frequency Chirp sonar, and a low-frequency Chirp sonar; with each source having its own transducer. The parametric sonar has a reported sound level of 239 dB re 1 µPa m with an operating frequency centered at 102 kHz. The beam width of the parametric sonar is narrow (<8°) and the sonar is operating roughly 3.5 m (11.5 ft) above the seabed with the transducer pointed directly downwards. This configuration represents the expected operation of the acoustic corer during the survey and subsequently results in energy channeled into the seabed rather than released into the water column with nominal horizontal propagation as reported by Kongsberg (2011). Because of this configuration, the User Spreadsheet was not incorporated for the acoustic corer and instead the measurements conducted by PanGeo as part of the environmental assessment of the acoustic corer are used for impact isopleth estimates.

  Within the PanGeo assessment, source levels were measured and distances to the SPL_{rms} equal to 160 dB re 1 µPa were calculated using the 15log(R) transmission loss to 3.5 meters then 10logR transmission loss equation beyond 3.5 meters from the source. This resulted in highly conservative estimates of the propagation distance given the beam width, frequency, and sea bed placement. The measured source levels for the HF (190 dB) and LF (195 dB) chirps were used with a 15log(R) applied to calculate the distance to the 160 dB re 1 µPa. The PanGeo parametric sonar uses Innomar 2000 SES technology for which an SSV was conducted. Therefore, the SSV ranges for the Innomar 2000 was applied to the PanGeo parametric sonar. Given the placement of the source on seabed, we expect nominal propagation from the source. Therefore, the PanGeo acoustic corer is not expected to produce Level B take.
- **SBP (Chirp)**: Crocker and Fratantonio (2016) tested two chirpers, the Edge Tech (ET) models 424 and 512. SSVs were completed on three ET chirpers. When comparing the distance to Level B for the C&F referenced values, the ET 512 is within range with the SSV values, but the distance for the ET 424 is greater at 71 meters and should be met with skepticism based on the SSV CPA measured values which ranged from 141 to 144 at a distance of 30 to 40 m.
- **SBP (sparkers)**: There are two valid SSVs currently on file for medium penetration sub-bottom profilers (sparkers) operating at 600 and 800 joules. There is one SSV available for the Dura Spark 400. However, the SSV conducted for the Dura Spark lacked critical information and contained *in-situ* measurements that were suspect. Therefore, for the purposes of determining

distance to regulatory thresholds for the Dura Spark 400, the differential distance using the 600J sparker as a proxy is presented along with the results from Crocker and Fratantonio (2016). By using the differential SL_{rms} of 192 dB re 1 µPa m for the Dura Spark (derived from applying the -22 dB differential for the 600 joule sparker system) and conservatively applying the practical spreading model of 15Log(R) results in a distance of 136 m to the Level B threshold for the Dura Spark 400. Corresponding source levels in Crocker and Fratantonio (2016) results in a Level B distance of 141 m using the spherical spreading model (20Log(R)). The spherical spreading model was used due to the fact that controlled-measurement SLs reported in Crocker and Fratantonio (2016) have not undergone environmental attenuation and subsequent back calculations from received levels measured far from the source (100 m) as was done in the 600J sparker SSV. Given the close alignment of the of the results from the two methods, the Applicant is confident that these measures best represent the distance to Level B isolpleths for the Dura Spark rather than the reported distances in the SSV (19 m and 17 m).

- **SBP (boomers):** Three SSVs were completed on boomers (AA-400 sparker SBP and AA S-Boom SBP) that were also investigated by Crocker and Fratantonio (2016). The resulting comparison between SSV distance to level B and Crocker and Fratantonio (2016) calculated with 20log(R) are orders of magnitude larger and therefore do not result in good reference values as they directly conflict with the SSV values at the CPA. There is high confidence in the SSV values and are preferred as far field measurement values incorporate the effects of beam width and directivity of HRG sound sources, and the variable characteristics of the ocean environment.

Table 5-4 Distances to Regulatory Level B Thresholds and SSV Comparatives with supporting calculation methodologies.

HRG Survey Equipment	Source Level (SL_{RMS}) (dB re 1µPa)	Lateral Distance (m) to Level B thresholds used in take analysis	Reference method for determining Level B distance used in analysis	Proxy source	Measured SPL at Closest Point of Approach (CPA) Single Pulse $SPL_{RMS,90\%}$ (dB re 1µPa)	Spreading loss calculation used to determine Level B distance
USBL & GAPS transponders and transceivers						
Sonardyne Ranger 2 transponder a/	166	2	SSV- reported	-	126 -132 dB @ 40 m	SSV distance used
Sonardyne Ranger 2 USBL HPT 5/7000 transceiver	166	2	Differential SL_{rms} by proxy	Sonardyne Ranger 2 transponder	-	15Log(R)
Sonardyne Ranger 2 USBL HPT 3000	160	2	Differential SL_{rms} by proxy	Sonardyne Ranger 2 transponder	-	15Log(R)
Sonardyne Scout Pro	154	2	Differential SL_{rms} by proxy	Sonardyne Ranger 2 transponder	-	15Log(R)
Easytrak Nexus 2 USBL	158	2	Differential SL_{rms} by proxy	Sonardyne Ranger 2 transponder	-	15Log(R)

Table 5-4 Distances to Regulatory Level B Thresholds and SSV Comparatives with supporting calculation methodologies.

HRG Survey Equipment	Source Level (SL_{RMS}) (dB re 1µPa)	Lateral Distance (m) to Level B thresholds used in take analysis	Reference method for determining Level B distance used in analysis	Proxy source	Measured SPL at Closest Point of Approach (CPA) Single Pulse $SPL_{RMS,90\%}$ (dB re 1µPa)	Spreading loss calculation used to determine Level B distance
IxSea GAPS System e/	188	6	SSV-reported distance	-	144 dB @ 35 m 132 dB @ 200 m	SSV distance used
Kongsberg HiPAP 501/502 USBL	156	2	Differential SL_{rms} by proxy	Sonardyne Ranger 2 transponder	-	15Log(R)
Edgetech BATS II	170	2	Differential SL_{rms} by proxy	Sonardyne Ranger 2 transponder	-	15Log(R)
Shallow Sub-Bottom Profiler (Chirp)						
Edgetech 3200 f/	171	5	SSV provided only SL_{pk}		153 dB @ 30 m	15Log(R)
EdgeTech 216 e/	159	2	SSV-reported distance		142 dB @ 35 m 120 dB @ 200 m	SSV distance used
EdgeTech 424	165	2	Differential SL_{rms} by proxy		-	15Log(R)
	176	*6*	*Crocker and Fratantonio (2016) 3200 processor 100% power*	*For Comparison Only, not used in calculations*	-	*20Log(R)*
EdgeTech 512 c/	166	2.4	SSV-reported distance	-	141 dB @ 40 m 130 dB @ 200 m	SSV distance used
	177	*7*	*Crocker and Fratantonio (2016) 100% power 5 ms pulse width*	*For Comparison Only, not used in calculations*	-	*20Log(R)*
Teledyne Benthos Chirp III - TTV 170	156	<1	Differential SL_{rms} by proxy		-	15Log(R)
GeoPulse 5430 A Sub-Bottom Profiler a/	173	4	SSV-reported distance		145 dB @ 20 m	SSV distance used
PanGeo LF Chirp (Corer)	184	40	Differential SL_{rms} by proxy		-	15Log(R)
PanGeo HF Chirp (Corer)	179	18	Differential SL_{rms} by proxy		-	15Log(R)

Table 5-4 Distances to Regulatory Level B Thresholds and SSV Comparatives with supporting calculation methodologies.

HRG Survey Equipment	Source Level (SL_{RMS}) (dB re 1µPa)	Lateral Distance (m) to Level B thresholds used in take analysis	Reference method for determining Level B distance used in analysis	Proxy source	Measured SPL at Closest Point of Approach (CPA) Single Pulse $SPL_{RMS,90\%}$ (dB re 1µPa)	Spreading loss calculation used to determine Level B distance
Parametric Sub-Bottom Profiler*						
Innomar SES-2000 Medium 100 Parametric Sub-Bottom Profiler b/	187	63	SSV received levels back calculated to SL	-	129 to 133 @ 100 m	15Log(R)
Innomar SES-2000 Medium 70 Parametric Sub-Bottom Profiler	181	25	Differential SL_{rms} by proxy	Innomar SES-2000 Medium 100 Parametric SBP	-	15Log(R)
Innomar SES-2000 Standard & Plus Parametric Sub-Bottom Profiler	176	12	Differential SL_{rms} by proxy	Innomar SES-2000 Medium 100 Parametric SBP	-	15Log(R)
Innomar SES-2000 Quattro	185	46	Differential SL_{rms} by proxy	Innomar SES-2000 Medium 100 Parametric SBP	-	15Log(R)
PanGeo 2i Parametric (Corer)	179	18	Differential SL_{rms} by proxy	Innomar SES-2000 Medium 100 Parametric SBP	-	15Log(R)
Medium Penetration Sub-Bottom Profiler (Sparker)						
GeoMarine Geo-Source 400J	179	18	Differential SL_{rms} by proxy	GeoMarine Geo-Source 600J	-	15Log(R)
GeoMarine Geo-Source 600J a/	183	34	Distance to 160 dB in SSV not used	-	155 @ 20 m	15Log(R)
GeoMarine Geo-Source 800J a/	189	86	Distance to 160 dB not SSV not used	-	144 @ 200 m	15Log(R)
Applied Acoustics Dura-Spark 400 System	192	136	Differential SL_{rms} by proxy	GeoMarine Geo-Source 600J	-	15Log(R)
	203	141	Crocker and Fratantonio (2016)	-	-	20Log(R)
GeoResources Sparker 800 System	189	86	Differential SL_{rms} by proxy	GeoMarine Geo-Source 800J a/	-	15Log(R)
Medium Penetration Sub-Bottom Profiler (Boomer)						
Applied Acoustics S-Boom Triple	198	20	SSV-reported distance	-	146 dB @ 144 m	SSV distance used

Table 5-4 Distances to Regulatory Level B Thresholds and SSV Comparatives with supporting calculation methodologies.

HRG Survey Equipment	Source Level (SL_{RMS}) (dB re 1µPa)	Lateral Distance (m) to Level B thresholds used in take analysis	Reference method for determining Level B distance used in analysis	Proxy source	Measured SPL at Closest Point of Approach (CPA) Single Pulse $SPL_{RMS,90\%}$ (dB re 1µPa)	Spreading loss calculation used to determine Level B distance
Plate Boomer (1000J) d/, g/	*203*	*141*	*Crocker and Fratantonio (2016) 1000J, single plate with low energy top unit*	*For Comparison Only, not used in calculations*	-	*20Log(R)*
Applied Acoustics S-Boom Boomer (700J) e/, g/	173	14	SSV-reported distance	-	142 dB @ 38 m 122 dB @ 200 m	SSV distance used
	205	*178*	*Crocker and Fratantonio (2016) 700J 3-plate with high energy top unit*	*For Comparison Only, not used in calculations*	-	*20Log(R)*
Sources: a/ Gardline 2016a, 2017 b/ Subacoustech 2018, c/ MAI 2018a, d/ RPS, 2018 e/ MAI 2018b, f/ Subacoustech 2017, g/ Crocker and Fratantonio, 2016.						

In regards to the Dura Spark 400, all sparkers operate under the same general principle. Such sparkers function by the electric discharge of a high-voltage impulse across one or more electrode tips and a ground point on the sparker body. Resultant heating of the surrounding seawater generates a rapidly expanding steam bubble with a nearly ideal positive impulse. Continued expansion of the steam bubble beyond the equilibrium hydrostatic pressure results in collapse and the formation of a series of bubble pulse oscillations of diminishing amplitude until all of the energy is dissipated. It is reasonable to assume that a sparker system with a 400 joule output would have a smaller acoustic footprint than a 600 or 800 joule system. If requested, a SSV field program for the Dura Spark 400 equipment to confirm distances to the regulatory thresholds for injury/mortality and behavior disturbance of marine mammals will be completed.

Therefore, in the case of this IHA application and equipment described, for the purposes of developing mitigation, the 141-m distance to the Level B threshold is deemed most appropriate. Therefore, Ørsted is requesting that the 141-m distance for Level B harassment associated with the Dura Spark 400 be adopted.

The Applicant is requesting the authorization for the incidental take by Level B harassment of small numbers of marine mammals in the waters of the Ørsted Wind Power North America Lease Areas pursuant to Section 101 (a) (5) of the MMPA and in accordance with 50 CFR § 216 Subpart I, in support of the Applicant's survey activities as further detailed in Section 6.

6. Take Estimates for Marine Mammals

The Applicant seeks authorization for potential "taking" of small numbers of marine mammals under the jurisdiction of NOAA Fisheries in the proposed region of activity. Anticipated impacts to marine mammals from the proposed survey activities will be associated with noise propagation from the use of specific HRG survey equipment. It should be noted that the estimates of exposure for marine mammals as presented in this section are conservative.

6.1 Basis for Estimating Numbers of Marine Mammals that Might be "Taken by Harassment"

Most marine animals can perceive underwater sounds over a broad range of frequencies from about 7 hertz (Hz) to more than 160,000 Hz (160 kHz) (Table 6-1). Many of the dolphins and porpoises use even higher frequency sound for echolocation and perceive these high frequency sounds with high acuity. Marine mammals respond to low-frequency sounds with broadband intensities of more than about 120 dB re 1 µPa, or about 10 to 20 dB above natural ambient noise at the same frequencies (Richardson et al. 1991).

Table 6-1 Functional Hearing Range of Marine Mammals

Species	Estimated Auditory Bandwidth
LF cetaceans (baleen whales)	7 Hz to 35 kHz
MF cetaceans (dolphins, toothed whales, beaked whales, bottlenose whales)	150 Hz to 160 kHz
HF cetaceans (true porpoises, Kogia, river dolphins, cephalorhynchid, *Lagenorhynchus cruciger* & *L. australis*)	275 Hz to 160 kHz
Phocid pinnipeds (underwater) (true seals)	50 Hz to 86 kHz
Otariid pinnipeds (underwater) (sea lions and fur seals)	60 Hz to 39 kHz
Source: NOAA Fisheries 2018	

Sound is important to marine mammals for communication, individual recognition, predator avoidance, prey capture, orientation, navigation, mate selection, and mother-offspring bonding. Potential effects of anthropogenic sounds to marine mammals can include physical injury (e.g., temporary or permanent loss of hearing sensitivity), behavioral modification (e.g., changes in foraging or habitat-use patterns), and masking (the prevention of marine mammals from hearing important sounds).

The survey activities that have the potential to cause harassment as defined by the MMPA (160 $dB_{RMS90\%}$ re 1 µPa) include the noise produced by the Sparkers (400J, 600J, 800J), the Innomar and PanGeo parametric sub-bottom profilers, and the Applied Acoustics boomers (S-Boom and S-Boom triple plate). Based on the results of this assessment (see Table 5-4), the furthest distance to the Level B harassment criteria is 462.6 ft (141.0 m) from the use of the Dura Spark 400 sparker. Therefore, the Applicant has applied the evaluated distance of 462.6 ft (141.0 m) to the 160 $dB_{RMS90\%}$ re 1 µPa Level B harassment criteria as the basis for determining potential take.

The basis for the take estimate is the number of marine mammals that would be exposed to sound levels in excess of Level B harassment criteria (160 $dB_{RMS90\%}$ re 1 µPa). Typically, this is determined by multiplying the ZOI out to the Level B harassment criteria isopleth by local marine mammal density estimates, and then correcting for seasonal use by marine mammals, seasonal duration of project-specific noise-generating activities, and estimated duration of individual activities when the maximum noise-generating activities are

intermittent or occasional. In the absence of any part of this information, it becomes prudent to take a conservative approach to ensure the potential number of takes is not greatly underestimated.

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. All noise producing survey equipment are assumed to be operated concurrently. Using the distance of 462.6 ft (141.0 m) to the 160 $dB_{RMS90\%}$ re 1 µPa Level B isopleth and the estimated daily vessel track of approximately 43.5 mi (70 km) for 24-hour operations, estimates of incidental take by HRG survey equipment has been based on the ensonified area around the survey equipment as depicted in Table 6-2. For comparative purposes between calculation methodologies, while Ørsted has deemed the 141-m distance to the Level B threshold as most appropriate, the ZOI and associated take calculations for the 178-m Level B distance estimated from use of Crocker and Frantantonio, 2016 data for the Applied Acoustics S-Boom Boomer (700J) has been included. As previously stated, SSV results for this equipment have measured the level B zone to be 14m, and therefore the C&F, 2016 estimate is considered highly over-conservative.

Table 6-2 Survey Segment Distances and ZOIs at 141 m and 178 m Level B Distances

Survey Segment	Number of Active Survey Vessel Days	Estimated distances per day (km)	Calculated ZOI per day (km^2)	
			141 m Level B Distance	178 m Level B Distance
Lease Area OCS-A 0486	79	70.000	19.804	25.022
Lease Area OCS-A 0487	140			
Lease Area OCS-A 0500	94			
ECR Corridor(s)	353			

6.2 Estimate of Numbers of Marine Mammals that Might be "Taken by Harassment"

Estimates of take are computed according to the following formula as provided by NOAA (Personal Communication, November 24, 2015):

Estimated Take = D x ZOI x (d)

Where:

D = average highest species density (number per km^2)

ZOI = maximum ensonified area to MMPA threshold for impulsive noise (160 $dB_{RMS90\%}$ re 1 µPa)

d = number of days

Per new NOAA guidance for mobile sound sources, the ZOI was calculated according to the following formula (Personal Communication, November 24, 2015):

ZOI = maximum ensonified area around the sound source x the expected distance travelled over a 24-hr period.

Refer to Table 6-2 for the calculated ZOI for each of the proposed HRG survey segments.

The data used as the basis for estimating species density for the Project 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 overestimated abundance assumption of the southern New England population of gray seals can be applied. Pinniped density data (as presented in Roberts et al. 2016b; 2017; 2018) were used to estimate pinniped densities for the Lease Areas Survey segments and ECR Corridor Survey segment(s).

Due to the spatial distribution and transient nature of marine mammal species identified and the implementation of the mitigation measures as described in Section 11.0, these activities are not likely result in serious injury or death.

6.2.1 Estimate of Potential Project HRG Survey Takes by Harassment

The parameters in Table 6-2 were used to estimate Level B for marine mammals for the entire HRG survey area. Density data from Roberts et al. (2016b; 2017; 2018) were mapped within the boundary of the Survey Area for each segment (Figure 1-1) 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 (see Table 1-2). Maximum values were used capture the perceived increase in local species densities based on observations made during previous BSW survey activities.

All noise producing survey equipment are assumed to be operated concurrently. Distances to NOAA Fisheries noise criteria include 462.6 ft (141 m) to the 160 $dB_{RMS90\%}$ re 1 µPa level B isopleth for the Applied Acoustics Dura-Spark 400 System (20Log(R)) and 584.0 ft (178 m) to the 160 $dB_{RMS90\%}$ re 1 µPa level B isopleth for the Applied Acoustics S-Boom Boomer (700J) C&F, 2016 reference (20Log(R)) For harbor porpoise, given the resulting level A PTS harassment criteria (155 dB cumulative sound exposure level [SEL_{cum}]) distance of less than 65.6 ft (20 m) and the mitigations proposed in Section 11.3, the potential for level A harassment of this species is so unlikely as to be discountable, and therefore not requested. In addition, NOAA Fisheries has acknowledged in comments to the Marine Mammal Commission for the previously issued IHA (dated July 24, 2018), that harbor porpoises display profound and sustained avoidance behavior to sound greater than 140 dB re 1 µPa and would be unlikely to occur within 75 m of a vessel (Barlow 1988; Palka and Hammond, 2001; Dyndo et al. 2015). Therefore, no exclusion zone for harbor porpoise is requested or proposed. The remaining ensonified area specific to level B, as well as the projected duration of each respective survey segment were then used to produce the results of take calculations provided in Table 6-3. It should be noted that calculations do not take into account whether a single animal is harassed multiple times or whether each exposure is a different animal. Therefore, the numbers in Table 6-3 are the maximum number of animals that may be harassed during the HRG surveys (i.e., the Applicant assumes that each exposure event is a different animal).

As noted in Table 6-3, requested take estimates were adjusted to account for typical group size for Risso's and Atlantic spotted dolphins. For Risso's and Atlantic spotted dolphins, as was the case for the previously issued Bay State Wind 2018 IHA, and despite the fact that the total number of takes authorized was unlikely to actually occur due to the very restrictive mitigation measures (e.g., shutdown/power-down if an animal enters the Level B harassment isopleths), it was NOAA Fisheries' opinion that some Level B takes would still occur due to the nature and duration of the survey activities within the harassment zones and included the potential to take Risso's and Atlantic spotted dolphins. These same numbers have been included with this IHA application for consistency. Upon NOAA Fisheries' recommendation, takes were added for Risso's

dolphin for a total of 30 authorized takes by Level B harassment. NOAA Fisheries also stated that no Atlantic spotted dolphins had been observed during any of the previous monitoring efforts, so considering minimal calculated takes for Atlantic spotted dolphins in combination with no previous sightings, NOAA Fisheries did not feel take was warranted. However, NOAA Fisheries recommended to include takes of Atlantic spotted dolphin, ensuring that the number of takes authorized is at least equal to the average group size. Takes were added for Atlantic spotted dolphin for a total of 50 authorized takes by Level B harassment.

In the instance of the North Atlantic right whale, the Applicant has proposed a 1,640.4-ft (500-m) exclusion zone which exceeds the distance to the level B harassment isopleth. Given that the proposed mitigation effectively prevents level B harassment, take has been adjusted to 0 individuals. In addition, the Applicant proposes a 328-ft (100 m) exclusion zone to be implemented for all non-delphinid large cetaceans. With exception of north Atlantic right whales, these estimates do not account for prescribed mitigation measures that the Applicant would implement during the specified activities and the fact that other mitigation measures may be imposed as part of other agreements that Ørsted Wind Power North America must adhere to, such as the lease agreement with BOEM.

Table 6-3 Marine Mammal Density and Estimated Level B Harassment Take Numbers at 141 m and 178 m Distances

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	
		141 m	178 m		141 m	178 m		141 m	178 m		141 m	178 m	141 m	178 m	141 m	178 m
North Atlantic right whale	0.502	9.338	11.798	0.383	5.992	7.570	0.379	10.496	13.262	0.759	53.052	67.029	0 c/	0 c/	0.000	0.000
Humpback whale	0.290	5.393	6.814	0.271	4.238	5.354	0.277	7.691	9.717	0.402	28.126	35.537	46	58	13.582	17.164
Fin whale	0.350	6.507	8.221	0.210	3.290	4.157	0.283	7.858	9.929	0.339	23.669	29.905	41	52	2.559	3.232
Sei whale	0.014	0.259	0.327	0.005	0.084	0.106	0.009	0.242	0.306	0.011	0.749	0.946	1	2	0.392	0.476
Sperm whale	0.018	0.329	0.416	0.014	0.216	0.272	0.017	0.459	0.581	0.047	3.259	4.118	4	5	0.188	0.236
Minke whale	0.122	2.268	2.866	0.075	1.177	1.487	0.094	2.592	3.275	0.126	8.822	11.146	15	19	0.575	0.726
Long-finned pilot whale	1.895	35.277	44.571	0.504	7.891	9.969	1.012	28.057	35.449	1.637	114.440	144.590	186	235	2.618	3.308
Bottlenose dolphin	1.992	37.076	46.844	1.492	45.747	57.800	1.478	34.726	43.874	25.002	1,748	2,208.314	1,865	2,357	2.406	3.040
Short beaked common dolphin	22.499	418.832	529.176	7.943	124.272	157.012	14.546	403.305	509.559	19.198	1,342	1,695.655	2,289	2,892	3.261	4.120
Atlantic white-sided dolphin	7.349	136.813	172.857	2.006	31.387	39.656	3.366	93.312	117.896	7.634	533.681	674.282	795	1,005	1.629	2.058
Spotted dolphin	0.105	1.960	2.477	2.924	0.248	0.313	1.252	0.886	1.119	0.109	7.607	9.611	50 d/	50 d/	0.112	0.112
Risso's dolphin	0.037	0.680	0.859	0.016	0.095	0.120	0.032	0.394	0.498	0.037	2.604	3.291	30 d/	30 d/	0.164	0.164
Harbor porpoise	5.389	100.326	126.757	5.868	91.809	115.997	4.546	126.045	159.253	20.098	1,405	1,775.180	1,723	2,177	0.020	0.020
Harbor seal b/	7.633	142.088	179.522	6.757	105.709	133.558	3.966	109.951	138.918	45.934	3,211	4,057.192	3,569	4,509	4.706	5.946
Gray Seal b/	7.633	142.088	179.522	6.757	105.709	133.558	3.966	109.951	138.918	45.934	3,211	4,057.192	3,569	4,509	13.155	16.620

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 0 given mitigation to prevent take
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).

7. Anticipated Impacts of the Activity

Consideration of negligible impact is required for NOAA Fisheries to authorize the incidental take of marine mammals. In 50 CFR § 216.103, NOAA Fisheries defines negligible impact to be "an impact resulting from a specified activity that cannot be reasonably expected to, and is not reasonably likely to, adversely affect the species or stocks [of marine mammals] through effects on annual rates of recruitment or survival." Based upon best available data regarding the marine mammal species (including density, status, and distribution) that are likely to occur in the Survey Area, the Applicant concludes that exposure to marine mammal species and stocks during marine site characterization surveys would result in short-term minimal effects and would not affect the overall annual recruitment or survival for the following reasons:

- As detailed in Section 1.2 and field verification reports, potential acoustic exposures from survey activities are within the non-injurious behavioral effects zone (Level B harassment);
- The potential for take as estimated in Sections 6.2.1 and 6.2.2 represents a highly conservative estimate of harassment based upon typical HRG survey scenarios without taking into consideration the effects of standard mitigation and monitoring measures; and
- The mitigation measures as described in Section 11.0 (below) are designed to avoid and/or minimize the potential for interactions with and exposure to marine mammals.

Marine mammals are mobile free-ranging animals and have the capacity to exit an area when noise-producing survey activities are initiated. Based on the conservative take estimations, survey activities may disturb more than one individual for some species (mainly dolphins), but in conjunction with other aforementioned factors we conclude the proposed HRG survey activities are not expected to result in population-level effects and that individuals will return to normal behavioral patterns after activities have ceased or after the animal has left the area under survey.

8. Anticipated Impacts on Subsistence Uses

There are no traditional subsistence hunting areas in the Lease Areas and/or ECR(s).

9. Anticipated Impacts on 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. The temporary and localized impact of the ZOI in relation to the comparatively vast area of surrounding open ocean, would render any potential impacts to prey availability or potential avoidance by marine mammals would be insignificant and not likely to affect marine mammal species. The HRG survey equipment will not contact the seafloor and would not be a source of air or water pollution. Impact to prey species is expected to be limited to avoidance of the area around the HRG survey activities and short-term changes in behavior. Such impacts are not expected to result in population-level effects on prey species (BOEM 2012). Individuals disturbed by a survey would likely return to normal behavioral patterns after the survey has ceased or after the animal has left the survey area. Because of the limited immediate area of ensonification and duration of individual HRG surveys, few fish may be expected in most cases to be present within the Survey Area (BOEM 2012).

Impact on marine mammal habitat from these activities will be negligible.

10. Anticipated Effects of Habitat Impacts on Marine Mammals

As stated in Section 9.0, the effects to marine mammals from loss or modification of habitat from the proposed survey activities will be insignificant and discountable.

11. Mitigation Measures

The Applicant commits to engaging in ongoing consultations with NOAA Fisheries. The Applicant is committed to following a comprehensive set of mitigation measures during marine site characterization surveys, as outlined in the stipulations of Lease OCS-A 0486, Lease OCS-A 0487, and Lease OCS-A 0500. The mitigation procedures outlined in this section are based on protocols and procedures that have been successfully implemented for similar offshore projects and previously approved by NOAA Fisheries (DONG Energy 2016 and 2017, ESS 2013; Dominion 2013 and 2014). Unless otherwise specified, the following mitigation measures apply to HRG survey activities.

Ørsted Wind Power North America LLC 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.

11.1 Vessel Strike Avoidance Procedures

The Applicant will ensure that vessel operators and crew maintain a vigilant watch for cetaceans, pinnipeds, and sea turtles and slow down or stop their vessels to avoid striking these protected 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, but are not limited to, 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 and crew will maintain vigilant watch for cetaceans, pinnipeds and sea turtles and slow down or stop their vessel to avoid striking these protected species;
- All vessel operators will comply with 10 knot (<18.5 km per hour [km/h]) speed restrictions in any Dynamic Management Area (DMA). In addition, all vessels 65 ft (19.8 m) or greater operating from November 1 through July 31 will operate at speeds of 10 knots (<18.5 km/h) or less;
- All vessel operators will reduce vessel speed to 10 knots or less when mother/calf pairs, pods, or larger assemblages of non-delphinid cetaceans are observed near an underway vessel;
- All survey vessels will maintain a separation distance of 1640 ft (500 m) or greater from any sighted North Atlantic right whale;
- If underway, vessels must steer a course away from any sited North Atlantic right whale at 10 knots (<18.5 km/h) or less until the 1640-ft (500-m) minimum separation distance has been

established. If a North Atlantic right whale is sited 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-delphinid cetacean. If sighted, the vessel underway must reduce speed and shift the engine to neutral, and must not engage the engines until the non-delphinid 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-delphinid 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 diver 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.

11.2 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 proposed Lease Area Survey segments, as well as the ECR Corridor Survey segment(s)s, are anticipated to start no earlier than March 1, 2019 which is within the seasonal mandatory speed restriction period for these SMA's (November 1 through April 30).

Throughout all survey operations, the Applicant 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 Areas under survey, the vessels will abide by speed restrictions in the DMA per the lease conditions.

11.3 Exclusion and Monitoring Zone Implementation

The Applicant proposes to employ the following exclusion and monitoring zones during all HRG survey activities:

- 1,640-ft (500-m) North Atlantic right whale exclusion zone;
- 328-ft (100-m) non-delphinid large cetacean and ESA-listed marine mammal exclusion zone; and,

- 462.6 ft (141.0 m) Level B monitoring zone for all marine mammals except for the North Atlantic right whale.

These proposed mitigation zones have been based on distances to NOAA Fisheries harassment criteria and have also been submitted to BOEM for review. These zones will be monitored as described in Sections 11.4 through 11.7.

11.4 Visual Monitoring Program

Visual monitoring of the established exclusion zones and monitoring zone will be performed by qualified and NOAA Fisheries-approved Protected Species Observers (PSOs). PSO qualifications will include direct field experience on a marine mammal/sea turtle observation vessel and/or aerial surveys in the Atlantic Ocean/Gulf of Mexico. 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, PSOs will be stationed for the ASV aboard the mother vessel to monitor the ASV, which will offer clear, unobstructed view of the ASV's exclusion and monitoring zones. When in use, the ASV will be within 2,625 ft (800 m) of the mothership 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 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. During daylight hours the PSOs will rotate in shifts of 1 on and 3 off, and while during nighttime operations PSOs will work in pairs. The Applicant will provide resumes of all proposed PSOs (including alternates) to BOEM for review and approval by NOAA Fisheries at least 45 days prior to the start of survey operations.

The PSOs will begin observation of the exclusion zones and monitoring zone 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. A copy of the PSO mitigation and monitoring communications flow diagram has been included in Appendix B.

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. Digital single-lens reflex camera equipment will be used to record sightings and verify species identification. 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. Recent studies have concluded that the use of IR (thermal) imaging technology may allow for the detection of marine mammals at night as well as improve the detection during all periods with automated detection algorithms (Weissenberger 2011). Studies have indicated that IR performance is independent of daylight and exhibits an almost uniform, omnidirectional detection probability within a radius of 3.1 miles (5 km). Results of studies demonstrate that thermal imaging can be used for reliable and continuous marine mammal protection (Zitterbart 2013). For this reason, Ørsted Wind Power North America LLC finds that use of IR systems for mitigation purposes warrants additional application in the field as both a standalone tool and in conjunction with other alternative monitoring methods (e.g., night vision binoculars). In addition,

results from the previous OCS-A 0500 Lease Area HRG surveys have indicated that the night vision binoculars were most effective at detecting animals at a close distance of 328 ft (100 m); however, the greatest distance at which animals were detected was 2,461 ft (750 m), demonstrating that the equipment could still be effective at greater distances. Specifications for representative night-vision and infrared equipment are included in Appendix C and Appendix D, respectively. These equipment specifications are provided as examples of equipment most likely to be utilized. Specific night-vision and infrared equipment models will be subject to availability.

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 PSO 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. PSOs will be able to monitor the real time out-put of the camera on hand-held iPads. Images from the cameras can be captured for review and to assist it 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. This system was used successfully in Ørsted's previous survey effort.

For each 12 hour shift, an ASV technician will be assigned to manage the vessel during his/her shift to ensure the vehicle is operating properly and to take over control of the vehicle should the need arise. The ASV is outfitted with an array of cameras, radars, thermal equipment and AIS, all of which is monitored in real time by the ASV technician. Additionally, there will be two survey technicians per shift assigned to acquire the ASV survey data.

One PSO will be on watch on board the mothership during all daylight hours. Two PSOs will be on watch on board the mothership during all hours of reduced visibility, including night time. 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;
- No PSO will be allowed more than four consecutive hours on watch as a visual observer before being allocated a break from visual watch; and
- No person on watch as a PSO will be assigned a combined watch schedule of more than 12 hours in a 24-hour period.

The PSOs will stand watch in a suitable location that will not interfere with the navigation or operation of the vessel and affords an optimal view of the sea surface. Observers will maintain 360° coverage surrounding the mothership vessel and the ASV, which will travel ahead and slightly offset to the mothership while on survey line. The ASV will be within 800 meters of the mothership while conducting survey

operations. 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. This will include dates and locations of construction operations; time of observation, location and weather; details of the sightings (e.g., species, age classification [if known], numbers, behavior); and details of any observed behavioral disturbances or injury/mortality. The data sheet will be provided to both NOAA Fisheries and BOEM for review and approval prior to the start of survey activities. In addition, prior to initiation of survey work, all crew members will undergo environmental training, a component of which will focus on the procedures for sighting and protection of marine mammals and sea turtles. A briefing will also be conducted between the survey supervisors and crews, the PSOs, and the Applicant. The purpose of the briefing will be to establish responsibilities of each party, define the chains of command, discuss communication procedures, provide an overview of monitoring purposes, and review operational procedures.

11.5 Pre-Clearance of the Exclusion Zones

The Applicant will implement a 30- minute clearance period of the exclusion zones prior to the initiation of ramp-up (Section 11.6). 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). Geophysical survey equipment must not be initiated if:

- a North Atlantic right whale is observed within a 500-m radius of geophysical survey equipment during the pre-clearance period; or
- any marine mammals are observed within a 100-m radius of geophysical survey equipment during the pre-clearance period.

11.6 Ramp-Up Procedures

Where technically feasible, 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 added in a way such that the source level would increase in steps not exceeding 6 dB per 5-minute period.

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).

11.7 Shut-Down 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 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 Section 11.6.

12. Arctic Plan of Cooperation

Potential impacts to species or stocks of marine mammals will be limited to individuals of marine mammal species located in the northeast region of the United States and will not affect Arctic marine mammals. Given that the Project is not located in Arctic waters, the activities associated with the Applicant's marine characterization surveys will not have an adverse effect on the availability of marine mammals for subsistence uses allowable under the MMPA.

13. Monitoring and Reporting

13.1 Monitoring

Visual monitoring protocols are described in Section 11.

13.2 Reporting

The Applicant will provide the following reports as necessary during construction activities:

- The Applicant will contact BOEM and NOAA Fisheries within 24 hours of the commencement of survey activities and again within 24 hours of the completion of the activity;
- The Applicant will report any observed injury or mortality in accordance with NOAA Fisheries' standard reporting guidelines; and
- Within 90 days after completion survey activities, a draft technical report will be provided to BOEM, and NOAA Fisheries that fully documents the methods and monitoring protocols, summarizes the data recorded during monitoring, estimates the number of listed 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 NOAA Fisheries shall be addressed in the final report prior to acceptance by NOAA Fisheries.

14. Suggested Means of Coordination Research

All marine mammal data collected by the Applicant during marine characterization survey activities will be provided to NOAA Fisheries, BOEM, and other interested government agencies, and be made available upon request to educational institutions and environmental groups. These organizations could use the data collected during this period to study ways to reduce incidental taking and evaluate its effects.

All hydroacoustic data and resulting transmission loss rates collected during field verification of the monitoring and/or exclusion zones by the Applicant during HRG surveys will be provided to NOAA Fisheries, BOEM, and other interested government agencies, and be made available upon request to educational institutions and environmental groups. These organizations could use the data collected during this period to study ways to reduce incidental taking from survey activities and evaluate its effects.

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16. References

ACSonline (American Cetacean Society). 2004. “Cetacean Fact Pack.” Site visited February 12, 2005. http://www.ACSonline.org/factpack/index.html

Barlow J. Harbor porpoise 1988. Phocoena phocoena, abundance estimation for California, Oregon, and Washington. I. Ship surveys. Fish. Bull. 86, 417–432.

Baumgartner, M.F., and B.R. Mate. 2005. Summer and fall habitat of North Atlantic right whales (Eubalaena glacialis) inferred from satellite telemetry. Canadian Journal of Fisheries and Aquatic Sciences 62:527-543.

Blaylock, R.A., J.W. Hain, L.J. Hansen, D.L. Palka, and G.T. Waring. 1995. U.S. Atlantic and gulf of Mexico Marine Mammal Stock Assessments. NOAA Technical Memorandum NMFS-SEFSC-363.

BOEM (U.S. Department of the Interior, Bureau of Ocean Energy Management). 2012. Effects of Noise on Fish, Fisheries, and Invertebrates in the U.S. Atlantic and Arctic from Energy Industry Sound-Generating Activities, Literature Synthesis.

BOEM. 2013. NOAA's National Marine Fisheries Service Endangered Species Act Section 7 Consultation: Biological Opinion.

BOEM. 2014. Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf Offshore Massachusetts, Revised Environmental Assessment. OCS EIS/EA, BOEM 2014-603.

Breiwick, J.M., E. Mitchell and R.R. Reeves. 1983. Simulated population trajectories for northwest Atlantic humpback whales, 1865-1980. In Abstracts of the Fifth Biennial Conference on the Biology of Marine Mammals, Boston, MA.

Bulloch, D.K. 1993. The Whale-Watcher’s Handbook, A Field Guide to the Whales, Dolphins, and Porpoises of North America.

Caldwell, D. K. and M. C. Caldwell. 1966. Observations on the distribution, coloration, behavior and audible sound production of the spotted dolphin, Stenella plagiodon (Cope). Los Angeles County Museum Contribution to Science, 104: 1-28.

CETAP. 1982. A characterization of marine mammals and turtles in the mid- and north Atlantic areas of the U.S. outer continental shelf. Cetacean and Turtle Assessment Program, University of Rhode Island. Final Report #AA551-CT8-48 to the Bureau of Land Management, Washington, DC, 538 pp.

Clark, C.W. 1995. Application of U.S. Navy underwater hydrophone arrays for scientific research on whales. Reports of the International Whaling Commission 45: 210-212.

Crocker and Fratantonio. 2016. Characteristics of Sounds Emitted During High-Resolution Marine Geophysical Surveys. Naval Undersea Warfare Center Division (Sponsored by BOEM & USGS).

Curtice C., Cleary J., Shumchenia E., Halpin P.N. 2018. Marine-life Data and Analysis Team (MDAT) technical report on the methods and development of marine-life data to support regional ocean planning and management. Prepared on behalf of the Marine-life Data and Analysis Team (MDAT). Accessed at: http://seamap.env.duke.edu/models/MDAT/MDAT-Technical-Report.pdf

Collins, M.D., R.J. Cederberg, D.B. King, and S.A. Chin-Bing. 1996. Comparison of algorithms for solving parabolic wave equations. Journal of the Acoustical Society of America 100:178-182

Collins, M. D. 1993. A split-step Padé solution for the parabolic equation method. The Journal of the Acoustical Society of America, 93(4), 1736–1742.

Davis GE, Baumgartner MF, Bonnell JM, Bell J, Berchok C, Bort Thornton J, Brault S, Buchanan G, Charif RA, Cholewiak D, Clark CW, Corkeron P, Delarue J, Dudzinski K, Hatch L, Hildebrand J, Hodge L, Klinck H, Kraus S, Martin B, Mellinger DK, Moors-Murphy H, Nieukirk S, Nowacek DP, Parks S, Read AJ, Rice AN, Risch D, Širović A, Soldevilla M, Stafford K, Stanistreet JE, Summers E, Todd S, Warde A, Van Parijs SM. 2017. Long-term passive acoustic recordings track the changing distribution of North Atlantic right whales (Eubalaena glacialis) from 2004 to 2014. Sci Rep. 2017 Oct 18;7(1):13460. doi: 10.1038/s41598-017-13359-3.

Dominion Resources Inc. (Dominion). 2013. Virginia Offshore Wind Technology Advancement Project (VOWTAP) Site Characterization Survey Marine Mammal and Sea Turtle Harassment Avoidance Summary Report.

Dominion Resources Inc. (Dominion). 2014. Virginia Offshore Wind Technology Advancement Project (VOWTAP) Site Characterization Survey Marine Mammal and Sea Turtle Harassment Avoidance Nearshore Marine Geophysical and Geotechnical Surveys Summary Report.

DoN (Department of the Navy). 2005. Marine Resources Assessment for the Northeast Operating Areas: Atlantic City, Narragansett Bay, and Boston. Final Report. Contract Number N62470-02-D-9997, CTO 0018. Department of the Navy, US Fleet Forces Command, Norfolk, VA. Prepared by Geo-Marine, Inc., Newport News, VA. xvi + 535 pp.

DoN. 2007. Navy OPAREA Density Estimates (NODE) for the Northeast OPAREAs: Boston, Naragansett Bay, and Atlantic City. Final report. Contract number N62470-02- D-9997, CTO 0045. Norfolk, Virginia: Atlantic Division, Naval Facilities Engineering Command. Prepared by Geo-Marine, Inc., Plano, Texas.

Dong Energy. 2016. Incidental Harassment Authorization for Bay State Wind LLC Geophysical and Geotechnical Survey Investigations Off the Coast of Massachusetts In the Area of the Commercial Lease of Submerged Lands for Renewable Energy Development on the Outer Continental Shelf. Issued August 3, 2016.

Dong Energy. 2017. Incidental Harassment Authorization for Ocean Wind LLC Geotechnical Survey Investigations Off the Coast of New Jersey In the Area of the Commercial Lease of Submerged Lands for Renewable Energy Development on the Outer Continental Shelf (OCS-A 0498). Issued June 8, 2017.

Dyndo, M., D. M. Wisniewska, L. Rojano-Donate, and P.T. Madsen. 2015. Harbour porpoises react to low levels of high frequency vessel noise. Sci. Rep. 5, 11083; doi: 10.1038/srep11083

ESS Group (ESS). 2013. Summary of Marine Mammal Monitoring Activities for Cape Wind Energy Project – Geophysical Survey 2012. Available at: http://www.nmfs.noaa.gov/pr/pdfs/permits/capewind_monitoring2012.pdf

Fritts, T. H., A. B. Irvine, R. D. Jennings, L. A. Collum, W. Hoffman and M. A. McGehee. 1983. Turtles, birds, and mammals in the northern Gulf of Mexico and nearby Atlantic waters. U.S. Fish and Wildlife Service, Division of Biological Services, Washington, D.C., FWS/OBS-82/65, 455 pp.

Flinn, R.D., A.W. Trites and E.J. Gregr. 2002. Diets of fin, sei, and sperm whales in British Columbia: An analysis of commercial whaling records, 1963–1967. Mar. Mamm Sci. 18(3): 663–679.

Fulling, G. L., K.D. Mullin and C. W. Hubard. 2003. Abundance and distribution of cetaceans in outer continental shelf waters of the U.S. Gulf of Mexico. Fish. Bull. 101:923-932.

Gardline 2016a. Field Verification and Vessel Signature Report. Survey report for Baystate Wind Offshore Wind Farm. (Submitted under separate cover).

Gardline 2016b. Draft Bay State Wind Protected Species Observer Report. 22-Aug-16 – 04-Oct-16. Project Number 10807. Lease Number OCS-A 0500.

Gardline 2017. Technical Memo in support of Bay State Wind Field Verification Report.: (Submitted under separate cover).

Garrison, L.P. 2003. Estimated bycatch of marine mammals and turtles in the U.S. Atlantic pelagic longline fleet during 2001-2002. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SEFSC-515, 52 pp. Available from NMFS, Southeast Fisheries Science Center, 75 Virginia Beach Road, Miami, Fl 33149.

Garrison, L.P. and P.M. Richards. 2004. Estimated bycatch of marine mammals and turtles in the U.S. Atlantic pelagic longline fleet during 2003. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SEFSC-527, 57 pp. Available from NMFS, Southeast Fisheries Science Center, 75 Virginia Beach Road, Miami, FL.

Gambell, R. 1985. Fin whale *Balaenoptera physalus* (Linnaeus, 1758). Pp. 171B192 in S.H. Ridgway and R. Harrison (eds.), Handbook of marine mammals, Vol. 3. Academic Press, London.

Glass, A.H., T.V.N Cole, M. Garron, R.L. Merrick, and R.M. Pace III. 2008. Mortality and serious injury determinations for baleen whale stocks along the United States eastern seaboard and adjacent Canadian Maritimes, 2002-2006. U.S. Department of Commerce, Northeast Fisheries Science Center Ref Doc. 08-04; 18 p. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026.

Hain, J.H.W., M.A. Hyman, R.D. Kenney and H.E. Winn. 1985. The role of cetaceans in the shelf-edge region of the northeastern United States. Mar. Fish. Rev. 47(1): 13–17.

Hain, J.H.W., M.J. Ratnaswamy, R.D. Kenney, and H.E. Winn. 1992. The fin whale, *Balaenoptera physalus*, in waters of the northeastern United States continental shelf. Rep. Int. Whal. Commn 42:653B669.

Hayes SA, Josephson E, Maze-Foley K, Rosel PE, Byrd B, Chavez-Rosales S, Col TVN, Engleby L, Garrison LP, Hatch J, Henry A, Horstman SC, Litz J, Lyssikatos MC, Mullin KD, Orphanides C, Pace RM, Palka DL, Soldevilla M, Wenzel FW. 2018. TM 245 U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments - 2017. NOAA Technical Memorandum NMFS NE-245. Available at: https://www.nefsc.noaa.gov/publications/tm/tm245/tm245.pdf

Hayes, S.A., E. Josephson, K. Maze-Foley, and P.E. Rosel (eds.). 2017. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments - 2016. NOAA Technical Memorandum. Available at: https://www.nefsc.noaa.gov/publications/tm/tm241/tm241.pdf

Herzing, D. L. 1997. The natural history of tree-ranging Atlantic spotted dolphins (*Stenella frontalis*): Age classes, color phases and female reproduction. Marine Mammal Science, 13, 40-59

IUCN (The World Conservation Union). 2010. 2010 IUCN Red List of Threatened Species. Available at: http://www.iucnredlist.org (Accessed in February 2010).

Jahoda, M., Lafortuna, C.L., Biassoni, N., Almirante, C., Azzellino, A., Panigada, S., Zanardelli, M. & Notarbartolo di Sciara, G. 2003. Mediterranean fin whale's (*Balaenoptera physalus*) response to small vessel and biopsy sampling assessed through passive tracking and timing of respiration. Marine Mammal Science, 19, 96–110.

Jefferson, T.A., M.A. Webber, and R.L. Pitman. 2008. Marine mammals of the world: A comprehensive guide to their identification. Amsterdam: Elsevier. 573 pp. London, UK: Elsevier.

Jefferson, T.A., S. Leatherwood, and M.A. Webber. 1993. FAO Species Identification Guide; Marine Mammals of the World. United Nations Environment Programme, Food and Agriculture Organization of the United Nations, Rome. viii + 320 pp.

Jensen, A.S., and G.K. Silber. 2004. Large Whale Ship Strike Database. U.S. Department of Commerce, NOAA Technical Memorandum. NMFS-OPR-, 37 pp.

Jonsgård, Å. 1966. Biology of the North Atlantic fin whale *Balaenoptera physalus* (L): taxonomy, distribution, migration and food. Hvalrådets Skrifter 49:1B62.

Kenney, R.D. 2002. North Atlantic, North Pacific and Southern Right Whales. pp. 806-813, In: W.F. Perrin, B. Würsig, and J.G.M. Thewissen (eds.). Encyclopedia of Marine Mammals. Academic Press, San Diego, CA.

Kenney, R.D. 2013. Marine Mammals of Rhode Island, Part 3, Bottlenose Dolphin. Rhode Island Natural History Survey. Available at: http://rinhs.org/animals/marinemammsofri3/.

Kenney, R.D. and H.E. Winn. 1986. Cetacean high-use habitats of the northeast United States continental shelf. Fishery Bulletin 84(2): 345-357.

Kenney, R.D., and K.J. Vigness-Raposa. 2009. Marine Mammals and Sea Turtles of Narragansett Bay, Block Island Sound,Rhode Island Sound, and Nearby Waters: An Analysis of Existing Data for the Rhode Island Ocean Special Area Management Plan. Technical Report, May 31, 2009.

Knowlton A.R. and S.D. Kraus. 2001. “Mortality and serious injury of northern right whales (*Eubalaena glacialis*) in the western North Atlantic Ocean”. Journal of Cetacean Research and Management, Special Issue 2:193-208.

Kongsberg Marine Limited (Kongsberg). 2011. Estimated Impact Zones of an Acoustic Corer. Prepared for PanGeo Subsea Inc. KM Doc. 448-RP-002. (Confidential and Proprietary).

Laist, D.W., A.R. Knowlton, J.G. Mead, A.S. Collet, and M. Podesta. 2001. Collisions between ships and whales. Marine Mammal *Science 17 (1), 35–75. Lesage, V. and M.O. Hammill. 2001. The status of the grey seal, Halichoerus* grypus, in the Northwest Atlantic. Can. Field-Nat. 115(4): 653-662.

Lesage, V. and M.O. Hammill. 2001. The status of the grey seal, Halichoerus grypus, in the Northwest Atlantic. Can. Field-Nat. 115(4): 653-662.

Marine Acoustics, Inc. (MAI). 2018a. Final Report for Oceaneering International, Inc. Sound Source Verification: Edgetech 512i Chirp Sonar Supporting Deepwater Wind’s Skipjack Wind Farm Project off Maryland and Delaware. Adam S. Frankel. MAI 1046. TN 18-025. August 3, 2018.

Marine Acoustics, Inc. (MAI). 2018b. Final Report for Oceaneering International, Inc. Sound Source Verification: Supporting Deepwater Wind’s Skipjack Wind Farm Project off Maryland and Delaware. Adam S. Frankel. MAI 1046. TN 18-026. August 21, 2018.

Martin, K.J., S.C. Alessi, J.C. Gaspard, A.D. Tucker, G.B. Bauer, and D.A. Mann. 2012. Underwater hearing in the loggerhead turtle (*Caretta caretta*): a comparison of behavioral and auditory evoked potential audiograms. *The Journal of Experimental Biology* 215:3001-3009.

McCauley, R.D., J. Fewtrell, A.J. Duncan, C. Jenner, M-N Jenner, J.D. Penrose, R.I.T. Prince, A Adhitya, J. Murdoch, and K. McCabe. 2000. Marine seismic surveys: A study of environmental implications. *Appea Journal*: 692-706.

Mullin, K.D. and G. L. Fulling. 2003. Abundance and distribution of cetaceans in the southern U.S. Atlantic Ocean during summer 1998. Fish. Bull. 101:603-613.

Mullin, K.D. and G. L. Fulling. 2004. Abundance of cetaceans in the oceanic northern Gulf of Mexico. Mar. Mamm. Sci. 20(4):787-807

NatureServe. 2010. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. Accessed: January 5, 2010

Nelson, M., M. Garron, R.L. Merrick, R.M. Pace and T.V.N. Cole. 2007. Mortality and serious injury determinations for large whale stocks along the United States Eastern Seaboard and Adjacent Canadian Maritimes, 2001-2005. U. S. Dep. Commer., Northeast Fish. Sci. Cent. Ref. Doc. 07-05. 18 pp.

NOAA (National Oceanic and Atmospheric Administration). 1993. Stellwagen Bank Management Plan and Final Environmental Impact Statement. http://stellwagen.noaa.gov/management/1993plan.html.

NOAA. 2005. Marine Mammal Protection Act (MMPA) of 1972. Office of Protected Resources.

NOAA. 2008. High numbers of right whales seen in Gulf of Maine: NOAA researchers identify wintering ground and potential breeding ground. NOAA press release; December 31, 2008.

NOAA. 2010. Reducing Ship Strikes to North Atlantic Right Whales. http://www.nmfs.noaa.gov/pr/shipstrike/.

NOAA. 2015. Office of Protected Resources, Marine Mammal Stock Assessment Reports. (SARs) by Species/Stock http://nefsc.noaa.gov/publications/tm/tm231/7_rightwhale_F2014July.pdf Accessed November 3, 2015.

NOAA. 2017. 2017 North Atlantic Right Whale Unusual Mortality Event. http://www.nmfs.noaa.gov/pr/health/mmume/2017northatlanticrightwhaleume.html Accessed October 13, 2017.

NOAA Fisheries (National Oceanic and Atmospheric Administration, National Marine Fisheries Service). 1991a. Recovery Plan for the Northern Right Whale (*Eubalaena glacialis*). Prepared by the Right Whale Recovery Team for the National Marine Fisheries Service", Silver Spring, Maryland. 86 pp.

NOAA Fisheries. 1991b. Recovery Plan for the Humpback Whale (*Megaptera novaeangliae*). Prepared by the Humpback Whale Recovery Team for the National Marine Fisheries Service", Silver Spring, Maryland. 105 pp.

NOAA Fisheries. 2006. Recovery Plan for The Sperm Whale (*Physeter macrocephalus*) [Draft Report]. (pp. 92). Silver Spring, MD: National Marine Fisheries Service.

NOAA Fisheries. 2009. Sperm Whale (*Physeter macrocephalus*): 5-Year Review: Summary and Evaluation. (pp. 41). Silver Spring, MD: National Marine Fisheries Service.

NOAA Fisheries. 2011. Final Recovery Plan for the Sei Whale. Office of Protected Resources NMFS NOAA. December 2011.

NOAA Fisheries. 2012. NMFS Office of Protected Resources Gray Seal (*Halichoerus grypus*) species profile. Accessed September, 2012, at: http://www.nmfs.noaa.gov/pr/species/mammals/pinnipeds/grayseal.htm

NOAA Fisheries. 2016. Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing: Underwater Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts. (and companion spreadsheet) U.S. Dept. of Commerce., NOAA. NOAA Technical Memorandum NMFS-OPR-55, 178 p.

NOAA Fisheries. 2018. 2018 Revisions to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts. U.S. Dept. of Commer., NOAA. NOAA Technical Memorandum NMFS-OPR-59, 167 p.

Nowak, R.M. 2002. Walker's Mammals of the World 6th edition. John Hopkins University Press, Baltimore, MD.

NYDOS (New York Department of State). 2013. Offshore Atlantic Ocean Study. http://docs.dos.ny.gov/communitieswaterfronts/ocean_docs/NYSDOS_Offshore_Atlantic_Ocean_Study.pdf

Pace RM, PJ Corkeron, and SD Kraus. 2017. State space estimates reveal a recent decline in abundance of North Atlantic right whales. Ecol Evol 7: 8730–8741

Pace RM, TVN Cole, and AG Henry. 2014. Incremental fishing gear modifications fail to significantly reduce large whale serious injury rates. Endangered Species Research 26:115–126.

Palka D. L. & Hammond P. S. 2001. Accounting for responsive movement in line transect estimates of abundance. Can. J. Fish. Aquat. Sci.58, 777–787.

Payne, P.M., L.A. Selzer and A.R. Knowlton. 1984. Distribution and density of cetaceans, marine turtles and seabirds in the shelf waters of the northeast U.S., June 1980 - Dec. 1983, based on shipboard observations. National Marine Fisheries Service, Woods Hole. NA81FAC00023: 245.

Payne, P.M. and D.W. Heinemann 1993. The distribution of pilot whales (*Globicephala* sp.) in shelf/shelf edge and slope waters of the northeastern United States, 1978-1988. Rep. Int. Whal. Comm. (Special Issue) 14: 51-68.

Perrin, W. F., E. D. Mitchell, J. G. Mead, D. K. Caldwell, M. C. Caldwell, P. J. H. van Bree and W. H. Dawbin. 1987. Revision of the spotted dolphins, *Stenella* spp. Mar. Mamm. Sci. 3(2):99-170.

Perry, S. L., D. P. Demaster, and G. K. Silber. 1999. The sei whale (*Balaenoptera borealis*). Marine Fisheries Review 61(1):52-58. W. L. Hobart (Ed.). In the Great Whales History and Status of Six Species Listed As Endangered Under the U.S. Endangered Species Act of1973

Porter, Michael. B and Bucker, Homer P. 1987. Gaussian beam tracing for computing ocean acoustic fields. Journal of the Acoustical Society of America. 82: 1349-1359

Reeves, R.R. and A.J. Reed. 2003. Bottlenose dolphin, harbor porpoise, sperm whale and other toothed cetaceans Tursiops truncatus, Phocoena phocoena,a nd Physeter macrocephalus). Pp. 397-424 in Wild mammals of North American biology, management and conservation. (G.A. Feldhamer, B.C. Thomspon and J.A. Chapman, eds.). Johns Hopkins Univ. Press, Baltimore.

Reeves, R.R. G.K. Silber and P.M. Payne. 1998. "Draft recovery plan for the Fin Whale (*Balaenoptera physalus*) and Sei Whale (*Balenoptera borealis*)." Office of Protected Resources, National Marine Fisheries Service, Silver Spring, MD. 65pp.

Reeves, R.R., B.S. Stewart, P.J. Clapham, and J.A. Powell. 2002. Guide to Marine Mammals of the World. National Audubon Society.

RI Ocean SAMP. 2011. Rhode Island Coastal Resources Management Council. Draft, May 4, 2010.

Rice, D.W. 1989. Marine Mammals of the World: Systematics and Distribution D. Wartzok (Ed.), (Society for Marine Mammology Special Publication 4, pp. 231). Lawrence, KS: Allen Press.

Richardson, W.J, C.R. Greene, Jr., C.I. Malme, and D.H. Thomson with S.E. Moore and B. Wursig. 1991. Effects of noise on marine mammals. OCS Study MMS 90 0093. Report from LGL Ecol. Resl. Assoc. Inc., Bryan, TX for U.S. Minerals Management Service, Atlantic OCS Region, Herndon, Virginia. NTIS PB91 168914.

Right Whale Consortium. 2014. North Atlantic Right Whale Consortium Sightings Database. 03/11/2014. New England Aquarium, Boston, MA. USA.

Roberts JJ, Best BD, Mannocci L, Fujioka E, Halpin PN, Palka DL, Garrison LP, Mullin KD, Cole TVN, Khan CB, McLellan WM, Pabst DA, Lockhart GG (2016a) Habitat-based cetacean density models for the U.S. Atlantic and Gulf of Mexico. Scientific Reports 6: 22615. doi: 10.1038/srep22615.

Roberts JJ, Mannocci L, Halpin PN (2016b) Final Project Report: Marine Species Density Data Gap Assessments and Update for the AFTT Study Area, 2015-2016 (Base Year). Document version 1.0. Report prepared for Naval Facilities Engineering Command, Atlantic by the Duke University Marine Geospatial Ecology Lab, Durham, NC.

Roberts JJ, Mannocci L, Halpin PN (2017) Final Project Report: Marine Species Density Data Gap Assessments and Update for the AFTT Study Area, 2016-2017 (Opt. Year 1). Document version 1.4. Report prepared for Naval Facilities Engineering Command, Atlantic by the Duke University Marine Geospatial Ecology Lab, Durham, NC.

Roberts JJ, Mannocci L, Schick RS, Halpin PN (2018) Final Project Report: Marine Species Density Data Gap Assessments and Update for the AFTT Study Area, 2017-2018 (Opt. Year 2). Document version 1.2. Report prepared for Naval Facilities Engineering Command, Atlantic by the Duke University Marine Geospatial Ecology Lab, Durham, NC.

Rolland, Rosalind M., Robert S. Schick, Heather M. Pettis, Amy R. Knowlton, Philip K. Hamilton, James S. Clark, Scott D. Kraus. 2016. Health of North Atlantic right whales *Eubalaena glacialis* over three decades: from individual health to demographic and population health trends. Mar Ecol Prog Ser 542:265-282. https://doi.org/10.3354/meps11547.

Ronald, K., and B. L. Gots. 2003. Seals: Phocidae, Otariidae, and Odobenidae. Pp. 789–854 in: G. A. Feldhamer, B. C. Thompson, and J. A. Chapman, eds. Wild Mammals of North America: Biology, Management, and Economics, second edition. Johns Hopkins University Press, Baltimore, MD.

Rough, V. 1995. Gray Seals in Nantucket Sound, Massachusetts, Winter and Spring, 1994. Final Report to Marine Mammal Commission in Fulfillment of Contract T10155615.

RPS 2018. HRG Survey Equipment Acoustic Field Verification Report. Prepared for Terrasond on behalf of Ørsted. Report by RPS and Noise Control Engineering, May 28, 2018

Schroeder, C. L. 2000. Population Status and Distribution of the Harbor Seal in Rhode Island Waters. M.S. thesis. University of Rhode Island, Graduate School of Oceanography, Narragansett, RI. xiii + 197 pp.

Sergeant, D.E. 1977. Stocks of fin whales *Balaenoptera physalus* L. in the North Atlantic Ocean. Rep. int. Whal. Commn 27:460B473.

Smultea Environmental Services LLC. 2016. Draft G&G Survey Activities and Observation Report MAW01 Geotechnical 1A Survey (2016). Prepared for Fugro Marine GeoServices, Inc and DONG Energy (Confidential and Proprietary).

Southall, B.L., Bowles, A.E., Ellison, W.T., Finneran, J.J., Gentry, R.L., Greene Jr., C.R., Kastak, D., Ketten, D.R., Miller, J.H., Nachtigall, P.E., Richardson, W.J., Thomas, J.A, and P.L. Tyack. 2007. Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations. Aquatic Mammals, Volume 33, Number 4, ISSN 0167-5427. 521 pp.

Stevick, P.T., L. Pacheco de Godoy, M. McOsker, M.H. Engel, J. Allen. 2006. A note on the movement of a humpback whale from Abrolhos Bank, Brazil to South Georgia. J Cetacean Res Manage 8:297-300

Subacoustech. 2017. Deepwater Wind Sound Source Verification. 17 July 2017. (Confidential and Proprietary).

Subacoustech. 2018. Sound Source Verification for High Resolution Geophysical Survey Equipment, Fugro Enterprise. Subacoustech Environmental Report No. P236R0202. 12 November 2018. (Confidential and Proprietary).

Sutcliffe M.H., and P.F. Brodie. 1977. Whale distributions in Nova Scotia waters. Fish Mar Serv Tech Rep 722:1-89

Swingle, W.M., S.G. Barco, T.D. Pitchford, W.A. McLellan, and D.A. Pabst. 1993. Appearance of juvenile humpback whales feeding in the nearshore waters of Virginia. Mar. Mamm. Sci. 9:309-315.

van der Hoop, J.M., P. Corkeron, A.G. Henry, A.R. Knowlton and M.J. Moore. 2017. Predicting lethal entanglements as a consequence of drag from fishing gear. Marine Pollution Bulletin 115: 91-104

van der Hoop Corkeron, J., 2016. Entanglement is a costly life-history stage in large whales. Ecology and Evolution 00:1–15. http://dx.doi.org/10.1002/ece3.2615.

van der Hoop, J.M., A.S.M. Vanderlaan, T.V.N. Cole, A.G. Henry, L. Hall, B. Mase-Guthrie, T. Wimmer, and M.J. Moore. 2015. Vessel strikes to large whales before and after the 2008 Ship Strike Rule. Cons. Letters 8(1) 24–32.

Viricel, A. and P.E. Rosel. 2014. Hierarchical population structure and habitat differences in a highly mobile marine species: the Atlantic spotted dolphin. Mol. Ecol. 23: 5018–5035.

Waring, G.T., E. Josephson, C.P. Fairfield, and K. Maze-Foley, eds., with contributions from: Dana Beldon, Timothy V. N. Cole, Lance P. Garrison, Keith D. Mullin, Christopher Orphanides, Richard M. Pace, Debra L. Palka, Marjorie C. Rossman, and Fredrick W. Wenzel. 2007. Technical Memorandum NMFS-NE-201. National Oceanic and Atmospheric Administration, U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments – 2006.

Waring, G.T., E. Josephson, C.P. Fairfield-Walsh, and K. Maze-Foley (eds.). 2009. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments -- 2008. NOAA Tech Memo NMFS NE 210; 440 p.

Waring, G. T., Josephson, E., Maze-Foley, K. & Rosel, P. E. (eds.). 2009. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments -- 2009 [Technical Memorandum]. (NMFS NE 213, pp. 528). Woods Hole, MA: NOAA Retrieved from http://www.nefsc.noaa.gov/nefsc/publications/tm/tm213/index.html

Waring GT, Josephson E, Maze-Foley K, and Rosel PE (eds.). 2010. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments -- 2009. NOAA Tech Memo NMFS NE 213; 528 p.

Waring, G., E. Josephson, K. Maze-Foley, and P.E. Rosel (eds.). 2011. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments - 2011, 330 pages. Available at: http://www.nmfs.noaa.gov/pr/pdfs/sars/ao2011.pdf.

Waring, G., E. Josephson, K. Maze-Foley, and P.E. Rosel (eds.). 2012. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments – 2011. NOAA Tech Memo NMFS NE 221; 330 pages.

Waring, G., E. Josephson, K. Maze-Foley, and P.E. Rosel (eds). 2013. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments - 2012, 419 pages. Available at: www.nmfs.noaa.gov/pr/sars/pdf/ao2012.pdf.

Waring, G.T., E. Josephson, K. Maze-Foley, and P.E. Rosel (eds.). 2015. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments - 2014. NOAA Technical Memorandum. Available at: http://www.nmfs.noaa.gov/pr/sars/pdf/atl2014_final.pdf

Waring, G.T., E. Josephson, K. Maze-Foley, and P.E. Rosel (eds.). 2016. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments - 2015. NOAA Technical Memorandum. Available at: http://www.nmfs.noaa.gov/pr/sars/pdf/atlantic2015_final.pdf

Waring, G.T., M.C. Rossman and F.W. Wenzel. 2014. Serious injury determinations for small cetaceans and pinnipeds caught in commercial fisheries off the northeast U.S. coast, 2007–2011. Northeast Fish. Sci.Cent. Ref. Doc. 14-13. 32 pp.

Waring, G.T., L. Nøttestad, E. Olsen, H. Skov, and G. Vikingsson. 2008. Distribution and density estimates of cetaceans along the mid-Atlantic ridge during summer 2004. J Cetacean Res Manage 10:137-46.

Waring, G.T., R.M. Pace, J.M. Quintal, C.P. Fairfield, and K. Maze-Foley (eds.). 2004. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments—2003. NOAA Technical Memorandum NMFS-NE-182.

Watkins, W.A., K.E. Moore, J. Sigurjonsson, D. Wartzok, and G. Notarbartolo di Sciara. 1984. Fin whale (Balaenoptera physalus) tracked by radio in the Irminger Sea. Rit Fiskideildar 8(1):1-14

Weissenberger, J., M. Blees, J. Christensen, K. Hartin, D. Ireland, D. Zitterbart. 2011. Monitoring for marine mammals in Alaska using a 360° infrared camera system.

Wells, R. S. and Scott, M. D. 2002. Bottlenose dolphins *Tursiops trurlcatus* and *T. aduncus*. Pages 122-128, In: W.F. Perrin, B. Wiirsig, & J.G.M. Thewissen (eds.) Encyclopedia of Marine Mammals. Academic Press, San Diego.

Whitehead, H. 2003. Sperm Whales: Social Evolution in the Ocean (pp. 431). University of Chicago Press.

Whitehead, H. 2008. Sperm whale *Physeter macrocephalus*. In W. F. Perrin, B. Wursig and J. G. M. Thewissen (Eds.), Encyclopedia of Marine Mammals (Second Edition) (pp. 1091-1097). Academic Press.

Whitehead, H., S. Brennan, and D. Grover. 1992. Distribution and behaviour of male sperm whales on the Scotian shelf. Canadian Journal of Zoology 70, 912-918.

Wilson and Ruff. 1999. The Smithsonian Book of North American Mammals. Smithsonian Institution Press, Washington, DC.

World Wildlife Fund. 2005. “Green Turtle: Introduction”. Site visited February 22, 2005.http://www.panda.org/about_wwf/what_we_do/species/showspecies.cfm?SID=32& LID=2&FH=E.

Wynne, K., and M. Schwartz. 1999. Marine Mammals and Turtles of the U. S. Atlantic and Gulf of Mexico. Rhode Island Sea Grant. Narragansett, Rhode Island. 114 pp.

Yeung, C. 1999. Estimates of marine mammal and marine turtle bycatch by the U.S. Atlantic pelagic longline fleet in 1998. NOAA Tech. Memo. NMFS-SEFSC-430, 26 pp.

Yeung, C. 2001. Estimates of marine mammal and marine turtle bycatch by the U.S. Atlantic pelagic longline fleet in 1999-2000. NOAA Tech. Memo. NMFS-SEFSC-467, 43 pp.

Zitterbart DP, Kindermann L, Burkhardt E, Boebel O. (2013). Automatic Round-the-Clock Detection of Whales for Mitigation from Underwater Noise Impacts. PLoS ONE 8(8): e71217 doi:10.1371/journal.pone.0071217

Appendix A
National Marine Fisheries Service Screening Level Methodology Calculation Spreadsheets for the Determination for Onset of Permanent and Temporary Threshold Shifts

(Version 2.0 April 2018)

Appendix B
Mitigation and Monitoring Communications Flow Diagram

Appendix C
Night Vision Binocular Specifications

Appendix D
Infrared Equipment Specifications

Appendix E
Sound Source Verification Reports