DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

RIN 0648–XG882

Takes of Marine Mammals Incidental to Specified Activities; Taking Marine Mammals Incidental to Construction of the Vineyard Wind Offshore Wind Project

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

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

SUMMARY: NMFS has received a request from Vineyard Wind, LLC to take marine mammals incidental to construction of a commercial wind energy project offshore Massachusetts. Pursuant to the Marine Mammal Protection Act (MMPA), NMFS is requesting comments on its proposal to issue an incidental harassment authorization (IHA) to incidentally take marine mammals during the specified activities. NMFS is also requesting comments on a possible one-year renewal that could be issued under certain circumstances and if all requirements are met, as described in *Request for Public Comments* at the end of this notice. NMFS will consider public comments prior to making any final decision on the issuance of the requested MMPA authorizations and agency responses will be summarized in the final notice of our decision.

DATES: Comments and information must be received no later than May 30, 2019.

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

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

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

SUPPLEMENTARY INFORMATION:

Background

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

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

The definitions of all applicable MMPA statutory terms cited above are included in the relevant sections below.

National Environmental Policy Act

To comply with the National Environmental Policy Act of 1969 (NEPA; 42 U.S.C. 4321 *et seq.*) and NOAA Administrative Order (NAO) 216–6A, NMFS must review our proposed action (*i.e.,* the issuance of an incidental harassment authorization) with respect to potential impacts on the human environment. Accordingly, NMFS plans to adopt the Bureau of Ocean Energy Management's (BOEM) Environmental Impact Statement (EIS), provided our independent evaluation of the document finds that it includes adequate information analyzing the effects on the human environment of issuing the IHA. NMFS is a cooperating agency on BOEM's EIS. BOEM's draft EIS was made available for public comment from December 7, 2018 to February 22, 2019 and is available at: *www.boem.gov/Vineyard-Wind.*

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

Summary of Request

On September 7, 2018, NMFS received a request from Vineyard Wind LLC (Vineyard Wind) for an IHA to take marine mammals incidental to construction of an offshore wind energy project south of Massachusetts. Vineyard Wind submitted revised versions of the application on October 11, 2018 and on January 28, 2019. The application was deemed adequate and complete on February 15, 2018. Vineyard Wind's request is for take of 15 species of marine mammals by harassment. Neither Vineyard Wind nor NMFS expects serious injury or mortality to result from this activity and, therefore, an IHA is appropriate.

Description of Proposed Activity

Overview

Vineyard Wind proposes to construct an 800 megawatt (mw) offshore wind energy project in Lease Area OCS–A 0501, offshore Massachusetts. The project would consist of up to 100 offshore wind turbine generators (WTGs) and one or more electrical service platforms (ESPs), an onshore substation, offshore and onshore cabling, and onshore operations and maintenance facilities. Take of marine mammals may occur incidental to the construction of the project due to in-water noise exposure resulting from pile driving activities associated with installation of WTG and ESP foundations.

Vineyard Wind intends to install the WTGs and ESPs between April and December in the northeast portion of the 675 square kilometer (km^2) (166,886 acre) Lease Area, referred to as the Wind Development Area (WDA) (See Figure 1 in the IHA application).

Dates and Duration

Construction of the project is planned to commence between August 1, 2020—October 1, 2020. Up to 102 days of pile driving may occur between May 1 and December 31; no pile driving activities would occur from January 1 through April 30.

Specific Geographic Region

Vineyard Wind's proposed activity would occur in the northern portion of the 675 square kilometer (km) (166,886 acre) Vineyard Wind Lease Area OCS–A 0501 (Figure 1 in the IHA application), also referred to as the WDA. At its nearest point, the WDA is just over 23 km (14 mi) from the southeast corner of Martha's Vineyard and a similar distance from Nantucket. Water depths in the WDA range from approximately 37–49.5 meters (m) (121–162 feet (ft)).

Detailed Description of Specific Activity

Vineyard Wind is proposing to construct an 800 mw commercial wind energy project in Lease Area OCS–A 0501, offshore Massachusetts. The Project would consist of up to 100 offshore WTGs and as many as two ESPs, an onshore substation, offshore and onshore cabling, and onshore operations and maintenance facilities. Vineyard Wind intends to install the WTGs and ESPs in the northeast portion of the WDA (see Figure 1 in the IHA application). WTGs would be arranged in a grid-like pattern with spacing of 1.4–1.9 km (0.76–1.0 nm) between turbines. Each WTG would interconnect with the ESP(s) via an inter-array submarine cable system. The offshore export cable transmission system would connect the ESP(s) to a landfall location in either Barnstable or Yarmouth, Massachusetts. Construction of the project, including pile driving, could occur on any day from May through December. Activities associated with the construction of the project are described in more detail below.

Cable Laying

Cable burial operations will occur both in the WDA for the inter-array cables connecting the WTGs to the ESPs and in the offshore export cable corridor (OECC) for the cables carrying power from the ESPs to land. Inter-array cables will connect radial ''strings'' of six to 10 WTGs to the ESPs. Up to a maximum of two offshore export cables will connect the offshore ESPs to the shore. An inter-link cable will connect the ESPs to each other. The offshore export and inter-array cables will be buried beneath the seafloor at a target depth of up to 1.5–2.5 m (5–8 ft). Installation of an offshore export cable is anticipated to last ~16 days. The estimated installation time for the inter-array cables is ~60 days. Installation days are not continuous and do not include equipment preparation or down time that may result from weather or maintenance.

Some dredging may be required prior to cable laying due to the presence of sand waves. The upper portions of sand waves may be removed via mechanical or hydraulic means in order to achieve the proper burial depth below the stable sea bottom. The majority of the export and inter-link cable is expected to be installed using simultaneous lay and bury via jet plowing. Jet plowing entails the use of an adjustable blade, or plow, which rests on the sea floor and is towed by a surface vessel. The plow creates a narrow trench at the desired depth, while water jets fluidize the sediment within the trench. The cable is then fed through the plow and is laid into the trench as it moves forward. The fluidized sediments then settle back down into the trench and bury the cable. Jet plow technology has been shown to minimize impacts to marine habitat and excessive dispersion of bottom sediments. The majority of the inter-array cable is also expected to be installed via jet plowing after the cable has been placed on the seafloor. Other methods, such as mechanical plowing or trenching, may be needed in areas of coarser or more consolidated sediment, rocky bottom, or other difficult conditions in order to ensure a proper burial depth. The jet plowing tool may be based from a seabed tractor or a sled deployed from a vessel. A mechanical plow is also deployed from a vessel. More information on cable laying associated with the proposed project is provided in Vineyard Wind's COP (Vineyard Wind, 2018b). As the only potential impacts from these activities is sediment suspension, the potential for take to result from these activities is so low as to be discountable; therefore these activities are not analyzed further in this document.

Construction-Related Vessel Activity

During construction of the project, Vineyard Wind anticipates that an average of approximately 25 vessels will operate during a typical work day in the WDA and along the OECC. Many of these vessels will remain in the WDA or OECC for days or weeks at a time, potentially making only infrequent trips to port for bunkering and provisioning, as needed. Therefore, although an average of ~25 vessels will be involved in construction activities on any given day, fewer vessels will transit to and from New Bedford Harbor or a secondary port each day. The actual number of vessels involved in the project at one time is highly dependent on the project's final schedule, the final design of the project's components, and the logistics needed to ensure compliance with the Jones Act, a Federal law that regulates maritime commerce in the United States.

Existing vessel traffic in the vicinity of the project area south of Massachusetts is relatively high; therefore, marine mammals in the area are presumably habituated to vessel noise. In addition, construction vessels would be stationary on site for significant periods of time and the large vessels would travel to and from the site at relatively low speeds. Project-related vessels would be required to adhere to several mitigation measures designed to reduce the potential for marine mammals to be struck by vessels associated with the project; these measures are described further below (see *Proposed Mitigation Measures*). As part of various construction related activities, including cable laying and construction material delivery, dynamic positioning thrusters may be utilized to hold vessels in position or move slowly. Sound produced through use of dynamic positioning thrusters is similar to that produced by transiting vessels and dynamic positioning thrusters are typically operated either in a similarly predictable manner or used for short durations around stationary activities. Sound produced by dynamic positioning thrusters would be preceded by, and associated with, sound from ongoing vessel noise and would be similar in nature; thus, any marine mammals in the vicinity of the activity would be aware of the vessel's presence, further reducing the potential for startle or flight responses on the part of marine mammals. Construction related vessel activity, including the use of dynamic positioning thrusters, is not expected to result in take of marine mammals and NMFS does not propose to authorize any takes associated with construction related vessel activity. Accordingly, these activities are not analyzed further in this document.

Installation of WTGs and ESPs

Two foundation types are proposed for the project: Monopiles and jackets.

A monopile is a single, hollow cylinder fabricated from steel that is secured in the seabed. Monopiles have been used successfully at many offshore wind energy locations, including in Europe where they account for more than 80 percent of the installed foundations. The largest potential pile diameter proposed for the project for monopile foundations would be 10.3 m (33.8 ft). Piles for monopile foundations would be constructed for specific locations with maximum diameters ranging from ~8 m (26.2 ft) up to 10.3 m (33.8 ft) and an expected median diameter of ~9 m (29.5 ft). The piles for the monopile foundations are up to 95 m (311.7 ft) in length and will be driven to a penetration depth of 20–45 m (65.6–147.6 ft) (mean penetration depth 30 m (98.4 ft)). A schematic diagram showing potential heights and dimensions of the various components of a monopile foundation are shown in Figure 2 of the IHA application.

The jacket design concept consists of three to four steel piles, a large lattice jacket structure, and a transition piece. Jacket foundations each require the installation of three to four jacket securing piles, known as jacket piles, of ~3 m (9.8 ft) diameter. The 3 m (9.8 ft) diameter jacket piles for the jacket foundations are up to ~65 m (213.3 ft) in length and would be driven to a penetration depth of 30–75 m (98.4–196.9 ft) (mean penetration depth of 45 m (147. ft)). A schematic diagram showing potential heights and dimensions of the various components of a jacket foundation are shown in Figure 3 of the IHA application.

WTGs and ESPs may be placed on either type of foundation. Vineyard Wind has proposed that up to 100 WTG foundations may be constructed and that, of those 100 foundations, no more than 10 may be jackets. In addition, either one or two ESPs would be built on a jacket foundation(s). Therefore up to 102 foundations may be installed in the WDA. Vineyard Wind has incorporated more than one design scenario in their planning of the project. This approach, called the ''design envelope'' concept, allows for flexibility on the part of the developer, in recognition of the fact that offshore wind technology and installation techniques are constantly evolving and exact specifications of the project are not yet certain as of the publishing of this document. Variables that are not yet certain include the number, size, and configuration of WTGs and ESPs and their foundations, and the number of foundations that may be installed per day (a maximum of two foundations would be installed per day). The flexibility provided in the envelope concept is important because it precludes the need for numerous authorization modifications as infrastructure or construction techniques evolve after authorizations are granted but before construction commences. Under a scenario where 100 WTGs are installed on monopiles, a total of as many as 108 piles may be driven (*i.e.,* 100 monopiles for WTG foundations and 8 jacket piles for two ESPs). Under a scenario where 90 WTGs are installed on monopiles and 10 WTGs are installed on jacket foundations, a total of as many as 138 piles may be driven (*i.e.,* 90 monopiles for WTG foundations, 40 jacket piles for WTG foundations, and 8 jacket piles for ESPs). Specifications for both foundation types are shown in Table 1.

TABLE 1—FOUNDATION TYPES AND SPECIFICATIONS FOR THE VINEYARD WIND PROJECT

Foundation type	Pile diameter	Pile length	Penetration depth	Maximum number that may be installed *
Monopile	~8 to ~10.3 m (26.2 to 33.8 ft)	~60 m up to ~95 m (196.9–311.7 ft).	20–45 m (65.6–147.6 ft)	100
Jacket	3 m (9.8 ft)	~65 m (213.3 ft)	30–75 m (98.4–196.9 ft)	12

* The total of all foundations installed would not exceed 102.

The monopile and jacket foundations would be installed by one or two heavy lift or jack-up vessels. The main installation vessel(s) will likely remain at the WDA during the installation phase and transport vessels, tugs, and/or feeder barges would provide a continuous supply of foundations to the WDA. If appropriate vessels are available, the foundation components could be picked up directly in the marshalling port by the main installation vessel(s).

At the WDA, the main installation vessel would upend the monopile with a crane, and place it in the gripper frame, before lowering the monopile to the seabed. The gripper frame, depending upon its design, may be placed on the seabed scour protection materials to stabilize the monopile's vertical alignment before and during piling. Scour protection is included to protect the foundation from scour development, which is the removal of the sediments near structures by hydrodynamic forces, and consists of the placement of stone or rock material around the foundation. The scour protection would be one to two m high (3–6 ft), with stone or rock sizes of approximately 10–30 centimeters (4–12 inches). Once the monopile is lowered to the seabed, the crane hook would be released, and the hydraulic hammer would be picked up and placed on top of the monopile. Figure 4 of the IHA application shows a vessel lowering a monopile and typical jack-up installation vessels.

A typical pile driving operation is expected to take less than approximately three hours to achieve the target penetration depth. It is anticipated that a maximum of two monopiles could potentially be driven into the seabed per day. Concurrent driving (*i.e.,* the driving of more than one pile at the same time) would not occur.

Impact pile driving entails the use of a hammer that utilizes a rising and falling piston to repeatedly strike a pile and drive it into the ground. Using a crane, the installation vessel would upend the monopile, place it in the gripper frame, and then lower the monopile to the seabed. The gripper frame would stabilize the monopile's vertical alignment before and during piling. Once the monopile is lowered to the seabed, the crane hook would be released and the hydraulic hammer would be picked up and placed on top of the monopile. A temporary steel cap called a helmet would be placed on top of the pile to minimize damage to the head during impact driving. The intensity (*i.e.,* hammer energy level) would be gradually increased based on the resistance that is experienced from the sediments. The expected hammer size for monopiles is up to 4,000 kilojoules (kJ) (however, required energy may ultimately be far less than 4,000 kJ).

The typical pile driving operation is expected to take less than approximately three hours to achieve the target penetration depth. It is anticipated that a maximum of two piles can be driven into the seabed per day. Impact pile driving is the preferred method of pile installation for the proposed project.

In order to initiate impact pile driving the pile must be upright, level, and stable. The preferred option to achieve this is by utilizing a pile frame, which sits on the sea floor and holds the pile or to use a pile gripper as described above. In the unlikely scenario that both preferred options have unforeseen challenges, vibratory hammering may be utilized as a contingency. Vibratory hammering is accomplished by rapidly alternating (~250 Hz) forces to the pile. A system of counter-rotating eccentric weights powered by hydraulic motors are designed such that horizontal vibrations cancel out, while vertical vibrations are transmitted into the pile. The vibrations produced cause liquefaction of the substrate surrounding the pile, enabling the pile to be driven into the ground using the weight of the pile plus the impact hammer. If required, a vibratory hammer would be used before impact hammering begins to ensure the pile is stable in the seabed and is level for impact hammering. However, as stated above, impact driving is the preferred method of pile installation and vibratory driving would only occur for very short periods of time and only if Vineyard Wind engineers determine vibratory driving is required to seat the pile. The degree of potential effects of underwater sound on marine mammals is intrinsically related to the signal characteristics, received level, distance from the source, and duration of the sound exposure. If vibratory pile driving were required, Vineyard Wind anticipates that any vibratory pile driving would occur for less than 10 minutes per pile, in rare cases up to 30 minutes, as it would be used only to seat a pile such that impact driving can commence (Vineyard Wind, 2019). If vibratory driving does occur, the noise resulting from this activity would occur only sporadically, and for very brief periods when it does occur. Additionally, the source levels and source characteristics associated with vibratory driving would be generally similar to those produced through other concurrent use of vessels and related construction equipment, such that behavioral harassment of marine mammals cannot reasonably be attributed to use of the vibratory hammer in this case. Vibratory driving produces a continuous sound with peak sound levels that are much lower than those resulting from impact pile driving. Any elevated noise levels produced through vibratory driving are expected to be intermittent, of short duration, and with low peak values. As such, we expect that if marine mammals are exposed to sound from vibratory pile driving, they may alert to the sound but are unlikely to exhibit a behavioral response that rises to the level of take. As such, vibratory driving is not analyzed further in this document.

The intensity (*i.e.,* hammer energy level) of impact pile driving would be gradually increased based on the resistance that is experienced from the sediments. The expected maximum hammer energy for monopiles is 4,000 kilojoules (kJ). However, typical energy use is anticipated to be far less than 4,000 kJ. When piles are driven with impact hammers, they deform, sending a bulge travelling down the pile that radiates sound into the surrounding air, water, and seabed. This sound may be received by biological receivers such as marine mammals through the water, as the result of reflected paths from the surface, or re-radiated into the water from the seabed (See Figure 5 in the IHA application for a schematic diagram illustrating sound propagation paths associated with pile driving). Underwater sound produced during impact pile driving during construction of the WTGs and ESPs could result in incidental take of marine mammals by Level B harassment and, for some species, Level A harassment.

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

Description of Marine Mammals in the Area of Specified Activities

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

There are 42 marine mammal species that have been documented within the US Atlantic Exclusive Economic Zone (EEZ). However, 16 of these species are not expected to occur within the project area, based on a lack of sightings in the area and their known habitat preferences and distributions. These are: the West Indian manatee (*Trichechus manatus latirostris*), Bryde's whale (*Balaenoptera edeni*), beluga whale (*Delphinapterus leucas*), northern bottlenose whale (*Hyperoodon ampullatus*), killer whale (*Orcinus orca*), pygmy killer whale (*Feresa attenuata*), false killer whale (*Pseudorca crassidens*), melon-headed whale (*Peponocephala electra*), white-beaked dolphin (*Lagenorhynchus albirostris*), pantropical spotted dolphin (*Stenella attenuata*), Fraser's dolphin (*Lagenodelphis hosei*), rough-toothed dolphin (*Steno bredanensis*), Clymene dolphin (*Stenella clymene*), spinner dolphin (*Stenella longirostris*), hooded seal (*Cystophora cristata*), and ringed seal (*Pusa hipsida*). These species are not analyzed further in this document.

There are 26 marine mammal species that could potentially occur in the proposed project area and that are included in Table 3 of the IHA application. However, the temporal and/or spatial occurrence of several species listed in Table 3 of the IHA application is such that take of these species is not expected to occur, and they are therefore not discussed further beyond the explanation provided here. Take of these species is not anticipated either because they have very low densities in the project area, or because they are not expected to occur in the project area due to their more likely occurrence in habitat that is outside the WDA, based on the best available information. There are two pilot whale species (long-finned and short-finned (*Globicephala macrorhynchus*)) with distributions that overlap in the latitudinal range of the WDA (Hayes et al., 2017; Roberts et al., 2016). Because it is difficult to discriminate the two species at sea, sightings, and thus the densities calculated from them, are generally reported together as *Globicephala* spp. (Hayes et al., 2018; Roberts et al., 2016). However, based on the best available information, short-finned pilot whales occur in habitat that is both further offshore on the shelf break and further south than the project area (Hayes et al., 2018). Therefore, we assume that any take of pilot whales would be of long-finned pilot whales. Blue whales (*Balaenoptera musculus musculus*), dwarf and pygmy sperm whales (*Kogia sima* and *K. breviceps*), Cuvier's beaked whale (*Ziphius cavirostris*), striped dolphins (*Stenella coeruleoalba*) and four species of Mesoplodont beaked whale (*Mesoplodon* spp.), also occur in deepwater habitat that is further offshore than the project area (Hayes et al., 2018, Roberts et al., 2016). Likewise, Atlantic spotted dolphins (*Stenella frontalis*) primarily occur near the continental shelf edge and continental slope, in waters that are further offshore than the project area (Hayes et al., 2018).

Between October 2011 and June 2015 a total of 76 aerial surveys were conducted throughout the MA and RI/MA Wind Energy Areas (WEAs) (the WDA is contained within the MA WEA along with several other offshore renewable energy lease areas). Between November 2011 and March 2015, Marine Autonomous Recording Units (MARU; a type of static passive acoustic monitoring (PAM) recorder) were deployed at nine sites in the MA and RI/MA WEAs. The goal of the study was to collect visual and acoustic baseline data on distribution, abundance, and temporal occurrence patterns of marine mammals (Kraus et al., 2016). The lack of sightings of any of the species listed above reinforces the fact that these species are not expected to occur in the project area. As these species are not expected to occur in the project area during the proposed activities, they are not discussed further in this document.

We expect that the species listed in Table 2 will potentially occur in the project area and will potentially be taken as a result of the proposed project. Table 2 summarizes information related to the population or stock, including regulatory status under the MMPA and ESA and potential biological removal (PBR), where known. For taxonomy, we follow Committee on Taxonomy (2018). PBR is defined by the MMPA as the maximum number of animals, not including natural mortalities, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population (as described in NMFS' SARs). While no mortality is anticipated or authorized here, PBR is included here as a gross indicator of the status of the species and other threats.

Marine mammal abundance estimates presented in this document represent the total number of individuals that make up a given stock or the total number estimated within a particular study or survey area. NMFS' stock abundance estimates for most species represent the total estimate of individuals within the geographic area, if known, that comprises that stock. For some species, this geographic area may extend beyond U.S. waters. All managed stocks in this region are assessed in NMFS' U.S. Atlantic SARs. All values presented in Table 2 are the most recent available at the time of publication and are available in the 2017 Atlantic SARs (Hayes *et al.,* 2018) or draft 2018 SARs, available online at: *www.fisheries.noaa.gov/action/2018-draft-marine-mammal-stock-assessment-reports-available.*

TABLE 2—MARINE MAMMALS KNOWN TO OCCUR IN THE PROJECT AREA THAT MAY BE AFFECTED BY VINEYARD WIND'S PROPOSED ACTIVITY

Common name (scientific name)	Stock	MMPA and ESA status; strategic (Y/N) [1]	Stock abundance (CV, N_{min}, most recent abundance survey) [2]	Predicted abundance (CV) [3]	PBR [4]	Annual M/SI [4]	Occurrence and seasonality in project area
Toothed whales (Odontoceti)							
Sperm whale (*Physeter macrocephalus).*	North Atlantic	E; Y	2,288 (0.28; 1,815; n/a).	5,353 (0.12)	3.6	0.8	Rare.
Long-finned pilot whale (*Globicephala melas).*	W North Atlantic	-; N	5,636 (0.63; 3,464; n/a).	18,977 (0.11) [5]	35	27	Rare.
Atlantic white-sided dolphin (*Lagenorhynchus acutus).*	W North Atlantic	-; N	48,819 (0.61; 30,403; n/a).	37,180 (0.07)	304	30	Common year round.
Bottlenose dolphin (*Tursiops truncatus).*	W North Atlantic, Offshore.	-; N	77,532 (0.40; 56,053; 2011).	97,476 (0.06)[5]	561	39.4	Common year round.
Common dolphin [6] (*Delphinus delphis).*	W North Atlantic	-; N	173,486 (0.55; 55,690; 2011).	86,098 (0.12)	557	406	Common year round.
Risso's dolphin (*Grampus griseus*).	W North Atlantic	-; N	18,250 (0.46; 12,619; 2011).	7,732 (0.09)	126	49.9	Rare.
Harbor porpoise (*Phocoena phocoena).*	Gulf of Maine/Bay of Fundy.	-; N	79,833 (0.32; 61,415; 2011).	45,089 (0.12)*	706	255	Common year round.
Baleen whales (Mysticeti)							
North Atlantic right whale (*Eubalaena glacialis).*	W North Atlantic	E; Y	451 (0; 455; n/a)	535 (0.45)*	0.9	56	Year round in continental shelf and slope waters, occur seasonally.
Humpback whale [7] (*Megaptera novaeangliae).*	Gulf of Maine	-; N	896 (0.42; 239; n/a)	1,637 (0.07)*	14.6	9.8	Common year round.
Fin whale [6] (*Balaenoptera physalus).*	W North Atlantic	E; Y	3,522 (0.27; 1,234; n/a).	4,633 (0.08)	2.5	2.5	Year round in continental shelf and slope waters, occur seasonally.
Sei whale (*Balaenoptera borealis).*	Nova Scotia	E; Y	357 (0.52; 236; n/a)	717 (0.30)*	0.5	0.6	Year round in continental shelf and slope waters, occur seasonally.
Minke whale [6] (*Balaenoptera acutorostrata).*	Canadian East Coast	-; N	20,741 (0.3; 1,425; n/a).	2,112 (0.05)*	14	7.5	Year round in continental shelf and slope waters, occur seasonally.
Earless seals (Phocidae)							
Gray seal [8] (*Halichoerus grypus).*	W North Atlantic	-; N	27,131 (0.10; 25,908; n/a).		1,389	5,688	Common year round.
Harbor seal (*Phoca vitulina).*	W North Atlantic	-; N	75,834 (0.15; 66,884; 2012).		2,006	345	Common year round.

TABLE 2—MARINE MAMMALS KNOWN TO OCCUR IN THE PROJECT AREA THAT MAY BE AFFECTED BY VINEYARD WIND'S PROPOSED ACTIVITY—Continued

Common name (scientific name)	Stock	MMPA and ESA status; strategic (Y/N) [1]	Stock abundance (CV, N_{min}, most recent abundance survey) [2]	Predicted abundance (CV) [3]	PBR [4]	Annual M/SI [4]	Occurrence and seasonality in project area
Harp seal (*Pagophilus groenlandicus*).	W North Atlantic	-; N	7,411,000 (unk.; unk; 2014).	....	unk	225,687	Rare.

[1] ESA status: Endangered (E), Threatened (T)/MMPA status: Depleted (D). A dash (-) indicates that the species is not listed under the ESA or designated as depleted under the MMPA. Under the MMPA, a strategic stock is one for which the level of direct human-caused mortality exceeds PBR (see footnote 3) or which is determined to be declining and likely to be listed under the ESA within the foreseeable future. Any species or stock listed under the ESA is automatically designated under the MMPA as depleted and as a strategic stock.

[2] Stock abundance as reported in NMFS marine mammal stock assessment reports (SAR) except where otherwise noted. SARs available online at: *www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-stock-assessments.* CV is coefficient of variation; N_{min} is the minimum estimate of stock abundance. In some cases, CV is not applicable. For certain stocks, abundance estimates are actual counts of animals and there is no associated CV. The most recent abundance survey that is reflected in the abundance estimate is presented; there may be more recent surveys that have not yet been incorporated into the estimate. All values presented here are from the 2018 draft Atlantic SARs.

[3] This information represents species- or guild-specific abundance predicted by recent habitat-based cetacean density models (Roberts *et al.,* 2016, 2017, 2018). These models provide the best available scientific information regarding predicted density patterns of cetaceans in the U.S. Atlantic Ocean, and we provide the corresponding abundance predictions as a point of reference. Total abundance estimates were produced by computing the mean density of all pixels in the modeled area and multiplying by its area. For those species marked with an asterisk, the available information supported development of either two or four seasonal models; each model has an associated abundance prediction. Here, we report the maximum predicted abundance.

[4] Potential biological removal, defined by the MMPA as the maximum number of animals, not including natural mortalities, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population size (OSP). Annual M/SI, found in NMFS' SARs, represent annual levels of human-caused mortality plus serious injury from all sources combined (*e.g.,* commercial fisheries, subsistence hunting, ship strike). Annual M/SI values often cannot be determined precisely and is in some cases presented as a minimum value. All M/SI values are as presented in the draft 2018 SARs.

[5] Abundance estimates are in some cases reported for a guild or group of species when those species are difficult to differentiate at sea. Similarly, the habitat-based cetacean density models produced by Roberts *et al.* (2016) are based in part on available observational data which, in some cases, is limited to genus or guild in terms of taxonomic definition. Roberts *et al.* (2016) produced density models to genus level for *Globicephala* spp. and produced a density model for bottlenose dolphins that does not differentiate between offshore and coastal stocks.

[6] Abundance as reported in the 2007 Canadian Trans-North Atlantic Sighting Survey (TNASS), which provided full coverage of the Atlantic Canadian coast (Lawson and Gosselin, 2009). Abundance estimates from TNASS were corrected for perception and availability bias, when possible. In general, where the TNASS survey effort provided superior coverage of a stock's range (as compared with NOAA shipboard survey effort), the resulting abundance estimate is considered more accurate than the current NMFS abundance estimate (derived from survey effort with inferior coverage of the stock range). NMFS stock abundance estimate for the common dolphin is 70,184. NMFS stock abundance estimate for the fin whale is 1,618. NMFS stock abundance estimate for the minke whale is 2,591.

[7] 2018 U.S. Atlantic draft SAR for the Gulf of Maine feeding population lists a current abundance estimate of 896 individuals. However, we note that the estimate is defined on the basis of feeding location alone (*i.e.,* Gulf of Maine) and is therefore likely an underestimate.

[8] NMFS stock abundance estimate applies to U.S. population only, actual stock abundance is approximately 505,000.

Four marine mammal species that are listed under the Endangered Species Act (ESA) may be present in the project area and may be taken incidental to the proposed activity: The North Atlantic right whale, fin whale, sei whale, and sperm whale.

Below is a description of the species that are both common in the project area south of Massachusetts that have the highest likelihood of occurring in the project area and are thus expected to potentially be taken by the proposed activities. For the majority of species potentially present in the specific geographic region, NMFS has designated only a single generic stock (*e.g.,* ''western North Atlantic'') for management purposes. This includes the ''Canadian east coast'' stock of minke whales, which includes all minke whales found in U.S. waters is also a generic stock for management purposes. For humpback and sei whales, NMFS defines stocks on the basis of feeding locations, *i.e.,* Gulf of Maine and Nova Scotia, respectively. However, references to humpback whales and sei whales in this document refer to any individuals of the species that are found in the specific geographic region. Any biologically important areas (BIAs) that overlap spatially with the project area are addressed in the species sections below.

North Atlantic Right Whale

The North Atlantic right whale ranges from calving grounds in the southeastern United States to feeding grounds in New England waters and into Canadian waters (Hayes *et al.,* 2018). Surveys have demonstrated the existence of seven areas where North Atlantic right whales congregate seasonally, including north and east of the proposed project area in Georges Bank, off Cape Cod, and in Massachusetts Bay (Hayes *et al.,* 2018). In the late fall months (*e.g.,* October), right whales are generally thought to depart from the feeding grounds in the North Atlantic and move south to their calving grounds off Georgia and Florida. However, recent research indicates our understanding of their movement patterns remains incomplete (Davis *et al.,* 2017). A review of passive acoustic monitoring data from 2004 to 2014 throughout the western North Atlantic demonstrated nearly continuous year-round right whale presence across their entire habitat range (for at least some individuals), including in locations previously thought of as migratory corridors, suggesting that not all of the population undergoes a consistent annual migration (Davis *et al.,* 2017). Acoustic monitoring data from 2004 to 2014 indicated that the number of North Atlantic right whale vocalizations detected in the proposed project area were relatively constant throughout the year, with the exception of August through October when detected vocalizations showed an apparent decline (Davis *et al.,* 2017).

The western North Atlantic population demonstrated overall growth of 2.8 percent per year between 1990 to 2010, despite a decline in 1993 and no growth between 1997 and 2000 (Pace *et al.,* 2017). However, since 2010 the population has been in decline, with a 99.99 percent probability of a decline of just under 1 percent per year (Pace *et al.,* 2017). Between 1990 and 2015, calving rates varied substantially, with low calving rates coinciding with all three periods of decline or no growth (Pace *et al.,* 2017). On average, North Atlantic right whale calving rates are estimated to be roughly half that of southern right whales (*Eubalaena australis*) (Pace *et al.,* 2017), which are increasing in abundance (NMFS 2015). In 2018, no new North Atlantic right whale calves were documented in their calving grounds; this represented the first time since annual NOAA aerial surveys began in 1989 that no new right whale calves were observed. As of the writing of this document, 7 calves had been documented thus far in 2019. The current best estimate of population abundance for the species is 411 individuals, based on data as of September 4, 2018 (Pettis *et al.,* 2018).

Elevated North Atlantic right whale mortalities have occurred since June 7, 2017 along the United States and Canadian coast. A total of 20 confirmed dead stranded whales (12 in Canada; 8 in the United States) have been documented, with 17 of those occurring in 2017. This event has been declared an Unusual Mortality Event (UME), with human interactions, including entanglement in fixed fishing gear and vessel strikes, implicated in 10 of the 20 mortalities. There had been no North Atlantic right whale standings reported in 2019 as of the publication of this document. More information is available online at: *www.fisheries.noaa.gov/national/marine-life-distress/2017-2019-north-atlantic-right-whale-unusual-mortality-event.*

During the aerial surveys conducted from 2011–2015 in the project area, the highest number of right whale sightings occurred in March (n = 21), with sightings also occurring in December (n = 4), January (n = 7), February (n = 14), and April (n = 14), and no sightings in any other months (Kraus *et al.,* 2016). There was not significant variability in sighting rate among years, indicating consistent annual seasonal use of the area by right whales. North Atlantic right whales were acoustically detected in 30 out of the 36 recorded months (Kraus *et al.,* 2016). However, right whales exhibited strong seasonality in acoustic presence, with mean monthly acoustic presence highest in January (mean = 74%), February (mean = 86%), and March (mean = 97%), and the lowest in July (mean = 16%), August (mean = 2%), and September (mean = 12%). Density data from Roberts *et al.* (2017) confirms that the highest density of right whales in the project area occurs in March. The proposed project area is part of an important migratory area for North Atlantic right whales; this important migratory area is comprised of the waters of the continental shelf offshore the East Coast of the United States and extends from Florida through Massachusetts. Aerial surveys conducted in and near the project area from 2011–2015 documented a total of six instances of feeding behavior by North Atlantic right whales (Kraus *et al.,* 2016), however the area has not been identified as an important feeding area for right whales.

NMFS' regulations at 50 CFR 224.105 designated nearshore waters of the Mid-Atlantic Bight as Mid-Atlantic U.S. Seasonal Management Areas (SMA) for right whales in 2008. SMAs were developed to reduce the threat of collisions between ships and right whales around their migratory route and calving grounds. A portion of one SMA, which occurs off Block Island, Rhode Island, occurs near the project area, but does not overlap spatially with the project area (see Figure 7 in the IHA application). The SMA that occurs off Block Island is active from November 1 through April 30 of each year.

Humpback Whale

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

In New England waters, feeding is the principal activity of humpback whales, and their distribution in this region has been largely correlated to abundance of prey species, although behavior and bathymetry are factors influencing foraging strategy (Payne *et al.,* 1986, 1990). Humpback whales are frequently piscivorous when in New England waters, feeding on herring (*Clupea harengus*), sand lance (*Ammodytes* spp.), and other small fishes, as well as euphausiids in the northern Gulf of Maine (Paquet *et al.,* 1997). During winter, the majority of humpback whales from North Atlantic feeding areas (including the Gulf of Maine) mate and calve in the West Indies, where spatial and genetic mixing among feeding groups occurs, though significant numbers of animals are found in mid- and high-latitude regions at this time and some individuals have been sighted repeatedly within the same winter season, indicating that not all humpback whales migrate south every winter (Hayes *et al.,* 2018).

In aerial surveys conducted from 2011–2015 in the project area, sightings of humpback whales occurred during all seasons, however they were primarily sighted in the spring and summer seasons, with the greatest number of sightings during the month of April (*n*=33). Based on the pattern of sightings during those years their presence in the area seemed to start in March and end in July, though a few sightings also occurred in October, December and January (Kraus *et al.,* 2016).

Since January 2016, elevated humpback whale mortalities have occurred along the Atlantic coast from Maine to Florida. Partial or full necropsy examinations have been conducted on approximately half of the 93 known cases. Of the whales examined, about 50 percent had evidence of human interaction, either ship strike or entanglement. While a portion of the whales have shown evidence of pre-mortem vessel strike, this finding is not consistent across all whales examined and more research is needed. NOAA is consulting with researchers that are conducting studies on the humpback whale populations, and these efforts may provide information on changes in whale distribution and habitat use that could provide additional insight into how these vessel interactions occurred. Three previous UMEs involving humpback whales have occurred since 2000, in 2003, 2005, and 2006. More information is available at: *www.fisheries.noaa.gov/national/marine-life-distress/2016-2019-humpback-whale-unusual-mortality-event-along-atlantic-coast.*

Fin Whale

Fin whales are common in waters of the U.S. Atlantic EEZ, principally from Cape Hatteras northward (Hayes *et al.,* 2018). Fin whales are present north of 35-degree latitude in every season and are broadly distributed throughout the western North Atlantic for most of the year, though densities vary seasonally (Hayes *et al.,* 2018). In this region fin whales are the dominant large cetacean species during all seasons, having the largest standing stock, the largest food requirements, and therefore the largest influence on ecosystem processes of any cetacean species (Hain *et al.,* 1992; Kenney *et al.,* 1997). It is likely that fin whales occurring in the U.S. Atlantic EEZ undergo migrations into Canadian waters, open-ocean areas, and perhaps even subtropical or tropical regions (Edwards *et al.,* 2015).

New England waters represent a major feeding ground for fin whales and a biologically important feeding area for the species exists just west of the proposed project area, stretching from just south of the eastern tip of Long Island to south of the western tip of Martha's Vineyard. In aerial surveys conducted from 2011–2015 in the project area sightings occurred in every season with the greatest numbers of sightings during the spring (*n*=35) and summer (*n*=49) months (Kraus *et al.,* 2016). Despite much lower sighting rates during the winter, confirmed acoustic detections of fin whales recorded on a hydrophone array in the project area from 2011–2015 occurred throughout the year; however, due to acoustic detection ranges in excess of 200 km, the detections do not confirm that fin whales were present in the project area during that time (Kraus *et al.,* 2016).

Sei Whale

The Nova Scotia stock of sei whales can be found in deeper waters of the continental shelf edge waters of the northeastern United States and northeastward to south of Newfoundland. The southern portion of the stock's range during spring and summer includes the Gulf of Maine and Georges Bank. Spring is the period of greatest abundance in U.S. waters, with sightings concentrated along the eastern margin of Georges Bank and into the Northeast Channel area, and along the southwestern edge of Georges Bank in the area of Hydrographer Canyon (Hayes *et al.,* 2018). Sei whales occur in shallower waters to feed. Sei whales were only sighted during the spring and summer. In aerial surveys conducted from 2011–2015 in the project area sightings of Sei whales occurred between March and June, with the greatest number of sightings in May (*n*=8) and June (*n*=13), and no sightings from July through January (Kraus *et al.,* 2016).

Minke Whale

Minke whales occur in temperate, tropical, and high-latitude waters. The Canadian East Coast stock can be found in the area from the western half of the Davis Strait (45° W) to the Gulf of Mexico (Hayes *et al.,* 2018). This species generally occupies waters less than 100 m deep on the continental shelf. There appears to be a strong seasonal component to minke whale distribution in which spring to fall are times of relatively widespread and common occurrence, and when the whales are most abundant in New England waters, while during winter the species appears to be largely absent (Hayes *et al.,* 2016). In aerial surveys conducted from 2011–2015 in the project area sightings of minke whales occurred between March and September, with the greatest number of sightings occurring in May (n=38) and no sightings from October through February (Kraus *et al.,* 2016).

Since January 2017, elevated minke whale mortalities have occurred along the Atlantic coast from Maine through South Carolina, with a total of 59 strandings recorded when this document was written. This event has been declared a UME. Full or partial necropsy examinations were conducted on more than 60 percent of the whales. Preliminary findings in several of the whales have shown evidence of human interactions or infectious disease, but these findings are not consistent across all of the whales examined, so more research is needed. More information is available at: *www.fisheries.noaa.gov/national/marine-life-distress/2017-2019-minke-whale-unusual-mortality-event-along-atlantic-coast.*

Sperm Whale

The distribution of the sperm whale in the U.S. EEZ occurs on the continental shelf edge, over the continental slope, and into mid-ocean regions (Hayes *et al.,* 2018). The basic social unit of the sperm whale appears to be the mixed school of adult females plus their calves and some juveniles of both sexes, normally numbering 20–40 animals in all. There is evidence that some social bonds persist for many years (Christal *et al.,* 1998). In summer, the distribution of sperm whales includes the area east and north of Georges Bank and into the Northeast Channel region, as well as the continental shelf (inshore of the 100-m isobath) south of New England. In the fall, sperm whale occurrence south of New England on the continental shelf is at its highest level, and there remains a continental shelf edge occurrence in the mid-Atlantic bight. In winter, sperm whales are concentrated east and northeast of Cape Hatteras. Sperm whales are not expected to be common in the project area due to the relatively shallow depths in the project area. In aerial surveys conducted from 2011–2015 in the project area only four sightings of sperm whales occurred, three in summer and one in autumn (Kraus *et al.,* 2016).

Long-Finned Pilot Whale

Long-finned pilot whales are found from North Carolina and north to Iceland, Greenland and the Barents Sea (Hayes *et al.,* 2018). In U.S. Atlantic waters the species is distributed principally along the continental shelf edge off the northeastern U.S. coast in winter and early spring and in late spring, pilot whales move onto Georges Bank and into the Gulf of Maine and more northern waters and remain in these areas through late autumn (Waring *et al.,* 2016). In aerial surveys conducted from 2011–2015 in the project area the majority of pilot whale sightings were in spring (n=11); sightings were also documented in summer, with no sightings in autumn or winter (Kraus *et al.,* 2016).

Atlantic White-Sided Dolphin

White-sided dolphins are found in temperate and sub-polar waters of the North Atlantic, primarily in continental shelf waters to the 100-m depth contour from central West Greenland to North Carolina (Hayes *et al.,* 2018). The Gulf of Maine stock is most common in continental shelf waters from Hudson Canyon to Georges Bank, and in the Gulf of Maine and lower Bay of Fundy. Sighting data indicate seasonal shifts in distribution (Northridge *et al.,* 1997). During January to May, low numbers of white-sided dolphins are found from Georges Bank to Jeffreys Ledge (off New Hampshire), with even lower numbers south of Georges Bank, as documented by a few strandings collected on beaches of Virginia to South Carolina. From June through September, large numbers of white-sided dolphins are found from Georges Bank to the lower Bay of Fundy. From October to December, white-sided dolphins occur at intermediate densities from southern Georges Bank to southern Gulf of Maine (Payne and Heinemann 1990). Sightings south of Georges Bank, particularly around Hudson Canyon, occur year round but at low densities. In aerial surveys conducted from 2011–2015 in the project area there were sightings of white-sided dolphins in every season except winter (Kraus *et al.,* 2016).

Common Dolphin

The common dolphin is found world-wide in temperate to subtropical seas. In the North Atlantic, common dolphins are found over the continental shelf between the 100-m and 2,000-m isobaths and over prominent underwater topography and east to the mid-Atlantic Ridge (Hayes *et al.,* 2018), but may be found in shallower shelf waters as well. Common dolphins are expected to occur in the vicinity of the project area in relatively high numbers. Common dolphins were the most frequently observed dolphin species in aerial surveys conducted from 2011–2015 in the project area (Kraus *et al.,* 2016). Sightings peaked in the summer between June and August, though there were sightings recorded in nearly every month of the year (Kraus *et al.,* 2016).

Bottlenose Dolphin

There are two distinct bottlenose dolphin mophotypes in the western North Atlantic: The coastal and offshore forms (Hayes *et al.,* 2018). The two mophotypes are genetically distinct based upon both mitochondrial and nuclear markers (Hoelzel *et al.,* 1998;

Rosel *et al.,* 2009). The offshore form is distributed primarily along the outer continental shelf and continental slope in the Northwest Atlantic Ocean from Georges Bank to the Florida Keys and is the only type that may be present in the project area as the northern extent of the range of the Western North Atlantic Northern Migratory Coastal Stock occurs south of the project area. Bottlenose dolphins are expected to occur in the project area in relatively high numbers. They were the second most frequently observed species of dolphin in aerial surveys conducted from 2011–2015 in the project area, and were observed in every month of the year except January and March (Kraus *et al.,* 2016).

Risso's Dolphin

Risso's dolphins are distributed worldwide in tropical and temperate seas and in the Northwest Atlantic occur from Florida to eastern Newfoundland (Leatherwood *et al.,* 1976; Baird and Stacey 1991). Off the northeastern U.S. coast, Risso's dolphins are distributed along the continental shelf edge from Cape Hatteras northward to Georges Bank during spring, summer, and autumn (CETAP 1982; Payne *et al.,* 1984) with the range extending outward into oceanic waters in the winter (Payne *et al.,* 1984). Risso's dolphins are not expected to be common in the project area due to the relatively shallow water depths. In aerial surveys conducted from 2011–2015 in the project there were only two confirmed sightings of Risso's dolphins, both of which occurred in the spring (Kraus *et al.,* 2016).

Harbor Porpoise

Harbor porpoises occur from the coastline to deep waters (>1800 m; Westgate *et al.,* 1998), although the majority of the population is found over the continental shelf (Hayes *et al.,* 2018). In the project area, only the Gulf of Maine/Bay of Fundy stock of harbor porpoise may be present. This stock is found in U.S. and Canadian Atlantic waters and is concentrated in the northern Gulf of Maine and southern Bay of Fundy region, generally in waters less than 150 m deep (Waring *et al.,* 2016). In aerial surveys conducted from 2011–2015 in the project area, sightings of harbor porpoise occurred from November through May, with the highest number of detections occurring in April and almost none during June–September (Kraus *et al.,* 2016).

Harbor Seal

The harbor seal is found in all nearshore waters of the North Atlantic and North Pacific Oceans and adjoining seas above about 30° N (Burns, 2009). In the western North Atlantic, harbor seals are distributed from the eastern Canadian Arctic and Greenland south to southern New England and New York, and occasionally to the Carolinas (Hayes *et al.,* 2018). Haulout and pupping sites are located off Manomet, MA and the Isles of Shoals, ME (Waring *et al.,* 2016). Based on harbor seal sightings reported at sea in shipboard surveys conducted by the NMFS Northeast Fisheries Science Center from 1995–2011, harbor seals would be expected to occur in the project area from September to May (Hayes *et al.,* 2018). Harbor seals are expected to be relatively common in the project area. Since July 2018, elevated numbers of harbor seal and gray seal mortalities have occurred across Maine, New Hampshire and Massachusetts. This event has been declared a UME. Additionally, stranded seals have shown clinical signs as far south as Virginia, although not in elevated numbers, therefore the UME investigation now encompasses all seal strandings from Maine to Virginia. Lastly, ice seals (harp and hooded seals) have also started stranding with clinical signs, again not in elevated numbers, and those two seal species have also been added to the UME investigation. Full or partial necropsy examinations have been conducted on some of the seals and samples have been collected for testing. Based on tests conducted thus far, the main pathogen found in the seals is phocine distemper virus. NMFS is performing additional testing to identify any other factors that may be involved in this UME. Information on this UME is available online at: *www.fisheries.noaa.gov/new-england-mid-atlantic/marine-life-distress/2018-2019-pinniped-unusual-mortality-event-along.*

Gray Seal

There are three major populations of gray seals found in the world; eastern Canada (western North Atlantic stock), northwestern Europe and the Baltic Sea. Gray seals in the project area belong to the western North Atlantic stock. The range for this stock is from New Jersey to Labrador. Current population trends show that gray seal abundance is likely increasing in the U.S. Atlantic EEZ (Hayes *et al.,* 2018). Although the rate of increase is unknown, surveys conducted since their arrival in the 1980s indicate a steady increase in abundance in both Maine and Massachusetts (Hayes *et al.,* 2018). It is believed that recolonization by Canadian gray seals is the source of the U.S. population (Hayes *et al.,* 2018). Gray seals are expected to be relatively common in the project area. As described above, elevated seal mortalities, including gray seals, have occurred across Maine, New Hampshire and Massachusetts, and as far south as Virginia, since July 2018. This event has been declared a UME, with phocine distemper virus identified as the main pathogen found in the seals. NMFS is performing additional testing to identify any other factors that may be involved in this UME.

Harp Seal

Harp seals are highly migratory and occur throughout much of the North Atlantic and Arctic Oceans (Hayes *et al.,* 2018). Breeding occurs between late-February and April and adults then assemble on suitable pack ice to undergo the annual molt. The migration then continues north to Arctic summer feeding grounds. Harp seal occurrence in the project area is considered rare. However, since the early 1990s, numbers of sightings and strandings have been increasing off the east coast of the United States from Maine to New Jersey (Katona *et al.,* 1993; Rubinstein 1994; Stevick and Fernald 1998; McAlpine 1999; Lacoste and Stenson 2000; Soulen *et al.,* 2013). These extralimital appearances usually occur in January–May (Harris *et al.,* 2002), when the western North Atlantic stock is at its most southern point of migration. Harp seals are not expected to be common in the project area. As described above, elevated seal mortalities, including harp seals, have occurred across Maine, New Hampshire and Massachusetts, and as far south as Virginia, since July 2018. This event has been declared a UME, with phocine distemper virus identified as the main pathogen found in the seals. NMFS is performing additional testing to identify any other factors that may be involved in this UME.

Marine Mammal Hearing

Hearing is the most important sensory modality for marine mammals underwater, and exposure to anthropogenic sound can have deleterious effects. To appropriately assess the potential effects of exposure to sound, it is necessary to understand the frequency ranges marine mammals are able to hear. Current data indicate that not all marine mammal species have equal hearing capabilities (*e.g.,* Richardson *et al.,* 1995; Wartzok and Ketten, 1999; Au and Hastings, 2008). To reflect this, Southall *et al.* (2007, 2019) recommended that marine mammals be divided into functional hearing groups based on directly measured or estimated hearing ranges on the basis of available behavioral response data, audiograms derived using auditory evoked potential techniques, anatomical modeling, and other data. Note that no direct measurements of hearing ability have been successfully completed for mysticetes (*i.e.,* low-frequency cetaceans). Subsequently, NMFS (2018) described generalized hearing ranges for these marine mammal hearing groups. Generalized hearing ranges were chosen based on the approximately 65 decibel (dB) threshold from the normalized composite audiograms, with the exception for lower limits for low-frequency cetaceans where the lower bound was deemed to be biologically implausible and the lower bound from Southall *et al.,* (2007) retained. Marine mammal hearing groups and their associated hearing ranges are provided in Table 3.

TABLE 3—MARINE MAMMAL HEARING GROUPS

[NMFS, 2018]

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

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

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

For more detail concerning these groups and associated frequency ranges, please see NMFS (2018) for a review of available information. Fifteen marine mammal species (twelve cetacean and three pinniped (all phocid species)) have the reasonable potential to co-occur with the proposed activities. Please refer to Table 2. Of the cetacean species that may be present, five are classified as low-frequency cetaceans (*i.e.,* all mysticete species), six are classified as mid-frequency cetaceans (*i.e.,* all delphinid species and the sperm whale), and one is classified as a high-frequency cetacean (*i.e.,* harbor porpoise).

Potential Effects of Specified Activities on Marine Mammals and Their Habitat

This section includes a summary and discussion of the ways that components of the specified activity may impact marine mammals and their habitat. The *Estimated Take* section later in this document includes a quantitative analysis of the number of individuals that are expected to be taken by this activity. The *Negligible Impact Analysis and Determination* section considers the content of this section, the *Estimated Take* section, and the *Proposed Mitigation* section, to draw conclusions regarding the likely impacts of these activities on the reproductive success or survivorship of individuals and how those impacts on individuals are likely to impact marine mammal species or stocks.

Description of Sound Sources

This section contains a brief technical background on sound, on the characteristics of certain sound types, and on metrics used in this proposal inasmuch as the information is relevant to the specified activity and to a discussion of the potential effects of the specified activity on marine mammals found later in this document. For general information on sound and its interaction with the marine environment, please see, *e.g.,* Au and Hastings (2008); Richardson *et al.* (1995); Urick (1983).

Sound travels in waves, the basic components of which are frequency, wavelength, velocity, and amplitude. Frequency is the number of pressure waves that pass by a reference point per unit of time and is measured in hertz (Hz) or cycles per second. Wavelength is the distance between two peaks or corresponding points of a sound wave (length of one cycle). Higher frequency sounds have shorter wavelengths than lower frequency sounds, and typically attenuate (decrease) more rapidly, except in certain cases in shallower water. Amplitude is the height of the sound pressure wave or the ''loudness'' of a sound and is typically described using the relative unit of the decibel (dB). A sound pressure level (SPL) in dB is described as the ratio between a measured pressure and a reference pressure (for underwater sound, this is 1 microPascal (μPa)), and is a logarithmic unit that accounts for large variations in amplitude; therefore, a relatively small change in dB corresponds to large changes in sound pressure. The source level (SL) represents the SPL referenced at a distance of 1 m from the source (referenced to 1 μPa), while the received level is the SPL at the listener's position (referenced to 1 μPa).

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

Sound exposure level (SEL; represented as dB re 1 μPa^2–s) represents the total energy in a stated frequency band over a stated time interval or event, and considers both intensity and duration of exposure. The per-pulse SEL is calculated over the time window containing the entire pulse (*i.e.,* 100 percent of the acoustic energy). SEL is a cumulative metric; it can be accumulated over a single pulse, or calculated over periods containing multiple pulses. Cumulative SEL represents the total energy accumulated by a receiver over a defined time window or during an event. Peak sound pressure (also referred to as zero-to-peak sound pressure or 0-pk) is the maximum instantaneous sound pressure measurable in the water at a specified distance from the source, and is represented in the same units as the rms sound pressure.

When underwater objects vibrate or activity occurs, sound-pressure waves are created. These waves alternately compress and decompress the water as the sound wave travels. Underwater sound waves radiate in a manner similar to ripples on the surface of a pond and may be either directed in a beam or beams or may radiate in all directions (omnidirectional sources), as is the case for sound produced by the pile driving activity considered here. The compressions and decompressions associated with sound waves are detected as changes in pressure by aquatic life and man-made sound receptors such as hydrophones.

Even in the absence of sound from the specified activity, the underwater environment is typically loud due to ambient sound, which is defined as environmental background sound levels lacking a single source or point (Richardson *et al.,* 1995). The sound level of a region is defined by the total acoustical energy being generated by known and unknown sources. These sources may include physical (*e.g.,* wind and waves, earthquakes, ice, atmospheric sound), biological (*e.g.,* sounds produced by marine mammals, fish, and invertebrates), and anthropogenic (*e.g.,* vessels, dredging, construction) sound. A number of sources contribute to ambient sound, including wind and waves, which are a main source of naturally occurring ambient sound for frequencies between 200 hertz (Hz) and 50 kilohertz (kHz) (Mitson, 1995). In general, ambient sound levels tend to increase with increasing wind speed and wave height. Precipitation can become an important component of total sound at frequencies above 500 Hz, and possibly down to 100 Hz during quiet times. Marine mammals can contribute significantly to ambient sound levels, as can some fish and snapping shrimp. The frequency band for biological contributions is from approximately 12 Hz to over 100 kHz. Sources of ambient sound related to human activity include transportation (surface vessels), dredging and construction, oil and gas drilling and production, geophysical surveys, sonar, and explosions. Vessel noise typically dominates the total ambient sound for frequencies between 20 and 300 Hz. In general, the frequencies of anthropogenic sounds are below 1 kHz and, if higher frequency sound levels are created, they attenuate rapidly.

The sum of the various natural and anthropogenic sound sources that comprise ambient sound at any given location and time depends not only on the source levels (as determined by current weather conditions and levels of biological and human activity) but also on the ability of sound to propagate through the environment. In turn, sound propagation is dependent on the spatially and temporally varying properties of the water column and sea floor, and is frequency-dependent. As a result of the dependence on a large number of varying factors, ambient sound levels can be expected to vary widely over both coarse and fine spatial and temporal scales. Sound levels at a given frequency and location can vary by 10–20 decibels (dB) from day to day (Richardson *et al.,* 1995). The result is that, depending on the source type and its intensity, sound from the specified activity may be a negligible addition to the local environment or could form a distinctive signal that may affect marine mammals. Underwater ambient sound in the Atlantic Ocean south of Massachusetts is comprised of sounds produced by a number of natural and anthropogenic sources. Human-generated sound is a significant contributor to the ambient acoustic environment in the project location. Details of source types are described in the following text.

Sounds are often considered to fall into one of two general types: Pulsed and non-pulsed (defined in the following). The distinction between these two sound types is important because they have differing potential to cause physical effects, particularly with regard to hearing (*e.g.,* Ward, 1997 in Southall *et al.,* 2007). Please see Southall *et al.* (2007) for an in-depth discussion of these concepts. The distinction between these two sound types is not always obvious, as certain signals share properties of both pulsed and non-pulsed sounds. A signal near a source could be categorized as a pulse, but due to propagation effects as it moves farther from the source, the signal duration becomes longer (*e.g.,* Greene and Richardson, 1988).

Pulsed sound sources (*e.g.,* airguns, explosions, gunshots, sonic booms, impact pile driving) produce signals that are brief (typically considered to be less than one second), broadband, atonal transients (ANSI, 1986, 2005; Harris, 1998; NIOSH, 1998; ISO, 2003) and occur either as isolated events or repeated in some succession. Pulsed sounds are all characterized by a relatively rapid rise from ambient pressure to a maximal pressure value followed by a rapid decay period that may include a period of diminishing, oscillating maximal and minimal pressures, and generally have an increased capacity to induce physical injury as compared with sounds that lack these features.

Non-pulsed sounds can be tonal, narrowband, or broadband, brief or prolonged, and may be either continuous or intermittent (ANSI, 1995; NIOSH, 1998). Some of these non-pulsed sounds can be transient signals of short duration but without the essential properties of pulses (*e.g.,* rapid rise time). Examples of non-pulsed sounds include those produced by vessels, aircraft, machinery operations such as drilling or dredging, vibratory pile driving, and active sonar systems. The duration of such sounds, as received at a distance, can be greatly extended in a highly reverberant environment.

The impulsive sound generated by impact hammers is characterized by rapid rise times and high peak levels. Vibratory hammers produce non-impulsive, continuous noise at levels significantly lower than those produced by impact hammers. Rise time is slower, reducing the probability and severity of injury, and sound energy is distributed over a greater amount of time (*e.g.,* Nedwell and Edwards, 2002; Carlson *et al.,* 2005).

Acoustic Effects

We previously provided general background information on marine mammal hearing (see ''Description of Marine Mammals in the Area of the Specified Activity''). Here, we discuss the potential effects of sound on marine mammals.

Potential Effects of Underwater Sound—Note that, in the following discussion, we refer in many cases to a review article concerning studies of noise-induced hearing loss conducted from 1996–2015 (*i.e.,* Finneran, 2015). For study-specific citations, please see that work. Anthropogenic sounds cover a broad range of frequencies and sound levels and can have a range of highly variable impacts on marine life, from none or minor to potentially severe responses, depending on received levels, duration of exposure, behavioral context, and various other factors. The potential effects of underwater sound from active acoustic sources can potentially result in one or more of the following: temporary or permanent hearing impairment, non-auditory physical or physiological effects, behavioral disturbance, stress, and masking (Richardson *et al.,* 1995; Gordon *et al.,* 2004; Nowacek *et al.,* 2007; Southall *et al.,* 2007; Götz *et al.,* 2009). The degree of effect is intrinsically related to the signal characteristics, received level, distance from the source, and duration of the sound exposure. In general, sudden, high level sounds can cause hearing loss, as can longer exposures to lower level sounds. Temporary or permanent loss of hearing will occur almost exclusively for noise within an animal's hearing range. We first describe specific manifestations of acoustic effects before providing discussion specific to pile driving.

Richardson *et al.* (1995) described zones of increasing intensity of effect that might be expected to occur, in relation to distance from a source and assuming that the signal is within an animal's hearing range. First is the area within which the acoustic signal would be audible (potentially perceived) to the animal but not strong enough to elicit any overt behavioral or physiological response. The next zone corresponds with the area where the signal is audible to the animal and of sufficient intensity to elicit behavioral or physiological responsiveness. Third is a zone within which, for signals of high intensity, the received level is sufficient to potentially cause discomfort or tissue damage to auditory or other systems. Overlaying these zones to a certain extent is the area within which masking (*i.e.,* when a sound interferes with or masks the ability of an animal to detect a signal of interest that is above the absolute hearing threshold) may occur; the masking zone may be highly variable in size.

We describe the more severe effects (*i.e.,* certain non-auditory physical or physiological effects) only briefly as we do not expect that there is a reasonable likelihood that pile driving may result in such effects (see below for further discussion). Potential effects from impulsive sound sources can range in severity from effects such as behavioral disturbance or tactile perception to physical discomfort, slight injury of the internal organs and the auditory system, or mortality (Yelverton *et al.,* 1973). Non-auditory physiological effects or injuries that theoretically might occur in marine mammals exposed to high level underwater sound or as a secondary effect of extreme behavioral reactions (*e.g.,* change in dive profile as a result of an avoidance reaction) caused by exposure to sound include neurological effects, bubble formation, resonance effects, and other types of organ or tissue damage (Cox *et al.,* 2006; Southall *et al.,* 2007; Zimmer and Tyack, 2007; Tal *et al.,* 2015). The construction activities considered here do not involve the use of devices such as explosives or mid-frequency tactical sonar that are associated with these types of effects.

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

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

Relationships between TTS and PTS thresholds have not been studied in marine mammals, and there is no PTS data for cetaceans, but such relationships are assumed to be similar to those in humans and other terrestrial mammals. PTS typically occurs at exposure levels at least several decibels above (a 40-dB threshold shift approximates PTS onset; *e.g.,* Kryter *et al.,* 1966; Miller, 1974) that inducing mild TTS (a 6-dB threshold shift approximates TTS onset; *e.g.,* Southall *et al.,* 2007). Based on data from terrestrial mammals, a precautionary assumption is that the PTS thresholds for impulse sounds (such as impact pile driving pulses as received close to the source) are at least 6 dB higher than the TTS threshold on a peak-pressure basis and PTS cumulative sound exposure level thresholds are 15 to 20 dB higher than TTS cumulative sound exposure level thresholds (Southall *et al.,* 2007). Given the higher level of sound or longer exposure duration necessary to cause PTS as compared with TTS, it is considerably less likely that PTS could occur.

TTS is the mildest form of hearing impairment that can occur during exposure to sound (Kryter, 1985). While experiencing TTS, the hearing threshold rises, and a sound must be at a higher level in order to be heard. In terrestrial and marine mammals, TTS can last from minutes or hours to days (in cases of strong TTS). In many cases, hearing sensitivity recovers rapidly after exposure to the sound ends. Few data on sound levels and durations necessary to elicit mild TTS have been obtained for marine mammals.

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

Currently, TTS data only exist for four species of cetaceans (bottlenose dolphin, beluga whale (*Delphinapterus leucas*), harbor porpoise, and Yangtze finless porpoise (*Neophocoena asiaeorientalis*)) and three species of pinnipeds (northern elephant seal (*Mirounga angustirostris*), harbor seal, and California sea lion (*Zalophus californianus*)) exposed to a limited number of sound sources (*i.e.,* mostly tones and octave-band noise) in laboratory settings (Finneran, 2015). TTS was not observed in trained spotted (*Phoca largha*) and ringed (*Pusa hispida*) seals exposed to impulsive noise at levels matching previous predictions of TTS onset (Reichmuth *et al.,* 2016). In general, harbor seals and harbor porpoises have a lower TTS onset than other measured pinniped or cetacean species (Finneran, 2015). Additionally, the existing marine mammal TTS data come from a limited number of individuals within these species. There are no data available on noise-induced hearing loss for mysticetes. For summaries of data on TTS in marine mammals or for further discussion of TTS onset thresholds, please see Southall *et al.* (2007), Finneran and Jenkins (2012), Finneran (2015), and NMFS (2018).

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

Habituation can occur when an animal's response to a stimulus wanes with repeated exposure, usually in the absence of unpleasant associated events (Wartzok *et al.,* 2003). Animals are most likely to habituate to sounds that are predictable and unvarying. It is important to note that habituation is appropriately considered as a ''progressive reduction in response to stimuli that are perceived as neither aversive nor beneficial,'' rather than as, more generally, moderation in response to human disturbance (Bejder *et al.,* 2009). The opposite process is sensitization, when an unpleasant experience leads to subsequent responses, often in the form of avoidance, at a lower level of exposure. As noted, behavioral state may affect the type of response. For example, animals that are resting may show greater behavioral change in response to disturbing sound levels than animals that are highly motivated to remain in an area for feeding (Richardson *et al.,* 1995; NRC, 2003; Wartzok *et al.,* 2003). Controlled experiments with captive marine mammals have showed pronounced behavioral reactions, including avoidance of loud sound sources (Ridgway *et al.,* 1997; Finneran *et al.,* 2003). Observed responses of wild marine mammals to loud pulsed sound sources (typically airguns or acoustic harassment devices) have been varied but often consist of avoidance behavior or other behavioral changes suggesting discomfort (Morton and Symonds, 2002; see also Richardson *et al.,* 1995; Nowacek *et al.,* 2007). However, many delphinids approach low-frequency airgun source vessels with no apparent discomfort or obvious behavioral change (*e.g.,* Barkaszi *et al.,* 2012), indicating the importance of frequency output in relation to the species' hearing sensitivity.

Available studies show wide variation in response to underwater sound; therefore, it is difficult to predict specifically how any given sound in a particular instance might affect marine mammals perceiving the signal. If a marine mammal does react briefly to an underwater sound by changing its behavior or moving a small distance, the impacts of the change are unlikely to be significant to the individual, let alone the stock or population. However, if a sound source displaces marine mammals from an important feeding or breeding area for a prolonged period, impacts on individuals and populations could be significant (*e.g.,* Lusseau and Bejder, 2007; Weilgart, 2007; NRC, 2005). However, there are broad categories of potential response, which we describe in greater detail here, that include alteration of dive behavior, alteration of foraging behavior, effects to breathing, interference with or alteration of vocalization, avoidance, and flight.

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

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

Variations in respiration naturally vary with different behaviors and alterations to breathing rate as a function of acoustic exposure can be expected to co-occur with other behavioral reactions, such as a flight response or an alteration in diving. However, respiration rates in and of themselves may be representative of annoyance or an acute stress response. Various studies have shown that respiration rates may either be unaffected or could increase, depending on the species and signal characteristics, again highlighting the importance in understanding species differences in the tolerance of underwater noise when determining the potential for impacts resulting from anthropogenic sound exposure (*e.g.,* Kastelein *et al.,* 2001, 2005, 2006; Gailey *et al.,* 2007; Gailey *et al.,* 2016).

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

Avoidance is the displacement of an individual from an area or migration path as a result of the presence of a sound or other stressors, and is one of the most obvious manifestations of disturbance in marine mammals (Richardson *et al.,* 1995). For example, gray whales are known to change direction—deflecting from customary migratory paths—in order to avoid noise from airgun surveys (Malme *et al.,* 1984). Avoidance may be short-term, with animals returning to the area once the noise has ceased (*e.g.,* Bowles *et al.,* 1994; Goold, 1996; Stone *et al.,* 2000;

Morton and Symonds, 2002; Gailey *et al.,* 2007). Longer-term displacement is possible, however, which may lead to changes in abundance or distribution patterns of the affected species in the affected region if habituation to the presence of the sound does not occur (*e.g.,* Blackwell *et al.,* 2004; Bejder *et al.,* 2006; Teilmann *et al.,* 2006).

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

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

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

Stress Responses—An animal's perception of a threat may be sufficient to trigger stress responses consisting of some combination of behavioral responses, autonomic nervous system responses, neuroendocrine responses, or immune responses (*e.g.,* Seyle, 1950; Moberg, 2000). In many cases, an animal's first and sometimes most economical (in terms of energetic costs) response is behavioral avoidance of the potential stressor. Autonomic nervous system responses to stress typically involve changes in heart rate, blood pressure, and gastrointestinal activity. These responses have a relatively short duration and may or may not have a significant long-term effect on an animal's fitness.

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

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

Relationships between these physiological mechanisms, animal behavior, and the costs of stress responses are well studied through controlled experiments and for both laboratory and free-ranging animals (*e.g.,* Holberton *et al.,* 1996; Hood *et al.,* 1998; Jessop *et al.,* 2003; Krausman *et al.,* 2004; Lankford *et al.,* 2005). Stress responses due to exposure to anthropogenic sounds or other stressors and their effects on marine mammals have also been reviewed (Fair and Becker, 2000; Romano *et al.,* 2002b) and, more rarely, studied in wild populations (*e.g.,* Romano *et al.,* 2002a). For example, Rolland *et al.,* (2012) found that noise reduction from reduced ship traffic in the Bay of Fundy was associated with decreased stress in North Atlantic right whales. These and other studies lead to a reasonable expectation that some marine mammals will experience physiological stress responses upon exposure to acoustic stressors and that it is possible that some of these would be classified as ''distress.'' In addition, any animal experiencing TTS would likely also experience stress responses (NRC, 2003).

Auditory Masking—Sound can disrupt behavior through masking, or interfering with, an animal's ability to detect, recognize, or discriminate between acoustic signals of interest (*e.g.,* those used for intraspecific communication and social interactions, prey detection, predator avoidance, navigation) (Richardson *et al.,* 1995; Erbe *et al.,* 2016). Masking occurs when the receipt of a sound is interfered with by another coincident sound at similar frequencies and at similar or higher intensity, and may occur whether the sound is natural (*e.g.,* snapping shrimp, wind, waves, precipitation) or anthropogenic (*e.g.,* shipping, sonar, seismic exploration) in origin. The ability of a noise source to mask biologically important sounds depends on the characteristics of both the noise source and the signal of interest (*e.g.,* signal-to-noise ratio, temporal variability, direction), in relation to each other and to an animal's hearing abilities (*e.g.,* sensitivity, frequency range, critical ratios, frequency discrimination, directional discrimination, age or TTS hearing loss), and existing ambient noise and propagation conditions.

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

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

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

Potential Effects of the Specified Activity—As described previously (see ''Description of Active Acoustic Sound Sources''), Vineyard Wind proposes to conduct pile driving in the WDA. The effects of pile driving on marine mammals are dependent on several factors, including the size, type, and depth of the animal; the depth, intensity, and duration of the pile driving sound; the depth of the water column; the substrate of the habitat; the distance between the pile and the animal; and the sound propagation properties of the environment.

Noise generated by impact pile driving consists of regular, pulsed sounds of short duration. These pulsed sounds are typically high energy with fast rise times. Exposure to these sounds may result in harassment depending on proximity to the sound source and a variety of environmental and biological conditions (Dahl *et al.,* 2015; Nedwell *et al.,* 2007). Illingworth & Rodkin (2007) measured an unattenuated sound pressure within 10 m (33 ft) at a peak of 220 dB re 1 μPa for a 2.4 m (96 in) steel pile driven by an impact hammer, and Brandt *et al.* (2011) found that for a pile driven in a Danish wind farm in the North Sea, the peak pressure at 720 m (0.4 nm) from the source was 196 dB re 1 μPa. Studies of underwater sound from pile driving finds that most of the acoustic energy is below one to two kHz, with broadband sound energy near the source (40 Hz to >40 kHz) and only low-frequency energy (<~400 Hz) at longer ranges (Bailey *et al.,* 2010; Erbe, 2009; Illingworth & Rodkin, 2007). There is typically a decrease in sound pressure and an increase in pulse duration the greater the distance from the noise source (Bailey *et al.,* 2010). Maximum noise levels from pile driving usually occur during the last stage of driving each pile where the highest hammer energy levels are used (Betke, 2008).

Available information on impacts to marine mammals from pile driving associated with offshore wind is limited to information on harbor porpoises and seals, as the vast majority of this research has occurred at European offshore wind projects where large whales are uncommon. Harbor porpoises, one of the most behaviorally sensitive cetaceans, have received particular attention in European waters due to their protection under the European Union Habitats Directive (EU 1992, Annex IV) and the threats they face as a result of fisheries bycatch. Brandt *et al.* (2016) summarized the effects of the construction of eight offshore wind projects within the German North Sea between 2009 and 2013 on harbor porpoises, combining PAM data from 2010–2013 and aerial surveys from 2009–2013 with data on noise levels associated with pile driving. Baseline analyses were conducted initially to identify the seasonal distribution of porpoises in different geographic subareas. Results of the analysis revealed significant declines in porpoise detections during pile driving when compared to 25–48 hours before pile driving began, with the magnitude of decline during pile driving clearly decreasing with increasing distances to the construction site. During the majority of projects significant declines in detections (by at least 20 percent) were found within at least 5–10 km of the pile driving site, with declines at up to 20–30 km of the pile driving site documented in some cases. Such differences between responses at the different projects could not be explained by differences in noise levels alone and may be associated instead with a relatively high quality of feeding habitat and a lower motivation of porpoises to leave the noise impacted area in certain locations, though the authors were unable to determine exact reasons for the apparent differences. There were no indications for a population decline of harbor porpoises over the five year study period based on analyses of daily PAM data and aerial survey data at a larger scale (Brandt *et al.,* 2016). Despite extensive construction activities over the study period and an increase in these activities over time, there was no long-term negative trend in acoustic porpoise detections or densities within any of the subareas studied. In some areas, PAM data even detected a positive trend from 2010 to 2013. Even though clear negative short-term effects (1–2 days in duration) of offshore wind farm construction were found (based on acoustic porpoise detections), the authors found no indication that harbor porpoises within the German Bight were negatively affected by wind farm construction at the population level (Brandt *et al.,* 2016).

Monitoring of harbor porpoises before and after construction at the Egmond aan Zee offshore wind project in the Dutch North Sea showed that more porpoises were found in the wind project area compared to two reference areas post-construction, leading the authors to conclude that this effect was linked to the presence of the wind project, likely due to increased food availability as well as the exclusion of fisheries and reduced vessel traffic in the wind project (Lindeboom *et al.,* 2013). The available literature indicates harbor porpoise avoidance of pile driving at offshore wind projects has occurred during the construction phase.

Where long term monitoring has been conducted, harbor porpoises have re-populated the wind farm areas after construction ceased, with the time it takes to re-populate the area varying somewhat, indicating that while there are short-term impacts to porpoises during construction, population-level or long-term impacts are unlikely.

Harbor seals are also a particularly behaviorally sensitive species. A harbor seal telemetry study off the East coast of England found that seal abundance was significantly reduced up to 25 km from WTG pile driving during construction, but found no significant displacement resulted from construction overall as the seals' distribution was consistent with the non-piling scenario within two hours of cessation of pile driving (Russell *et al.,* 2016). Based on two years of monitoring at the Egmond aan Zee offshore wind project in the Dutch North Sea, satellite telemetry, while inconclusive, seemed to show that harbor seals avoided an area up to 40 km from the construction site during pile driving, though the seals were documented inside the wind farm after construction ended, indicating any avoidance was temporary (Lindeboom *et al.,* 2013).

Taken as a whole, the available literature suggests harbor seals and harbor porpoises have shown avoidance of pile driving at offshore wind projects during the construction phase in some instances, with the duration of avoidance varying greatly, and with re-population of the area generally occurring post-construction. The literature suggests that marine mammal responses to pile driving in the offshore environment are not predictable and may be context-dependent. It should also be noted that the only studies available on marine mammal responses to offshore wind-related pile driving have focused on species which are known to be more behaviorally sensitive to auditory stimuli than the other species that occur in the project area. Therefore, the documented behavioral responses of harbor porpoises and harbor seals to pile driving in Europe should be considered as a worst case scenario in terms of the potential responses among all marine mammals to offshore pile driving, and these responses cannot reliably predict the responses that will occur in other species.

The onset of behavioral disturbance from anthropogenic sound depends on both external factors (characteristics of sound sources and their paths) and the specific characteristics of the receiving animals (hearing, motivation, experience, demography) and is difficult to predict (Southall *et al.,* 2007). It is possible that the onset of pile driving could result in temporary, short-term changes in an animal's typical behavioral patterns and/or temporary avoidance of the affected area. These behavioral changes may include (Richardson *et al.,* 1995): Changing durations of surfacing and dives, number of blows per surfacing, or moving direction and/or speed; reduced/increased vocal activities; changing/cessation of certain behavioral activities (such as socializing or feeding); visible startle response or aggressive behavior (such as tail/fluke slapping or jaw clapping); avoidance of areas where sound sources are located; and/or flight responses. The biological significance of many of these behavioral disturbances is difficult to predict, especially if the detected disturbances appear minor. However, the consequences of behavioral modification could be expected to be biologically significant if the change affects growth, survival, or reproduction. Significant behavioral modifications that could lead to effects on growth, survival, or reproduction, such as drastic changes in diving/surfacing patterns or significant habitat abandonment are considered extremely unlikely in the case of the proposed project, as it is expected that mitigation measures, including clearance zones and soft start (described in detail below, see ''Proposed Mitigation Measures'') will minimize the potential for marine mammals to be exposed to sound levels that would result in more extreme behavioral responses. In addition, marine mammals in the project area are expected to avoid any area that would be ensonified at sound levels high enough for the potential to result in more severe acute behavioral responses, as the offshore environment would allow marine mammals the ability to freely move to other areas without restriction.

In the case of pile driving, sound sources would be active for relatively short durations, with relation to potential for masking. The frequencies output by pile driving activity are lower than those used by most species expected to be regularly present for communication or foraging. Those species who would be more susceptible to masking at these frequencies (LF cetaceans) use the area only seasonally. We expect insignificant impacts from masking, and any masking event that could possibly rise to Level B harassment under the MMPA would occur concurrently within the zones of behavioral harassment already estimated for impact pile driving, and which have already been taken into account in the exposure analysis.

Anticipated Effects on Marine Mammal Habitat

The proposed activities would result in the placement of permanent structures (*i.e.,* WTGs) in the marine environment. Based on the best available information, the long-term presence of the WTGs is not expected to have negative impacts on habitats used by marine mammals, and may ultimately have beneficial impacts on those habitats as a result of increased presence of prey species in the project area due to the WTGs acting as artificial reefs (Russell *et al.,* 2014). The proposed activities may have potential short-term impacts to food sources such as forage fish. The proposed activities could also affect acoustic habitat (see masking discussion above), but meaningful impacts are unlikely. There are no known foraging hotspots, or other ocean bottom structures of significant biological importance to marine mammals present in the project area. Therefore, the main impact issue associated with the proposed activity would be temporarily elevated sound levels and the associated direct effects on marine mammals, as discussed previously. The most likely impact to marine mammal habitat occurs from pile driving effects on likely marine mammal prey (*e.g.,* fish). Impacts to the immediate substrate during installation of piles are anticipated, but these would be limited to minor, temporary suspension of sediments, which could impact water quality and visibility for a short amount of time, but which would not be expected to have any effects on individual marine mammals. Impacts to substrate are therefore not discussed further.

Effects to Prey—Sound may affect marine mammals through impacts on the abundance, behavior, or distribution of prey species (*e.g.,* crustaceans, cephalopods, fish, zooplankton). Marine mammal prey varies by species, season, and location and, for some, is not well documented. Here, we describe studies regarding the effects of noise on known marine mammal prey.

Fish utilize the soundscape and components of sound in their environment to perform important functions such as foraging, predator avoidance, mating, and spawning (*e.g.,* Zelick *et al.,* 1999; Fay, 2009). Depending on their hearing anatomy and peripheral sensory structures, which vary among species, fishes hear sounds using pressure and particle motion sensitivity capabilities and detect the motion of surrounding water (Fay *et al.,* 2008). The potential effects of noise on fishes depends on the overlapping frequency range, distance from the sound source, water depth of exposure, and species-specific hearing sensitivity, anatomy, and physiology. Key impacts to fishes may include behavioral responses, hearing damage, barotrauma (pressure-related injuries), and mortality.

Fish react to sounds which are especially strong and/or intermittent low-frequency sounds, and behavioral responses such as flight or avoidance are the most likely effects. Short duration, sharp sounds can cause overt or subtle changes in fish behavior and local distribution. The reaction of fish to noise depends on the physiological state of the fish, past exposures, motivation (*e.g.,* feeding, spawning, migration), and other environmental factors. Hastings and Popper (2005) identified several studies that suggest fish may relocate to avoid certain areas of sound energy. Additional studies have documented effects of pile driving on fish, although several are based on studies in support of large, multiyear bridge construction projects (*e.g.,* Scholik and Yan, 2001, 2002; Popper and Hastings, 2009). Several studies have demonstrated that impulse sounds might affect the distribution and behavior of some fishes, potentially impacting foraging opportunities or increasing energetic costs (*e.g.,* Fewtrell and McCauley, 2012; Pearson *et al.,* 1992; Skalski *et al.,* 1992; Santulli *et al.,* 1999; Paxton *et al.,* 2017). However, some studies have shown no or slight reaction to impulse sounds (*e.g.,* Pena *et al.,* 2013; Wardle *et al.,* 2001; Jorgenson and Gyselman, 2009; Cott *et al.,* 2012). More commonly, though, the impacts of noise on fish are temporary.

SPLs of sufficient strength have been known to cause injury to fish and fish mortality. However, in most fish species, hair cells in the ear continuously regenerate and loss of auditory function likely is restored when damaged cells are replaced with new cells. Halvorsen *et al.,* (2012a) showed that a TTS of 4–6 dB was recoverable within 24 hours for one species. Impacts would be most severe when the individual fish is close to the source and when the duration of exposure is long. Injury caused by barotrauma can range from slight to severe and can cause death, and is most likely for fish with swim bladders. Barotrauma injuries have been documented during controlled exposure to impact pile driving (Halvorsen *et al.,* 2012b; Casper *et al.,* 2013).

The most likely impact to fish from pile driving activities at the project areas would be temporary behavioral avoidance of the area. The duration of fish avoidance of an area after pile driving stops is unknown, but a rapid return to normal recruitment, distribution and behavior is anticipated. In general, impacts to marine mammal prey species are expected to be minor and temporary due to the expected short daily duration of individual pile driving events and the relatively small areas being affected.

The area likely impacted by the activities is relatively small compared to the available habitat in shelf waters in the region. Any behavioral avoidance by fish of the disturbed area would still leave significantly large areas of fish and marine mammal foraging habitat in the nearby vicinity. Based on the information discussed herein, we conclude that impacts of the specified activity are not likely to have more than short-term adverse effects on any prey habitat or populations of prey species. Further, any impacts to marine mammal habitat are not expected to result in significant or long-term consequences for individual marine mammals, or to contribute to adverse impacts on their populations.

Estimated Take

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

Harassment is the only type of take expected to result from these activities. Except with respect to certain activities not pertinent here, section 3(18) of the MMPA defines ''harassment'' as any act of pursuit, torment, or annoyance, which (i) has the potential to injure a marine mammal or marine mammal stock in the wild (Level A harassment); or (ii) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering (Level B harassment).

Authorized takes would primarily be by Level B harassment, as noise from pile driving has the potential to result in disruption of behavioral patterns for individual marine mammals. There is also some potential for auditory injury (Level A harassment) to result. The proposed mitigation and monitoring measures are expected to minimize the severity of such taking to the extent practicable.

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

Generally speaking, we estimate take by considering: (1) Acoustic thresholds above which NMFS believes the best available science indicates marine mammals will be behaviorally harassed or incur some degree of permanent hearing impairment; (2) the area or volume of water that will be ensonified above these levels in a day; (3) the density or occurrence of marine mammals within these ensonified areas; and, (4) and the number of days of activities. We note that while these basic factors can contribute to a basic calculation to provide an initial prediction of takes, additional information that can qualitatively inform take estimates is also sometimes available (*e.g.,* previous monitoring results or average group size). Below, we describe the factors considered here in more detail and present the proposed take estimate.

Acoustic Thresholds

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

Level B Harassment—Though significantly driven by received level, the onset of behavioral disturbance from anthropogenic noise exposure is also informed to varying degrees by other factors related to the source (*e.g.,* frequency, predictability, duty cycle), the environment (*e.g.,* bathymetry), and the receiving animals (hearing, motivation, experience, demography, behavioral context) and can be difficult to predict (Southall *et al.,* 2007, Ellison *et al.,* 2012). Based on what the available science indicates and the practical need to use a threshold based on a factor that is both predictable and measurable for most activities, NMFS uses a generalized acoustic threshold based on received level to estimate the onset of behavioral harassment. NMFS predicts that marine mammals are likely to be behaviorally harassed in a manner we consider Level B harassment when exposed to underwater anthropogenic noise above received levels of 160 dB re 1 μPa (rms) for impulsive and/or intermittent sources (*e.g.,* impact pile driving).

Level A harassment—NMFS' Technical Guidance for Assessing the Effects of Anthropogenic Sound on

Marine Mammal Hearing (Version 2.0) (Technical Guidance, 2018) identifies dual criteria to assess auditory injury (Level A harassment) to five different marine mammal groups (based on hearing sensitivity) as a result of exposure to noise from two different types of sources (impulsive or non-impulsive). The components of Vineyard Wind's proposed activity that may result in the take of marine mammals include the use of impulsive sources.

These thresholds are provided in Table 4. The references, analysis, and methodology used in the development of the thresholds are described in NMFS 2018 Technical Guidance, which may be accessed at: *www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-acoustic-technical-guidance.*

TABLE 4—THRESHOLDS IDENTIFYING THE ONSET OF PERMANENT THRESHOLD SHIFT

Hearing group	PTS onset acoustic thresholds * (received level)	
	Impulsive	Non-impulsive
Low-Frequency (LF) Cetaceans	*Cell 1:* $L_{pk,flat}$: 219 dB; $L_{E,LF,24h}$: 183 dB	*Cell 2:* $L_{E,LF,24h}$: 199 dB.
Mid-Frequency (MF) Cetaceans	*Cell 3:* $L_{pk,flat}$: 230 dB; $L_{E,MF,24h}$: 185 dB	*Cell 4:* $L_{E,MF,24h}$: 198 dB.
High-Frequency (HF) Cetaceans	*Cell 5:* $L_{pk,flat}$: 202 dB; $L_{E,HF,24h}$: 155 dB	*Cell 6:* $L_{E,HF,24h}$: 173 dB.
Phocid Pinnipeds (PW) (Underwater)	*Cell 7:* $L_{pk,flat}$: 218 dB; $L_{E,PW,24h}$: 185 dB	*Cell 8:* $L_{E,PW,24h}$: 201 dB.
Otariid Pinnipeds (OW) (Underwater)	*Cell 9:* $L_{pk,flat}$: 232 dB; $L_{E,OW,24h}$: 203 dB	*Cell 10:* $L_{E,OW,24h}$: 219 dB.

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

Note: Peak sound pressure (L_{pk}) has a reference value of 1 μPa, and cumulative sound exposure level (L_E) has a reference value of 1μPa²s. In this Table, thresholds are abbreviated to reflect American National Standards Institute standards (ANSI 2013). However, peak sound pressure is defined by ANSI as incorporating frequency weighting, which is not the intent for this Technical Guidance. Hence, the subscript "flat" is being included to indicate peak sound pressure should be flat weighted or unweighted within the generalized hearing range. The subscript associated with cumulative sound exposure level thresholds indicates the designated marine mammal auditory weighting function (LF, MF, and HF cetaceans, and PW and OW pinnipeds) and that the recommended accumulation period is 24 hours. The cumulative sound exposure level thresholds could be exceeded in a multitude of ways (*i.e.,* varying exposure levels and durations, duty cycle). When possible, it is valuable for action proponents to indicate the conditions under which these acoustic thresholds will be exceeded.

Ensonified Area

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

As described above, Vineyard Wind is proposing to install up to 100 WTGs and up to two ESPs in the WDA (*i.e.,* a maximum of 102 foundations). Two types of foundations may be used in the construction of the project and were therefore considered in the acoustic modeling study conducted to estimate the potential number of marine mammal exposures above relevant harassment thresholds: Monopile foundations varying in size with a maximum of 10.3 m (33.8 ft) diameter piles and jacket-style foundations using three or four 3 m (9.8 ft) diameter (pin) piles per foundation.

As described above, Vineyard Wind has incorporated more than one design scenario in their planning of the project. This approach, called the "design envelope" concept, allows for flexibility on the part of the developer, in recognition of the fact that offshore wind technology and installation techniques are constantly evolving and exact specifications of the project are not yet certain as of the publishing of this document. Variables that are not yet certain include the number, size, and configuration of WTGs and ESPs and their foundations, and the number of foundations that may be installed per day (a maximum of two foundations would be installed per day).

In recognition of the need to ensure that the range of potential impacts to marine mammals from the various potential scenarios within the design envelope are accounted for, potential design scenarios were modeled separately in order to conservatively assess the impacts of each scenario. The two installation scenarios modeled are shown in Table 5 and consist of:

(1) The "maximum design" consisting of ninety 10.3 m (33.8 ft) WTG monopile foundations, 10 jacket foundations (*i.e.,* 40 jacket piles), and two jacket foundations for ESPs (*i.e.,* eight jacket piles), and

(2) The "most likely design" consisting of one hundred 10.3 m (33.8 ft) WTG monopile foundations and two jacket foundations for ESPs (*i.e.,* eight jacket piles).

TABLE 5—POTENTIAL CONSTRUCTION SCENARIOS MODELED

Design scenario	WTG monopiles (pile size: 10.3 m (33.8 ft))	WTG jacket foundations (pile size: 3 m (9.8 ft))	ESP jacket foundations (pile size: 3 m (9.8 ft))	Total number of piles	Total number of installation locations
Maximum design	90	10	2	138	102
Most likely design	100	0	2	108	102

As Vineyard Wind may install either one or two monopiles per day, both the "maximum design" and "most likely design" scenarios were modeled assuming the installation of one foundation per day and two foundations per day distributed across the same calendar period. No more than one jacket would be installed per day thus one jacket foundation per day (four piles) was assumed for both scenarios. No concurrent pile driving (*i.e.,* driving of more than one pile at a time) would occur and therefore concurrent driving was not modeled. The pile-driving schedules for modeling were created based on the number of expected suitable weather days available per month (based on weather criteria determined by Vineyard Wind) in which pile driving may occur to better understand when the majority of pile driving is likely to occur throughout the year. The number of suitable weather days per month was obtained from historical weather data. The modeled pile-driving schedule for the Maximum Design scenario is shown in Table 2 of the IHA application.

Piles for monopile foundations would be constructed for specific locations with maximum diameters ranging from ~8 m (26.2 ft) up to ~10.3 m (33.8 ft) and an expected median diameter of ~9 m (29.5 ft). The 10.3 m (33.8 ft) monopile foundation is the largest potential pile diameter proposed for the project; while a smaller diameter pile may ultimately end up being installed, 10.3 m represents the largest potential diameter and was therefore used in modeling of monopile installation to be conservative. Jacket foundations each require the installation of three to four jacket securing piles, known as jacket piles, of ~3 m (9.8 ft) diameter. All modeling assumed 10.3 m piles would be used for monopiles and 3 m piles would be used for jacket foundations (other specifications associated with monopiles and jacket piles are shown in Table 1 above and Figures 2 and 3 in the IHA application).

Representative hammering schedules of increasing hammer energy with increasing penetration depth were modeled, resulting in, generally, higher intensity sound fields as the hammer energy and penetration increases. For both monopile and jacket structure models, the piles were assumed to be vertical and driven to a penetration depth of 30 m and 45 m, respectively. While pile penetrations across the site would vary, these values were chosen as reasonable penetration depths. The estimated number of strikes required to drive piles to completion were obtained from drivability studies provided by Vineyard Wind. All acoustic modeling was performed assuming that only one pile is driven at a time.

Additional modeling assumptions for the monopiles were as follows:

- 1,030 cm steel cylindrical piling with wall thickness of 10 cm.
- Impact pile driver: IHC S–4000 (4000 kJ rated energy; 1977 kN ram weight).
- Helmet weight: 3234 kN.

Additional modeling assumptions for the jacket pile are as follows:

- 300 cm steel cylindrical pilings with wall thickness of 5 cm.
- Impact pile driver: IHC S–2500 (2500 kJ rated energy; 1227 kN ram weight).
- Helmet weight: 2401 kN.
- Up to four jacket piles installed per day.

Sound fields produced during pile driving were modeled by first characterizing the sound signal produced during pile driving using the industry-standard GRLWEAP (wave equation analysis of pile driving) model and JASCO Applied Sciences' (JASCO) Pile Driving Source Model (PDSM).

Underwater sound propagation (*i.e.,* transmission loss) as a function of range from each source was modeled using JASCO's Marine Operations Noise Model (MONM) for multiple propagation radials centered at the source to yield 3D transmission loss fields in the surrounding area. The MONM computes received per-pulse SEL for directional sources at specified depths. MONM uses two separate models to estimate transmission loss.

At frequencies less than 2 kHz, MONM computes acoustic propagation via a wide-angle parabolic equation (PE) solution to the acoustic wave equation based on a version of the U.S. Naval Research Laboratory's Range-dependent Acoustic Model (RAM) modified to account for an elastic seabed. MONM–RAM incorporates bathymetry, underwater sound speed as a function of depth, and a geoacoustic profile based on seafloor composition, and accounts for source horizontal directivity. The PE method has been extensively benchmarked and is widely employed in the underwater acoustics community, and MONM–RAM's predictions have been validated against experimental data in several underwater acoustic measurement programs conducted by JASCO. At frequencies greater than 2 kHz, MONM accounts for increased sound attenuation due to volume absorption at higher frequencies with the widely used BELLHOP Gaussian beam ray-trace propagation model. This component incorporates bathymetry and underwater sound speed as a function of depth with a simplified representation of the sea bottom, as subbottom layers have a negligible influence on the propagation of acoustic waves with frequencies above 1 kHz. MONM–BELLHOP accounts for horizontal directivity of the source and vertical variation of the source beam pattern. Both propagation models account for full exposure from a direct acoustic wave, as well as exposure from acoustic wave reflections and refractions (*i.e.,* multi-path arrivals at the receiver).

The sound field radiating from the pile was simulated using a vertical array of point sources. Because sound itself is an oscillation (vibration) of water particles, acoustic modeling of sound in the water column is inherently an evaluation of vibration. For this study, synthetic pressure waveforms were computed using FWRAM, which is JASCO's acoustic propagation model capable of producing time-domain waveforms.

Models are more efficient at estimating SEL than rms SPL. Therefore, conversions may be necessary to derive the corresponding rms SPL. Propagation was modeled for a subset of sites using a full-wave RAM PE model (FWRAM), from which broadband SEL to SPL conversion factors were calculated. The FWRAM required intensive calculation for each site, thus a representative subset of modeling sites were used to develop azimuth-, range-, and depth-dependent conversion factors. These conversion factors were used to calculate the broadband rms SPL from the broadband SEL prediction.

Two locations within the WDA were selected to provide representative propagation and sound fields for the project area (see Table 6). The two locations were selected to span the region from shallow to deep water and varying distances to dominant bathymetric features (*i.e.,* slope and shelf break). Water depth and environmental characteristics (*e.g.,* bottom-type) are similar throughout the WDA (Vineyard Wind, 2016), and therefore minimal difference was found in sound propagation results for the two sites (see Appendix A of the IHA application for further detail).

TABLE 6—LOCATIONS USED IN PROPAGATION MODELING

Site	Location (UTM zone 19N)		Water depth (m)	Sound sources modeled
	Easting	Northing		
P1	382452	4548026	38	Monopile, Jacketed pile.

TABLE 6—LOCATIONS USED IN PROPAGATION MODELING—Continued

Site	Location (UTM zone 19N)		Water depth (m)	Sound sources modeled
	Easting	Northing		
P2	365240	4542200	46	Monopile, Jacketed pile.

Estimated pile driving schedules were used to calculate the SEL sound fields at different points in time during pile driving. The pile driving schedule for monopiles is shown in Tables A–3 and A–4 in the IHA application. For each hammer energy level, the pile penetration is expected to be 20% of the total depth.

The sound propagation modeling incorporated site-specific environmental data that describes the bathymetry, sound speed in the water column, and seabed geoacoustics in the construction area. Sound level estimates are calculated from three-dimensional sound fields and then collapsed over depth to find the ranges to predetermined threshold levels (see the IHA application; Appendix A.3.2). Contour maps (see the IHA application; Appendix A.14) show the planar distribution of the limits of the areas affected by levels that are higher than the specific sound level thresholds.

The modeled source spectra are provided in Figures 11 and 12 of the IHA application. For both pile diameters, the dominant energy is below 100 Hz. The source spectra of the 10.3 m (33.8 ft) pile installation contain more energy at lower frequencies than for the smaller 3 m (9.8 ft) piles. Please see Appendix A of the IHA application for further details on the modeling methodology.

Noise attenuation systems, such as bubble curtains, are sometimes used to decrease the sound levels radiated from a source. Bubbles create a local impedance change that acts as a barrier to sound transmission. The size of the bubbles determines their effective frequency band, with larger bubbles needed for lower frequencies. There are a variety of bubble curtain systems, confined or unconfined bubbles, and some with encapsulated bubbles or panels. Attenuation levels also vary by type of system, frequency band, and location. Small bubble curtains have been measured to reduce sound levels but effective attenuation is highly dependent on depth of water, current, and configuration and operation of the curtain (Austin, Denes, MacDonnell, & Warner, 2016; Koschinski & Lüdemann, 2013). Bubble curtains vary in terms of the sizes of the bubbles and those with larger bubbles tend to perform a bit better and more reliably, particularly when deployed with two separate rings (Bellmann, 2014; Koschinski & Lüdemann, 2013; Nehls, Rose, Diederichs, Bellmann, & Pehlke, 2016).

Encapsulated bubble systems (*e.g.,* Hydro Sound Dampers (HSDs)), can be effective within their targeted frequency ranges, *e.g.,* 100–800 Hz, and when used in conjunction with a bubble curtain appear to create the greatest attenuation. The literature presents a wide array of observed attenuation results for bubble curtains. The variability in attenuation levels is the result of variation in design, as well as differences in site conditions and difficulty in properly installing and operating in-water attenuation devices. A California Department of Transportation (CalTrans) study tested several systems and found that the best attenuation systems resulted in 10–15 dB of attenuation (Buehler *et al.,* 2015). Similarly, Dähne, Tougaard, Carstensen, Rose, and Nabe-Nielsen (2017) found that single bubble curtains that reduced sound levels by 7 to 10 dB reduced the overall sound level by ~12 dB when combined as a double bubble curtain for 6 m steel monopiles in the North Sea. In modeling the sound fields for the proposed project, hypothetical broadband attenuation levels of 6 dB and 12 dB were modeled to gauge the effects on the ranges to thresholds given these levels of attenuation.

The updated acoustic thresholds for impulsive sounds (such as pile driving) contained in the Technical Guidance (NMFS, 2018) were presented as dual metric acoustic thresholds using both SEL_{cum} and peak sound pressure level metrics. As dual metrics, NMFS considers onset of PTS (Level A harassment) to have occurred when either one of the two metrics is exceeded (*i.e.,* metric resulting in the largest isopleth). The SEL_{cum} metric considers both level and duration of exposure, as well as auditory weighting functions by marine mammal hearing group.

Table 7 shows the modeled radial distances to the dual Level A harassment thresholds using NMFS (2018) frequency weighting for marine mammals, with 0, 6, and 12 dB sound attenuation incorporated. For the peak level, the greatest distances expected are shown, typically occurring at the highest hammer energies. The distances to SEL thresholds were calculated using the hammer energy schedules for driving one monopile or four jacket piles, as shown. The radial distances shown in Table 7 are the maximum distances from the piles, averaged between the two modeled locations.

TABLE 7—RADIAL DISTANCES (m) TO LEVEL A HARASSMENT THRESHOLDS FOR EACH FOUNDATION TYPE WITH 0, 6, AND 12 dB SOUND ATTENUATION INCORPORATED

Foundation type	Hearing group	Level A harassment (peak)			Level A harassment (SEL)		
		No attenuation	6 dB attenuation	12 dB attenuation	No attenuation	6 dB attenuation	12 dB attenuation
10.3 m (33.8 ft) monopile	LFC	34	17	8.5	5,443	3,191	1,599
	MFC	10	5	2.5	56	43	0
	HFC	235	119	49	101	71	71
	PPW	38	19	10	450	153	71
Four, 3 m (9.8 ft) jacket piles.	LFC	7.5	4	2.5	12,975	7,253	3,796
	MFC	2.5	1	0.5	71	71	56
	HFC	51	26	13.5	1,389	564	121

TABLE 7—RADIAL DISTANCES (m) TO LEVEL A HARASSMENT THRESHOLDS FOR EACH FOUNDATION TYPE WITH 0, 6, AND 12 dB SOUND ATTENUATION INCORPORATED—Continued

Foundation type	Hearing group	Level A harassment (peak)			Level A harassment (SEL)		
		No attenuation	6 dB attenuation	12 dB attenuation	No attenuation	6 dB attenuation	12 dB attenuation
	PPW	9	5	2.5	2,423	977	269

* Radial distances were modeled at two different representative modeling locations as described above. Distances shown represent the average of the two modeled locations.

Table 8 shows the modeled radial distances to the Level B harassment threshold with no attenuation, 6 dB and 12 dB sound attenuation incorporated. Acoustic propagation was modeled at two representative sites in the WDA as described above. The radial distances shown in Table 8 are the maximum distance to the Level B harassment threshold from the piles, averaged between the two modeled locations, using the maximum hammer energy.

TABLE 8—RADIAL DISTANCES (m) TO THE LEVEL B HARASSMENT THRESHOLD

Foundation type	No attenuation	6 dB attenuation	12 dB attenuation
10.3 m (33.8 ft) monopile	6,316	4,121	2,739
Four, 3 m (9.8 ft) jacket piles	4,104	3,220	2,177

Please see Appendix A of the IHA application for further detail on the acoustic modeling methodology.

Marine Mammal Occurrence

In this section we provide the information about the presence, density, or group dynamics of marine mammals that will inform the take calculations.

The best available information regarding marine mammal densities in the project area is provided by habitat-based density models produced by the Duke University Marine Geospatial Ecology Laboratory (Roberts *et al.,* 2016, 2017, 2018). Density models were originally developed for all cetacean taxa in the U.S. Atlantic (Roberts et al., 2016); more information, including the model results and supplementary information for each model, is available at *seamap.env.duke.edu/models/Duke-EC–GOM-2015/.* In subsequent years, certain models have been updated on the basis of additional data as well as certain methodological improvements. Although these updated models (and a newly developed seal density model) are not currently publicly available, our evaluation of the changes leads to a conclusion that these represent the best scientific evidence available. Marine mammal density estimates in the WDA (animals/km^2) were obtained using these model results (Roberts *et al.,* 2016, 2017, 2018). As noted, the updated models incorporate additional sighting data, including sightings from the NOAA Atlantic Marine Assessment Program for Protected Species (AMAPPS) surveys from 2010–2014, which included some aerial surveys over the RI/MA & MA WEAs (NEFSC & SEFSC, 2011b, 2012, 2014a, 2014b, 2015, 2016).

Mean monthly densities for all animals were calculated using a 13 km (8 mi) buffered polygon around the WDA perimeter and overlaying it on the density maps from Roberts et al. (2016, 2017, 2018). Please see Figure 13 in the IHA application for an example of a density map showing Roberts et al. (2016, 2017, 2018) density grid cells with a 13 km buffer overlaid on a map of the WDA. The 13 km (8 mi) buffer is conservative as it encompasses and extends beyond the estimated distances to the isopleth corresponding to the Level B harassment (with no attenuation, as well as with 6 dB and 12 dB sound attenuation) for all hearing groups using the unweighted threshold of 160 dB re 1 μPa (rms) (Table 8). The 13 km buffer incorporates the maximum area around the WDA with the potential to result in behavioral disturbance for the 10.3 m (33.8 ft) monopile installation using (Wood, Southall, & Tollit, 2012) threshold criteria.

The mean density for each month was determined by calculating the unweighted mean of all 10 x 10 km (6.2 x 6.2 mi) grid cells partially or fully within the buffer zone polygon. Densities were computed for the months of May to December to coincide with planned pile driving activities (as described above, no pile driving would occur from January through April). In cases where monthly densities were unavailable, annual mean densities (*e.g.,* pilot whales) and seasonal mean densities (*e.g.,* all seals) were used instead. Table 9 shows the monthly marine mammal density estimates for each species incorporated in the exposure modeling analysis.

TABLE 9—MONTHLY MARINE MAMMAL DENSITY ESTIMATES FOR EACH SPECIES USED IN THE EXPOSURE MODELING ANALYSIS

Species	Monthly densities (animals/100 km2) [1]												Annual	May to Dec
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean	Mean
Fin whale	0.151	0.115	0.122	0.234	0.268	0.276	0.26	0.248	0.197	0.121	0.12	0.131	0.187	0.203
Humpback whale	0.033	0.018	0.034	0.204	0.138	0.139	0.199	0.109	0.333	0.237	0.078	0.049	0.131	0.16
Minke whale	0.052	0.064	0.063	0.136	0.191	0.171	0.064	0.051	0.048	0.045	0.026	0.037	0.079	0.079
North Atlantic right whale	0.205	0.309	0.543	0.582	0.287	0.308	0.002	0.002	0.006	0.001	0.001	0.267	0.209	0.109
Sei whale	0.001	0.002	0.001	0.033	0.029	0.012	0.003	0.002	0.003	0.001	0.002	0.001	0.007	0.007
Atlantic white sided dolphin	1.935	0.972	1.077	2.088	4.059	3.742	2.801	1.892	1.558	1.95	2.208	3.281	2.297	2.686

TABLE 9—MONTHLY MARINE MAMMAL DENSITY ESTIMATES FOR EACH SPECIES USED IN THE EXPOSURE MODELING ANALYSIS—Continued

Species	Monthly densities (animals/100 km2) [1]												Annual	May to Dec
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean	Mean
Bottlenose dolphin	0.382	0.011	0.007	0.497	0.726	2.199	5.072	3.603	4.417	4.46	2.136	1.216	2.061	2.979
Pilot whales	0.555	0.555	0.555	0.555	0.555	0.555	0.555	0.555	0.555	0.555	0.555	0.555	0.555	0.555
Risso's dolphin	0.006	0.003	0.001	0.001	0.005	0.005	0.01	0.02	0.016	0.006	0.013	0.018	0.009	0.012
Short beaked dolphin	7.734	1.26	0.591	1.613	3.093	3.153	3.569	6.958	12.2	12.727	9.321	16.831	6.588	8.482
Sperm whale *	0.001	0.001	0.001	0.001	0.003	0.006	0.029	0.033	0.012	0.012	0.008	0.001	0.009	0.013
Harbor porpoise	3.939	6.025	12.302	6.959	3.904	1.332	0.91	0.784	0.717	0.968	2.609	2.686	3.595	1.739
Gray seal [2]	6.844	8.291	8.621	15.17	19.123	3.072	0.645	0.372	0.482	0.687	0.778	3.506	5.633	3.583
Harbor seal [2]	6.844	8.291	8.621	15.17	19.123	3.072	0.645	0.372	0.482	0.687	0.778	3.506	5.633	3.583
Harp seal [2]	6.844	8.291	8.621	15.17	19.123	3.072	0.645	0.372	0.482	0.687	0.778	3.506	5.633	3.583

[1] Density estimates are from habitat-based density modeling of the entire Atlantic EEZ from Roberts *et al.* (2016, 2017, 2018).
[2] All seal species are grouped together in the density models presented by Roberts *et al.* (2018).

JASCO's Animal Simulation Model Including Noise Exposure (JASMINE) animal movement model was used to predict the probability of marine mammal exposure to project-related sound. Sound exposure models like JASMINE use simulated animals (also known as ''animats'') to forecast behaviors of animals in new situations and locations based on previously documented behaviors of those animals. The predicted 3D sound fields (*i.e.,* the output of the acoustic modeling process described earlier) are sampled by animats using movement rules derived from animal observations. The output of the simulation is the exposure history for each animat within the simulation.

The precise location of animals (and their pathways) are not known prior to a project, therefore a repeated random sampling technique (Monte Carlo) is used to estimate exposure probability with many animats and randomized starting positions. The probability of an animat starting out in or transitioning into a given behavioral state can be defined in terms of the animat's current behavioral state, depth, and the time of day. In addition, each travel parameter and behavioral state has a termination function that governs how long the parameter value or overall behavioral state persists in the simulation.

The output of the simulation is the exposure history for each animat within the simulation, and the combined history of all animats gives a probability density function of exposure during the project. Scaling the probability density function by the real-world density of animals (Table 9) results in the mean number of animals expected to be exposed over the duration of the project. Due to the probabilistic nature of the process, fractions of animals may be predicted to exceed threshold. If, for example, 0.1 animals are predicted to exceed threshold in the model, that is interpreted as a 10% chance that one animal will exceed a relevant threshold during the project, or equivalently, if the simulation were re-run ten times, one of the ten simulations would result in an animal exceeding the threshold. Similarly, a mean number prediction of 33.11 animals can be interpreted as re-running the simulation where the number of animals exceeding the threshold may differ in each simulation but the mean number of animals over all of the simulations is 33.11. A portion of an animal cannot be taken during a project, so it is common practice to round mean number animal exposure values to integers using standard rounding methods. However, for low-probability events it is more precise to provide the actual values. For this reason mean number values are not rounded.

Sound fields were input into the JASMINE model and animats were programmed based on the best available information to ''behave'' in ways that reflect the behaviors of the 15 marine mammal species expected to occur in the project area during the proposed activity. The various parameters for forecasting realistic marine mammal behaviors (*e.g.,* diving, foraging, surface times, etc.) are determined based on the available literature (*e.g.,* tagging studies); when literature on these behaviors was not available for a particular species, it was extrapolated from a similar species for which behaviors would be expected to be similar to the species of interest. See Appendix B of the IHA application for a description of the species that were used as proxies when data on a particular species was not available. The parameters used in JASMINE describe animal movement in both the vertical and horizontal planes. The parameters relating to travel in these two planes are briefly described below:

Travel Sub-Models

- Direction—determines an animat's choice of direction in the horizontal plane. Sub-models are available for determining the heading of animats, allowing for movement to range from strongly biased to undirected. A random walk model can be used for behaviors with no directional preference, such as feeding and playing. A directional bias can also be incorporated in the random walk for use in situations where animals have a preferred absolute direction, such as migration.
- Travel rate—defines an animat's rate of travel in the horizontal plane. When combined with vertical speed and dive depth, the dive profile of the animat is produced.

Dive Sub-Models

- Ascent rate—defines an animat's rate of travel in the vertical plane during the ascent portion of a dive.
- Descent rate—defines an animat's rate of travel in the vertical plane during the descent portion of a dive.
- Depth—defines an animat's maximum dive depth.
- Bottom following—determines whether an animat returns to the surface once reaching the ocean floor, or whether it follows the contours of the bathymetry.
- Reversals—determines whether multiple vertical excursions occur once an animat reaches the maximum dive depth. This behavior is used to emulate the foraging behavior of some marine mammal species at depth. Reversal-specific ascent and descent rates may be specified.
- Surface interval—determines the duration an animat spends at, or near, the surface before diving again.

An individual animat's received sound exposure levels are summed over a specified duration, such as 24 hours, to determine its total received energy, and then compared to the threshold criteria described above. As JASMINE modeling includes the movement of animats both within as well as in and out of the modeled ensonified area, some animats enter and depart the modeled ensonified area within a modeled 24 hour period; however, it is important to note that the model accounts for the acoustic energy that an animat accumulates even if that animat departs the ensonified area prior to the full 24 hours (*i.e.,* even if the animat departs prior to a full 24 hour modeled period, if that animat accumulated enough acoustic energy to be taken, it is accounted for in the take estimate). Also note that animal aversion was not incorporated into the Jasmine model runs that were the basis for the take estimate for any species. See Figure 14 in the IHA application for a depiction of animats in an environment with a moving sound field. See Appendix B of the IHA application for more details on the JASMINE modeling methodology, including the literature sources used for the parameters that were input in JASMINE to describe animal movement for each species that is expected to occur in the project area.

Take Calculation and Estimation

Here we describe how the information provided above is brought together to produce a quantitative take estimate. The following steps were performed to estimate the potential numbers of marine mammal exposures above Level A and Level B harassment thresholds as a result of the proposed activity:

(1) The characteristics of the sound output from the proposed pile-driving activities were modeled using the GRLWEAP (wave equation analysis of pile driving) model and JASCO's PDSM;

(2) Acoustic propagation modeling was performed using JASCO's MONM and FWRAM that combined the outputs of the source model with the spatial and temporal environmental context (*e.g.,* location, oceanographic conditions, seabed type) to estimate sound fields;

(3) Animal movement modeling integrated the estimated sound fields with species-typical behavioral parameters in the JASMINE model to estimate received sound levels for the animals that may occur in the operational area; and

(4) The number of potential exposures above Level A and Level B harassment thresholds was calculated for each potential scenario within the project design envelope.

As described above, two project design scenarios were modeled: The ''maximum design'' consisting of ninety 10.3 m (33.8 ft) WTG monopile foundations, 10 jacket foundations, and two jacket foundations for ESPs, and the ''most likely design'' consisting of one hundred 10.3 m (33.8 ft) WTG monopile foundations and two jacket foundations for ESPs (Table 5). Both of these design scenarios were also modeled with either one or two monopile foundations installed per day. All scenarios were modeled with both 6 dB sound attenuation and 12 dB sound attenuation incorporated. Results of marine mammal exposure modeling of these scenarios is shown in Tables 10–13. Note that while fractions of an animal cannot be taken, these tables are meant simply to show the modeled exposure numbers, versus the actual proposed take estimate. Requested and proposed take numbers are shown below in Tables 14 and 15.

TABLE 10—MEAN NUMBERS OF MARINE MAMMALS ESTIMATED TO BE EXPOSED ABOVE LEVEL A AND LEVEL B HARASSMENT THRESHOLDS DURING THE PROPOSED PROJECT USING THE MAXIMUM DESIGN SCENARIO AND ONE FOUNDATION INSTALLED PER DAY

Species	6 dB attenuation			12 dB attenuation		
	Level A harassment (peak)	Level A harassment (SEL)	Level B harassment	Level A harassment (peak)	Level A harassment (SEL)	Level B harassment
Fin Whale	0.1	4.13	33.11	0.02	0.29	21.78
Humpback Whale	0.03	9.01	30.1	0.01	1	19.66
Minke Whale	0.04	0.22	12.21	0	0.07	7.9
North Atlantic Right Whale	0.03	1.36	13.25	0	0.09	8.74
Sei Whale	0	0.14	1.09	0	0.01	0.74
Atlantic White-Sided Dolphin	0	0	449.2	0	0	277.82
Bottlenose Dolphin	0	0	96.21	0	0	62.21
Pilot Whales	0	0	0	0	0	0
Risso's Dolphin	0	0	1.61	0	0	1.04
Common Dolphin	0.1	0	1059.97	0.1	0	703.81
Sperm Whale	0	0	0	0	0	0
Harbor Porpoise	4.23	0.17	150.13	1.54	0	91.96
Gray Seal	0.11	0.3	196.4	0.04	0.07	118.06
Harbor Seal	0.36	0.21	214.04	0.33	0.07	136.33
Harp Seal	0.73	0.87	217.35	0	0.04	132.91

TABLE 11—MEAN NUMBERS OF MARINE MAMMALS ESTIMATED TO BE EXPOSED ABOVE LEVEL A AND LEVEL B HARASSMENT THRESHOLDS DURING THE PROPOSED PROJECT USING THE MAXIMUM DESIGN SCENARIO AND TWO FOUNDATIONS INSTALLED PER DAY

Species	6 dB attenuation			12 dB attenuation		
	Level A harassment (peak)	Level A harassment (SEL)	Level B harassment	Level A harassment (peak)	Level A harassment (SEL)	Level B harassment
Fin Whale	0.1	4.49	29.71	0	0.41	20.57
Humpback Whale	0.03	9.59	27.23	0	1.09	18.48
Minke Whale	0.03	0.23	11.52	0	0.05	7.76
North Atlantic Right Whale	0.02	1.39	11.75	0.01	0.1	7.96
Sei Whale	0	0.14	0.93	0	0.01	0.65

TABLE 11—MEAN NUMBERS OF MARINE MAMMALS ESTIMATED TO BE EXPOSED ABOVE LEVEL A AND LEVEL B HARASSMENT THRESHOLDS DURING THE PROPOSED PROJECT USING THE MAXIMUM DESIGN SCENARIO AND TWO FOUNDATIONS INSTALLED PER DAY—Continued

Species	6 dB attenuation			12 dB attenuation		
	Level A harassment (peak)	Level A harassment (SEL)	Level B harassment	Level A harassment (peak)	Level A harassment (SEL)	Level B harassment
Atlantic White-Sided Dolphin	0.13	0	428.23	0	0	272.67
Bottlenose Dolphin	0	0	67.71	0	0	43.87
Pilot Whales	0	0	0	0	0	0
Risso's Dolphin	0	0	1.38	0	0	0.95
Common Dolphin	0.44	0	897.91	0.1	0	622.78
Sperm Whale	0	0	0	0	0	0
Harbor Porpoise	4.23	0.17	125.23	1.85	0.06	82.28
Gray Seal	0.29	0.47	145.2	0.04	0.25	96.41
Harbor Seal	1.01	0.86	164.48	0.16	0.39	110.25
Harp Seal	0.38	0.53	162.03	0.17	0.04	108.19

TABLE 12—MEAN NUMBERS OF MARINE MAMMALS ESTIMATED TO BE EXPOSED ABOVE LEVEL A AND LEVEL B HARASSMENT THRESHOLDS DURING THE PROPOSED PROJECT USING THE MOST LIKELY SCENARIO AND ONE FOUNDATION INSTALLED PER DAY

Species	6 dB attenuation			12 dB attenuation		
	Level A harassment (peak)	Level A harassment (SEL)	Level B harassment	Level A harassment (peak)	Level A harassment (SEL)	Level B harassment
Fin Whale	0.11	2.84	29.85	0.02	0.23	19.43
Humpback Whale	0.04	6.54	26.27	0.01	0.83	17.08
Minke Whale	0.04	0.13	10.28	0	0.06	6.77
North Atlantic Right Whale	0.04	0.72	10.82	0	0.04	7.09
Sei Whale	0	0.09	0.95	0	0.01	0.65
Atlantic White-Sided Dolphin	0	0	380.82	0	0	236.77
Bottlenose Dolphin	0	0	98.56	0	0	64.19
Pilot Whales	0	0	0	0	0	0
Risso's Dolphin	0	0	1.48	0	0	0.94
Common Dolphin	0.01	0	941.41	0.01	0	617.01
Sperm Whale	0	0	0	0	0	0
Harbor Porpoise	3.86	0.14	134.88	1.38	0	80.89
Gray Seal	0	0.01	176.92	0	0	104.6
Harbor Seal	0.34	0.01	191.06	0.34	0	120.64
Harp Seal	0.72	0.72	193.65	0	0	116.13

TABLE 13—MEAN NUMBERS OF MARINE MAMMALS ESTIMATED TO BE EXPOSED ABOVE LEVEL A AND LEVEL B HARASSMENT THRESHOLDS DURING THE PROPOSED PROJECT USING THE MOST LIKELY SCENARIO AND TWO FOUNDATIONS INSTALLED PER DAY

Species	6 dB attenuation			12 dB attenuation		
	Level A harassment (peak)	Level A harassment (SEL)	Level B harassment	Level A harassment (peak)	Level A harassment (SEL)	Level B harassment
Fin Whale	0.11	3.24	26.07	0	0.36	18.08
Humpback Whale	0.04	7.18	23.09	0	0.93	15.77
Minke Whale	0.03	0.15	9.53	0	0.04	6.62
North Atlantic Right Whale	0.02	0.76	9.21	0.01	0.06	6.25
Sei Whale	0	0.09	0.78	0	0.01	0.55
Atlantic White-Sided Dolphin	0.14	0	357.71	0	0	231.09
Bottlenose Dolphin	0	0	66.75	0	0	43.72
Pilot Whales	0	0	0	0	0	0
Risso's Dolphin	0	0	1.22	0	0	0.84
Common Dolphin	0.39	0	761.48	0.01	0	527.04
Sperm whale	0	0	0	0	0	0
Harbor Porpoise	3.86	0.14	107.61	1.72	0.07	70.29
Gray Seal	0.19	0.19	123.97	0	0.18	82.23
Harbor Seal	1.01	0.68	139.82	0.17	0.34	93.67
Harp Seal	0.36	0.36	136.45	0.18	0	90.56

As shown in Tables 10–13, the greatest potential number of marine mammal exposures above the Level B harassment threshold occurs under the Maximum Design scenario with one monopile foundation installed per day (Table 10) while the greatest potential number of marine mammal exposures above the Level A harassment thresholds occurs under the Maximum Design scenario with one monopile foundation installed per day. With the inclusion of more jacket foundations, which would require more piles and more overall pile driving, marine mammal exposure estimates for the Maximum Design scenario (Tables 10 and 11) are higher than under the Most Likely scenario (Tables 12 and 13). In all scenarios, the maximum number of jacket foundations modeled per day was one (four jacket piles). Modeling indicates that whether one monopile foundation is installed per day or two makes little difference with respect to estimated Level A harassment exposures; total exposures above the Level A harassment threshold differed by less than one exposure over the duration of the project, for each species. For exposures above the Level B harassment threshold, exposure estimates for one monopile foundation per day are somewhat higher than for two monopile foundations per day. With two monopile foundations per day, there are half as many days of pile driving so there is likewise a reduced number of overall predicted Level B harassment exposures over the duration of the project.

To be conservative, Vineyard Wind based their take request on the Maximum Design scenario with one monopile installed per day. Vineyard Wind also assumed that 12 dB sound attenuation can be achieved consistently during the proposed activity, thus their take request was based on modeled exposure numbers incorporating 12 dB effective attenuation.

Although the exposure modeling indicated that no Level A harassment takes are expected for several species (*i.e.,* minke whale, sei whale, and all small cetaceans and pinnipeds), Vineyard Wind requested Level A harassment takes for most species as a precautionary measure, based on the fact that shutdown of pile driving may not be technically feasible once pile driving has begun, thus if a marine mammal were to enter the Level A harassment zone after pile driving has commenced Vineyard Wind may not be able to avoid that animal(s) being taken by Level A harassment. Vineyard Wind requested Level A harassment takes for these species based on mean group size for each respective species, based on an assumption that if one group member were to be exposed, it is likely that all animals in the same group would receive a similar exposure level. Thus, for the species for which exposure modeling indicated less than a group size would be taken (by either Level A or Level B harassment), Vineyard Wind increased the value from the exposure modeling results to equal one mean group size, rounded up to the nearest integer, for species with predicted exposures of less than one mean group size (with the exception of North Atlantic right whales, as described below). Mean group sizes for species were derived from Kraus *et al.* (2016), where available, as the best representation of expected group sizes within the RI/MA & MA WEAs. These were calculated as the number of individuals sighted, divided by the number of sightings summed over the four seasons (from Tables 5 and 19 in Kraus *et al.,* 2016). Sightings for which species identification was considered either definite or probable were used in the Kraus *et al.* (2016) data. For species that were observed very rarely during the Kraus *et al.* (2016) study (*i.e.,* sperm whales and Risso's dolphins) or observed but not analyzed (*i.e.,* pinnipeds), data derived from AMAPPS surveys (Palka *et al.,* 2017) were used to evaluate mean group size. For sperm whales and Risso's dolphins, the number of individuals divided by the number of groups observed during 2010–2013 AMAPPS NE summer shipboard surveys and NE aerial surveys during all seasons was used (Appendix I of Palka *et al.,* 2017). Though pinnipeds congregate in large numbers on land, at sea they are generally foraging alone or in small groups. For harbor and gray seals, Palka *et al.* (2017) report sightings of seals at sea during 2010–2013 spring, summer, and fall NE AMAPPS aerial surveys. Those sightings include both harbor seals and gray seals, as well as unknown seals, and thus a single group size estimate was calculated for these two species. Harp seals are occasionally recorded south of the RI/MA & MA WEAs on Long Island, New York, and in the nearshore waters, usually in groups of one or two individuals. During 2002–2018, the Coastal Research and Education Society of Long Island (CRESLI) reported seven sightings of harp seals (CRESLI, 2018). Five of these were of single individuals and two were of two animals. Calculated group sizes for all species are shown in Table 14.

TABLE 14—MEAN GROUP SIZES OF MARINE MAMMAL SPECIES USED TO ESTIMATE TAKES

Species	Mean group size
Fin Whale	1.8
Humpback Whale	2
Minke Whale	1.2
North Atlantic Right Whale	2.4
Sei Whale	1.6
Atlantic White-Sided Dolphin	27.9
Common Bottlenose Dolphin	7.8
Pilot whale	8.4
Risso's Dolphin	5.3
Short-Beaked Common Dolphin	34.9
Sperm Whale	1.5
Harbor Porpoise	2.7
Gray Seal	1.4
Harbor Seal	1.4
Harp Seal	1.3

Vineyard Wind also requested Level B take numbers that differ from the numbers modeled and were instead based on monitoring data from site characterization surveys conducted at the same location. Vineyard Wind reviewed monitoring data recorded during site characterization surveys in the WDA from 2016–2018 and calculated a daily sighting rate (individuals per day) for each species in each year, then multiplied the maximum sighting rate from the three years by the number of pile driving days under the Maximum Design scenario (*i.e.,* 102 days). This method assumes that the largest average group size for each species observed during the three years of surveys may be present during piling on each day. Vineyard Wind used this method for all species that were documented by protected species observers (PSOs) during the 2016–2018 surveys. For sei whales, this approach resulted in the same number of estimated Level B harassment takes as Level A harassment takes (two), so to be conservative Vineyard Wind doubled the Level A harassment value to arrive at the requested number of Level B harassment takes. Risso's dolphins and harp seals were not documented by PSOs during those surveys, so Vineyard Wind requested take based on two average group sizes for those species. The Level B harassment take calculation methodology described here resulted in higher take numbers than those modeled (Table 10) for 10 out of 15 species expected to be taken.

We reviewed Vineyard Wind's take request and propose to authorize take numbers that are slightly different than the numbers requested for some species. Vineyard Wind's requested take numbers for Level A harassment authorization are based on an expectation that 12 dB sound attenuation will be effective during the proposed activity. NMFS reviewed the CalTrans bubble curtain ''on and off'' studies conducted in San Francisco Bay in 2003 and 2004. Based on 74 measurements (37 with the bubble curtain on and 37 with the bubble curtain off) at both near (<100 m) and far (>100 m) distances, the linear averaged received level reduction is 6 dB (CalTrans, 2015). Nehls et al. (2016) reported that attenuation from use of a bubble curtain during pile driving at the Borkum West II offshore wind farm in the North Sea was between 10 dB and 17 dB (mean 14 dB) (peak).

Based on the best available information, we believe it reasonable to assume some level of effective attenuation due to implementation of noise attenuation during impact pile driving. Vineyard Wind has not provided information regarding the attenuation system that will ultimately be used during the proposed activity (*e.g.,* what size bubbles and in what configuration a bubble curtain would be used, whether a double curtain will be employed, whether hydro-sound dampers, noise abatement system, or some other alternate attenuation device will be used, etc.) to support their conclusion that 12 dB effective attenuation can be expected. In the absence of this information regarding the attenuation system that will be used, and in consideration of the available information on attenuation that has been achieved during impact pile driving, we conservatively assume that 6 dB sound attenuation will be achieved (although we do encourage Vineyard Wind to target 12 dB noise attenuation). Therefore, where Vineyard Wind's requested Level A take numbers were less than the Level A take numbers modeled based on 6 dB noise attenuation (*i.e.,* fin whale, humpback whale and harbor porpoise) we propose to authorize higher Level A take numbers than those requested. Vineyard Wind also requested all take numbers based on the Maximum Design scenario with one pile driven per day (Table 10); however, the Maximum Design scenario with two piles driven per day resulted in slightly higher modeled takes by Level A harassment (Table 11). We therefore propose to authorize takes by Level A harassment based on the higher modeled take numbers.

Vineyard Wind's requested take numbers for Level B harassment authorization are based on visual observation data recorded during the company's site characterization surveys, as described above. In some cases these numbers are lower than the Level B harassment exposure numbers modeled based on marine mammal densities reported by Roberts et al. (2016, 2017, 2018) with 6 dB sound attenuation applied (Table 10). While we agree that Vineyard Wind's use of visual observation data as the basis for Level B harassment take requests is generally sound, we believe that, to be conservative, the higher of the two calculated take numbers (*i.e.,* take numbers based on available visual observation data, or, based on modeled exposures above threshold) should be used to estimate Level B exposures. Therefore, for species for which the Level B harassment exposure numbers modeled based on marine mammal densities reported by Roberts et al. (2016, 2017, 2018) with 6 dB sound attenuation applied (Table 10) were higher than the take numbers based on visual observation data (*i.e.,* fin whale, bottlenose dolphin, harbor porpoise, harbor seal and harp seal) we propose to authorize take numbers based on those modeled using densities derived from Roberts et al. (2016, 2017, 2018) with 6 dB sound attenuation applied.

For North Atlantic right whales, one exposure above the Level A harassment threshold was modeled over the duration of the proposed project based on the Maximum Design scenario and 6 dB effective attenuation (Tables 10 and 11). However, Vineyard Wind has requested no authorization for Level A harassment takes of North Atlantic right whales, based on an expectation that any potential exposures above the Level A harassment threshold will be avoided through enhanced mitigation and monitoring measures proposed specifically to minimize potential right whale exposures. We believe that, based on the enhanced mitigation and monitoring measures proposed specifically for North Atlantic right whales (described below, see ''Proposed Mitigation''), including the proposed seasonal moratorium on construction from January through April and enhanced clearance measures from November through December and May 1 through May 14, any potential take of right whales by Level A harassment will be avoided. Therefore, we do not propose to authorize any takes of North Atlantic right whales by Level A harassment.

Take numbers proposed for authorization are shown in Table 15.

TABLE 15—TOTAL NUMBERS OF POTENTIAL INCIDENTAL TAKE OF MARINE MAMMALS PROPOSED FOR AUTHORIZATION AND PROPOSED TAKES AS A PERCENTAGE OF POPULATION

Species	Takes by Level A harassment	Takes by Level B harassment	Total takes proposed for authorization	Total takes as a percentage of stock taken *
Fin whale	4	33	37	0.8
Humpback Whale	10	56	65	4.0
Minke Whale	2	98	100	4.7
North Atlantic Right Whale	0	20	20	4.9
Sei Whale	2	4	6	0.8
Sperm whale	2	5	7	0.1
Atlantic White-Sided Dolphin	28	1,107	1,135	3.1
Bottlenose Dolphin	8	96	104	0.1
Long-finned Pilot Whale	9	91	100	0.5
Risso's Dolphin	6	12	18	0.2
Common Dolphin	35	4,646	4,681	5.4
Harbor porpoise	4	150	154	0.3
Gray seal	2	414	416	1.5
Harbor seal	2	214	216	0.3

TABLE 15—TOTAL NUMBERS OF POTENTIAL INCIDENTAL TAKE OF MARINE MAMMALS PROPOSED FOR AUTHORIZATION AND PROPOSED TAKES AS A PERCENTAGE OF POPULATION—Continued

Species	Takes by Level A harassment	Takes by Level B harassment	Total takes proposed for authorization	Total takes as a percentage of stock taken *
Harp seal	2	217	219	0.0

* Calculations of percentage of stock taken are based on the best available abundance estimate as shown in Table 1. For North Atlantic right whales the best available abundance estimate is derived from the 2018 North Atlantic Right Whale Consortium 2018 Annual Report Card (Pettis *et al.,* 2018). For the pinniped species the best available abundance estimates are derived from the most recent NMFS Stock Assessment Reports. For all other species, the best available abundance estimates are derived from Roberts *et al.* (2016, 2017, 2018).

The take numbers we propose for authorization (Table 15) are considered conservative for the following reasons:

• Proposed take numbers are based on an assumption that all installed monopiles would be 10.3 m in diameter, when some or all monopiles ultimately installed may be smaller;

• Proposed take numbers are based on an assumption that 102 foundations would be installed, when ultimately the total number installed may be lower;

• Proposed take numbers are based on a construction scenario that includes up to 10 jacket foundations, when it is possible no more than two jacket foundations may be installed;

• Proposed Level A take numbers do not account for the likelihood that marine mammals will avoid a stimulus when possible before that stimulus reaches a level that would have the potential to result in injury;

• Proposed take numbers do not account for the effectiveness of proposed mitigation and monitoring measures in reducing the number of takes (with the exception of North Atlantic right whales, for which proposed mitigation and monitoring measures are factored into the proposed Level A harassment take number);

• For 11 of 15 species, no Level A takes were predicted based on modeling, however proposed Level A take numbers have been conservatively increased from zero to mean group size for these species.

Proposed Mitigation

In order to issue an IHA under Section 101(a)(5)(D) of the MMPA, NMFS must set forth the permissible methods of taking pursuant to such activity, and other means of effecting the least practicable impact on such species or stock and its habitat, paying particular attention to rookeries, mating grounds, and areas of similar significance, and on the availability of such species or stock for taking for certain subsistence uses (latter not applicable for this action). NMFS regulations require applicants for incidental take authorizations to include information about the availability and feasibility (economic and technological) of equipment, methods, and manner of conducting such activity or other means of effecting the least practicable adverse impact upon the affected species or stocks and their habitat (50 CFR 216.104(a)(11)).

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

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

(2) the practicability of the measures for applicant implementation, which may consider such things as cost and impact on operations.

The mitigation strategies described below are consistent with those required and successfully implemented under previous incidental take authorizations issued in association with in-water construction activities. Additional measures have also been incorporated to account for the fact that the proposed construction activities would occur offshore. Modeling was performed to estimate zones of influence (ZOI; see "Estimated Take"); these ZOI values were used to inform mitigation measures for pile driving activities to minimize Level A harassment and Level B harassment to the extent possible, while providing estimates of the areas within which Level B harassment might occur.

In addition to the specific measures described later in this section, Vineyard Wind would conduct briefings for construction supervisors and crews, the marine mammal and acoustic monitoring teams, and Vineyard Wind staff prior to the start of all pile driving activity, and when new personnel join the work, in order to explain responsibilities, communication procedures, the marine mammal monitoring protocol, and operational procedures.

Seasonal Restriction on Pile Driving

No pile driving activities would occur between January 1 through April 30. This seasonal restriction would be established to minimize the potential for North Atlantic right whales to be exposed to pile driving noise. Based on the best available information (Kraus *et al.,* 2016; Roberts *et al.,* 2017), the highest densities of right whales in the project area are expected during the months of January through April. This restriction would greatly reduce the potential for right whale exposure to pile driving noise associated with the proposed project.

Clearance Zones

Vineyard Wind would use PSOs to establish clearance zones around the pile driving equipment to ensure these zones are clear of marine mammals prior to the start of pile driving. The purpose of "clearance" of a particular zone is to prevent potential instances of auditory injury and potential instances of more severe behavioral disturbance as a result of exposure to pile driving noise (serious injury or death are unlikely outcomes even in the absence of mitigation measures) by delaying the activity before it begins if marine mammals are detected within certain pre-defined distances of the pile driving equipment. The primary goal in this case is to prevent auditory injury (Level A harassment), and the proposed clearance zones are larger than the modeled distances to the isopleths corresponding to Level A harassment (based on peak SPL) for all marine mammal functional hearing groups, assuming an effective 6 dB attenuation of pile driving noise. Proposed clearance zones would apply to both monopile and jacket installation. These zones vary depending on species and are shown in Table 16. All distances to clearance zones are the radius from the center of the pile.

TABLE 16—PROPOSED CLEARANCE ZONES DURING VINEYARD WIND PILE DRIVING

Species	Clearance zone
North Atlantic right whale	*1,000 m
All other mysticete whales (including humpback, sei, fin and minke whale)	500 m
Harbor porpoise	120 m
All other marine mammals (including dolphins and pinnipeds)	50 m

* An extended clearance zone of 10 km for North Atlantic right whales is proposed from May 1–14 and November 1–December 31, as described below.

If a marine mammal is observed approaching or entering the relevant clearance zones prior to the start of pile driving operations, pile driving activity will be delayed until either the marine mammal has voluntarily left the respective clearance zone and been visually confirmed beyond that clearance zone, or, 30 minutes have elapsed without re-detection of the animal in the case of mysticetes, sperm whales, Risso's dolphins and pilot whales, or 15 minutes have elapsed without re-detection of the animal in the case of all other marine mammals.

Prior to the start of pile driving activity, the clearance zones will be monitored for 60 minutes to ensure that they are clear of the relevant species of marine mammals. Pile driving would only commence once PSOs have declared the respective clearance zones clear of marine mammals. Marine mammals observed within a clearance zone will be allowed to remain in the clearance zone (*i.e.,* must leave of their own volition), and their behavior will be monitored and documented. The clearance zones may only be declared clear, and pile driving started, when the entire clearance zones are visible (*i.e.,* when not obscured by dark, rain, fog, etc.) for a full 30 minutes prior to pile driving.

Extended Clearance Zones for North Atlantic Right Whales

In addition to the clearance zones described in Table 16, Vineyard Wind has proposed extended clearance zones for North Atlantic right whales during certain times of year. These extended zones are designed to further minimize the potential for right whales to be exposed to pile driving noise, and are proposed during times of year that are considered to be ''shoulder seasons'' in terms of right whale presence in the project area: November 1 through December 31, and May 1 through May 14. While North Atlantic right whale presence during these times of year is considered less likely than during the proposed seasonal closure (January through April), based on the best available information right whales may occur in the project area during these times of year (Roberts *et al.,* 2017; Kraus *et al.*, 2016). Extended clearance zones would be maintained through passive acoustic monitoring (PAM) as well as by visual observation conducted on aerial or vessel-based surveys as described below. Extended clearance zones for North Atlantic right whales are as follows:

- May 1 through May 14: An extended clearance zone of 10 km would be established based on real-time PAM. Real-time PAM would begin at least 60 minutes prior to pile driving. In addition, an aerial or vessel-based survey would be conducted across the extended 10 km extended clearance zone, using visual PSOs to monitor for right whales.
- November 1 through December 31: An extended clearance zone of 10 km would be established based on real-time PAM. In addition, an aerial survey may be conducted across the extended 10 km extended clearance zone, using visual PSOs to monitor for right whales.

During these periods (May 1 through May 14 and November 1 through December 31), if a right whale were detected either via real-time PAM or vessel-based or aerial surveys within 10 km of the pile driving location, pile driving would be postponed and would not commence until the following day, or, until a follow-up aerial or vessel-based survey could confirm the extended clearance zone is clear of right whales, as determined by the lead PSO. Aerial surveys would not begin until the lead PSO on duty determines adequate visibility and at least one hour after sunrise (on days with sun glare). Vessel-based surveys would not begin until the lead PSO on duty determines there is adequate visibility.

Real-time acoustic monitoring would begin at least 60 minutes prior to pile driving. The real-time PAM system would be designed and established such that detection capability extends to 10 km from the pile driving location. The real-time PAM system must ensure that acoustic detections can be classified (*i.e.,* potentially originating from a North Atlantic right whale) within 30 minutes of the original detection. The PAM operator must be trained in identification of mysticete vocalizations. The PAM operator responsible for determining if the acoustic detection originated from a North Atlantic right whale within the 10 km PAM monitoring zone would be required to make such a determination if they had at least 75 percent confidence that the vocalization within 10 km of the pile driving location originated from a North Atlantic right whale. A record of the PAM operator's review of any acoustic detections would be reported to NMFS.

We note that these proposed extended clearance zones would exceed the distance to the isopleth that corresponds to the estimated Level B harassment threshold (4,121 m for a 10.3 m monopile foundation and 3,220 m for a jacket foundation with four piles, based on 6 dB attenuation), minimizing the potential for exposures above the Level A harassment threshold as well as the potential for exposures above the Level B harassment threshold during the times of year when right whales are most likely to be present in the project area.

Soft Start

The use of a soft start procedure is believed to provide additional protection to marine mammals by warning marine mammals or providing them with a chance to leave the area prior to the hammer operating at full capacity, and typically involves a requirement to initiate sound from the hammer at reduced energy followed by a waiting period. Vineyard Wind will utilize soft start techniques for impact pile driving by performing an initial set of three strikes from the impact hammer at a reduced energy level followed by a one minute waiting period. We note that it is difficult to specify the reduction in energy for any given hammer because of variation across drivers and, for impact hammers, the actual number of strikes at reduced energy will vary because operating the hammer at less than full power results in ''bouncing'' of the hammer as it strikes the pile, resulting in multiple ''strikes''; however, Vineyard Wind has proposed that they will target less than 40 percent of total hammer energy for the initial hammer strikes during soft start. The soft start process would be conducted a total of three times prior to driving each pile (*e.g.,* three single strikes followed by a one minute delay, then three additional single strikes followed by a one minute delay, then a final set of three single strikes followed by an additional one minute delay). Soft start would be required at the beginning of each day's impact pile driving work and at any time following a cessation of impact pile driving of thirty minutes or longer.

Shutdown

The purpose of a shutdown is to prevent some undesirable outcome, such as auditory injury or behavioral disturbance of sensitive species, by halting the activity. If a marine mammal is observed entering or within the respective clearance zones (Table 16) after pile driving has begun, the PSO will request a temporary cessation of pile driving. Vineyard Wind has proposed that, when called for by a PSO, shutdown of pile driving would be implemented when feasible but that shutdown would not always be technically practicable once driving of a pile has commenced as it has the potential to result in pile instability. We therefore propose that shutdown would be implemented when feasible, with a focus on other proposed mitigation measures as the primary means of minimizing potential impacts on marine mammals from noise related to pile driving. If shutdown is called for by a PSO, and Vineyard Wind determines a shutdown to be technically feasible, pile driving would be halted immediately.

In situations when shutdown is called for but Vineyard Wind determines shutdown is not practicable due to human safety or operational concerns, reduced hammer energy would be implemented when practicable. After shutdown, pile driving may be initiated once all clearance zones are clear of marine mammals for the minimum species-specific time periods, or, if required to maintain installation feasibility. Installation feasibility refers to ensuring that the pile installation results in a usable foundation for the WTG (*e.g.,* installed to the target penetration depth without refusal and with a horizontal foundation/tower interface flange). In cases where pile driving is already started and a PSO calls for shutdown, the lead engineer on duty will evaluate the following to determine whether shutdown is feasible: (1) Use the site-specific soil data and the real-time hammer log information to judge whether a stoppage would risk causing piling refusal at re-start of piling; and (2) Check that the pile penetration is deep enough to secure pile stability in the interim situation, taking into account weather statistics for the relevant season and the current weather forecast. Determinations by the lead engineer on duty will be made for each pile as the installation progresses and not for the site as a whole.

Visibility Requirements

Pile driving would not be initiated at night, or, when the full extent of all relevant clearance zones cannot be confirmed to be clear of marine mammals, as determined by the lead PSO on duty. The clearance zones may only be declared clear, and pile driving started, when the full extent of all clearance zones are visible (*i.e.,* when not obscured by dark, rain, fog, etc.) for a full 30 minutes prior to pile driving. Pile driving may continue after dark only when the driving of the same pile began during the day when clearance zones were fully visible and must proceed for human safety or installation feasibility reasons.

Sound Attenuation Devices

Vineyard Wind would implement sound attenuation technology that would target at least a 12 dB reduction in pile driving noise, and that must achieve at least a 6 dB reduction in pile driving noise, as described above. The attenuation system may include one of the following or some combination of the following: A Noise Mitigation System, Hydro-sound Damper, Noise Abatement System, and/or bubble curtain. Vineyard Wind would also have a second back-up attenuation device (*e.g.,* bubble curtain or similar) available, if needed, to achieve the targeted reduction in noise levels, pending results of sound field verification testing.

If Vineyard Wind uses a bubble curtain, the bubble curtain must distribute air bubbles around 100 percent of the piling perimeter for the full depth of the water column. The lowest bubble ring shall be in contact with the mudline for the full circumference of the ring, and the weights attached to the bottom ring shall ensure 100 percent mudline contact. No parts of the ring or other objects shall prevent full mudline contact. Vineyard Wind would require that construction contractors train personnel in the proper balancing of airflow to the bubblers, and would require that construction contractors submit an inspection/performance report for approval by Vineyard Wind within 72 hours following the performance test. Corrections to the attenuation device to meet the performance standards would occur prior to impact driving.

Monitoring Protocols

Monitoring would be conducted before, during, and after pile driving activities. In addition, observers will record all incidents of marine mammal occurrence, regardless of distance from the construction activity, and monitors will document any behavioral reactions in concert with distance from piles being driven. Observations made outside the clearance zones will not result in delay of pile driving; that pile segment may be completed without cessation, unless the marine mammal approaches or enters the clearance zone, at which point pile driving activities would be halted when practicable, as described above. Pile driving activities include the time to install a single pile or series of piles, as long as the time elapsed between uses of the pile driving equipment is no more than 30 minutes.

The following additional measures apply to visual monitoring:

(1) Monitoring will be conducted by qualified, trained PSOs, who will be placed on the installation vessel, which represents the best vantage point to monitor for marine mammals and implement shutdown procedures when applicable;

(2) A minimum of two PSOs will be on duty at all times during pile driving activity. A minimum of four PSOs will be stationed at the pile driving site at all times during pile driving activity;

(3) PSOs may not exceed four consecutive watch hours; must have a minimum two hour break between watches; and may not exceed a combined watch schedule of more than 12 hours in a 24- hour period;

(4) Monitoring will be conducted from 60 minutes prior to commencement of pile driving, throughout the time required to drive a pile, and for 30 minutes following the conclusion of pile driving;

(5) PSOs will have no other construction-related tasks while conducting monitoring;

(6) PSOs should have the following minimum qualifications:

• Visual acuity in both eyes (correction is permissible) sufficient for discernment of moving targets at the water's surface with ability to estimate target size and distance; use of binoculars may be necessary to correctly identify the target;

• Ability to conduct field observations and collect data according to assigned protocols;

• Experience or training in the field identification of marine mammals, including the identification of behaviors;

• Sufficient training, orientation, or experience with the construction operation to provide for personal safety during observations;

• Writing skills sufficient to document observations including, but not limited to: The number and species of marine mammals observed; dates and times when in-water construction activities were conducted; dates and times when in-water construction activities were suspended to avoid potential incidental injury of marine mammals from construction noise within a defined shutdown zone; and marine mammal behavior; and

• Ability to communicate orally, by radio or in person, with project personnel to provide real-time information on marine mammals observed in the area as necessary.

Observer teams employed by Vineyard Wind in satisfaction of the mitigation and monitoring requirements described herein must meet the following additional requirements:

• Independent observers (*i.e.,* not construction personnel) are required;

• At least one observer must have prior experience working as an observer;

• Other observers may substitute education (degree in biological science or related field) or training for experience;

• One observer will be designated as lead observer or monitoring coordinator. The lead observer must have prior experience working as an observer; and

• NMFS will require submission and approval of observer CVs.

Vessel Strike Avoidance

Vessel strike avoidance measures will include, but are not limited to, the following, except under circumstances when complying with these measures would put the safety of the vessel or crew at risk:

• All vessel operators and crew must maintain vigilant watch for cetaceans and pinnipeds, and slow down or stop their vessel to avoid striking these protected species;

• All vessels transiting to and from the WDA and traveling over 10 knots would have a visual observer who has undergone marine mammal training stationed on the vessel. Visual observers monitoring the vessel strike avoidance zone may be third-party observers (*i.e.,* PSOs) or crew members, but crew members responsible for these duties must be provided sufficient training to distinguish marine mammals from other phenomena and broadly to identify a marine mammal as a right whale, other whale (defined in this context as sperm whales or baleen whales other than right whales), or other marine mammal;

• From November 1 through May 14, all vessels must travel at less than 10 knots (18.5 km/hr) within the WDA;

• From November 1 through May 14, when transiting to or from the WDA, vessels must either travel at less than 10 knots, or, must implement visual surveys with at least one visual observer to monitor for North Atlantic right whales (with the exception of vessel transit within Nantucket Sound);

• All vessels must travel at 10 knots (18.5 km/hr) or less within any designated Dynamic Management Area (DMA), with the exception of crew transfer vessels;

• Crew transfer vessels traveling within any designated DMA must travel at 10 knots (18.5 km/hr) or less, unless North Atlantic right whales are clear of the transit route and WDA for two consecutive days, as confirmed by vessel based surveys conducted during daylight hours and real-time PAM, or, by an aerial survey, conducted once the lead aerial observer determines adequate visibility. If confirmed clear by one of the measures above, vessels transiting within a DMA must employ at least two visual observers to monitor for North Atlantic right whales. If a North Atlantic right whale is observed within or approaching the transit route, vessels must operate at less than 10 knots until clearance of the transit route for two consecutive days is confirmed by the procedures described above;

• All vessels greater than or equal to 65 ft (19.8 m) in overall length will comply with 10 knot (18.5 km/hr) or less speed restriction in any Seasonal Management Area (SMA) per the NOAA ship strike reduction rule (73 FR 60173; October 10, 2008);

• All vessel operators will reduce vessel speed to 10 knots (18.5 km/hr) or less when any large whale, any mother/calf pairs, pods, or large assemblages of non-delphinoid cetaceans are observed near (within 100 m (330 ft)) an underway vessel;

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

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

• All vessels will maintain a separation distance of 100 m (330 ft) 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 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 (164 ft) or greater from any sighted delphinoid cetacean, with the exception of delphinoid cetaceans that voluntarily approach the vessel (*i.e.,* bow ride). Any vessel underway must remain parallel to a sighted delphinoid cetacean's course whenever possible, and avoid excessive speed or abrupt changes in direction. Any vessel underway must reduce vessel speed to 10 knots (18.5 km/hr) 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 pinniped; and

• All vessels underway will not divert or alter course in order to approach any whale, delphinoid cetacean, or pinniped. Any vessel underway will avoid excessive speed or abrupt changes in direction to avoid injury to the sighted cetacean or pinniped.

Vineyard Wind will ensure that vessel operators and crew maintain a vigilant watch for marine mammals by slowing down or stopping the vessel to avoid striking marine mammals. Project-specific training will be conducted for all vessel crew prior to the start of the construction activities. Confirmation of the training and understanding of the requirements will be documented on a training course log sheet.

We have carefully evaluated Vineyard Wind's proposed mitigation measures and considered a range of other measures in the context of ensuring that we prescribed the means of effecting the least practicable adverse impact on the affected marine mammal species and stocks and their habitat. Based on our evaluation of these measures, we have preliminarily determined that the proposed mitigation measures provide the means of effecting the least practicable adverse impact on marine mammal species or stocks and their habitat, paying particular attention to rookeries, mating grounds, and areas of similar significance, and on the availability of such species or stock for subsistence uses.

Proposed Monitoring and Reporting

In order to issue an IHA for an activity, Section 101(a)(5)(D) of the MMPA states that NMFS must set forth requirements pertaining to the monitoring and reporting of such taking. The MMPA implementing regulations at 50 CFR 216.104 (a)(13) indicate that requests for authorizations must include the suggested means of accomplishing the necessary monitoring and reporting that will result in increased knowledge of the species and of the level of taking or impacts on populations of marine mammals that are expected to be present in the proposed action area. Effective reporting is critical both to compliance as well as ensuring that the most value is obtained from the required monitoring.

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

• Occurrence of marine mammal species or stocks in the area in which take is anticipated (*e.g.,* presence, abundance, distribution, density).

• Nature, scope, or context of likely marine mammal exposure to potential stressors/impacts (individual or cumulative, acute or chronic), through better understanding of: (1) Action or environment (*e.g.,* source characterization, propagation, ambient noise); (2) affected species (*e.g.,* life history, dive patterns); (3) co-occurrence of marine mammal species with the action; or (4) biological or behavioral context of exposure (*e.g.,* age, calving or feeding areas).

• Individual marine mammal responses (behavioral or physiological) to acoustic stressors (acute, chronic, or cumulative), other stressors, or cumulative impacts from multiple stressors.

• How anticipated responses to stressors impact either: (1) Long-term fitness and survival of individual marine mammals; or (2) populations, species, or stocks.

• Effects on marine mammal habitat (*e.g.,* marine mammal prey species, acoustic habitat, or other important physical components of marine mammal habitat).

• Mitigation and monitoring effectiveness.

Visual Marine Mammal Observations

Vineyard Wind will collect sighting data and behavioral responses to pile driving activity for marine mammal species observed in the region of activity during the period of activity. All observers will be trained in marine mammal identification and behaviors and are required to have no other construction-related tasks while conducting monitoring. PSOs would monitor all clearance zones at all times. PSOs would also monitor Level B harassment zones (*i.e.,* 4,121 m for monopiles and 3,220 m for jacket piles) and would document any marine mammals observed within these zones, to the extent practicable (noting that some distances to these zones are too large to fully observe). Vineyard Wind would conduct monitoring before, during, and after pile driving, with observers located at the best practicable vantage points on the pile driving vessel.

Vineyard Wind would implement the following procedures for pile driving:

• A minimum of two PSOs will maintain watch at all times when pile driving is underway.

• PSOs would be located at the best vantage point(s) on the installation vessel to ensure that they are able to observe the entire clearance zones and as much of the Level B harassment zone as possible.

• During all observation periods, PSOs will use binoculars and the naked eye to search continuously for marine mammals.

• PSOs will be equipped with reticle binoculars and night vision binoculars.

• If the clearance zones are obscured by fog or poor lighting conditions, pile driving will not be initiated until clearance zones are fully visible. Should such conditions arise while impact driving is underway, the activity would be halted when practicable, as described above.

• The clearance zones will be monitored for the presence of marine mammals before, during, and after all pile driving activity.

When monitoring is required during vessel transit (as described above), the PSO(s) will be stationed on vessels at the best vantage points to ensure maintenance of standoff distances between marine mammals and vessels (as described above). Vineyard Wind would implement the following measures during vessel transit when there is an observation of a marine mammal:

• PSOs will record the vessel's position and speed, water depth, sea state, and visibility will be recorded at the start and end of each observation period, and whenever there is a change in any of those variables that materially affects sighting conditions.

• PSOs will record the time, location, speed, and activity of the vessel, sea state, and visibility.

Individuals implementing the monitoring protocol will assess its effectiveness using an adaptive approach. PSOs will use their best professional judgment throughout implementation and seek improvements to these methods when deemed appropriate. Any modifications to the protocol will be coordinated between NMFS and Vineyard Wind.

Data Collection

We require that observers use standardized data forms. Among other pieces of information, Vineyard Wind will record detailed information about any implementation of delays or shutdowns, including the distance of animals to the pile and a description of specific actions that ensued and resulting behavior of the animal, if any. We require that, at a minimum, the following information be collected on the sighting forms:

• Date and time that monitored activity begins or ends;

• Construction activities occurring during each observation period;

• Weather parameters (*e.g.,* wind speed, percent cloud cover, visibility);

• Water conditions (*e.g.,* sea state, tide state);

• Species, numbers, and, if possible, sex and age class of marine mammals;

• Description of any observable marine mammal behavior patterns, including bearing and direction of travel and distance from pile driving activity;

• Distance from pile driving activities to marine mammals and distance from the marine mammals to the observation point;

• Type of construction activity (*e.g.,* monopile or jacket pile installation) when marine mammals are observed.

• Description of implementation of mitigation measures (*e.g.,* delay or shutdown).

• Locations of all marine mammal observations; and

• Other human activity in the area.

Vineyard Wind will note behavioral observations, to the extent practicable, if an animal has remained in the area during construction activities.

Acoustic Monitoring

Vineyard Wind would utilize a PAM system to supplement visual monitoring. The PAM system would be monitored by a minimum of one acoustic PSO beginning at least 30 minutes prior to ramp-up of pile driving and at all times during pile driving. Acoustic PSOs would immediately communicate all detections of marine mammals to visual PSOs, including any determination regarding species identification, distance, and bearing and the degree of confidence in the determination. PAM would be used to inform visual monitoring during construction; no mitigation actions would be required on PAM detection alone. The PAM system would not be located on the pile installation vessel.

Acoustic PSOs may be on watch for a maximum of four consecutive hours followed by a break of at least two hours between watches. Acoustic PSOs would be required to complete specialized training for operating PAM systems. PSOs can act as acoustic or visual observers (but not simultaneously) as long as they demonstrate that their training and experience are sufficient to perform each task.

Vineyard Wind will also conduct hydroacoustic monitoring for a subset of impact-driven piles. Hydroacoustic monitoring would be performed for at least one of each pile type (*e.g.,* monopile and jacket pile). For each pile that is monitored via hydroacoustic monitoring, a minimum of two autonomous acoustic recorders will be deployed. Each acoustic recorder will consist of a vertical line array with two hydrophones deployed at depths spanning the water column (one near the seabed and one in the water column).

Vineyard Wind would be required to conduct sound source verification during pile driving. Sound source verification would be required during impact installation of a 10.3 m monopile (or, of the largest diameter monopile used over the duration of the IHA) with noise attenuation activated; during impact installation of the same size monopile, without noise attenuation activated (if a monopile is installed without noise attenuation; impact pile driving without noise attenuation would be limited to one monopile); and, during impact installation of the largest jacket pile used over the duration of the IHA. Sound source measurements would be conducted at distances of approximately 50, 500, 750 and 1,500 m from the pile being driven.

Vineyard Wind would be required to empirically determine the distances to the isopleths corresponding to the Level A and Level B harassment thresholds either by extrapolating from in situ measurements conducted at several points between 50, 500, 750, and 1,500 m from the pile being driven, or by direct measurements to locate the distance where the received levels reach the relevant thresholds or below. Isopleths corresponding to the Level A and Level B harassment thresholds would be empirically verified for impact driving of the largest diameter monopile used over the duration of the IHA, and impact driving of the largest diameter jacket pile used over the duration of the IHA. For verification of the extent of the Level B harassment zone, Vineyard Wind would be required to report the measured or extrapolated distances where the received levels SPLrms decay to 160-dB, as well as integration time for such SPLrms.

The acoustic monitoring report would include: Peak sound pressure level (SPLpk), root-mean-square sound pressure level that contains 90 percent of the acoustic energy (SPLrms), single strike sound exposure level, integration time for SPLrms, SELss spectrum, and 24-hour cumulative SEL extrapolated from measurements. All these levels would be reported in the form of median, mean, max, and minimum. The sound levels reported would be in median and linear average (*i.e.,* taking averages of sound intensity before converting to dB). The acoustic monitoring report would also include a description of depth and sediment type at the recording location.

Recording would also occur when no construction activities are occurring in order to establish ambient sound levels. Vineyard Wind would also conduct real-time PAM during certain times of year to facilitate mitigation (as described above).

Reporting

A draft report would be submitted to NMFS within 90 days of the completion of monitoring for each installation's in-water work window. The report would include marine mammal observations pre-activity, during-activity, and post-activity during pile driving days, and would also provide descriptions of any behavioral responses to construction activities by marine mammals. The report would detail the monitoring protocol, summarize the data recorded during monitoring including an estimate of the number of marine mammals that may have been harassed during the period of the report, and describe any mitigation actions taken (*i.e.,* delays or shutdowns due to detections of marine mammals, and documentation of when shutdowns were called for but not implemented and why). The report would also include results from acoustic monitoring including dates and times of all detections, types and nature of sounds heard, whether detections were linked with visual sightings, water depth of the hydrophone array, bearing of the animal to the vessel (if determinable), species or taxonomic group (if determinable), spectrogram screenshot, a record of the PAM operator's review of any acoustic detections, and any other notable information. A final report must be submitted within 30 days following resolution of comments on the draft report.

Negligible Impact Analysis and Determination

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

Pile driving activities associated with the proposed project, as described previously, have the potential to disturb or temporarily displace marine mammals. Specifically, the specified activities may result in take, in the form of Level A harassment (potential injury) or Level B harassment (potential behavioral disturbance) from underwater sounds generated from pile driving. Potential takes could occur if individual marine mammals are present in the ensonified zone when pile driving is occurring.

To avoid repetition, the majority of our analyses apply to all the species listed in Table 1, given that many of the anticipated effects of the proposed project on different marine mammal stocks are expected to be relatively similar in nature. Where there are meaningful differences between species or stocks—as is the case of the North Atlantic right whale—they are included as separate sub-sections below.

North Atlantic Right Whales

North Atlantic right whales are currently threatened by low population abundance, higher than normal mortality rates and lower than normal reproductive rates. As described above, the project area represents part of an important migratory area for North Atlantic right whales, which make annual migrations up and down the Atlantic coast. Due to the current status of North Atlantic right whales, and the spatial overlap of the proposed project with an area of biological significance for right whales, the potential impacts of the proposed project on right whales warrant particular attention.

As described above, North Atlantic right whale presence in the project area is seasonal. As a result of several years of aerial surveys and PAM deployments in the area we have confidence that right whales are expected in the project area during certain times of year while at other times of year right whales are not expected to occur in the project area. During aerial surveys conducted from 2011–2015 in the project area, right whale sightings occurred only December through April, with no sightings from May through November (Kraus *et al.,* 2016). There was not significant variability in sighting rate among years, indicating consistent annual seasonal use of the area by right whales (Kraus et al., 2016).

Due to this seasonal pattern in right whale occurrence in the project area, we expect the most significant measure in minimizing impacts to right whales to be the proposed seasonal closure that would occur from January through April, when right whale abundance in the project area is greatest. In addition, proposed mitigation measures outside of those months—including a 10 km clearance zone facilitated through PAM and vessel or aerial surveys during the ''shoulder seasons'' when right whale abundance in the area is lower than the peak months of January to April, as well as a 1 km clearance zone for all other months—will greatly minimize any takes that may otherwise occur outside of the months of peak abundance in the area. As a result of these mitigation measures, we expect the already small potential for right whales to be exposed to project-related sound above the Level A harassment threshold to be eliminated. We also expect these proposed measures to greatly reduce the amount of exposures to project-related noise above the Level B harassment threshold, the duration and intensity of any exposures above the Level B harassment threshold that do occur, as well as the potential for mother-calf pairs to be exposed to project-related noise above the Level B harassment threshold during their annual migration through the project area. No serious injury or mortality of North Atlantic right whales would be expected even in the absence of the proposed mitigation measures.

Instances of Level B harassment of North Atlantic right whales will be reduced to the level of least practicable adverse impact through use of proposed mitigation measures, including soft start. Any individuals that are exposed above the Level B harassment threshold are expected to move away from the sound source and temporarily avoid the areas of pile driving. We expect that any avoidance of the project area by North Atlantic right whales would be temporary in nature and that any North Atlantic right whales that avoid the project area during construction would not be permanently displaced. Even repeated Level B harassment of some small subset of the overall stock is unlikely to result in any significant realized decrease in viability for the affected individuals, and thus would not result in any adverse impact to the stock as a whole.

Prey for North Atlantic right whales are mobile and broadly distributed throughout the project area; therefore, right whales that may be temporarily displaced during construction activities are expected to be able to resume foraging once they have moved away from areas with disturbing levels of underwater noise. Because of the temporary nature of the disturbance and the availability of similar habitat and resources in the surrounding area, the impacts to right whales and the food sources that they utilize are not expected to cause significant or long-term consequences for individual right whales or their population. In addition, there are no right whale mating or calving areas within the proposed project area.

As described above, North Atlantic right whales are experiencing an ongoing UME. However, as described above, no injury of right whales as a result of the proposed project is expected or proposed for authorization, and Level B harassment takes of right whales are expected to be in the form of avoidance of the immediate area of construction. As no injury or mortality is expected or proposed for authorization, and Level B harassment of North Atlantic right whales will be reduced to the level of least practicable adverse impact through use of proposed mitigation measures, the proposed authorized takes of right whales would not exacerbate or compound the ongoing UME in any way.

NMFS concludes that exposures to North Atlantic right whales would be greatly reduced due to the seasonal restrictions, and additional proposed mitigation measures that would ensure that any exposures above the Level B harassment threshold would result in only short-term effects to individuals exposed. With implementation of the proposed mitigation requirements, take by Level A harassment is unlikely and is therefore not proposed for authorization. Potential impacts associated with Level B harassment would include only low-level, temporary behavioral modifications, most likely in the form of avoidance behavior or potential alteration of vocalizations. In order to evaluate whether or not individual behavioral responses, in combination with other stressors, impact animal populations, scientists have developed theoretical frameworks which can then be applied to particular case studies when the supporting data are available. One such framework is the population consequences of disturbance model (PCoD), which attempts to assess the combined effects of individual animal exposures to stressors at the population level (NAS 2017). Nearly all PCoD studies and experts agree that infrequent exposures of a single day or less are unlikely to impact individual fitness, let alone lead to population level effects (Booth *et al.,* 2016; Booth *et al.,* 2017; Christiansen and Lusseau 2015; Farmer *et al.,* 2018; Harris *et al.,* 2017; Harwood and Booth 2016; King *et al.,* 2015; McHuron *et al.,* 2018; NAS 2017; New *et al.,* 2014; Pirotta *et al.,* 2018; Southall *et al.,* 2007; Villegas-Amtmann *et al.,* 2015). Since NMFS expects that any exposures would be very brief, and repeat exposures to the same individuals are unlikely, any behavioral responses that would occur due to animals being exposed to construction activity are expected to be temporary, with behavior returning to a baseline state shortly after the acoustic stimuli ceases. Given this, and NMFS' evaluation of the available PCoD studies, any such behavioral responses are not expected to impact individual animals' health or have effects on individual animals' survival or reproduction, thus no detrimental impacts at the population level are anticipated. North Atlantic right whales may temporarily avoid the immediate area but are not expected to permanently abandon the area. Impacts to breeding, feeding, sheltering, resting, or migration are not expected, nor are shifts in habitat use, distribution, or foraging success. NMFS does not anticipate North Atlantic right whales takes that would result from the proposed project would impact annual rates of recruitment or survival. Thus, any takes that occur would not result in population level impacts.

All Other Marine Mammal Species

Impact pile driving has source characteristics (short, sharp pulses with higher peak levels and sharper rise time to reach those peaks) that are potentially injurious or more likely to produce severe behavioral reactions. However, modeling indicates there is limited potential for injury even in the absence of the proposed mitigation measures, with several species predicted to experience no Level A harassment based on modeling results (Tables 10–13). In addition, the potential for injury is expected to be greatly minimized through implementation of the proposed mitigation measures including soft start, use of a sound attenuation system, and the implementation of clearance zones that would facilitate a delay of pile driving if marine mammals were observed approaching or within areas that could be ensonified above sound levels that could result in auditory injury. Given sufficient notice through use of soft start, marine mammals are expected to move away from a sound source that is annoying prior to its becoming potentially injurious or resulting in more severe behavioral reactions. The proposed requirement that pile driving can only commence when the full extent of all clearance zones are fully visible to PSOs will ensure a high marine mammal detection capability, enabling a high rate of success in implementation of clearance zones to avoid injury.

We expect that any exposures above the Level A harassment threshold would be in the form of slight PTS, *i.e.,* minor degradation of hearing capabilities within regions of hearing that align most completely with the energy produced by pile driving (*i.e.,* the low-frequency region below 2 kHz), not severe hearing impairment. If hearing impairment occurs, it is most likely that the affected animal would lose a few decibels in its hearing sensitivity, which in most cases is not likely to meaningfully affect its ability to forage and communicate with conspecifics. However, given sufficient notice through use of soft start, marine mammals are expected to move away from a sound source that is annoying prior to its becoming potentially injurious or resulting in more severe behavioral reactions.

Additionally, the numbers of exposures above the Level A harassment proposed for authorization are relatively low for all marine mammal stocks and species: For 13 of 15 stocks, we propose to authorize less than 10 takes by Level A harassment over the duration of the project; for the other two stocks we propose to authorize no more than 35 takes by Level A harassment. As described above, we expect that marine mammals would be likely to move away from a sound source that represents an aversive stimulus, especially at levels that would be expected to result in PTS, given sufficient notice through use of soft start, thereby minimizing the degree of PTS that would be incurred.

Repeated exposures of individuals to relatively low levels of sound outside of preferred habitat areas are unlikely to significantly disrupt critical behaviors. Thus, even repeated Level B harassment of some small subset of an overall stock is unlikely to result in any significant realized decrease in viability for the affected individuals, and thus would not result in any adverse impact to the stock as a whole. Level B harassment will be reduced to the level of least practicable adverse impact through use of proposed mitigation measures and, if sound produced by project activities is sufficiently disturbing, marine mammals are likely to simply avoid the area while the activity is occurring. Effects on individuals that are taken by Level B harassment, on the basis of reports in the literature as well as monitoring from other similar activities, will likely be limited to reactions such as increased swimming speeds, increased surfacing time, or decreased foraging (if such activity were occurring) (*e.g.,* Thorson and Reyff, 2006; HDR, Inc., 2012; Lerma, 2014). Most likely, individuals will simply move away from the sound source and temporarily avoid the area where pile driving is occurring. Therefore, we expect that animals annoyed by project sound would simply avoid the area during pile driving in favor of other, similar habitats. We expect that any avoidance of the project area by marine mammals would be temporary in nature and that any marine mammals that avoid the project area during construction would not be permanently displaced.

Feeding behavior is not likely to be significantly impacted, as prey species are mobile and are broadly distributed throughout the project area; therefore, marine mammals that may be temporarily displaced during construction activities are expected to be able to resume foraging once they have moved away from areas with disturbing levels of underwater noise. Because of the temporary nature of the disturbance and the availability of similar habitat and resources in the surrounding area, the impacts to marine mammals and the food sources that they utilize are not expected to cause significant or long-term consequences for individual marine mammals or their populations. There are no areas of notable biological significance for marine mammal feeding known to exist in the project area. In addition, there are no rookeries or mating or calving areas known to be biologically important to marine mammals within the proposed project area.

NMFS concludes that exposures to marine mammals due to the proposed project would result in only short-term effects to individuals exposed. Marine mammals may temporarily avoid the immediate area but are not expected to permanently abandon the area. Impacts to breeding, feeding, sheltering, resting, or migration are not expected, nor are shifts in habitat use, distribution, or foraging success. NMFS does not anticipate the marine mammal takes that would result from the proposed project would impact annual rates of recruitment or survival.

As described above, humpback whales, minke whales, and gray, harbor and harp seals are experiencing ongoing UMEs. For minke whales, although the ongoing UME is under investigation (as occurs for all UMEs), this event does not provide cause for concern regarding population level impacts, as the likely population abundance is greater than 20,000 whales. Even though the PBR value is based on an abundance for U.S. waters that is negatively biased and a small fraction of the true population abundance, annual M/SI does not exceed the calculated PBR value for minke whales. With regard to humpback whales, the UME does not yet provide cause for concern regarding population-level impacts. Despite the UME, the relevant population of humpback whales (the West Indies breeding population, or distinct population segment (DPS)) remains healthy. The West Indies DPS, which consists of the whales whose breeding range includes the Atlantic margin of the Antilles from Cuba to northern Venezuela, and whose feeding range primarily includes the Gulf of Maine, eastern Canada, and western Greenland, was delisted. The status review identified harmful algal blooms, vessel collisions, and fishing gear entanglements as relevant threats for this DPS, but noted that all other threats are considered likely to have no or minor impact on population size or the growth rate of this DPS (Bettridge *et al.,* 2015). As described in Bettridge *et al.* (2015), the West Indies DPS has a substantial population size (*i.e.,* approximately 10,000; Stevick *et al.,* 2003; Smith *et al.,* 1999; Bettridge *et al.,* 2015), and appears to be experiencing consistent growth. With regard to gray seals, harbor seals and harp seals, although the ongoing UME is under investigation, the UME does not yet provide cause for concern regarding population-level impacts to any of these stocks. For harbor seals, the population abundance is over 75,000 and annual M/SI (345) is well below PBR (2,006) (Hayes *et al.,* 2018). For gray seals, the population abundance is over 27,000, and abundance is likely increasing in the U.S. Atlantic EEZ and in Canada (Hayes *et al.,* 2018). For harp seals, the current population trend in U.S. waters is unknown, as is PBR (Hayes *et al.,* 2018), however the population abundance is over 7 million seals, suggesting that the UME is unlikely to result in population-level impacts (Hayes *et al.,* 2018). Proposed authorized takes by Level A harassment for all species are very low (*i.e.,* no more than 10 takes by Level A harassment proposed for any of these species) and as described above, any Level A harassment would be expected to be in the form of slight PTS, *i.e.,* minor degradation of hearing capabilities which is not likely to meaningfully affect the ability to forage or communicate with conspecifics. No serious injury or mortality is expected or proposed for authorization, and Level B harassment of humpback whales and minke whales and gray, harbor and harp seals will be reduced to the level of least practicable adverse impact through use of proposed mitigation measures. As such, the proposed authorized takes of humpback whales and minke whales would not exacerbate or compound the ongoing UMEs in any way.

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

- No mortality or serious injury is anticipated or proposed for authorization;
- The anticipated impacts of the proposed activity on marine mammals would be temporary behavioral changes due to avoidance of the project area and limited instances of Level A harassment in the form of a slight PTS;
- Potential instances of exposure above the Level A harassment threshold are expected to be relatively low for most species; any potential for exposures above the Level A harassment threshold would be minimized by proposed mitigation measures including clearance zones;
- Total proposed authorized takes as a percentage of population are very low for all species and stocks (*i.e.,* less than 6 percent for five stocks, and less than 1 percent for the remaining 10 stocks);
- The availability of alternate areas of similar habitat value for marine mammals to temporarily vacate the project area during the proposed project to avoid exposure to sounds from the activity;
- Effects on species that serve as prey species for marine mammals from the proposed project are expected to be short-term and are not expected to result in significant or long-term consequences for individual marine mammals, or to contribute to adverse impacts on their populations;
- There are no known important feeding, breeding or calving areas in the project area. A biologically important migratory area exists for North Atlantic right whales, however the proposed seasonal moratorium on construction is expected to largely avoid impacts to the right whale migration, as described above;
- The proposed mitigation measures, including visual and acoustic monitoring, clearance zones, and soft start, are expected to minimize potential impacts to marine mammals.

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

Small Numbers

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

We propose to authorize incidental take of 15 marine mammal stocks. The total amount of taking proposed for authorization is less than 6 percent for five of these stocks, and less than 1 percent for the remaining 10 stocks (Table 15), which we consider to be relatively small percentages and we preliminarily find are small numbers of marine mammals relative to the estimated overall population abundances for those stocks.

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

Unmitigable Adverse Impact Analysis and Determination

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

Endangered Species Act (ESA)

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

NMFS is proposing to authorize take of North Atlantic right, fin, sei, and sperm whales, which are listed under the ESA. The NMFS Office of Protected Resources has requested initiation of Section 7 consultation with the NMFS Greater Atlantic Regional Fisheries Office for the issuance of this IHA. NMFS will conclude the ESA consultation prior to reaching a determination regarding the proposed issuance of the authorization.

Proposed Authorization

As a result of these preliminary determinations, NMFS proposes to issue an IHA to Vineyard Wind for conducting construction activities south of Massachusetts for a period of one year, provided the previously mentioned mitigation, monitoring, and reporting requirements are incorporated. A draft of the proposed IHA can be found at: *www.fisheries.noaa.gov/permit/incidental-take-authorizations-under-marine-mammal-protection-act.*

Request for Public Comments

We request comment on our analyses, the proposed authorization, and any other aspect of this Notice of Proposed IHA for the proposed construction of the Vineyard Wind offshore wind project. We also request comment on the potential for renewal of this proposed IHA as described in the paragraph below. Please include with your comments any supporting data or literature citations to help inform our final decision on the request for MMPA authorization.

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

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

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

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

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

Dated: April 24, 2019.

Catherine Marzin,

Acting Director, Office of Protected Resources, National Marine Fisheries Service.

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