REPORT

Bay State Wind Offshore Wind Farm – Request for the Taking of Marine Mammals Incidental to the Site Characterization of the DONG Energy Bay State Wind Offshore Wind Farm Lease Area

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Acronyms and Abbreviations

μPa	microPascal
Applicant	DONG Energy Massachusetts (U.S.), LLC
BOEM	Bureau of Ocean Energy Management
CeTAP	Cetacean and Turtles Assessment Program
CFR	Code of Federal Regulations
cm	centimeter
CPT	cone penetration test
dB	decibel
DMA	Dynamic Management Area
DoN	U.S. Department of the Navy
EA	Environmental Assessment
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
FLIDAR	floating light and detection ranging buoy
ft	foot
GPS	global positioning system
HDD	Horizontal Directional Drill
HRG	high-resolution geophysical
Hz	hertz
IHA	Incidental Harassment Authorization
in	inch
IUCN	World Conservation Union
IWC	International Whaling Commission
km	kilometer
km^2	square kilometer
km/h	kilometer per hour
kHz	kilohertz
m	meter
MA	Massachusetts
mi	mile
MMPA	Marine Mammal Protection Act
MW	megawatt
nm	nautical mile
NOAA	National Oceanic and Atmospheric Administration
NMFS	National Marine Fisheries Service
OCS	Outer Continental Shelf
OPAREA	Operations Area
PAM	Passive Acoustic Monitoring
PSO	Protected Species Observer
RAM	Range-Dependent Acoustic Model
RMS	root mean square
SMA	Seasonal Management Area
SPUE	sightings per unit effort
WEA	Wind Energy Area

ZOI	Zone of Influence

1. Description of Specified Activity

DONG Energy Massachusetts (U.S.) LLC (the Applicant) is proposing to conduct marine site characterization surveys off the coast of Massachusetts in the area of the Commercial Lease of Submerged Lands for Renewable Energy Development on the Outer Continental Shelf (OCS-A 0500) (the Lease Area; 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 Lease Area specifically associated with the operation of high-resolution geophysical (HRG) survey equipment during geophysical survey activities. This request is specifically being submitted as the result of recent guidance from the National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS) that modifies the methods used to calculate the potential take of marine mammals by acoustic harassment from mobile noise sources.

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 NMFS 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.

1.1 Survey Activities

The Applicant will conduct marine site characterization surveys in the marine environment of the approximately 187,532-acre Lease Area located approximately 14 miles (mi) south of Martha’s Vineyard, Massachusetts, at its closest point (see Figure 1-1). Marine site characterization surveys will include the following HRG survey activities:

- Depth sounding (multibeam depth sounder) to determine water depths and general bottom topography;
- Magnetic intensity measurements for detecting local variations in regional magnetic field from geological strata and potential ferrous objects on and below the bottom;
- 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;
- Shallow penetration sub-bottom profiler (pinger/chirp) to map the near surface stratigraphy (top 0-5 meter [m] soils below seabed); and
- Medium penetration sub-bottom profiler (sparker) to map deeper subsurface stratigraphy as needed (soils down to 75-100 m below seabed).

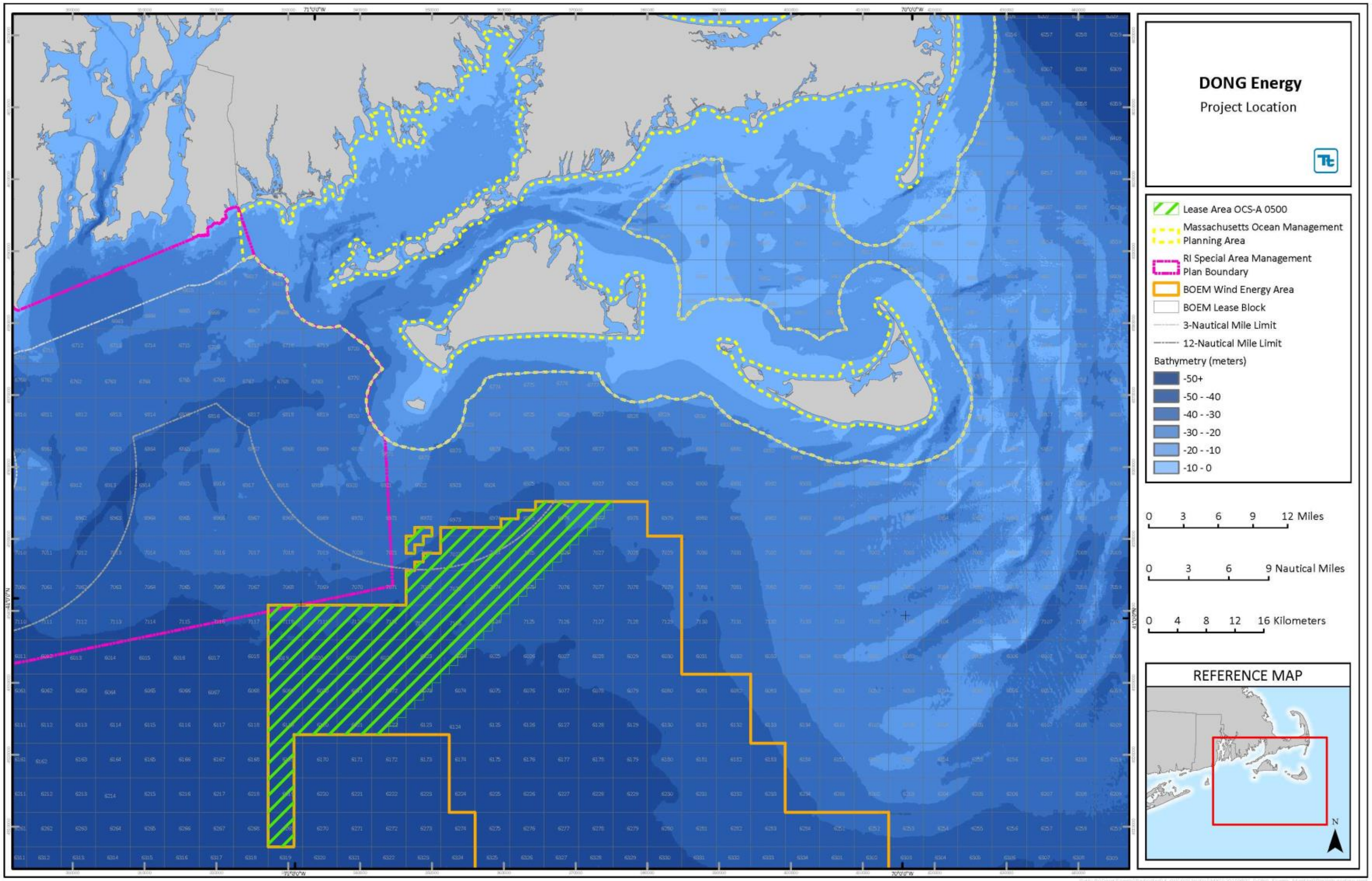

Figure 1-1 Project Location

The purpose of the marine site characterization surveys is to:

- Support the siting, design, and deployment of up to two meteorological data collection buoys referred to as floating light and detection ranging buoys (FLIDARs) and up to two metocean and current buoys; and
- Obtain a baseline assessment of seabed/sub-surface soil conditions in the DONG Energy Massachusetts Lease Area to support the siting of the proposed wind farm.

The HRG surveys are scheduled to begin, at the earliest, on May 1st of 2016. Table 1-1 identifies the representative survey equipment that are being considered in support the HRG survey activities. The make and model of the listed HRG equipment will vary depending on availability, but will be finalized as part of the survey preparations and contract negotiations with the survey contractor, and therefore the final selection of the survey equipment will be confirmed prior to the start of the HRG survey program. None of the proposed HRG survey activities will result in the disturbance of bottom habitat in the Lease Area.

Table 1-1 Summary of Representative DONG Energy HRG Survey Equipment

HRG Equipment	Operating Frequencies	Source Level	Source Depth	Beamwidth (degree)	Pulse Duration (millisec)
iXBlue GAPS	22-30 kHz	192 dB_{RMS}	2-5 m below surface	180	1
Sonardyne Scout USBL	35-50 kHz	187 dB_{RMS}	2-5 m below surface	180	1
Edgtech 4125 Sidescan Sonar[1]	400/900/1600 kHz	205 dB_{RMS}	1-2 m below surface	50	0.6 to 4.9
Klein 3000H Sidescan Sonar[1]	445/900 kHz	242 dB_{RMS}	3-8 m above seafloor	.2	0.0025 to 0.4
GeoPulse Sub-bottom Profiler	1.5 to 18 kHz	208 dB_{RMS}	3-8 m above seafloor	55	0.1 to 1
Geo-Source 200/800	50 to 5000 Hz	221 dB_{RMS}/ 217 dB_{RMS}	1-2 m below surface	110	1 to 2
SeaBat 7125 Multibeam Sonar[2]	200/400 kHz	220 dB_{peak}	1 to 3 m below surface	2	0.03 to .3
EM 2040 Multibeam Sonar[2]	200/400 kHz	207 dB_{RMS}	1 to 3 m below surface	1.5	0.05 to 0.6

[1]It should be noted that only one of the representative sidescan sonars would be selected for deployment.
[2]It should be noted that only one of the representative multibeam sonars would be selected for deployment.

The survey activities will be supported by a vessel approximately 98 to 180 feet (ft) in length and capable of maintaining course and a survey speed of approximately 4 knots while transiting survey lines.

Should the Applicant decide to characterize conditions across the entirety of the Lease Area, HRG surveys will be conducted at 900-meter (m) line spacing. Up to two FLIDARs would be deployed within the lease area, and up to three potential locations for FLIDAR deployment will be investigated. At the three potential FLIDAR deployment locations the survey will be conducted along a tighter 30-m line spacing to meet the Bureau of Energy Management (BOEM) requirements as set out in the July 2015 Guidelines for Providing Geophysical, Geotechnical, and Geohazard Information Pursuant and Archeological and Historic Property Information to 30 CFR Part 585.

Given the size of the Lease Area (187,532 acres), to minimize cost, the duration of survey activities, and the period of potential impact on marine species, the Applicant has proposed conducting survey operations 24 hours per day. Based on 24-hour operations, the estimated duration of the survey activities would be approximately 4 to 5 weeks (including estimated weather down time).

Both NOAA and BOEM have advised that the deployment of HRG survey equipment including the use of sound-producing 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. 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 Lease Area during survey activities (Table 6-1), only the potential equipment positioning systems (iXBlue GAPS and Sonardyne Scout USBL) and the sub-bottom profilers (GeoPulse Sub-bottom Profiler and Geo-Source 200 and 800) fall within the established marine mammal hearing ranges and have the potential to result in Level 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. NOAA defines the Level A Harassment zone of injury to marine mammals as the range of received sound pressure levels from 180 decibels (dB) referenced to 1 microPascal (μPa) root mean square (RMS), for mysticetes and odontocetes within the 180 dB_{RMS} re 1μPa sound exposure limit, and 190 dB_{RMS} re 1μPa for pinnipeds. This threshold considers instantaneous sound pressure levels at a given receiver location. The NOAA 180 dB_{RMS} re 1 μPa guideline is designed to protect all marine species from high sound pressure levels at any discrete frequency across the entire frequency spectrum. It is a very conservative criterion as it does not consider species-specific hearing capabilities.

The MMPA defines Level B harassment 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. NOAA has defined the threshold level for Level B harassment at 120 dB_{RMS} re 1 μPa for continuous noise and 160 $dB_{RMS90\%}$ re 1 μPa for impulse noise. Within this zone, the sound produced by the 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.

A summary of the NOAA cause and effect noise criteria are summarized in Table 1-2.

Table 1-2 NMFS Marine Mammal Noise Criteria (NMFS 2005)

	Criteria Level	Type
Marine Mammals		
Level A Harassment (Injury) - Mysticetes and Odontocetes	180 dB_{RMS} re 1 μPa	Absolute
Level A Harassment (Injury) - Pinnipeds	190 dB_{RMS} re 1 μPa	Absolute
Level B Harassment (Disturbance)	160 $dB_{RMS90\%}$ re 1 μPa 120 dB_{RMS} re 1 μPa	Impulse Continuous

The Applicant's survey activities that could result in the incidental take of marine mammals are limited to Level B harassment caused by the generation of underwater noise from operation of the HRG survey sub-bottom profiler and equipment positioning systems as described in Section 1.1.

To better understand both the level and extent of underwater noise generated by Project activities, the Applicant conducted a hydroacoustic modeling exercise of the representative survey equipment to predict the potential acoustic zones of influence (ZOIs) associated with the various HRG survey equipment. Modeling took into consideration the following factors:

- **Sound sources:** HRG survey sound sources were modeled using the loudest potential operational parameters, which are expected to be well beyond the needs of this survey.
- **Bathymetry:** Seabed topography was included in the model, which provided site-specific boundary conditions that affect underwater sound propagation and attenuation by shielding, refracting or reflecting sound. Given the size of the survey area calculations were done at three representative water depths (38 m, 44 m and 54 m).
- **Geoacoustic properties (e.g., hard rock, sand, mud) of the Lease Area:** The physical properties of the seabed were characterized (e.g., density, compressional and shear attenuation). These varying properties govern the sound speed and attenuation of acoustic signals through sediment and the model calculates the bottom loss and the reflecting differences in the speed of sound to determine bottom loss.
- **Time of Year:** The sound speed profile has an influence on sound attenuation and varies by location and month. As the proposed survey activities could occur in both May and June, the sound speed profiles for both months were evaluated.
- **Marine mammal hearing ranges:** Only equipment with operational frequency ranges within the hearing range of the marine mammal species known to occur in the Lease Area at the time of the proposed survey activities were evaluated.

The complete Hydroacoustic Modeling Assessment is provide in Appendix A. Results of the assessment are summarized in Table 1-3. The sound levels presented in Table 1-3 are consistent with data for similar offshore survey activities. As demonstrated by the assessment, the equipment with the greatest potential for effect on marine mammals is the proposed sub-bottom profilers. The estimated maximum critical distance to the 160 $dB_{RMS90\%}$ re 1μPa) MMPA threshold for all water depths for this equipment was approximately 380 m from the source (see Table 1-3).

Table 1-3 Worst-Case Modeled Distances to MMPA Thresholds for Maine Mammals

HRG Equipment	Marine Mammal Level A Harassment 180 dB_{RMS} re 1 μPa (m)	Marine Mammal Level B Harassment 160 $dB_{RMS90\%}$ re 1 μPa (m)	Marine Mammal Level B Harassment 120 dB_{RMS} re 1 μPa (m)
ixBlue GAPS	< 10	25	N/A[a/]
Sonardyne Scout USBL	-	25	N/A
GeoPulse Sub-bottom Profiler	30	75	N/A
Geo-Source 800	80	250	N/A
Geo-Source 200	90	380	N/A
a/ Not applicable for impulsive noise.			

Per the DONG Energy Lease, to verify distances calculated by hydroacoustic modeling, the Applicant will conduct underwater acoustic measurements of noise-producing activities at the start of HRG survey program. Field verification of actual sound propagation will enable adjustment of the critical MMPA threshold level distances to fit actual survey conditions, if necessary. See Sections 11.0 and 13.0 for additional details on mitigation, monitoring and reporting.

2. Dates, Duration, and Specific Geographic Region

2.1 Survey Activity Dates and Duration

HRG surveys are anticipated to commence in early May 2016 and will last for approximately 4 to 5 weeks. This survey schedule is based on 24-hour operations and includes estimated weather down time.

2.2 Specific Geographic Region

The Applicant's survey activities will occur in the approximately 187,532-acre Lease Area designated and offered by BOEM. The Lease Area falls within the Massachusetts Wind Energy Area (MA WEA; Figure 1-1). An evaluation of site assessment activities within the MA WEA was fully assessed in the BOEM Environmental Assessment (EA) and associated Finding of No Significant Impact as revised in June 2014. A Biological Opinion on site assessment activities within the MA WEA was issued by NOAA to BOEM in April 2013.

3. Species and Numbers of Marine Mammals

The BOEM (2014) Revised EA reports 38 species of marine mammals (whales, dolphins, porpoise, and seals) in the Northwest Atlantic Outer Continental Shelf (OCS) region that are protected by the MMPA, 6 of which are listed under the 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 are 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	NMFS Status	Estimated Population	Stock
Toothed Whales (Odontoceti)				
Atlantic white-sided dolphin	*Lagenorhynchus acutus*	N/A	48,819	W. North Atlantic
Atlantic spotted dolphin	*Stenella frontalis*	N/A	44,715	W. North Atlantic
Bottlenose dolphin	*Tursiops truncates*	Northern coastal stock is Strategic [a/]	11,548	W. North Atlantic, Northern Migratory Coastal
Clymene Dolphin	*Stenella clymene*	N/A	Unknown	W. North Atlantic
Fraser's Dolphin	*Lagenodelphis hosei*	N/A	Unknown	W. North Atlantic
Pan-Tropical Spotted Dolphin	*Stenella attenuate*	N/A	3,333	W. North Atlantic
Risso's dolphin	*Grampus griseus*	N/A	18,250	W. North Atlantic
Rough-Toothed Dolphin	*Steno bredanensis*	N/A	271	W. North Atlantic
Short-beaked common dolphin	*Delphinus delphis*	N/A	120,743	W. North Atlantic
Striped dolphin	*Stenella coeruleoalba*	N/A	46,882	W. North Atlantic
Spinner Dolphin	*Stenella longirostris*	N/A	Unknown	W. North Atlantic
White-beaked dolphin	*Lagenorhynchus albirostris*	N/A	2,003	W. North Atlantic
Harbor porpoise	*Phocoena phocoena*	N/A	79,833	Gulf of Maine/Bay of Fundy
Killer whale	*Orcinus orca*	N/A	Unknown	W. North Atlantic
Pygmy Killer Whale	*Feresa attenuate*	N/A	3,785	W. North Atlantic
False killer whale	*Pseudorca crassidens*	Strategic	442	W. North Atlantic
Long-finned pilot whale	*Globicephala malaena*	N/A	26,535	W. North Atlantic
Short-finned pilot whale	*Globicephala macrorhynchus*	N/A	21,515	W. North Atlantic
Sperm whale	*Physeter macrocephalus*	Endangered	2,288	North Atlantic
Pigmy sperm whale	*Kogia breviceps*	N/A	3,785 [b/]	W. North Atlantic
Dwarf sperm whale	*Kogia sima*	N/A	3,785 [b/]	W. North Atlantic
Cuvier's beaked whale	*Ziphius cavirostris*	N/A	6,532	W. North Atlantic
Blainville's beaked whale	*Mesoplodon densirostris*	N/A	7,092 [c/]	W. North Atlantic
Gervais' beaked whale	*Mesoplodon europaeus*	N/A	7,092 [c/]	W. North Atlantic
True's beaked whale	*Mesoplodon mirus*	N/A	7,092 [c/]	W. North Atlantic
Sowerby's Beaked Whale	*Mesoplodon bidens*	N/A	7,092 [c/]	W. North Atlantic
Northern bottlenose whale	*Hyperoodon ampullatus*	N/A	Unknown	W. North Atlantic
Melon-headed whale	*Peponocephala electra*	W. North Atlantic	W. North Atlantic	W. North Atlantic
Baleen Whales (Mysticeti)				
Minke whale	*Balaenoptera acutorostrata*	N/A	20,741	Canadian East Coast
Blue whale	*Balaenoptera musculus*	Endangered	Unknown	W. North Atlantic
Fin whale	*Balaenoptera physalus*	Endangered	1,618	W. North Atlantic
Humpback whale	*Megaptera novaeangliae*	Endangered	11,570	North Atlantic
North Atlantic right whale	*Eubalaena glacialis*	Endangered	465	W. North Atlantic
Sei whale	*Balaenoptera borealis*	Endangered	357	Nova Scotia
Earless Seals (Phocidae)				
Gray seals	*Halichoerus grypus*	N/A	348,900	North Atlantic
Harbor seals	*Phoca vitulina*	N/A	75,834	W. North Atlantic
Hooded seals	*Cystophora cristata*	N/A	Unknown	W. North Atlantic
Harp seal	*Phoca groenlandica*	N/A	8,300,000	North Atlantic

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: Waring et al. 2015; Waring et al 2013; Waring et al 2011; Warring et al 2010; RI SAMP 2011; Kenney and Vigness-Raposa 2009; NMFS 2012

4. Affected Species Status and Distribution

As described in Section 3.0, of the 38 marine mammal species potentially inhabiting the Northwest Atlantic OCS region, six marine mammal species are listed under the ESA and are known to be present, at least seasonally, in the waters of Southern New England: blue whale, fin whale, humpback whale, right whale, sei whale, and sperm whale. These species are highly migratory and do not spend extended periods of time in a localized area. The waters of Southern New England (including the Lease Area) are primarily used as a stopover point for these species during seasonal movements north or south between important feeding and breeding grounds. Some whale species (fin, humpback, and minke whales) are present year-round in the continental shelf and slope waters but are relatively rare in the more shallow waters of the Lease Area and the typical migratory routes for right whales and other baleen whales lie further offshore and outside of the Lease Area (Kenney and Vigness-Raposa 2009). While the fin, humpback, and right whales have the potential to occur within the Lease Area, the sperm, blue, and sei whales are more pelagic and/or northern species and their presence within the Lease Area is possible, but they are considered less common with regards to sightings. In particular, while sperm whales are known to occur occasionally in the region, their sightings are considered rare and thus their presence in the Lease 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 and sei whale to occur within the Lease Area during the marine survey period is unlikely, these 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-endangered or threatened and endangered marine mammals that are both common in the waters of the OCS south of Massachusetts and have the likelihood of occurring, at least seasonally, in the Lease Area. These species include the minke and long-finned pilot whales, short-beaked common, Atlantic white-sided, bottlenose, and Risso's dolphins, harbor porpoise, and harbor and gray seals (Right Whale Consortium 2014). White-beaked dolphins are likely to occur in the nearby waters surrounding the Lease Area (i.e., within 40 nautical miles [nm] [74 kilometers (km)]), but not in the Lease Area, and beaked whales are likely to occur in the region to the south of the Lease Area, but not within 40 nm (74 km) (Right Whale Consortium 2014). In general, the remaining non-ESA whale species listed in Table 3-1 range outside the DONG Energy Lease Area, usually in more pelagic waters, or are so rarely sighted that their presence in the Lease Area is unlikely.

4.1 Toothed Whales (Odontonceti)

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 200,000 and 1,500,000 sperm whales, based on extrapolations from only a few areas that have useful estimates (NMFS 2006). 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 (NMFS 2006; Waring et al. 2009). For the western North Atlantic, the minimum population size has been estimated at 1,815 individuals (Waring et al. 2014).

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 (NMFS 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 (Waring et al. 2015).

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).

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). 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 (Waring et al. 2015).

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 365 harbor porpoises are killed by human-related activities in U.S. and

Canadian waters each year. 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).

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 2.5 m and 2.8 m in length, with females being approximately 20 cm 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 (Department of the Navy [DoN] 2005). Recent population estimates for Atlantic white-sided dolphins in the Western North Atlantic Ocean places this species at 48,819 individuals (Waring et al. 2015). 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). Average annual fishery-related mortality and serious injury does not exceed the potential biological removal for this species; therefore, NMFS considers this species as “non-strategic” (Waring et al. 2011; 2015).

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 120,743 individuals (Waring et al. 2015).

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 2004 to 2008, it was estimated that on average approximately 167 dolphins were killed each year by human activities (Waring et al. 2010). This number increased to 289 dolphins during 2008 to 2012 (Waring et al. 2015). 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, NMFS considers this species as “non-strategic” (Waring et al. 2009; 2010; 2015).

4.2 Baleen Whales (Mysticeti)

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

The North Atlantic right whale is a strongly migratory species that moves annually between high-latitude feeding grounds and low-latitude calving and breeding grounds. This species was listed as a federally endangered species in 1970 and is one of the most endangered large whale species in the world. The North Atlantic right whale has seen a nominal 2 percent recovery rate since it was listed as a protected species (NOAA Fisheries 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). The historic range of this species reached its southern terminus between Florida and northwestern Africa and its northern terminus between Labrador and Norway (Kenney 2002). 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. 2007). 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. 2007). 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 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).

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 (NMFS 1991a; Waring et al. 2004). This is a tremendous difference from pre-exploitation numbers, which are thought to be around 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 2014, the Western North Atlantic population size was estimated to be at least 465 individuals (Waring et al. 2013)

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). 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). 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 2008 through 2012, the minimum rate of annual human-caused mortality and serious injury to this species from fishing entanglements averaged 3.65 per year, while ship strikes averaged 0.9 whales per year (Waring et al. 2015). 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. 2015).

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, NMFS designated the nearshore waters of the Mid-Atlantic Bight as the Mid-Atlantic U.S. Seasonal Management Area (SMA) for right whales. NMFS 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).

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).

Humpback Whale (*Megaptera novaeangliae*) – Endangered

The humpback whale was listed as endangered in 1970 due to population decrease resulting from overharvesting. 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 (NMFS 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 10.3 animals per year between 2008 and 2012 (Waring et al. 2015). 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 (NMFS 1991b). According to the species stock assessment report, the best estimate of abundance for the Gulf of Maine stock of humpback whales is 847 individuals (Waring et al. 2015).

Humpbacks occur off southern New England in all four seasons, with peak abundance in spring and summer. The species is listed as Endangered due to the depletion of its population from whaling (NMFS 1991b). A recovery plan has been written and is currently in effect (NMFS 1991b).

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 1985a). 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 2005 to 2009, the minimum annual rate of mortality for the North Atlantic stock from anthropogenic causes was approximately 2.6 per year (Waring et al. 2011) while from 2008 to 2012, this number has increased to 3.35 (Waring et al. 2015). 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 (Waring et al. 2015).

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 NMFS for review (Waring et al. 2010; 2011).

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 long) (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). The most recent estimate for minke whales in the Canadian East Coast stock is 20,741 (Waring et al. 2015). 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 2005 to 2009, the minimum annual rate of mortality for the North Atlantic stock from anthropogenic causes was approximately 5.9 per year (Waring et al. 2011), while from 2008 to 2012 this increased to 9.9 per year (Waring et al. 2015). 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, NMFS considers this species as "non-strategic" (Waring et al. 2010; 2011; 2015).

4.3 Earless Seals (Phocidae)

Harbor Seal (*Phocac 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 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 2006 to 2010, the average rate of mortality for the Western North Atlantic harbor seal stock from anthropogenic causes was approximately 337 per year (Waring et al. 2013). Average annual fishery-related mortality and serious injury does not exceed the potential biological removal for this species; therefore, NMFS considers this species as "non-strategic" (Waring et al. 2013).

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 2.3 m long and females reaching 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 miles (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 Muskegat Island (Nantucket Sound), Monomoy National Wildlife Refuge, and in eastern Maine (Rough 1995). 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). The total estimated human-caused mortality from 2006 to 2010 to gray seals was approximately 5,253 per year, which includes the removal of nuisance animals in Canada (Waring et al. 2015). Average annual fishery-related mortality and serious injury does not exceed the potential biological removal for this species; therefore, NMFS considers this species as “non-strategic” (Waring et al. 2015).

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 marine site characterization surveys. The request is based upon projected HRG survey activities during the anticipated survey schedule as stated in Section 2.1.

The results of the underwater acoustic modeling as summarized in Table 1-3 are consistent with similar marine site characterization survey activities. As evidenced in Table 1-3, sound levels associated with Level A harassment will only occur close to the source. However, survey activities could result in temporary Level B harassment of marine mammals during use of various HRG equipment.

To ensure that the potential for take by Level B harassment is avoided and/or minimized to the maximum extent possible, the Applicant has committed to the mitigation measures as outlined in Sections 11.0 and 13.0, which have been successfully implemented during similar activities in the North Atlantic.

5.1 Bay State Wind Marine Site Characterization Survey Activities

As detailed in Section 1.2, HRG equipment use would generate underwater noise with sounds exceeding the 160 $dB_{RMS90\%}$ re 1 µPa threshold for Level B harassment for impulsive sound. The Applicant is requesting the authorization for the incidental take by harassment, of small numbers of marine mammals in the waters of southern New England 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. This request is specifically driven by recent guidance from NOAA that modifies the methods used to calculate the potential take of marine mammals by acoustic harassment from mobile noise sources (Personal Communication, November 24, 2015). As a result, the following nine species are requested to be approved for take by Level B Harassment for HRG surveys in the spring of 2016:

- North Atlantic right whale (*Eubalaena glacialis*)
- Humpback whale (*Megaptera novaeangliae*)
- Fin whale (*Balaenoptera physalus*)
- Minke whale (*B. acutorostrata*)
- Atlantic white-sided dolphin (*Lagenorhynchus acutus*)
- Short beaked common dolphin (*Delphinus delphis*)
- Harbor porpoise (*Phocoena phocoena*)
- Harbor seal (*Phoca vitulina*)
- Gray seal (*Halichoerus grypus*)

As discussed further in this in the following sections, with the application of the proposed mitigation and monitoring measures detailed in Section 11.0, it is expected that the take of the aforementioned marine mammals will be successfully avoided.

6. Take Estimates for Marine Mammals

The Applicant seeks authorization for potential "taking" of small numbers of marine mammals under the jurisdiction of the NMFS in the proposed region of activity. Species for which authorization is sought include the North Atlantic right, humpback, fin and minke whales, as well as common and Atlantic white-sided dolphins, harbor porpoise, and harbor and gray seals. These nine species, described in detail in Section 4.0, have the highest likelihood of occurring, at least occasionally, in the Lease Area during the proposed survey events.

The only 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 take for marine mammals as presented in this section are highly conservative and based on worse-case assumptions. Based on the review of protected species observer sightings reports of similar surveys conducted along the Atlantic coast, data suggests that with the application of the mitigation and monitoring actions as proposed in Section 11.0, that take of marine mammals during HRG surveys can be successfully avoided (ESS 2013; Dominion 2013 and 2014).

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 10 hertz (Hz) to more than 10,000 Hz (10 kilohertz [kHz]). 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). The functional hearing ranges for the nine marine mammals have a potential for acoustic take by Level B Harassment in the Lease Area at the time of the proposed surveys are provided in Table 6-1.

Table 6-1 Functional Hearing Range of Marine Mammals with the Potential to Occur within Lease Area

Species	Estimated Auditory Bandwidth[1]
North Atlantic Right Whale	50 to 600 Hz2
Humpback Whale	7 Hz to 22 kHz
Fin Whale	7 Hz to 22 kHz
Minke Whale	7 Hz to 22 kHz
Atlantic White-Sided Dolphin	150 Hz to 160 kHz
Harbor Porpoise	200 Hz to 180 kHz
Short-Beaked Common Dolphin	150 Hz to 160 kHz
Harbor Seal	75 Hz to 75 kHz
Gray Seal	75 Hz to 75 kHz

[1]Southall et al. (2007)
[2]Vanderlaan et al. (2003); and Park et al. (2010)

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 only survey activities that have the potential to cause harassment as defined by the MMPA include the noise produced by various HRG survey equipment (160 $dB_{RMS90\%}$ re 1 µPa). As stated previously, the Applicant conducted hydroacoustic modeling assessments of the representative HRG survey equipment to better understand both the level and extent of underwater noise generated by the marine site characterization survey activities and their potential to impact marine species. The results of the underwater acoustic modeling assessment are summarized in Section 1.2 and Table 1-3. The assessment is included in Appendix A.

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 for impulsive noise (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.

Acoustic modeling of the HRG survey equipment was completed based on a version of the U.S. Naval Research Laboratory's Range-dependent Acoustic Model (RAM) and BELLHOP Gaussian beam ray-trace propagation model (Porter and Liu 1994). BELLHOP and RAM are widely used by sound engineers and marine biologists due to its adaptability to describe highly complex acoustic scenarios. RAM is based on the parabolic equation (Collins 1993) method using the split-step Padé algorithm for improved numerical accuracy and efficiency in solving range dependent acoustic problems and has been extensively benchmarked (Collins et al. 1996). The BELLHOP algorithm is based on a beam-tracing methodology and provides better accuracy by accounting for increased sound attenuation due to volume absorption at higher frequencies and allowing for source directivity components. The modeling methodologies employed calculate transmission loss based on a number of factors including the distance between the source and receiver along with basic ocean sound propagation parameters (e.g., depths, bathymetry, sediment type, and seasonal sound speed profiles). For each sound source, modeling was performed along transects originating out from the source along compass points (45°, 90°, 135°, 180°, 225°, 270°, 315°, and 360°) and propagated horizontally. The received sound field within each radial plane was then sampled at various ranges and depths from the source with fixed steps. The received sound level at a given location along a given transect was then taken as the maximum value that would occur over all samples within the water column. These values were then summed across frequencies to provide broadband received levels at the MMPA Level A and B harassment criteria as described in Table 1-3. The representative area ensonified to the MMPA Level B threshold for each of the pieces of HRG survey equipment represents the zone within which take of a marine mammal could occur. The maximum critical distances to the MMPA thresholds as detailed in Table 1-3 were used to support the estimate of take as well as the development of the monitoring and/or mitigation programs (see Sections 11.0).

As stated in Section 1.2, the equipment with the greatest potential for effect on marine mammals is the sub-bottom profiler equipment. The maximum predicted ensonified area associated with the sub-bottom profiler equipment at the 160 dB_{RMS} re 1 µPa isopleth would result in a maximum ensonified area of approximately 0.2 mi^2 (0.5 km^2). This area is the representative worst-case, as it is based upon the use of the Geo-Source 200. This area is also inclusive of the area were Level A acoustic harassment (180 dB_{RMS} re 1 µPa Level A could occur.

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 100 km^2)
ZOI = maximum ensonified area to MMPA thresholds 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 line miles traveled over a 24-hr period.

It should be noted however, that this calculation will result in an over conservative ZOI as it assumes that once an area along a survey trackline is ensonified by the sound source that the area will remain ensonified at a level that will result in Level B acoustic take (160 $dB_{RMS90\%}$ re 1 µPa) throughout the entire 24-hr period.

As evidenced by the Hydroacoustic Assessment Report provided in Appendix A and summarized in Section 1.2, the only time survey activities could result in take by Level B acoustic harassment is if a marine mammal were to enter into the ensonified area associated with the HRG survey equipment being operated. For the proposed DONG Energy HRG survey activities the maximum worst-case distance to the 160 $dB_{RMS90\%}$ re 1 μPa Level B threshold is 380 m from the source.

The data used as the basis for estimating species density ("D") for the Lease Area are sightings per unit effort (SPUE) taken from Kenney and Vigness-Raposa (2009). SPUE (or, the relative abundance of species) is derived by using a measure of survey effort and number of individual cetaceans sighted. SPUE allows for comparison between discrete units of time (i.e. seasons) and space within a project area (Shoop and Kenney, 1992). SPUE calculated by Kenney and Vigness-Raposa (2009) was derived from a number of sources including: 1) North Atlantic Right Whale Consortium database; 2) CeTAP (CeTAP 1982); 3) sightings data from the Coastal Research and Education Society of Long Island, Inc. and Okeanos Ocean Research Foundation; 4) the Northeast Regional Stranding network (marine mammals); and 5) the NMFS Sampling Branch (Woods Hole, MA).

The Northeast Navy Operations Area (OPAREA) Density Estimates (DoN 2007) were also used in support for estimating take for seals, which represents the only available comprehensive data for seal abundance. However, abundance estimates for the Southern New England area includes breeding populations on Cape Cod, and therefore using this dataset alone will result in a substantial over-estimate of take in the Project Area. However, based on reports conducted by Kenney and Vigness-Raposa (2009), Schroeder (2000), and Ronald and Gots (2003), harbor seal abundance off the Southern New England coast in the vicinity of the survey is likely to be approximately 20 percent of the total abundance. In addition, because the seasonality of, and habitat use by, gray seals roughly overlaps with harbor seals, the same abundance assumption of 20 percent of the southern New England population of gray seals can be applied when estimating abundance. Per this data, take due to Level B harassment for harbor seals and gray seals have been calculated based on 20 percent of the Northeast Navy OPAREA Density Estimates.

Due to the spatial distribution and transient nature of marine mammal species identified; the relatively short duration of the activities and the time of year the Applicant proposes to conduct marine characterization survey activities; and the implementation of the mitigation measures as described in Section 11.0, these activities are not likely to result in serious injury or death of marine mammals. In addition, the take estimates as provided in Section 6.2.1 are not only based on an overly conservative ZOI but they do not take into consideration mitigation measures and therefore are likely a significant overestimate of the actual potential for take by Level B acoustic harassment.

6.2.1 Estimate of Potential Project HRG Survey Takes by Harassment

Estimates of take by HRG survey equipment has been based on an overly conservative ZOI of 23.6 mi^2 (61 km^2) and a total survey period of 30 days. The ZOI is based on the worst case ensonified area of 380 m and a maximum survey trackline of 49 mi (79 km) per day. Based on the proposed HRG survey schedule (May 2016), take calculations were based on the spring seasonal species density. The resulting take estimates (rounded to the nearest whole number) for North Atlantic right, humpback, fin, and minke whales, as well as, common and Atlantic white-sided dolphins, harbor porpoise, and harbor and gray seals are presented in Table 6-2; the table illustrates the number of takes is very low. Statistically, the numbers presented in Table 6-2 represent a maximum for take estimates of 0.215, 0.017, 0.433, 0.010, 0.032, 0.045, 0.011, 0.047, and 0.015 percent of the populations for North Atlantic right whale, humpback whale, fin whale, minke whale, common dolphin, Atlantic white-sided dolphin, harbor porpoise, harbor seal, and gray seal. Since the calculation does not take into account whether the animal "harassed" is the same individual multiple times – which is a potential scenario and would result in actual harassment to far fewer individuals than calculated but in a higher cumulative take for those individual animals – the calculated take numbers are the considered the upper boundary of the animal population that could be affected. These numbers also represent potential take based on an assumption that no mitigation is applied during HRG survey activities, which will not be the case. Mitigation and monitoring of potential take during HRG survey activities is detailed in Section 11.0. Based on the review of protected species observer sightings reports of similar surveys conducted along the Atlantic coast, it is expected that with the application of the proposed mitigation and monitoring measures, the take of marine mammals as presented in Table 6-2 will be avoided. (ESS 2013; Dominion 2013 and 2014).

Table 6-2 Marine Mammal Density and Estimated Level B Harassment Take Numbers during HRG Survey Activities

Species	Density for Spring (No./100 km²)	Calculated Take (No.)	Requested Take Authorization (No.)
North Atlantic Right Whale	0.06	1.03	1
Humpback Whale	0.11	2.04	2
Fin Whale	0.37	6.72	7
Minke Whale	0.12	2.24	2
Common Dolphin	2.15	39.38	39
Atlantic White-sided Dolphin	1.23	22.45	22
Harbor Porpoise	0.47	8.52	9
Harbor Seal[1]	9.74	35.66	36
Gray Seal[1]	14.16	51.83	52

[1] Density values were derived using 20 percent of the number estimated from DoN (2007) density values.

7. Anticipated Impacts of the Activity

Consideration of negligible impact is required for the NMFS to authorize the incidental take of marine mammals. In 50 CFR § 216.103, the NMFS 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 Lease 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 Appendices A and B, potential acoustic exposures from survey activities are within the non-injurious behavioral effects zone (Level B harassment);
- The potential for take as estimated in Section 6.2 represents a highly conservative estimate of harassment based upon typical HRG survey scenarios utilizing an overly conservative ZOI and without taking into consideration the effects of standard mitigation and monitoring measures; and
- The protective measures as described in Section 11.0 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 short-term 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 on Subsistence Uses

There are no traditional subsistence hunting areas in the Lease Area.

9. Anticipated Impacts on Habitat

Bottom disturbance associated with the HRG survey 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.

Impact on marine mammal habitat from these activities will be insignificant and discountable.

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 NMFS. Per the Lease, the Applicant has committed the following comprehensive set of mitigation measures during marine site characterization surveys. The mitigation procedures outlined in this section are based on protocols and procedures that have been successfully implemented and resulted in no take of marine mammals for similar offshore projects and previously approved by NMFS (ESS 2013; Dominion 2013 and 2014).

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 the following, except under extraordinary circumstances when complying with these requirements would put the safety of the vessel or crew at risk:

- All vessel operators will comply with 10 knot (<18.5 km per hour [km/h]) speed restrictions in any Dynamic Management Area (DMA). In addition, all vessels operating from November 1 through July 31 will operate at speeds of 10 knots (<18.5 km/h) or less.
- All survey vessels will maintain a separation distance of 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 500 m minimum separation distance has been established. If a North Atlantic right whale is sited in a vessel's path, or within 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 100 m. If

stationary, the vessel must not engage engines until the North Atlantic right whale has moved beyond 100 m.

- All vessels will maintain a separation distance of 100 m or greater from any sighted non-delphinoid cetacean. If sighted, the vessel underway must reduce speed and shift the engine to neutral, and must not engage the engines until the non-delphinoid cetacean has moved outside of the vessel's path and beyond 100 m. If a survey vessel is stationary, the vessel will not engage engines until the non-delphinoid cetacean has moved out of the vessel's path and beyond 100 m.
- All vessels will maintain a separation distance of 50 m or greater from any sighted delphinoid cetacean. Any vessel underway remain parallel to a sighted delphinoid 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 delphinoid cetaceans are observed. Vessels may not adjust course and speed until the delphinoid cetaceans have moved beyond 50 m and/or the abeam of the underway vessel.
- All vessels will maintain a separation distance of 50 m (164 ft) or greater from any sighted sea turtle or pinniped.

The training program will be provided to NMFS for review and approval prior to the start of surveys. 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.

11.2 Seasonal Operating Requirements

Between watch shifts members of the monitoring team will consult the NMFS North Atlantic right whale reporting systems for the presence of North Atlantic right whales throughout survey operations. The proposed survey activities will, however, occur outside of the seasonal management area (SMA) located off the coast of Massachusetts and Rhode Island. The proposed survey activities will also occur in May/June and September, which is outside of the seasonal mandatory speed restriction period for this SMA (November 1 through April 30).

Throughout all survey operations, the Applicant will monitor the NMFS North Atlantic right whale reporting systems for the establishment of a DMA. If NMFS should establish a DMA in the Lease Area under survey, within 24 hours of the establishment of the DMN the Applicant will work with NMFS to shut down and/or altered the survey activities to avoid the DMA.

11.3 Visual Monitoring Program

Per the results of the hydroacoustic modeling assessment, the Applicant proposes to employ the following exclusion zones during survey activities:

- A 400-m exclusion zone during HRG surveys when the sub-bottom profiler is in operation
- A 200-m exclusion zone during HRG surveys when all other equipment is in operation

An exclusion zone is an area established for the Protected Species Observers (PSOs) to monitor for the presence of marine mammals. Its radial distance from the sound source (HRG survey equipment) is derived from the hydroacoustic modeling and covers the area for both the Level A and Level B harassment. Visual monitoring of the established exclusion zone(s) will be performed by qualified and NMFS-approved PSOs. Observer 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. An observer team comprising a minimum of four NMFS-approved PSOs and two certified Passive Acoustic Monitoring (PAM) operators, operating in shifts, will be stationed aboard either the survey vessel or a dedicated PSO-vessel. PSOs and PAM operators 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. Each PSO will monitor 360 degrees of the field of vision. Per the DONG Energy Lease requirements, the Applicant will provide resumes of all proposed PSOs and PAM operators (including alternates) to BOEM for review and approval by NMFS at least 45 days prior to the start of survey operations.

PSOs will be responsible for visually monitoring and identifying marine mammals approaching the established exclusion zone(s) 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. PAM operators will communicate detected vocalizations to the Lead PSO on duty, who will then be responsible for implementing the necessary mitigation procedures. A mitigation and monitoring communications flow diagram has been included as Appendix B.

PSOs will be equipped with binoculars and have the ability to estimate distances to marine mammals located in proximity to the vessel and/or exclusion 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, PAM, night-vision equipment, and infrared technology will be used. Position data will be recorded using hand-held or vessel global positioning system (GPS) units for each sighting.

Observations will take place from the highest available vantage point on the survey vessel. 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.

The PSOs will begin observation of the exclusion zone(s) at least 60 minutes prior to ramp-up of HRG survey equipment. Use of noise-producing equipment will not begin until the exclusion zone is clear of all marine mammals for at least 60 minutes.

Data on all PAM/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 "taking" (behavioral disturbances or injury/mortality). The data sheet will be provided to both NMFS 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.

11.4 Passive Acoustic Monitoring Program

To support 24-hour survey operations, the Applicant will include PAM as part of the project monitoring during the geophysical and geotechnical survey programs during nighttime operations to provide for optimal acquisition of species detections at night.

Given the range of species that could occur in the Lease Area, the PAM system will consist of an array of hydrophones with both broadband (sampling mid-range frequencies of 2 kHz to 200 kHz) and at least one low-frequency hydrophone (sampling range frequencies of 75 Hz to 30 kHz).

The PAM operator(s) will monitor the hydrophone signals in real time both aurally (using headphones) and visually (via the monitor screen displays). PAM operators will communicate detections to the Lead PSO on duty who will ensure the implementation of the appropriate mitigation measure.

11.5 Exclusion Zone Implementation

An exclusion zone out to the 160 $dB_{RMS90\%}$ re 1 μPa isopleth for impulsive noise has been established to minimize impacts to marine mammals during HRG survey activities. The Applicant will establish a 200-m default exclusion zone for all HRG survey operations. However, per the results of the acoustic analysis (Appendix A), a larger 400-m exclusion zone will be established during the operation of the sub-bottom profiler to avoid Level B acoustic harassment. These monitoring zones represent the maximum area of coverage for Level B harassment. At all times, the vessel operator will maintain a separation distance of 500 m from any sighted North Atlantic right whale as stipulated in the vessel strike avoidance procedures (Section 11.1). These stated requirements will be included in the site-specific training to be provided to the survey team. These exclusion zones will be field verified (see Section 13.0), adjusted as necessary, and monitored for individual take during HRG survey activities as described in Section 1.2.

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 Lease 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 daytime, night time, or periods of inclement weather if the exclusion zone cannot be adequately monitored by the PSOs using the appropriate visual technology (e.g., reticulated binoculars, night vision equipment) and/or PAM for a 60-minute period. A ramp-up would begin with the power 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 way such that the source level would increase in steps not exceeding 6 dB per 5-minute period. If marine mammals are sighted within the HRG survey exclusion zone prior to or during the ramp-up, activities will be delayed until the animal(s) has moved outside the monitoring zone and no marine mammals or sea turtles are sighted for a period of 60 minutes.

11.7 Shut-Down and Power-Down Procedures

The exclusion zone(s) around the noise-producing activities HRG survey equipment will be monitored, as previously described, by PSOs and at night by PAM operators for the presence of marine mammals before, during, and after any noise-producing activity. The vessel operator must comply immediately with any call for shutdown by the Lead PSO. Any disagreement should be discussed only after shutdown.

If a non-delphinoid cetacean or sea turtle is sighted at or within the established exclusion zone (200-m default during HRG survey equipment use; 400-m exclusion zone during the operation of the sub-bottom profiler), an immediate shutdown of the HRG survey equipment is required. Subsequent restart of the electromechanical survey equipment must use the ramp-up procedures described above and may only occur following clearance of the exclusion zone of all cetaceans, pinnipeds, and sea turtles for 60 minutes.

If a delphinoid cetacean or pinniped is sighted at or within the exclusion zone, the HRG survey equipment (including the sub-bottom profiler) must be powered down to the lowest power output that is technically feasible. Subsequent power up of the survey equipment must use the ramp-up procedures described above and may occur after (1) the exclusion zone is clear of a delphinoid cetacean and/or pinniped or (2) a determination by the PSO after a minimum of 10 minutes of observation that the delphinoid cetacean or pinniped is approaching the vessel or towed equipment at a speed and vector that indicates voluntary approach to bow-ride or chase towed equipment. An incursion into the exclusion zone by a non-delphinoid cetacean or sea turtle during power down requires implementation of the shut-down procedures as described above.

If the HRG sound source (including the sub-bottom profiler) shuts down for reasons other than encroachment into the exclusion zone by a non-delphinoid cetacean or sea turtle including but not limited to a mechanical or electronic failure, resulting in in the cessation of sound source for a period greater than 20 minutes, a restart for the HRG survey equipment (including the sub-bottom profiler) is required using the full ramp-up procedures and clearance of the exclusion zone of all cetaceans, pinnipeds and sea turtles for 60 minutes. If the pause is less than less than 20 minutes, the equipment may be restarted as soon as practicable at its operational level as long as visual surveys were continued diligently throughout the silent period and the exclusion zone remained clear of cetaceans, pinnipeds, and sea turtles. If the visual surveys were not continued diligently during the pause of 20 minutes or less, a restart the HRG survey equipment (including the sub-bottom profiler) is required using the full ramp-up procedures and clearance of the exclusion zone for all cetaceans, pinnipeds, and sea turtles for 60 minutes.

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

Field verification of the exclusion zones will be conducted to determine whether the proposed zones are adequate to minimize impacts to marine mammals. The details of the field verification strategy will be provided in a Field Verification Plan no later than 45 days prior to the commencement of field verification activities.

13.2 Reporting

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

- The Applicant will contact BOEM and NMFS within 24 hours of the commencement of survey activities and again within 24 hours of the completion of the activity.
- Any observed significant behavioral reactions (e.g., animals departing the area) or injury or mortality to any marine mammals or sea turtles must be reported to BOEM and NMFS within 24 hours of observation. Dead or injured protected species (e.g., marine mammals, sea turtles and sturgeon) are reported to the NMFS Northeast Region's Stranding Hotline (800-900-3622)

within 24 hours of sighting, regardless of whether the injury is caused by a vessel. In addition, if the injury of death was caused by a collision with a project related vessel, the Applicant must ensure that BOEM and NMFS are notified of the strike within 24 hours. The Applicant must use the form included as Appendix A to Addendum C of the Lease to report the sighting or incident. If The Applicant is responsible or the injury or death, the vessel must assist with any salvage effort as requested by NMFS.

- Within 90 days after completion of the marine site characterization survey activities, a final technical report will be provided to BOEM, and NMFS that fully documents the methods and monitoring protocols, summarizes the data recorded during monitoring, estimates the number of listed marine mammals and sea turtles that may have been taken during survey activities, and provides an interpretation of the results and effectiveness of all monitoring tasks.

In addition to the the Applicant's reporting requirements outlined above, the Applicant will provide an assessment report of the effectiveness of the various mitigation techniques, i.e. visual observations during day and night, compared to the PAM detections/operations. This will be submitted to BOEM and NOAA 30 days after the completion of HRG surveys.

14. Suggested Means of Coordination Research

All marine mammal data collected by the Applicant during marine characterization survey activities will be provided to NMFS, 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 safety and/or exclusion zone by the Applicant during HRG surveys will be provided to NMFS, 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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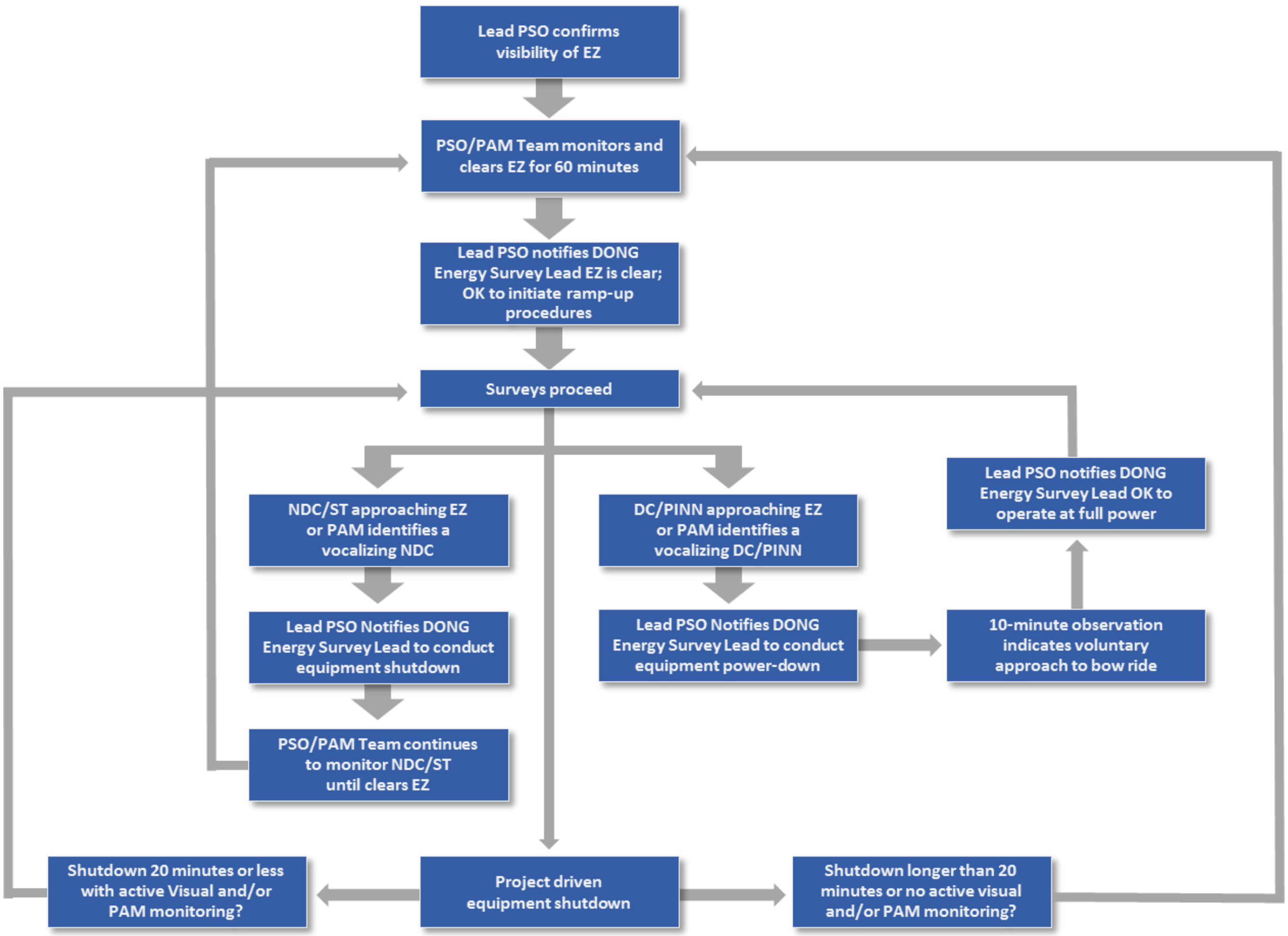
Appendix A

Bay State Wind Offshore Wind Farm – Hydroacoustic Assessment of High-Resolution Geophysical Survey Activities

Appendix B

Bay State Wind Offshore Wind Farm – Mitigation and Monitoring Communications Flow Diagram



PSO = Protected Species Observer
PAM + Passive Acoustic Monitor
EZ= Exclusion Zone
NDC = Non-Delphinoid Cetacean
ST = Sea Turtle
DC = Delphinoid Cetacean
PINN = Pinniped

Appendix A

Bay State Wind Offshore Wind Farm – Hydroacoustic Assessment of High-Resolution Geophysical Survey Activities

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Accepted	Jennifer Brack (JBRAC), 27-09-2015
Approved	Pernille Hermansen (PEHER), 04-12-2015

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Executive Summary

DONG Energy has contracted Tetra Tech, Inc. (Tetra Tech) to prepare this hydroacoustic assessment to support proposed marine site characterization surveys off the coast of Massachusetts. The marine site characterization surveys will take place in the area of DONG Energy's Commercial Lease of Submerged Lands for Renewable Energy Development on the Outer Continental Shelf (OCS-A 0500) (the Lease) to support the development of an offshore wind project. Surveys will be conducted 24 hours per day and are proposed to start, at the earliest, in May of 2016. The estimated duration of survey activities, including weather down time, is 4 to 5 weeks.

The National Oceanic Administration National Marine Fisheries Service (NMFS) and Bureau of Ocean Energy Management have advised that the deployment of marine survey equipment including the use of sound-producing equipment operating below 200 kilohertz (e.g., subbottom profilers) has the potential to cause acoustic harassment to marine species, in particular marine mammals and sea turtles. Acoustic modeling was completed for each of the representative high-resolution geophysical (HRG) survey equipment pieces that had the potential to fall within the hearing range of marine mammals and sea turtles known to occur in the Lease Area. The purpose of the modeling exercise was to determine the distance to the acoustic impact thresholds for injury (Level A Harassment) and behavioral disturbance (Level B Harassment) for marine mammals and sea turtles as defined by the Marine Mammal Protection Act (MMPA) and the most recent NMFS guidelines. Modeling was completed using a version of the U.S. Naval Research Laboratory's Range-dependent Acoustic Model (RAM) and BELLHOP Gaussian beam ray-trace propagation model.

Results of a detailed hydroacoustic analysis indicates that the ensonified area associated with the proposed HRG surveys will be small and very close to the source. The equipment with the greatest potential for effect on marine mammals and sea turtles is the subbottom profiler equipment with a maximum radius of 380 meters (m) to the MMPA Level B harassment threshold from the source. The potential for a marine mammal to experience a permanent threshold shift (PTS) and temporary threshold shift (TTS) from the operation of the HRG survey equipment was also determined to be very low, especially for low-frequency cetaceans that are of critical concern in the Lease Area (i.e., North Atlantic right whale, humpback whale, and fin whale). The greatest distance from the source that the onset of TTS could be experienced is 230 m for high-frequency cetaceans.

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1 Introduction

DONG Energy is proposing to conduct marine site characterization surveys off the coast of Massachusetts in the area of the Commercial Lease of Submerged Lands for Renewable Energy Development on the Outer Continental Shelf (OCS-A 0500) (the Lease), to support the development of an offshore wind project. The purpose of the marine surveys is to:

- Support the siting, design, and deployment of up to two meteorological data collection buoys referred to as floating light and detection ranging buoys (FLIDARs) and up to two metocean and current buoys; and
- Obtain a baseline assessment of seabed conditions in the DONG Energy Massachusetts Lease Area (Lease Area) to support the siting of the proposed wind farm.

The Lease Area is presented in Figure 1-1.

The proposed high-resolution geophysical (HRG) surveys will include the following:

- Depth sounding (multibeam depth sounder) to determine water depths and general bottom topography;
- Magnetic intensity measurements for detecting local variations in regional magnetic field from geological strata and potential ferrous objects on and below the bottom;
- 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;
- Shallow penetration subbottom profiler (pinger/chirp) to map the near surface stratigraphy (top 0-5 meter [m] soils below seabed); and
- Medium penetration subbottom profiler (sparker) to map deeper subsurface stratigraphy as needed (soils down to 75-100 m below seabed).

Deployment of HRG survey equipment have the potential to cause acoustic harassment to marine species. The assessment evaluates the potential acoustic effects of the proposed survey activities on marine mammals and sea turtles. DONG Energy’s proposed Marine Mammal and Sea Turtle Avoidance Plan in support of the HRG surveys has been provided under separate cover.

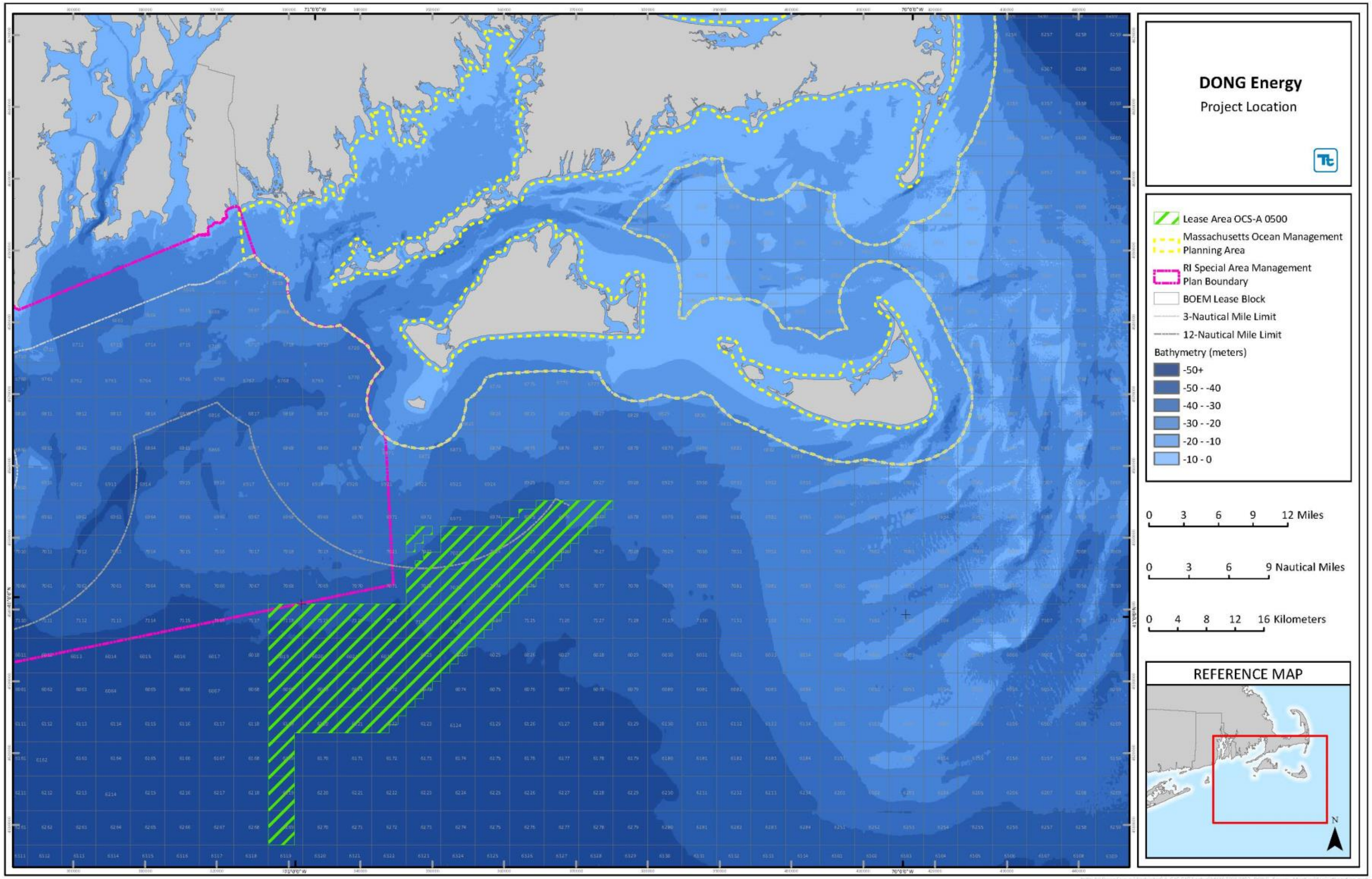

Figure 1-1 Project Location

2 Marine Mammal and Sea Turtle Exposure Criteria

The potential effects of underwater noise on marine mammals are federally managed by the National Oceanic and Atmospheric Administration National Marine Fisheries Service (NMFS) under the Marine Mammal Protection Act (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. The NMFS defines the Level A Harassment zone of injury to marine mammals as occurring at a sound exposure limit threshold of received sound pressure levels of 180 decibels (dB) referenced to 1 microPascal (µPa) root mean square (RMS), for both mysticetes and odontocetes, and 190 dB_{RMS} re 1µPa for pinnipeds. This threshold considers instantaneous sound pressure levels (SPLs) at a given receiver location. To determine the acoustic threshold at which Level A and Level B harassment occurs, we adopt the Truet (2007) definition of Level A harassment take as the noise exposure consistent with estimated PTS onset and Level B harassment take as the noise exposure consistent with estimated TTS onset. The NMFS 180 dB_{RMS} re 1 µPa guideline and 190 dB_{RMS} re 1 µPa respectively are designed to protect all marine species from high sound pressure levels at any discrete frequency across the entire frequency spectrum. These are very conservative criteria as they do not consider species-specific hearing capabilities.

The MMPA defines Level B harassment 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. The NMFS has defined the threshold level for Level B harassment at 120 dB_{RMS} re 1 µPa for continuous noise and 160 $dB_{RMS90\%}$ re 1 µPa for impulse noise. In zones where received sound levels exceed these thresholds, project sound 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.

Table 2-1 summarizes the definition of Level A and Level B Harassment for underwater noise as defined by the NMFS. These criteria levels are the regulatory thresholds used by NMFS under the ESA and MMPA to determine the potential for “take” by acoustic harassment.

Table 2-1 NMFS Marine Mammal Noise Criteria (NMFS, 2005)

	Criteria Level	Type
Marine Mammals		
Level A Harassment (Injury) - Mysticetes and Odontocetes	180 dB_{RMS} re 1 µPa	Absolute
Level A Harassment (Injury) - Pinnipeds	190 dB_{RMS} re 1 µPa	Absolute
Level B Harassment (Disturbance)	160 $dB_{RMS90\%}$ re 1 µPa 120 dB_{RMS} re 1 µPa	Impulse Continuous

While NMFS regulates impacts per the criteria in Table 3-1, these criteria are conservative and were purposely developed to be protective of all marine species from high sound pressure levels. However, the sound pressure levels are calculated from unweighted acoustic signals, so they do not account for the different hearing abilities of animals at different frequencies (Figure 2-1). Also, the NMFS (2005) states that such criteria have the disadvantage of not accounting for important attributes of exposure such as duration, sound frequency, or rate of repetition.

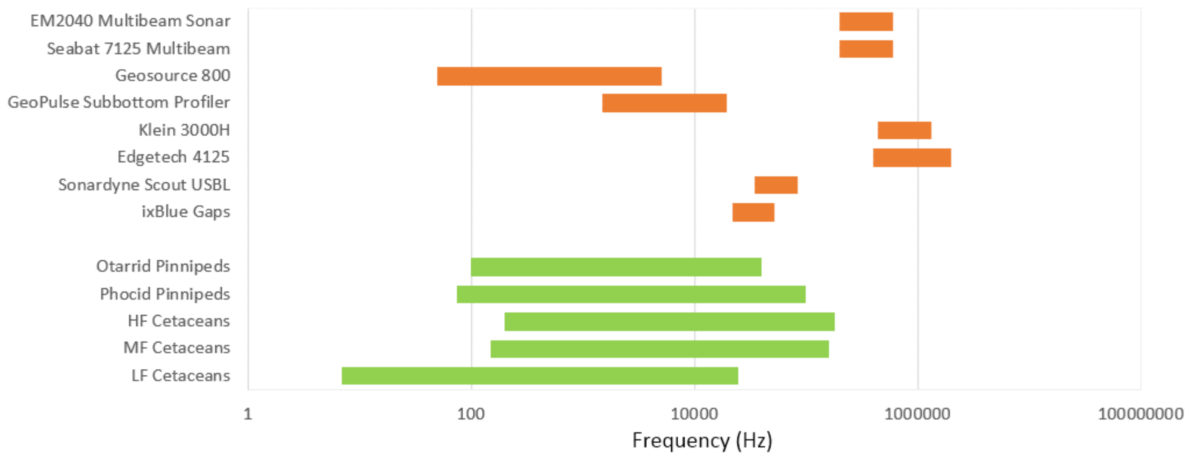

Figure 2-1 Representative HRG Survey Equipment Operational Frequencies as Compared to Marine Mammal Hearing Ranges

To address the stated limitations of the NMFS Marine Mammal noise criteria, the Noise Criteria Group (NCG) was established by support of the NMFS in 2005 to summarize research on marine mammal hearing with respect to their behavioral and physiological responses to anthropogenic noise. The group's findings were published in 2007 (Southall et al., 2007). It was determined that high exposure levels from underwater sound sources can cause hearing impairment. This can take the form of a temporary loss in hearing sensitivity, known as a Temporary Threshold Shift (TTS), or a permanent loss of hearing sensitivity known as a Permanent Threshold Shift (PTS). Onset of PTS and TTS impacts are considered equivalent to the statutory definition of Level A and Level B harassment, respectively. 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 TTS provides additional species-specific insight on the potential for affect that is not captured by evaluations completed using the standard NMFS thresholds for Level A and Level B harassment alone.In December of 2013, NMFS released the *Draft Guidance for Assessing the Effect of Anthropogenic Sound on Marine Mammals* which predominantly incorporated many of the key findings of the NCG. These guidelines were revised in July of 2015. The proposed threshold criteria established by these guidelines are based on both zero-to-peak (peak) sound pressure levels (SPLs) of acoustic waves, and total (i.e., cumulative) sound exposure level (SEL). If an animal is exposed to sound that exceeds either the peak SPL or cumulative SEL (SEL_{cum}) criterion, the assumption is that the received sound exposure causes injury. Sound modeling may either be evaluated throughout the event duration and account for the fleeing movement of the marine animals. The NMFS recommends a baseline accumulation period of 24 hours, but acknowledges there may be specific exposure situations where this accumulation period requires adjustment. SEL_{cum} can be calculated with the following equation, where exposure time is in seconds:

$$SEL_{cum} = SEL + 10 * \log10 \text{ (Exposure Time)}$$

For the purpose of the acoustic assessment, the following factors were used to establish the potential worst-case exposure period to the acoustic sound source:

- The survey activities and associated sound source are mobile, with the survey vessel continuously towing the equipment of a maximum speed of 4 knots (4.6 miles per hour [mph]).
- The vessel and marine mammals would be travelling along the same trajectory which represents the worst-case exposure potential.

- A worse-case acoustic boundary from the sound source of 500 m, which represents the minimum separation distance allowed under the Lease from a NARW and encompasses the minimum separation distances required by the Lease for both non-delphinoid (100 m) and delphiniod cetaceans (50 m) as well as the modeled distance of 380 m to the 160 $dB_{RMS90\%}$ re 1 μPa Level B Harassment zone for all marine mammals (Table 4-1).
- The exposure to the sound source starts from the moment the marine mammals enters the acoustic boundary, until it leaves the acoustic boundary.

To establish the amount of time the survey vessel could expose a marine mammal to the sound source the following calculation was applied. Inputs to this calculation considered the aforementioned factors as well as the average swimming speeds of the most critically endangered species likely to occur in the Lease Area at the time of the survey:

$$\text{Exposure Time} = \frac{2 \times \text{Acoustic Boundary}}{|\text{Velocity}_{vessel} - \text{Velocity}_{animal}|}$$

This equation is based on the notion of the vessel overtaking the slow-moving marine mammal, or vice versa, where the fast marine mammal overtakes the vessel. Exposure time begins when the animal is enveloped in the acoustic boundary, and continues until the animal is outside the boundary (Figure 2-2). Results of the potential exposure times are provided in Table 2-2.

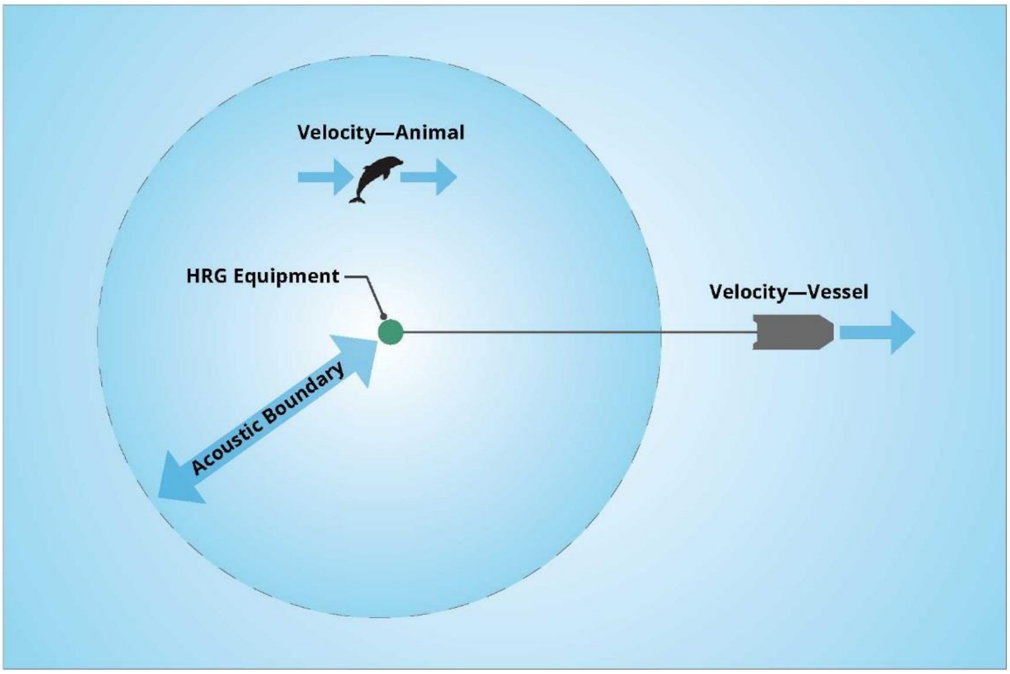

Figure 2-2 Diagram of Acoustic Boundary used to Calculate Exposure Time

Table 2-2 Summary of Marine Mammal Presence, Swimming Speeds and Calculated Exposure Time

Species	Average swim speed (knots)*	Exposure Time (minutes)	Likelihood of Presence in Lease Area During Survey (May-June)
North Atlantic Right Whale	0.7	10	high
Blue Whale	12	4	uncommon
Fin Whale	15	3	high
Humpback Whale	8	8	high
Sei Whale	14	3	uncommon
Sperm Whale	5	32	low
* Source: ACS (2015); Hain et al. (2013); MarineBio Conservation Society (2015); Noad et al. (2007); NY DEC (2015); and NMFS (2015a)			

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 Draft 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 two sets of hearing criteria thresholds provided by the NMFS for each of the groups. One set of criteria applies hearing adjustment curves for each animal group known as M-weighting (see Table 2-3). The second set of criteria is unweighted (see Table 2-4). For the purpose of this assessment, the unweighted criteria were applied to better account for equipment (e.g., subbottom profilers) that have rapid variations in frequencies over a given signal.

Table 2-3 Interim (M-Weighted) PTS and TTS Criteria and Functional Hearing Range for Maine Mammals (NMFS, 2015b)

Functional Hearing Group	PTS Onset Impulsive	PTS Onset Non-Impulsive	TTS Onset Impulsive	TTS Onset Non-Impulsive	Functional Hearing Range
LF cetaceans	230 dB_{peak} & 192 dB SEL_{cum}	230 dB_{peak} & 207 dB SEL_{cum}	172 dB SEL_{cum}	178 dB SEL_{cum}	7 Hz to 25 kHz
MF cetaceans	230 dB_{peak} & 187 dB SEL_{cum}	230 dB_{peak} & 199 dB SEL_{cum}	172 dB SEL_{cum}	178 dB SEL_{cum}	150 Hz to 160 kHz
HF cetaceans	202 dB_{peak} & 154 dB SEL_{cum}	202 dB_{peak} & 171 dB SEL_{cum}	146 dB SEL_{cum}	160 dB SEL_{cum}	200 Hz to 180 kHz
Phocid pinnipeds	230 dB_{peak} & 186 dB SEL_{cum}	230 dB_{peak} & 201 dB SEL_{cum}	177 dB SEL_{cum}	183 dB SEL_{cum}	75 Hz to 100 kHz
Otariid pinnipeds	230 dB_{peak} & 203 dB SEL_{cum}	230 dB_{peak} & 218 dB SEL_{cum}	200 dB SEL_{cum}	206 dB SEL_{cum}	100 Hz to 40 kHz

Table 2-4 Alternative (Unweighted) PTS and TTS Criteria and Functional Hearing Range for Maine Mammals (NMFS, 2015b)

Functional Hearing Group	PTS Onset Impulsive	PTS Onset Non-Impulsive	TTS Onset Impulsive	TTS Onset Non-Impulsive	Functional Hearing Range
LF Cetaceans	230 dB$_{peak}$ & 192 dB SEL$_{cum}$	230 dB$_{peak}$ & 207 dB SEL$_{cum}$	224 dB$_{peak}$ & 177 dB SEL$_{cum}$	224 dB$_{peak}$ & 187 dB SEL$_{cum}$	7 Hz to 25 kHz
MF Cetaceans	230 dB$_{peak}$ & 200 dB SEL$_{cum}$	230 dB$_{peak}$ & 199 dB SEL$_{cum}$	224 dB$_{peak}$ & 185 dB SEL$_{cum}$	224 dB$_{peak}$ & 179 dB SEL$_{cum}$	150 Hz to 160 kHz
		202 dB$_{peak}$ & 194 dB SEL$_{cum}$		224 dB$_{peak}$ ak & 192 dB SEL$_{cum}$	
HF Cetaceans	202 dB$_{peak}$ & 177 dB SEL$_{cum}$	Source: NB > 3 kHz 202 dB$_{peak}$ & 171 dB SEL$_{cum}$	196 dB$_{peak}$ & 162 dB SEL$_{cum}$	196 dB$_{peak}$ & 151 dB SEL$_{cum}$	200 Hz to 180 kHz
		202 dB peak & 194 dB SEL$_{cum}$		196 dB$_{peak}$ & 174 dB SEL$_{cum}$	
Phocid pinnipeds	230 dB$_{peak}$ & 186 dB SEL$_{cum}$	230 dB$_{peak}$ & 201 dB SEL$_{cum}$	224 dB$_{peak}$ & 171 dB SEL$_{cum}$	224 dB$_{peak}$ & 181 dB SEL$_{cum}$	75 Hz to 100 kHz
Otariid pinnipeds	230 dB$_{peak}$ & 203 dB SEL$_{cum}$	230 dB$_{peak}$ & 218 dB SEL$_{cum}$	224 dB$_{peak}$ & 188 dB SEL$_{cum}$	224 dB$_{peak}$ & 198 dB SEL$_{cum}$	100 Hz to 40 kHz

The hearing capabilities of sea turtle are poorly known and there is little information available on the effects of noise on sea turtles. Some studies have demonstrated that sea turtles have fairly limited capacity to detect sound, although all results are based on a limited number of individuals and must be interpreted cautiously. Limited research has shown that upper limit of the hearing range of sea turtles is generally in range 1,000 to 1,200 hertz (Hz) (Tech Environmental, 2006; Martin et al., 2012). BOEM states the hearing sensitivity of most sea turtles appears to be best at frequencies between about 200 Hz and 700 Hz (BOEM, 2013).

McCauley et al. (2000) serves as the best available information on the levels of underwater noise that may produce a startle, avoidance, and/or other behavioral or physiological response in sea turtles. McCauley noted that decibel levels of 166 dB$_{RMS}$ re 1µPa were required before any behavioral reaction (e.g., increased swimming speed) was observed, and decibel levels above 175 dB$_{RMS}$ re 1µPa elicited avoidance behavior of sea turtles. This study used impulsive sources of noise (e.g., air gun arrays) to ascertain the underwater noise levels that produce behavioral modifications in sea turtles.

Based on this and the best available information (BOEM, 2012a, b; Popper et al., 2014), the NMFS believes any sea turtles exposed to underwater noise greater than 166 dB$_{RMS}$ re 1µPa may experience behavioural disturbance/modification (e.g., movements away from ensonified area) and at levels greater than or equal to 207 dB$_{RMS}$ re 1 µPa have the potential to cause injury. Table 2-5 summarizes the present NMFS interim guidelines on underwater noise level which have the potential to cause injury or behavioral modification of sea turtles.

Table 2-5 NMFS Interim Underwater Noise Criteria for Sea Turtles

	Criteria Level	Functional Hearing Range
Sea Turtles		
Injury	207 dB$_{RMS}$ re 1 µPa	Up to 1.2 kHz (est.)
Behavioral Disturbance	166 dB$_{RMS}$ re 1 µPa	Up to 1.2 kHz (est.)

3 Modeling Methodology

Equipment sound source values and other operational parameters were derived from manufacturer specifications and in direct consultation with equipment operators incorporating site-specific conditions and anticipated systems settings to meet survey objectives within equipment operating ranges for optimal performance and efficiency. The subsections that follow provide more detailed information about the screening-level hydroacoustic modeling analysis that was completed to determine the expected distances to regulatory thresholds.

There are several methods for evaluating the attenuation of acoustic energy. Spherical and cylindrical spreading are simple propagation equations used to describe spreading loss. Spreading loss is the attenuation of acoustic energy over a larger area so that the acoustic energy decreases as the wave propagates away from a source. These equations are based on free-field conditions that assume uniform sound spreading in an infinite, homogeneous ocean and neglect specific environmental effects, such as water column refraction and bottom reflections. Given the variability of environmental effects in the ocean, and the focused directivity of the sources, more complex modeling was chosen.

Acoustic modeling was completed based on a version of the U.S. Naval Research Laboratory's Range-dependent Acoustic Model (RAM) and BELLHOP Gaussian beam ray-trace propagation model (Porter and Liu, 1994). RAM is based on the parabolic equation (Collins, 1993) method using the split-step Padé algorithm for improved numerical accuracy and efficiency in solving range dependent acoustic problems and has been extensively benchmarked (Collins et al., 1996). The BELLHOP algorithm is based on a beam-tracing methodology and provides better accuracy by accounting for increased sound attenuation due to volume absorption at higher frequencies and allowing for source directivity components. The modeling methodologies employed calculate transmission loss based on a number of factors including the distance between the source and receiver along with basic ocean sound propagation parameters (e.g., depths, bathymetry, sediment type, and seasonal sound speed profile). For each sound source, modeling was performed along transects originating out from the source along compass points (45°, 90°, 135°, 180°, 225°, 270°, 315°, and 360°) and propagated horizontally. The received sound field within each radial plane was then sampled at various ranges and depths from the source with fixed steps. The received sound level at a given location along a given transect was then taken as the maximum value that would occur over all samples within the water column.

These two calculation approaches were implemented in Acoustic Toolbox User Interface Post processor (AcTUP) via a MATLAB platform which was developed by HLS Research distributed by the Centre for Marine Science and Technology. AcTUP interface provides the graphical user interface for working with the propagation routines of RAM and BELLHOP. BELLHOP and RAM are widely used by sound engineers and marine biologists due to its adaptability to describe highly complex acoustic scenarios.

3.1 Acoustic Source Levels

Marine survey equipment may be categorized as impulsive, as it has somewhat unique features in comparison to other sound sources. Impulsive sounds can have moderate average, but high instantaneous pressure peaks. The modeling of transmission loss of impulsive sound types is complex, requiring the use of the RMS sound pressure "averaged over the duration of the pulse." For an impulsive sound source, an additional type of spreading will occur over time as the pulse propagates through the water. At increasing distances from the source, the pulse signal time duration will increase in addition to the decrease in intensity of signal amplitude due to geometric spreading and contain complex multi-path arrivals due to surface and bottom reflections which will affect the duration over which the $RMS_{90\%}$ and instantaneous peak occur. The sensitivity of received sound levels to the specific multipath arrival patterns involved is such that model predictions of received levels at any significant distance from the source will decrease in intensity due to elongation of the signal, especially in shallow water environments. The effects of signal elongation and the increased attenuation that will occur over time have been conservatively ignored.

A summary of representative underwater noise sources and hydroacoustic model inputs for the proposed survey equipment are summarized in Table 3-1.

Table 3-1 Summary of Representative Marine Survey Underwater Noise Sources (dB re 1 μPa at 1 m)

HRG Equipment	Operating Frequencies	Source Level	Source Depth	Beamwidth (degree)	Pulse Duration (millisec)
ixBLue Gaps	22-30 kHz	192 dB_{RMS}	2-5 m below surface	180	1
Sonardyne Scout USBL	35-50 kHz	187 dB_{RMS}	2-5 m below surface	180	1
Edgtech 4125 Side Scan Sonar[1]	400/900/1600 kHz	205 dB_{RMS}	1-2 m below surface	50	0.6 to 4.9
Klein 3000H Side Scan Sonar[1]	445/900 kHz	242 dB_{RMS}	3-8 m above seafloor	.2	0.0025 to 0.4
GeoPulse Sub-bottom Profiler	1.5 to 18 kHz	208 dB_{RMS}	3-8 m above seafloor	55	0.1 to 1
Geo-source 200/800	50 to 5000 Hz	221 dB_{RMS}/ 217 dB_{RMS}	1-2 m below surface	110	1 to 2
Seabat 7125 Multibeam Sonar[2]	200/400 kHz	220 dB_{peak}	1 to 3 m below surface	2	0.03 to 0.3
EM 2040 Multibeam Sonar[2]	200/400 kHz	207 dB_{RMS}	1 to 3 m below surface	1.5	0.05 to 0.6

[1]It should be noted that only one of the representative sidescan sonars would be selected for deployment.
[2]It should be noted that only one of the representative multibeam sonars would be selected for deployment.

3.2 Molecular Absorption

Calculation methods for wave spreading and seawater absorption effects during sound propagation underwater were applied employing standardized modeling techniques. For sound sources that operate at ultra-high frequencies (i.e. greater than 100 kHz) seawater absorption in which acoustic energy is converted into heat dominates the calculation result due to this important attenuation factor.

Absorption in the underwater environment involves a process of conversion of acoustic energy into heat and, thereby, represents a true loss of acoustic energy to the water. The primary causes of absorption have been attributed to several processes, including viscosity, thermal conductivity, and chemical reactions involving ions in the seawater. The viscosity of the medium causes sound energy to be converted into heat by internal friction. Some sound energy is converted into heat because sound waves alternately raise and lower the temperatures. Suspended particles are set to oscillating by the sound waves and in this process some of the sound energy is dissipated in the form of heat. While each of these factors offers its own unique contribution to the total absorption loss, all of them are caused by the repeated pressure fluctuations in the medium as the sound waves are propagated. In these processes, the area over which the signal is spread remains the same, but the energy in the signal, and therefore the intensity, is decreased.

The absorption of sound energy by water contributes to the transmission loss linearly with distance and is given by an attenuation coefficient in units of dB per kilometer (dB/km). This absorption coefficient is computed from empirical equations and increases with the square of frequency. For example, for typical open-ocean values (temperature of 10°C, pH of 8.0, and a salinity of 35 practical salinity units [psu]), the equations presented by Francois and Garrison (1982a, b) yield the following values for seawater absorption: 0.001 dB/km at 100 Hz, 0.06 dB/km at 1 kHz, 0.96 dB/km at 10 kHz, and 33.6 dB/km at 100 kHz. Thus, lower frequencies are favored for long-range propagation.

3.3 Sound Speed Profile

Seasonality within sound speed profiles can have a significant impact on sound propagation. In the Lease Area, the water depth is not sufficient to form a deep sound channel, and sound speed is strongly affected (and hence propagation) by seasonal and daily water temperature changes with depth. The speed of sound in sea water is dependent on the temperature T [°C], salinity S [ppt], and depth D [m]. Water column sound speed profiles (SSPs) were described from profiles downloaded from the U.S. Naval Oceanographic Office's (2003) Generalized Digital Environmental Model (GDEM) database. The latest release of the GDEM database provides average monthly profiles of temperature and salinity for the world's oceans on a latitude-longitude grid with 0.25-degree resolution. Profiles in GDEM are provided at 78 fixed depth points up to a maximum depth of 6,800 m. The profiles in GDEM are based on historical observations of global temperature and salinity from the U.S. Navy's Master Oceanographic Observational Data Set (MOODS). GDEM is a climatology meaning it represents the long-term mean. It will not be changed much by including data from a single exercise or oceanographic survey unless this new data was in a region where little data previously existed. Temperature-salinity profiles from GDEM can then be converted to SSPs using the equations of Mackenzie (1981):

$$c\ [\text{m/s}] = 1448.96 + 4.591\,T - 5.304 \times 10^{-2}\,T^{2} + 2.374 \times 10^{-4}\,T^{3} + 1.340\,(S - 35) + 1.630 \times 10^{-2}\,D + 1.675 \times 10^{-7}\,D^{2} - 1.025 \times 10^{-2}\,T(S - 35) - 7.139 \times 10^{-13}\,T$$

For the acoustic modeling, sound speed profiles for May - June were selected as this is the target period for the survey to take place. May represents the worst-case scenario and is used in support of this analysis (Figure 3-1).

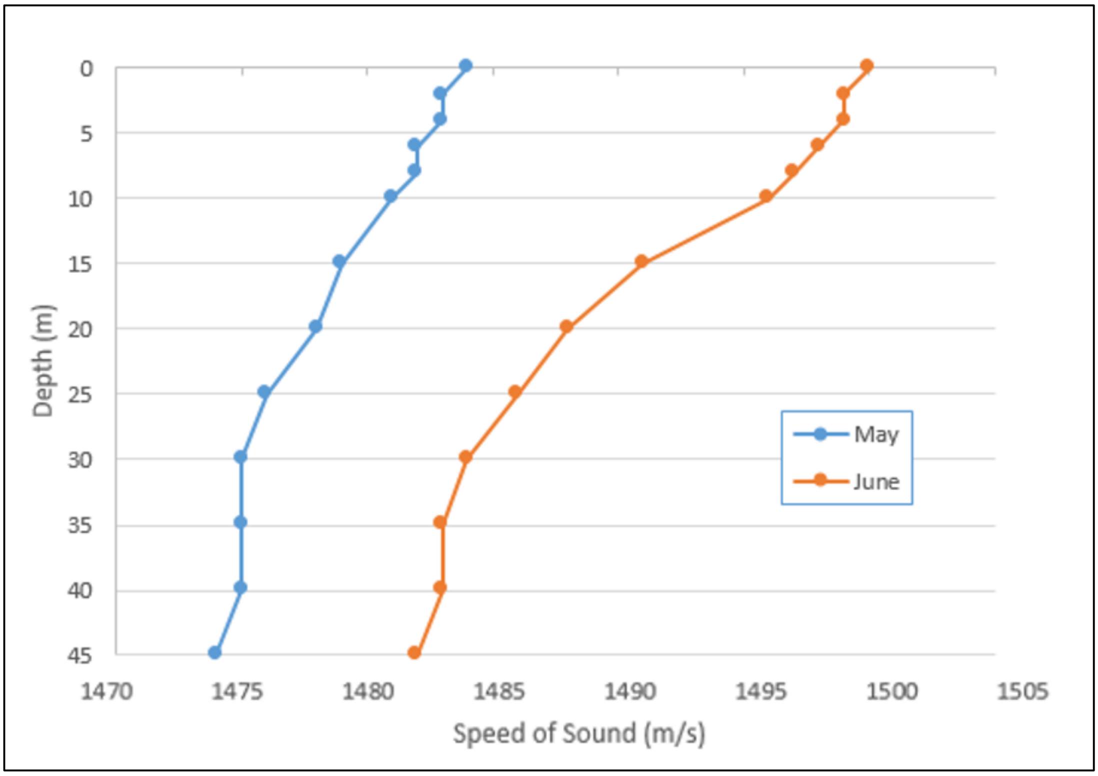

Figure 3-1 Sound Speed Profiles

3.4 Modeling Location and Geoacoustics

Bathymetry, such as large peaks or gradual inclines, can cause received sound levels to vary significantly based on what compass direction the receiver is in relation to the sound source. The Lease Area is characterized by bathymetry without major variation in water depth. For the purpose of this analysis three representative modeling locations were selected in the Lease Area to cover the range of depths (38 m, 44 m, and 54 m).

In addition to water depth, sea floor composition affects sound propagation. The sound from a source will travel through the water directly and by of means reflection from the ocean surface and seabed but will also travel through sediment and rock of the ocean floor and re-emerge at extended distances. The ability of a given sea floors to reflect, refract and absorb acoustic energy depends on the composition of the sediment. Data indicate that the Lease Area comprises predominantly sandy substrate (BOEM, 2014).

4 Results

Acoustic modeling algorithms were applied to estimate received sound levels from various Project survey activities to determine distances at biologically significant threshold levels as defined by NMFS. The results do not include contributions of existing acoustic underwater ambient conditions, which can be significant where boat traffic is present.

As the proposed HRG equipment is classified as impulsive noise the MMPA 120 dB_{RMS} re 1 μPa threshold for continuous noise was not evaluated. Otariid pinnipeds are not know to occur within the Lease Area and are not included in this analysis. In addition, as identified in Figure 2-1 and Table 3-1, the proposed multibeam sonar system operating at 200kHz and above and the Edgetech 4125 and Klein 3000 H operating at frequencies above 400 kHz are outside the hearing range of all marine mammals and sea turtles, and were therefore also not evaluated.

4.1 Marine Mammals and Sea Turtles

Geophysical devices operate across wide frequency ranges as well as different source levels and beam widths depending on survey objectives. In general, the lowest frequency at which the equipment may operate and loudest source level, represents a worst-case scenario. However, most geophysical equipment is highly directional and beamwidth can have a significant impact on sound propagation. Equipment that focuses its energy in vertical direction does not see as much horizontal propagation. While equipment that transmits its energy over a wider beamwidth, such as a towed sparker, is more likely to see greater horizontal propagation. Equipment was evaluated over the range of expected operating conditions, and the worst case scenario is presented in the following tables.

Table 4-1 reflect maximum distances to the NMFS MMPA Level A and Level B Harassment thresholds along the worst-case modeled transects for marine mammals and sea turtles.

Table 4-1 Modeled Distances to MMPA Thresholds for Marine Mammals and NMFS Interim Guidelines for Sea Turtles in Meters

HRG Equipment	Marine Mammal Level A Harassment 180 dB_{RMS} re 1 μPa (m)	Marine Mammal Level B Harassment 160 $dB_{RMS60\%}$ re 1 μPa (m)	Sea Turtle Injury 207 dB_{RMS} re 1 μPa (m)	Sea Turtle Behavioral Modification 166 dB_{RMS} re 1 μPa (m)
ixBlue GAPS	< 10	25	-	20
Sonardyne Scout USBL	-	25	-	20
GeoPulse Subbottom Profiler	30	75	-	35
Geo-Source 800	80	250	< 10	175
Geo-Source 200	90	380	< 10	240

Tables 4-2 through 4-5, present the worst-case modeled distance to the marine mammal critical PTS or TTS hearing thresholds for each of the four marine mammal groups known to occur in the Lease Area (LF Cetaceans, MF Cetaceans, HF Cetaceans, and Phocid pinnipeds). As stated in Section 3, the analysis was conducted based on the NMFS unweighted PTS and TTS criteria and functional hearing range for marine mammals. For the purpose of this assessment, a worse-case exposure period of 10 minutes was selected based on both the slowest and most critically endangered marine mammal (the NARW) with the potential to occur in the Lease Area at the time of the survey (Table 2-2) The analysis was also conducted using both the peak and cumulative threshold criteria (Table 2-3). Cumulative energy results were dominant and therefore represents the most conservative case presented in the following tables.

Table 4-2 Distance to Regulatory SEL_{CUM} Thresholds for iXBlue GAPS

Marine Mammal Group	PTS Onset	Distance (m)	TTS Onset	Distance (m)
LF cetaceans	192 dB SEL_{cum}	-	177 dB SEL_{cum}	15
MF cetaceans	200 dB SEL_{cum}	-	185 dB SEL_{cum}	< 10
HF cetaceans	177 dB SEL_{cum}	15	162 dB SEL_{cum}	25
Phocid pinnipeds	186 dB SEL_{cum}	< 10	171 dB SEL_{cum}	20

Table 4-3 Distance to Regulatory SEL_{CUM} Thresholds for Sonardyne Scout USBL

Marine Mammal Group	PTS Onset	Distance (m)	TTS Onset	Distance (m)
LF cetaceans	192 dB SEL_{cum}	-	177 dB SEL_{cum}	< 10
MF cetaceans	200 dB SEL_{cum}	-	185 dB SEL_{cum}	-
HF cetaceans	177 dB SEL_{cum}	< 10	162 dB SEL_{cum}	30
Phocid pinnipeds	186 dB SEL_{cum}	-	171 dB SEL_{cum}	15

Table 4-4 Distance to Regulatory SEL_{CUM} Thresholds for GeoPulse Subbottom Profiler

Marine Mammal Group	PTS Onset	Distance (m)	TTS Onset	Distance (m)
LF cetaceans	192 dB SEL_{cum}	< 10	177 dB SEL_{cum}	25
MF cetaceans	200 dB SEL_{cum}	-	185 dB SEL_{cum}	15
HF cetaceans	177 dB SEL_{cum}	25	162 dB SEL_{cum}	45
Phocid pinnipeds	186 dB SEL_{cum}	15	171 dB SEL_{cum}	30

Table 4-5 Distance to Regulatory SEL_{CUM} Thresholds for Geo-Source 200 & 800 Sparker up to 2.2 kJ

Marine Mammal Group	PTS Onset	Distance (m)	TTS Onset	Distance (m)
LF cetaceans	192 dB SEL_{cum}	10	177 dB SEL_{cum}	45
MF cetaceans	200 dB SEL_{cum}	15	185 dB SEL_{cum}	30
HF cetaceans	177 dB SEL_{cum}	45	162 dB SEL_{cum}	210-230
Phocid pinnipeds	186 dB SEL_{cum}	30	171 dB SEL_{cum}	90-100

5 Proposed Safety Radius

As evidenced by the results presented in Section 4, injury to marine mammals and sea turtles from the operation of the HRG survey equipment is not likely. The ensonified area associated with the proposed HRG surveys will be small and very close to the source. The equipment with the greatest potential for effect on marine mammals and sea turtles is the subbottom profiler equipment with a maximum radius of 380 m to the MMPA Level B harassment threshold from the source. The potential for a marine mammal to experience onset of PTS and TTS from the operation of the HRG survey equipment was also determined to be very low, especially for LF cetaceans that are of critical concern in the Lease Area (i.e., North Atlantic right whale, humpback whale, and fin whale). The greatest distance from the source that the onset of TTS could be experienced is 230 m for HF cetaceans.

To ensure no marine mammal or sea turtles enter waters with sound levels that would result in behavioral disturbance, it is recommended that a 400-m exclusion zone be applied when the subbottom profiler is in operation.

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