DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

[RTID 0648–XD687]

Takes of Marine Mammals Incidental to Specified Activities; Taking Marine Mammals Incidental to Phase 2 Construction of the Vineyard Wind 1 Offshore Wind Project Off Massachusetts

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.

SUMMARY: NMFS has received a request from Vineyard Wind LLC (Vineyard Wind) for authorization to take marine mammals incidental to the completion of the construction of a commercial wind energy project offshore Massachusetts in the northern portion of Lease Area OCS–A 0501. 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; which consists of a subset of activities for which take was authorized previously, but which Vineyard Wind did not complete within the effective dates of the previous IHA. NMFS will consider public comments prior to making any final decision on the issuance of the requested MMPA authorization and agency responses will be summarized in the final notice of our decision. The IHA would be valid for 1 year from date of issuance.

DATES: Comments and information must be received no later than May 23, 2024.

ADDRESSES: Comments should be addressed to Jolie Harrison, Chief, Permits and Conservation Division, Office of Protected Resources (OPR), NMFS and should be submitted via email to *ITP.taylor@noaa.gov.* Electronic copies of the application and supporting documents, as well as a list of the references cited in this document, may be obtained online at: *https://www.fisheries.noaa.gov/national/marine-mammal-protection/incidental-take-authorizations-other-energy-activities-renewable.* In case of problems accessing these documents, please call the contact listed below (see **FOR FURTHER INFORMATION CONTACT**).

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, including all attachments, must not exceed a 25-megabyte file size. All comments received are a part of the public record and will generally be posted online at *https://www.fisheries.noaa.gov/national/marine-mammal-protection/incidental-take-authorizations-other-energy-activities-renewable* without change. All personal identifying information (*e.g.,* name, address) voluntarily submitted by the commenter may be publicly accessible. Do not submit confidential business information or otherwise sensitive or protected information.

FOR FURTHER INFORMATION CONTACT: Jessica Taylor, OPR, NMFS, (301) 427–8401.

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 proposed or, if the taking is limited to harassment, a notice of a proposed IHA is 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 the 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 the 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 IHA) with respect to potential impacts on the human environment. NMFS participated as a cooperating agency on the Bureau of Ocean Energy Management (BOEM) 2021 Environmental Impact Statement (EIS) for the Vineyard Wind 1 Offshore Wind Project.

NMFS' proposal to issue Vineyard Wind the requested IHA constitutes a federal action subject to NEPA (42 U.S.C. 4321 *et seq.*). On May 10, 2021, NMFS adopted the Bureau of Ocean Energy Management's (BOEM) Vineyard Wind 1Final Environmental Impact Statement (FEIS), published on March 12, 2021 and available at: *https://www.boem.gov/renewable-energy/state-activities/vineyard-wind-1.* NMFS is currently evaluating if supplementation of the Vineyard Wind 1 EIS is required per 40 CFR 1502.9(d). 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 December 15, 2023, NMFS received a request from Vineyard Wind for an IHA to take marine mammals incidental to Phase 2 construction of the Vineyard Wind Offshore Wind Project off Massachusetts, specifically wind turbine generator (WTG) monopile foundation installation, in the northern portion of Lease Area OCS–A 0501. Vineyard Wind completed installation of 47 WTG monopiles and 1 electrical service platform (ESP) jacket foundation in 2023 under an IHA issued by NMFS on June 25, 2021 (86 FR 33810) with effective dates from May 1, 2023, through April 30, 2024. Due to unexpected delays, Vineyard Wind was not able to complete pile driving activities before the expiration date of the current IHA (April 30, 2024); thus, Vineyard Wind is requesting take of marine mammals incidental to installing the remaining 15 monopiles to complete foundation installation for the Project. In total, the Project will consist of 62 WTG monopiles and 1 offshore substation.

Following NMFS' review of the December 2023 application, Vineyard Wind submitted multiple revised versions of the application, and it was deemed adequate and complete on March 13, 2024. Vineyard Wind's request is for take of 14 species of marine mammals, by Level B harassment and, for 6 of these species, Level A harassment. Neither Vineyard

Wind nor NMFS expect serious injury or mortality to result from this activity and, therefore, an IHA is appropriate.

Vineyard Wind previously conducted high resolution geophysical (HRG) site characterization surveys within the Lease Area and associated export cable corridor in 2016, 2018–2021, and June–December 2023 (ESS Group *Inc.,* 2016; Vineyard Wind 2018, 2019; EPI Group, 2021; RPS, 2022; Vineyard Wind 2023a–f). During the 2023 construction season, NMFS coordinated closely with Vineyard Wind to ensure compliance with their IHA. In a few instances, NMFS raised concerns with Vineyard Wind regarding their implementation of certain required measures. NMFS worked closely with Vineyard Wind throughout the construction season to course correct, where needed, and ensure compliance with the requirements (*e.g.,* mitigation, monitoring, and reporting) of the previous IHA, and information regarding their monitoring results may be found in the Estimated Take of Marine Mammals section.

Description of Proposed Activity

Overview

Vineyard Wind proposes to construct and operate an 800-megawatt (MW) wind energy facility, the Project, in the Atlantic Ocean in Lease area OCS–A 0501, offshore of Massachusetts. The project would consist of up to 62 offshore wind turbine generators (WTGs), 1 electrical service platform (ESP), an onshore substation, offshore and onshore cabling, and onshore operations and maintenance facilities. The onshore substation and ESP are now complete. Installation of 47 monopile foundations was completed under a current IHA (86 FR 33810, June 25, 2021), effective from May 1, 2023, through April 30, 2024. However, due to unexpected, Vineyard Wind will not be able to complete pile driving activities before the expiration date of the current IHA (April 30, 2024). Take of marine mammals, in the form of behavioral harassment and limited instances of auditory injury, may occur incidental to the installation of the remaining 15 WTG monopile foundations due to in-water noise exposure resulting from impact pile driving. The remaining 15 monopile foundations would occur within a Limited Installation Area (LIA) (64.3 square kilometers (km^2; 15,888.9 acres)) within the Lease Area (264.4 km^2 (65,322.4 acres)). Installation of the remaining 15 monopile foundations is expected to occur in 2024.

Dates and Duration

The proposed pile driving activities are planned to occur in 2024 after the IHA is issued and, while not planned, may occur in June or July in 2025. Pile driving activities are estimated to require approximately 15 nonconsecutive days (30 nonconsecutive hours of pile driving). Given vessel availability, weather delay, and logistical constraints, these 15 days for installation of the remaining monopile foundations could occur close in time or spread out over months.

Although installation of a single monopile may last for several hours, active pile driving for installation of a single monopile is expected to last for a maximum of 2 hours. Up to 1 monopile may be installed per day, based upon the average pile driving time (up to 2 hours) for the installation of the currently installed 47 monopiles. Monopile foundations would be installed in batches of three to six monopiles at a time as this represents the maximum batch size that the installation vessel can carry to the LIA. After installation of a batch of three to six monopiles, there would be a 4 to 7 day pause in monopile installation to allow time for the installation vessel to return with a new batch of monopiles. No concurrent monopile installation is proposed. Vineyard Wind has proposed, and NMFS would require, that pile driving activities be prohibited from January 1 through May 31 due to the increased presence of North Atlantic right whales (NARWs) in the LIA and the timing of the project (*i.e.,* pile driving in May is not practicable). NMFS is also proposing to restrict pile driving in December to the maximum extent practicable.

Specific Geographic Region

Vineyard Wind's would construct the Project in within Federal waters off Massachusetts, in the northern portion of the Vineyard Wind Lease Area OCS–A 0501 (figure 1). This area is also referred to as the Wind Development Area (WDA). The 15 remaining monopiles would be installed in a LIA within a portion of the southwest corner of the WDA. The LIA is approximately 70.5 km^2 (17,420.9 acres) in size, as compared to the overall size of the Lease Area (264.4 km^2 (63,322.4 acres)). At its nearest point, the LIA is approximately 29 kilometers (km; 18.1 miles (mi)) from the southeast corner of Martha's Vineyard and a similar distance from Nantucket. Water depths in the WDA range from approximately 37 to 49.5 meters (m; 121–162 feet (ft)). Water depth and bottom habitat are similar throughout the Lease Area (Pyc *et al.,* 2018).

Vineyard Wind's specified activities would occur in the Northeast U.S. Continental Shelf Large Marine Ecosystem (NES LME), an area of approximately 260,000 km^2 from Cape Hatteras in the south to the Gulf of Maine in the north. Specifically, the LIA is located within the Mid-Atlantic Bight subarea of the NES LME, which extends between Cape Hatteras, North Carolina, and Martha's Vineyard, Massachusetts, extending westward into the Atlantic to the 100-m isobath. The specific geographic region includes the LIA as well as the crew transfer vessel transit corridors (see Proposed Mitigation section) and cable laying routes. The installation vessel and support vessels would conduct approximately three trips to Canada during the period of the IHA, transiting from New Bedford and nearby ports. Figure 1 shows the LIA and planned locations for the remaining 15 monopiles to be installed.

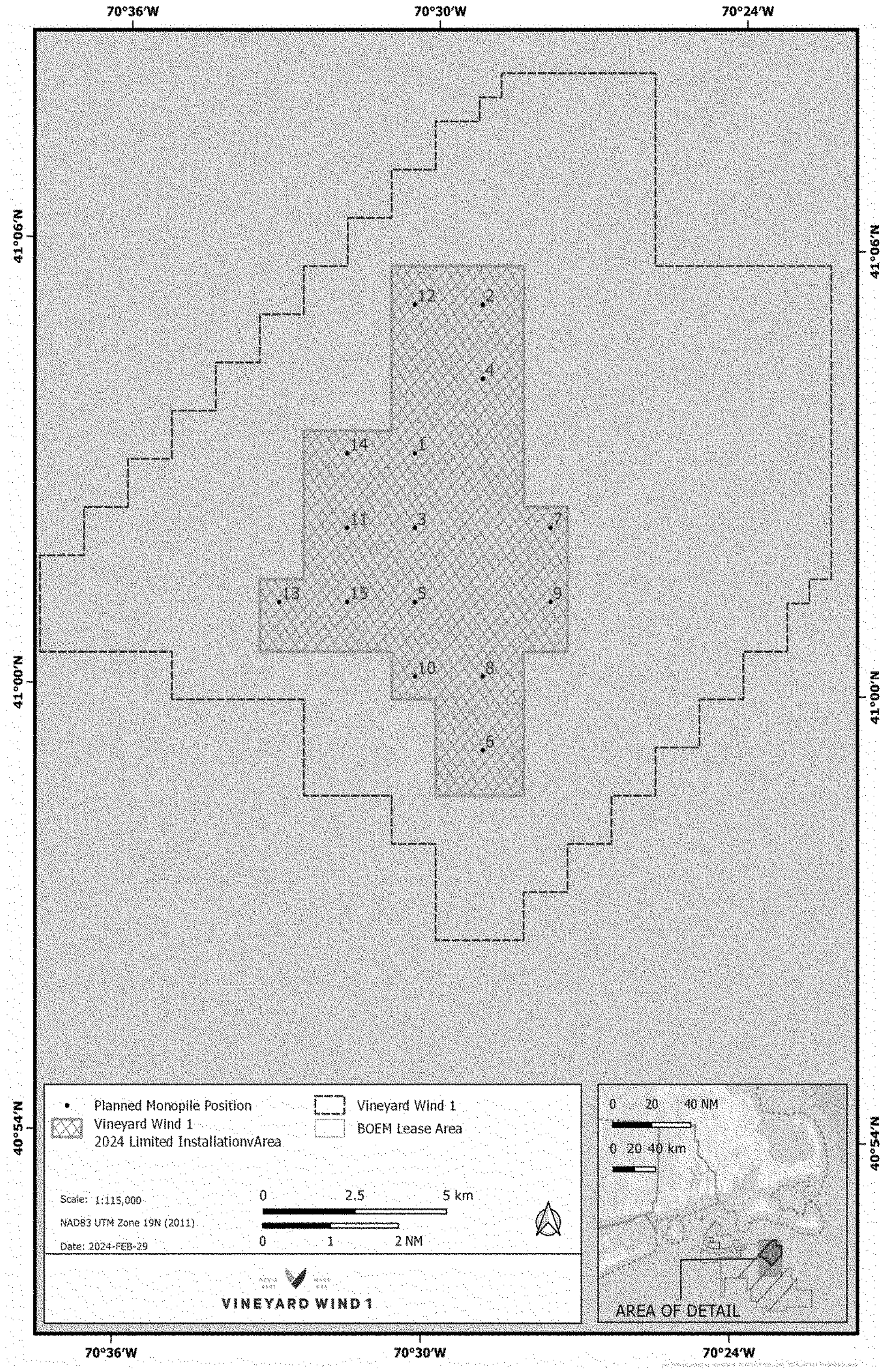

Figure 1 -- Vineyard Wind Limited Installation Area

Detailed Description of the Specified Activity

Monopile Installation

Vineyard Wind proposes to install 15 monopile WTG foundations in the LIA (figure 1) to complete the Vineyard Wind Offshore Wind Project (84 FR 18346, April 30, 2019; 86 FR 33810, June 25, 2021). Vineyard Wind assumes all monopile foundations would be installed using an impact hammer. Individual monopile installation would be sequenced according to the numbers in the cross-hatched area in figure 1.

A WTG monopile foundation typically consists of a coated single steel tubular section, with several sections of rolled steel plate welded together. Each 13–MW monopile would have a maximum diameter of 9.6 m (31.5 ft). WTGs would be arranged in a grid-like pattern within the LIA with spacing of

1.9 km (1 nautical mile (nmi)) between turbines, and driven to a maximum penetration depth of 28 m (92 ft) to 35 m (115 ft) below the seafloor (Vineyard Wind, 2023). Monopile foundations would consist of a monopile with a separate transition piece.

Monopile foundations would be installed by a heavy lift vessel. The installation vessel would upend the monopile with a crane and place it in a gripper frame before lowering the monopile foundation to the seabed (see figure 4 in IHA application). Vineyard Wind would use a Monopile Installation Tool (MPIT) to seat the monopile foundation and protect against pile gripper damage as well as risks to human safety associated with pile run. The MPIT creates buoyancy within the monopile foundation using air pressure to control lowering the monopile through the pile run risk zone (Vineyard Wind, 2023). As the monopile foundation is lowered, air is released from the top of the foundation above the water surface until the pile is stabilized within the seabed. Once the monopile is lowered to the seabed, the crane hook would be released. A hydraulic impact hammer would be placed on top of the monopile and used to drive the monopile into the seabed to the target penetration depth (28–35 m). Monopile foundations would be installed using a maximum hammer energy of 4,000 kilojoules (kJ) (table 1). Pile driving would begin with a 20-minute soft-start at reduced hammer energy (see Proposed Mitigation). The hammer energy would gradually be increased based upon resistance experienced from sediments. Prior to pile driving, the MPIT process may last from 6 to 15 hours and is dependent upon local soil conditions at each monopile foundation (Vineyard Wind, 2023). Vineyard Wind anticipates that one monopile would be installed per day at a rate of approximately 2 hours of active pile driving time per monopile (table 1). Rock scour protection would be applied after foundation installation. The scour protection would be 1–2 m high (3–6 ft), with stone or rock sizes of approximately 10–30 centimeters (4–12 inches).

While post-piling activities could be ongoing at one foundation position as pile driving is occurring at another position, no concurrent/simultaneous pile driving of foundations would occur (see *Dates and Duration* section). Installation of monopile foundations is anticipated to result in the take of marine mammals due to noise generated during pile driving. Proposed mitigation, monitoring, and reporting measures are described in detail later in this document (please see Proposed Mitigation and Proposed Monitoring and Reporting).

TABLE 1—IMPACT PILE DRIVING SCHEDULE

Pile type	Project component	Max hammer energy (kJ)	Number of hammer strikes	Max piling time duration per pile (min)	Max piling time duration per day (min)	Number piles/day
9.6-m monopile	WTG	[a] 4000	[b] 2,884	117	117	1

[a] Maximum hammer energy for representative monopiles installed during the 2023 Vineyard Wind Offshore Wind Project construction ranged from 3,227 to 3,831 kJ.

[b] Number of hammer strikes based upon the AU–38 representative monopile installed during the 2023 Vineyard Wind Offshore Wind Project construction period at a maximum hammer energy of 3,825 kJ.

After monopile installation, transition pieces, containing work platforms and other ancillary structures, and WTGs, consisting of a tower and the energy-generating components of the turbine, would be installed. Transition pieces and WTGs would be installed on top of monopile foundations using jack-up vessels. However, installation of transition pieces and WTGS on monopile foundations is not expected to result in take of marine mammals and, therefore, are not discussed further.

Vineyard Wind has developed a sequencing plan for installation of monopiles throughout the LIA, as shown in figure 1. The sequencing plan will allow for several of the monopiles located in the northeast corner of the LIA and highest density area of NARWs, to be installed first.

Vineyard Wind anticipates that it is possible for the 15 WTGs to become operational within the effective period of the IHA. Nine of the 47 WTGs previously installed in 2023 are currently operational.

Vessel Operation

Vineyard Wind would use various types of vessels over the course of the 1-year proposed IHA for foundation installation and transporting monopile batches between ports and the LIA (table 2). Construction-related vessel activity is anticipated to include approximately 20 vessels operating throughout the specified geographic area on any given work day. Many of these vessels would remain in the LIA for days or weeks at a time, making infrequent trips to port for bunkering and provisioning, as needed. Table 2 shows the type and number of vessels Vineyard Wind would use for various construction activities as well as the associated ports. Vineyard Wind would utilize ports in New London, Connecticut and New Bedford, Massachusetts (table 2) to support offshore construction, crew transfer and logistics, and other operational activities. In addition, monopile foundations would come from a Canadian port in Halifax. Monopile foundations would be transported on an installation vessel to the LIA from Canada, and would be installed in batches of three to six monopiles at a time. Upon completion of installation of a batch of monopiles, the installation vessel would return to Canada to load an additional batch of monopiles (Vineyard Wind, 2023). For the proposed activities, it is expected that the installation vessel would need to make a maximum of three trips between Canada and the LIA.

As part of vessel-based construction activities, dynamic positioning thrusters would be utilized to hold vessels in position or move slowly during monopile installation. 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. Construction-related vessel activity, including the use of dynamic positioning thrusters, is not expected to result in take of marine mammals. While a vessel strike could cause injury or mortality of a marine mammal, Vineyard Wind proposed and NMFS is proposing to require, extensive vessel strike avoidance measures that would avoid vessel strikes from occurring (see Proposed Mitigation and Proposed Monitoring and Reporting). Vineyard Wind did not request, and NMFS neither anticipates nor proposes to authorize, take associated with vessel activity, and this activity is not analyzed further.

TABLE 2—TYPE AND NUMBER OF VESSELS ANTICIPATED DURING CONSTRUCTION

Vessel type	Vessel role	Maximum number of vessels	Expected maximum number of transits per month	Port
Heavy lift vessel	Pile driving	1	2	Halifax, Canada.
Trans-shipment vessel	Bubble curtain	2	4	New London, CT.
Fishing vessel	PSO support vessel	2	3	New Bedford, MA.
	Service operations vessel	1	4	
	Safety vessel	4	2	
Motor vessel	Crew transfer vessel	2	12	

Inter-Array Cable Laying

Inter-array cables would be installed to connect WTGs to the ESP. In 2023, Vineyard Wind completed approximately 40 percent of the installation of inter-array cables in the Lease Area. Vineyard Wind anticipates approximately 50 percent of the inter-array cable laying to take place during the effective period of the IHA. Vineyard Wind would perform a pre-lay grapnel run to remove any obstructions, such as fishing gear, from the seafloor. The cable would be laid on the seafloor and buried using a jet trencher with scour added for cable protection near the transition pieces and ESPs. The sounds associated with cable laying are consistent with those of routine vessel operations and not expected to result in take of marine mammals. Inter-array cable laying activities are, therefore, not discussed further.

Other Activities

Vineyard Wind would not conduct high-resolution geophysical (HRG) surveys, UXO/MEC detonation, or fishery research surveys under this IHA.

Description of Marine Mammals in the Area of Specified Activities

Thirty-eight marine mammal species, comprising 39 stocks, under NMFS' jurisdiction have geographic ranges within the western North Atlantic OCS (Hayes *et al.,* 2023). However, for reasons described below, Vineyard Wind has requested, and NMFS proposes to authorize, take of only 14 species (comprising 14 stocks) of marine mammals. Sections 3 and 4 of the application summarize available information regarding status and trends, distribution and habitat preferences, and behavior and life history of the potentially affected species. NMFS fully considered all of this information, and we refer the reader to these descriptions, instead of reprinting the information. See **ADDRESSES**. Additional information regarding population trends and threats may be found in NMFS' Stock Assessment Reports (SARs; *https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-stock-assessments*) and more general information about these species (*e.g.,* physical and behavioral descriptions) may be found on NMFS' website (*https://www.fisheries.noaa.gov/find-species*).

Table 3 lists all species or stocks for which take is expected and proposed to be authorized for this activity and summarizes information related to the population or stock, including regulatory status under the MMPA and Endangered Species Act (ESA) and potential biological removal (PBR), where known. 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; 16 U.S.C. 1362(20)). While no serious injury or mortality is anticipated or proposed to be authorized here, PBR and annual serious injury and mortality from anthropogenic sources are included here as gross indicators of the status of the species or stocks and other threats. Four of the marine mammal species for which take is requested are listed as endangered under the ESA, including the NARW, fin whale, sei whale, and sperm whale.

Marine mammal abundance estimates presented in this document represent the total number of individuals that make up a given stock or the total number estimated within a particular study or survey area. NMFS' stock abundance estimates for most species represent the total estimate of individuals within the geographic area, if known, that comprise that stock. For some species, this geographic area may extend beyond U.S. waters. All managed stocks in this region are assessed in NMFS' U.S. 2023 draft SARs and NMFS' U.S. 2022 SARs. 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 United States waters and 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. All values presented in table 3 are the most recent available at the time of publication and are available online at: *https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-stock-assessments.*

TABLE 3—MARINE MAMMAL SPECIES THAT MAY OCCUR IN THE LIA AND BE TAKEN BY HARASSMENT

Common name [a]	Scientific name	Stock	ESA/MMPA status; strategic (Y/N) [b]	Stock abundance (CV, N_{min}, most recent abundance survey) [c]	PBR	Annual M/SI [d]
Order Artiodactyla—Cetacea—Mysticeti (baleen whales)						
Family Balaenidae:						
NARW	*Eubalaena glacialis*	Western Atlantic	E, D, Y	340 (0; 337; 2021) [e]	0.7	27.2 [f]
Family Balaenopteridae (rorquals):						
Fin whale	*Balaenoptera physalus*	Western North Atlantic	E, D, Y	6,802 (0.24, 5,573, 2021)	11	2.05
Sei whale	*Balaenoptera borealis*	Nova Scotia	E, D, Y	6,292 (1.02, 3098, 2021)	6.2	0.6
Minke whale	*Balaenoptera acutorostrata.*	Canadian Eastern Coastal	-, -, N	21,968 (0.31, 17,002, 2021).	170	9.4
Humpback whale	*Megaptera novaeangliae*	Gulf of Maine	-, -, Y	1,396 (0, 1,380, 2016)	22	12.15
Superfamily Odontoceti (toothed whales, dolphins, and porpoises)						
Family Physeteridae:						
Sperm whale	*Physeter macrocephalus*	North Atlantic	E, D, Y	5,895 (0.29, 4,639, 2021)	9.28	0.2
Family Delphinidae:						
Long-finned pilot whale	*Globicephala melas*	Western North Atlantic	-, -, N	39,215 (0.3, 30,627, 2021).	306	5.7
Bottlenose dolphin	*Tursiops truncatus*	Western North Atlantic Offshore	-, -, N	64,587 (0.24, 52,801, 2021) [g].	507	28
Common dolphin	*Delphinus delphis*	Western North Atlantic	-, -, N	93,100 (0.56, 59,897, 2021).	1,452	414
Risso's dolphin	*Grampus griseus*	Western North Atlantic	-, -, N	44,067 (0.19, 30,662, 2021).	307	18
Atlantic white-sided dolphin	*Lagenorhynchus acutus*	Western North Atlantic	-, -, N	93,233 (0.71, 54,443, 2021).	544	28
Family Phocoenidae (porpoises):						
Harbor porpoise	*Phocoena phocoena*	Gulf of Maine/Bay of Fundy	-, -, N	85,765 (0.53, 56,420, 2021).	649	145
Order Carnivora—Pinnipedia						
Family Phocidae (earless seals):						
Harbor seal	*Phoca vitulina*	Western North Atlantic	-, -, N	61,336 (0.08, 57,637, 2018).	1,729	339
Gray seal [h]	*Halichoerus grypus*	Western North Atlantic	-, -, N	27,911 (0.2, 23,924, 2021).	1,512	4,570

[a] Information on the classification of marine mammal species can be found on the web page for The Society for Marine Mammalogy's Committee on Taxonomy (*https://marinemammalscience.org/science-and-publications/list-marine-mammal-species-subspecies;* Committee on Taxonomy, 2023).
[b] ESA status: Endangered (E), Threatened (T)/MMPA status: Depleted (D). A dash (-) indicates that the species is not listed under the ESA or designated as depleted under the MMPA. Under the MMPA, a strategic stock is one for which the level of direct human-caused mortality exceeds PBR, or which is determined to be declining and likely to be listed under the ESA within the foreseeable future. Any species or stock listed under the ESA is automatically designated under the MMPA as depleted and as a strategic stock.
[c] NMFS 2022 marine mammal SARs online at: *https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-stock-assessments.* CV is the coefficient of variation; N_{min} is the minimum estimate of stock abundance.
[d] These values, found in NMFS's SARs, represent annual levels of human-caused mortality plus serious injury from all sources combined (*e.g.,* commercial fisheries, ship strike).
[e] The draft 2023 SAR includes an estimated population (N_{best} 340) based on sighting history through December 2021 (89 FR 5495, January 29, 2024). In October 2023, NMFS released a technical report identifying that the NARW population size based on sighting history through 2022 was 356 whales, with a 95 percent credible interval ranging from 346 to 363 (Linden, 2023).
[f] Total annual average observed NARW mortality during the period 2017–2021 was 7.1 animals and annual average observed fishery mortality was 4.6 animals. Numbers presented in this table (27.2 total mortality and 17.6 fishery mortality) are 2016–2020 estimated annual means, accounting for undetected mortality and serious injury.
[g] As noted in the draft 2023 SAR (89 FR 5495, January 29, 2024), abundance estimates may include sightings of the coastal form.
[h] NMFS' stock abundance estimate (and associated PBR value) applies to the U.S. population only. Total stock abundance (including animals in Canada) is approximately 394,311. The annual M/SI value given is for the total stock.

As indicated above, all 14 species (with 14 managed stocks) in table 3 temporally and spatially co-occur with the activity to the degree that take is expected to occur. The following species are not expected to occur in the LIA due to their known distributions, preferred habitats, and/or known temporal and spatial occurrences: the blue whale (*Balaenoptera musculus*), northern bottlenose whale (*Hyperoodon ampullatus*), false killer whale (*Pseudorca crassidens*), pygmy killer whale (*Feresa attenuata*), melon-headed whale (*Peponocephala electra*), dwarf and pygmy sperm whales (*Kogia* spp.), killer whale (*Orcinus orca*), Cuvier's beaked whale (*Ziphius cavirostris*), four species of Mesoplodont whale (*Mesoplodon densitostris, M. europaeus, M. mirus,* and *M. bidens*), Fraser's dolphin (*Lagenodelphis hosei*), Clymene dolphin (*Stenella clymene*), spinner dolphin (*Stenella longirostris*), rough-toothed dolphin (*Steno bredanensis*), Atlantic spotted dolphin (*Stenella frontalis*), pantropical spotted dolphin (*Stenella attenuata*), short-finned pilot whale (*Globicephala macrorhynchus*), striped dolphin (*Stenella coeruleoalba*), white-beaked dolphin (*Lagenorhynchus albirostris*), and hooded seal (*Crysophora cristata*). None of these species were observed during the 2023 construction season or during previous site assessment/characterization surveys (Vineyard Wind, 2018, 2019, 2023a–f). Due to the lack of sightings of these species in the MA Wind Energy Area (WEA) (Kenney and Vigness-Raposa, 2010; ESS Group, *Inc.,* 2016; Kraus *et al.,* 2016; Vineyard Wind, 2018; 2019; O'Brien *et al.,* 2020, 2021, 2022, 2023; EPI Group, 2021; Palka *et al.,* 2017 2021; RPS, 2022; Vineyard Wind, 2023a–f; Hayes *et al.,* 2023) as well as documented habitat preferences and distributions, we have determined that each of these species will not be considered further. Furthermore, the northern limit of the northern migratory coastal stock of the common bottlenose dolphin (*Tursiops truncatus*) does not extend as far north as the LIA. Thus, take is only proposed for the offshore stock which may occur within the LIA. Although harp seals (*Pagophilus groenlandicus*) are expected to occur within the WDA, no harp seals were observed by Protected Species Observers (PSOs) during Vineyard Wind's site characterization surveys (2016, 2018–2021; ESS Group, *Inc.,* 2016; Vineyard Wind, 2018, 2019) nor during the 2023 construction campaign (Vineyard Wind, 2023a-f). Thus, Vineyard Wind did not request, and NMFS is not proposing to authorize, take for this species.

In addition to what is included in sections 3 and 4 of Vineyard Wind's ITA application (Vineyard Wind, 2023), the SARs (*https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-stock-assessments*), and NMFS' website (*https://www.fisheries.noaa.gov/species-directory/marine-mammals*), we provide further detail below informing the baseline for select species (*e.g.,* information regarding current unusual mortality events (UMEs) and known important habitat areas, such as biologically important areas (BIAs; *https://oceannoise.noaa.gov/biologically-important-areas*) (Van Parijs, 2015)). There are no ESA-designated critical habitats for any species within the LIA (*https://www.fisheries.noaa.gov/resource/map/national-esa-critical-habitat-mapper*). Any areas of known biological importance (including the BIAs identified in LaBrecque *et al.,* 2015) that overlap spatially (or are adjacent) with the LIA are addressed in the species sections below.

Under the MMPA, a UME is defined as ''a stranding that is unexpected; involves a significant die-off of any marine mammal population; and demands immediate response'' (16 U.S.C. 1421h(6)). As of January 2024, three UMEs are occurring along the U.S. Atlantic coast for NARWs, humpback whales, and minke whales. Of these, the most relevant to the LIA are the NARW and humpback whale UMEs given the prevalence of these species in Southern New England (SNE). Below, we include information for a subset of the species that presently have an active or recently closed UME occurring along the Atlantic coast or for which there is information available related to areas of biological significance. More information on UMEs, including all active, closed, or pending, can be found on NMFS' website at *https://www.fisheries.noaa.gov/national/marine-life-distress/active-and-closed-unusual-mortality-events.*

North Atlantic Right Whale

The NARW has been listed as Endangered since the ESA's enactment in 1973. The species was recently uplisted from Endangered to Critically Endangered on the International Union for Conservation of Nature Red List of Threatened Species (Cooke, 2020). The uplisting was due to a decrease in population size (Pace *et al.,* 2017), an increase in vessel strikes and entanglements in fixed fishing gear (Daoust *et al.,* 2017; Davis & Brillant, 2019; Knowlton *et al.,* 2012; Knowlton *et al.,* 2022; Moore *et al.,* 2021; Sharp *et al.,* 2019), and a decrease in birth rate (Pettis *et al.,* 2022; Reed *et al.,* 2022). The western Atlantic stock is considered depleted under the MMPA (Hayes *et al.,* 2023). There is a recovery plan (NMFS, 2005) for the NARW, and NMFS completed 5-year reviews of the species in 2012, 2017, and 2022, which concluded no change to the listing status is warranted.

The NARW population had only a 2.8-percent recovery rate between 1990 and 2011 and an overall abundance decline of 23.5 percent from 2011 to 2019 (Hayes *et al.,* 2023). Since 2011, the NARW population has been in decline; however, the sharp decrease observed from 2015 to 2020 appears to have slowed, though the right whale population continues to experience annual mortalities above recovery thresholds (Pace *et al.,* 2017; Pace *et al.,* 2021; Linden, 2023). NARW calving rates dropped from 2017 to 2020 with zero births recorded during the 2017–2018 season. The 2020–2021 calving season had the first substantial calving increase in 5 years with 20 calves born (including 2 mortalities) followed by 15 calves during the 2021–2022 calving season and 12 births (including 1 mortality) in 2022–2023 calving season. These data demonstrate that birth rates are increasing. However, mortalities continue to outpace births (Linden, 2023). Best estimates indicate fewer than 70 reproductively active females remain in the population and adult females experience a lower average survival rate than males (Linden, 2023). In 2023, the total annual average observed NARW mortality increased from 8.1 (which represents 2016–2020) to 31.2 (which represents 2015–2019), however, this updated estimate also accounts for undetected mortality and serious injury (Hayes *et al.,* 2023). Although the predicted number of deaths from the population are lower in recent years (2021–2022) when compared to the high number of deaths from 2014 to 2020, suggesting a short-term increase in survival, annual mortality rates still exceed PBR (Linden, 2023).

NMFS' regulations at 50 CFR 224.105 designated Seasonal Management Areas (SMAs) for NARWs in 2008 (73 FR 60173, October 10, 2008). SMAs were developed to reduce the threat of collisions between vessels and NARWs. A portion of the Block Island SMA, which occurs off Block Island, Rhode Island, is near the LIA (approximately 4.3 km (2.7 mi) southwest of the OCS–A 0501 Lease Area at the closest point), but does not overlap spatially with the Lease Area or LIA. This SMA is active from November 1 through April 30 of each year, and may be used by NARWs for migrating and/or feeding. As noted below, NMFS is proposing changes to the NARW speed rule (87 FR 46921, August 1, 2022). NMFS has designated critical habitat for NARWs (81 FR 4838, January 27, 2016), along the U.S. southeast coast for calving as well as in the northeast, just east of the LIA. The LIA both spatially and temporally overlaps a portion of a migratory corridor BIA (LaBrecque *et al.,* 2015). Due to the current status of NARWs and the spatial proximity of the proposed project with areas of biological significance, (*i.e.,* a migratory corridor, SMA), the potential impacts of the proposed project on NARWs warrant particular attention.

NARWs range from calving grounds in the southeastern United States to feeding grounds in New England waters and into Canadian waters (Hayes *et al.,* 2023). Surveys have demonstrated the existence of seven areas where NARWs congregate seasonally in Georges Bank, off Cape Cod, and in Massachusetts Bay (Hayes *et al.,* 2023). In late fall (*i.e.,* November), a portion of the NARW population (including pregnant females) typically departs the feeding grounds in the North Atlantic, moves south along the migratory corridor BIA, including through the LIA, to calving grounds off Georgia and Florida. This movement is followed by a northward migration (primarily mothers with young calves) into northern feeding areas in March and April (LaBrecque *et al.,* 2015; Van Parijs, 2015). Recent research indicates our understanding of their movement patterns remains incomplete and not all of the population undergoes a consistent annual migration (Davis *et al.,* 2017; Gowan *et al.,* 2019; Krzystan *et al.,* 2018). Non-calving females may remain in the feeding grounds during the winter in the years preceding and following the birth of a calf to increase their energy stores (Gowen *et al.,* 2019). NARWs may migrate through the LIA to access more northern feeding grounds or southern calving grounds.

NARWs may occur year-round in SNE, near Martha's Vineyard and Nantucket Shoals as well as throughout the Massachusetts and Rhode Island/Massachusetts Wind Energy Areas (MA and RI/MA WEAs) (Quintan-Rizzo *et al.,* 2021; O'Brien *et al.,* 2023; Van Parijs *et al.,* 2023). Kraus *et al.* (2016) found acoustic detections in SNE to peak during the winter and early spring (January through March). Visual surveys (Quintana-Rizzo *et al.,* 2021) have also confirmed the abundance of NARWs in SNE to be the highest during the winter and spring (January through May), although peaks in acoustic detections may vary seasonally across years (Quintana-Rizzo *et al.,* 2021; Estabrook *et al.,* 2022). Distribution throughout SNE may vary seasonally with NARW occurrence being closest to the LIA during the spring (Quintana-Rizzo *et al.,* 2021). Van Parijs *et al.* (2023) monitored acoustic detections of baleen whales throughout SNE and detected NARWs near the LIA from January through May. Acoustic detections began to increase near the LIA in November and further increased into December (Van Parijs *et al.,* 2023).

An 8-year analysis of NARW sightings within SNE showed that the NARW distribution has been shifting (Quintana-Rizzo *et al.,* 2021). NARWs feed primarily on the copepod, *Calanus finmarchicus,* a species whose availability and distribution has changed both spatially and temporally over the last decade due to an oceanographic regime shift that has been ultimately linked to climate change (Meyer-Gutbrod *et al.,* 2021; Record *et al.,* 2019; Sorochan *et al.,* 2019). This distribution change in prey availability has led to shifts in NARW habitat-use patterns over the same time period (Davis *et al.,* 2020; Meyer-Gutbrod *et al.,* 2022; Quintano-Rizzo *et al.,* 2021; O'Brien *et al.,* 2022; Pendleton *et al.,* 2022; Van Parijs *et al.,* 2023), with reduced use of foraging habitats in the Great South Channel and Bay of Fundy and increased use of habitats within Cape Cod Bay and a region south of Martha's Vineyard and Nantucket Islands (Stone *et al.,* 2017; Mayo *et al.,* 2018; Ganley *et al.,* 2019; Record *et al.,* 2019; Meyer-Gutbrod *et al.,* 2021; Van Parijs *et al.,* 2023). Pendleton *et al.* (2022) observed shifts in the timing of NARW peak habitat use in Cape Cod Bay during the spring, likely in response to changing seasonal conditions, and characterized SNE as a ''waiting room'' for NARWs in the spring, providing sufficient, although sub-optimal, prey choices while the NARWs wait for foraging conditions in Cape Cod Bay (and other primary foraging grounds such as the Great South Channel) to optimize as seasonal primary and secondary production progresses.

While Nantucket Shoals is not designated as critical NARW habitat, its importance as a foraging habitat is well established (Leiter *et al.,* 2017; Quintana-Rizzo *et al.,* 2021; Estabrook *et al.,* 2022; O'Brien *et al.,* 2022). Nantucket Shoals' unique oceanographic and bathymetric features, including a persistent tidal front, help sustain year-round elevated phytoplankton biomass, and aggregate zooplankton prey for NARWs (Quintana-Rizzo *et al.,* 2021). SNE serves as a foraging habitat throughout the year, although not to the extent provided seasonally in more well-understood feeding habitats like Cape Cod Bay in late spring, the Great South Channel, and the Gulf of St. Lawrence (O'Brien *et al.,* 2022). A BIA for foraging (LaBrecque *et al.,* 2015) within Cape Cod Bay is approximately 71 km (44.1 mi) north of the LIA, while critical habitat northeast of Martha's Vineyard and Nantucket Island is within 56 km (34.8 mi). SNE also represents socializing habitat for NARWs as Leiter *et al.* (2017) documented surface active groups (SAGs), indicative of socializing behavior, year-round in SNE.

Observations of NARW transitions in habitat use, variability in seasonal presence in identified core habitats, and utilization of habitat outside of previously focused survey effort prompted the formation of a NMFS' Expert Working Group, which identified current data collection efforts, data gaps, and provided recommendations for future survey and research efforts (Oleson *et al.,* 2020). In addition, extensive data gaps that were highlighted in a recent report by the National Academy of Sciences (NAS, 2023) have prevented development of a thorough understanding of NARW foraging ecology in the Nantucket Shoals region. However, it is clear that the habitat was historically valuable to the species, given that the whaling industry capitalized on consistent NARW occurrence there, and has again become increasingly so over the last decade.

Since 2017, 125 dead, seriously injured, or sublethally injured or ill NARWs along the United States and Canadian coasts have been documented, necessitating a UME declaration in 2017 and subsequent investigation. The leading category for the cause of death for this ongoing UME is ''human interaction,'' specifically from entanglements or vessel strikes. As of April 9, 2024, there have been 39 confirmed mortalities, 1 pending mortality (dead, stranded, or floaters), and 34 seriously injured free-swimming whales for a total of 73 whales. Beginning on October 14, 2022, the UME also considers animals with sublethal injury or illness bringing the total number of whales in the UME to 125. Approximately 42 percent of the population is known to be in reduced health (Hamilton *et al.,* 2021) likely contributing to smaller body sizes at maturation, making them more susceptible to threats and reducing fecundity (Moore *et al.,* 2021; Reed *et al.,* 2022; Stewart *et al.,* 2022; Pirotta *et al.,* 2024). Pirotta *et al.* (2024) found an association between the decreased mean length of female NARWs and reduced calving probability. More information about the NARW UME is available online at *https://www.fisheries.noaa.gov/national/marine-life-distress/2017-2024-north-atlantic-right-whale-unusual-mortality-event.*

On August 1, 2022, NMFS announced proposed changes to the existing NARW vessel speed regulations to further reduce the likelihood of mortalities and serious injuries to endangered right whales from vessel collisions, which are a leading cause of the species' decline and a primary factor in the ongoing Unusual Mortality Event (87 FR 46921, August 1, 2022). Should a final vessel speed rule be issued and become effective during the effective period of this IHA (or any other MMPA incidental take authorization), the authorization holder would be required to comply with any and all applicable requirements contained within the final rule. Specifically, where measures in any final vessel speed rule are more protective or restrictive than those in this or any other MMPA authorization, authorization holders would be required to comply with the requirements of the rule. Alternatively, where measures in this or any other MMPA authorization are more restrictive or protective than those in any final vessel speed rule, the measures in the MMPA authorization would remain in place. These changes would become effective immediately upon the effective date of any final vessel speed rule and would not require any further action on NMFS's part.

Humpback Whale

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. On September 8, 2016, NMFS divided the once single species into 14 distinct population segments (DPS), removed the 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 whales that is expected to occur in the LIA. Bettridge *et al.* (2015) estimated the size of the West Indies DPS population at 12,312 (95 percent confidence interval 8,688–15,954) whales in 2004–2005, which is consistent with previous population estimates of approximately 10,000–11,000 whales (Stevick *et al.,* 2003; Smith *et al.,* 1999) and the increasing trend for the West Indies DPS (Bettridge *et al.,* 2015).

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

Kraus *et al.* (2016) conducted aerial surveys from 2011–2015 in SNE and observed humpback whales during all seasons, yet humpback whales were observed most often during the spring and summer. The greatest number of sightings occurred during the month of April (*n*=33) (Kraus *et al.,* 2016). Calves, feeding behavior, and courtship behavior were observed as well. More recent studies (O'Brien *et al.,* 2020, 2021, 2022, 2023) confirm that humpback whales peak in abundance in the LIA during spring and summer, with the majority of sightings year-round occurring in the eastern portion of the MA and RI/MA WEAs and near the Nantucket Shoals area (O'Brien *et al.,* 2020). O'Brien *et al.* (2022) identified seasonal distribution patterns of humpback whales throughout SNE with more concentrated sightings near Nantucket Shoals in the fall and sightings being distributed more evenly across the MA and RI/MA WEAs during spring and summer. As observed during the 2011–2015 surveys, O'Brien *et al.* (2023) also observed feeding behavior and mother/calf pairs throughout the spring and summer. Van Parijs *et al.* (2023) detected humpback whales near the LIA mainly from November through June. During the Vineyard Wind 2023 construction campaign, visual and acoustic detections of humpback whales occurred mainly from June through October, with the greatest detections occuring in October (Vineyard Wind, 2023).

The LIA does not overlap with any BIAs or other important areas for the humpback whales. A humpback whale feeding BIA extends throughout the Gulf of Maine, Stellwagen Bank, and Great South Channel from May through December, annually (LaBrecque *et al.,* 2015). This BIA is located approximately 73 km (45.5 mi) northeast of the Lease Area and would not likely be impacted by project activities.

Since January 2016, elevated humpback whale mortalities along the Atlantic coast from Maine to Florida led to the declaration of a UME in April 2017. As of April 9, 2024, 218 humpback whales have stranded as part of this UME. Partial or full necropsy examinations have been conducted on approximately 90 of the known cases. Of the whales examined, about 40 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. Since January 1, 2023, 43 humpbacks have stranded along the east coast of the United States (7 of these whales have stranded off Massachusetts). These whales may have been following their prey (small fish) which were reportedly close to shore this past winter. These prey also attract fish that are targeted by recreational and commercial fishermen, which increases the number of boats in these areas. More information is available at *https://www.fisheries.noaa.gov/national/marine-life-distress/active-and-closed-unusual-mortality-events.*

Fin Whale

Fin whales frequently occur in the waters of the U.S. Atlantic Exclusive Economic Zone (EEZ), principally from Cape Hatteras, North Carolina northward and are distributed in both continental shelf and deep-water habitats (Hayes *et al.,* 2023). Although fin whales are present north of the 35-degree latitude north region in every season and are broadly distributed throughout the western North Atlantic for most of the year, densities vary seasonally (Edwards *et al.,* 2015; Hayes *et al.,* 2023). Fin whales typically feed in the Gulf of Maine and the waters surrounding New England, but their mating and calving (and general wintering) areas are largely unknown (Hain *et al.,* 1992; Hayes *et al.,* 2023). Acoustic detections of fin whale singers augment and confirm these visual sighting conclusions for males. Recordings from Massachusetts Bay, New York Bight, and deep-ocean areas have detected some level of fin whale singing from September through June (Watkins *et al.,* 1987; Clark and Gagnon, 2002; Morano *et al.,* 2012). These acoustic observations from both coastal and deep-ocean regions support the conclusion that male fin whales are broadly distributed throughout the western North Atlantic for most of the year (Hayes *et al.,* 2022).

New England waters represent a major feeding ground for fin whales, and fin whale feeding BIAs occur offshore of Montauk Point, New York, from March to October (2,933 km^2) (Hain *et al.,* 1992; LaBrecque *et al.,* 2015) and year-round in the southern Gulf of Maine (18,015 km^2). Aerial surveys conducted from 2011–2015 in SNE documented fin whale occurrence in every season, with the greatest numbers of sightings during the spring (*n*=35) and summer (*n*=49) months (Kraus *et al.,* 2016). Fin whale distribution varied seasonally, with fin whales occurring in the southern regions of the MA and RI/MA WEAs during spring and closer to northern regions of the WEAs during summer (Kraus *et al.,* 2016). More recent surveys have documented fin whales throughout winter, spring, and summer (O'Brien *et al.,* 2020, 2021, 2022, 2023) with the greatest abundance occurring during the summer and clustered in the western portion of the WEAs (O'Brien *et al.,* 2023). Acoustic detection of fin whales in SNE indicate fin whale presence in the area from August through April and, sporadically, from May through July (Parijs *et al.,* 2023). During the 2023 construction campaign, Vineyard Wind detected fin whales from June through December (with the exception of August), with the most detections occurring in October (Vineyard Wind, 2023). Based upon observations of feeding behavior and the close proximity of the Lease Area to the feeding BIAs (8.0 km (5.0 mi) and 76.4 km (47.5 mi) to the Montauk Point and southern Gulf of Maine BIAs, respectively) fin whales may use the LIA for foraging as well as migrating.

Minke Whale

Minke whales are common and widely distributed throughout the U.S. Atlantic EEZ (Cetacean and Turtle Assessment Program (CETAP), 1982; Hayes *et al.,* 2022), although their distribution has a strong seasonal component. Individuals have often been detected acoustically in shelf waters from spring to fall and more often detected in deeper offshore waters from winter to spring (Risch *et al.,* 2013). Minke whales are abundant in New England waters from May through September (Pittman *et al.,* 2006; Waring *et al.,* 2014), yet largely absent from these areas during the winter, suggesting the possible existence of a migratory corridor (LaBrecque *et al.,* 2015). A migratory route for minke whales transiting between northern feeding grounds and southern breeding areas may exist to the east of the LIA, as minke whales may track warmer waters along the continental shelf while migrating (Risch *et al.,* 2014). Risch *et al.* (2014) suggests the presence of a minke whale breeding ground offshore of the southeastern US during the winter.

There are two minke whale feeding BIAs identified in the southern and southwestern section of the Gulf of Maine, including Georges Bank, the Great South Channel, Cape Cod Bay and Massachusetts Bay, Stellwagen Bank, Cape Anne, and Jeffreys Ledge from March through November, annually (LaBrecque *et al.,* 2015). The nearest BIA is approximately 44.0 km (27.3 mi) northeast of the Lease Area. Due to the close proximity of the BIA, minke whale feeding may occur within the LIA.

Although minke whales are sighted in every season in SNE (O'Brien *et al.,* 2022), minke whale use of the area is highest during the months of March through September (Kraus *et al.,* 2016; O'Brien *et al.,* 2023). Large feeding aggregations of humpback, fin, and minke whales have been observed during the summer (O'Brien *et al.,* 2023), suggesting the LIA may serve as a supplemental feeding grounds for these species. Acoustic detections data support visual sighting data, and indicate minke whale presence in SNE from March through June and August through late November/early December and, sporadically, in January (Parijs *et al.,* 2023). During the 2023 construction campaign, Vineyard Wind detected minke whales from June through August (Vineyard Wind, 2023).

From 2017 through 2024, elevated minke whale mortalities detected along the Atlantic coast from Maine through South Carolina resulted in the declaration of a UME in 2018. As of April 9, 2024, a total of 166 minke whale mortalities have occurred during this 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 minke whales examined, so more research is needed. More information is available at *https://www.fisheries.noaa.gov/national/marine-life-distress/2017-2022-minke-whale-unusual-mortality-event-along-atlantic-coast.*

Sei Whale

The Nova Scotia stock of sei whales can be found in deeper waters of the continental shelf edge of the eastern United States and northeastward to south of Newfoundland (Mitchell, 1975; Hain *et al.,* 1985; Hayes *et al.,* 2022). During spring and summer, the stock is mainly concentrated in northern feeding areas, including the Scotian Shelf (Mitchell and Chapman, 1977), the Gulf of Maine, Georges Bank, the Northeast Channel, and south of Nantucket (CETAP, 1982; Kraus *et al.,* 2016; Roberts *et al.,* 2016; Palka *et al.,* 2017; Cholewiak *et al.,* 2018; Hayes *et al.,* 2022). Sei whales have been detected acoustically along the Atlantic Continental Shelf and Slope from south of Cape Hatteras, North Carolina to the Davis Strait, with acoustic occurrence increasing in the mid-Atlantic region since 2010 (Davis *et al.,* 2020). Sei whale migratory movements are not well understood. In June and July, sei whales are believed to migrate north from SNE to feeding areas in eastern Canada, and south in September and October to breeding areas (Mitchell, 1975; CETAP, 1982; Davis *et al.,* 2020). Sei whales generally occur offshore; however, individuals may also move into shallower, more inshore waters (Payne *et al.,* 1990; Halpin *et al.,* 2009; Hayes *et al.,* 2022). A sei whale feeding BIA occurs in New England waters from May through November, approximately 101.4 km (63 mi) east of the LIA (LaBrecque *et al.,* 2015).

Aerial surveys conducted from 2011–2015 in SNE observed sei whales between March and June, with the greatest number of sightings occurring in May (n=8) and June (n=13), and no sightings from July through January (Kraus *et al.,* 2016). Acoustic detections confirm peak occurrences of sei whales in SNE from early spring and through mid-summer (March through July) (Davis *et al.,* 2020). In addition, Van Parijs *et al.* (2023) acoustically detected sei whales near the LIA during the months of February and August. However, Davis *et al.* (2020) acoustically detected sei whales in SNE year-round, suggesting this area is an important habitat for sei whales. As sei whales are known to target the prey such as copepods (*C. finmarchicus*), which are abundant in SNE waters (Quintana-Rizzo *et al.,* 2018), SNE likely represents a supplemental foraging area for sei whales as well.

Phocid Seals

Harbor and gray seals have experienced multiple UMEs since 2018. From June through July 2022, elevated numbers of harbor seal and gray seal mortalities occurred across the southern and central coast of Maine. This event was declared a UME. During the event, 181 seals stranded. Based upon necropsy, histopathology, and diagnostic findings, this UME was attributed to spillover events of the highly pathogenic avian influenza from infected birds to harbor and gray seals. While the UME did not occur in the LIA, the populations that were affected by the UME are the same as those potentially affected by the project. This UME has recently been closed. Information on this UME is available online at *https://www.fisheries.noaa.gov/2022-2023-pinniped-unusual-mortality-event-along-maine-coast.*

The above event was preceded by a different UME, occurring from 2018 to 2020 (closure of the 2018–2020 UME is pending). Beginning in July 2018, elevated numbers of harbor seal and gray seal mortalities occurred across Maine, New Hampshire, and Massachusetts. Additionally, stranded seals have shown clinical signs as far south as Virginia, although not in elevated numbers, therefore the UME investigation encompassed all seal strandings from Maine to Virginia. A total of 3,152 reported strandings (of all species) occurred from July 1, 2018, through March 13, 2020. 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, which is pending closure. Information on this UME is available online at: *https://www.fisheries.noaa.gov/new-england-mid-atlantic/marine-life-distress/2018-2020-pinniped-unusual-mortality-event-along.*

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. 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 hearing groups based on directly measured (behavioral or auditory evoked potential techniques) or estimated hearing ranges (behavioral response data, anatomical modeling, *etc.*). 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 4.

TABLE 4—MARINE MAMMAL HEARING GROUPS

[NMFS, 2018]

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

* Represents the generalized hearing range for the entire group as a composite (*i.e.,* all species within the group), where individual species' hearing ranges are typically not as broad. Generalized hearing range chosen based on the ~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 *et al.,* 2013).

For more detail concerning these groups and associated frequency ranges, please see NMFS (2018) for a review of available information.

Potential Effects of Specified Activities on Marine Mammals and Their Habitat

This section provides a discussion of the ways in which components of the specified activity may impact marine mammals and their habitat. The Estimated Take of Marine Mammals 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 of Marine Mammals 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 whether those impacts are reasonably expected to, or reasonably likely to, adversely affect the species or stock through effects on annual rates of recruitment or survival.

Vineyard Wind has requested, and NMFS proposes to authorize, the take of marine mammals incidental to the construction activities associated with the LIA. In their application, Vineyard Wind presented their analyses of potential impacts to marine mammals from the acoustic sources. NMFS carefully reviewed the information provided by Vineyard Wind, as well as independently reviewed applicable scientific research and literature and other information to evaluate the potential effects of the Project's activities on marine mammals.

The proposed activities would result in the construction and placement of 15 permanent foundations to support WTGs. There are a variety of types and degrees of effects to marine mammals, prey species, and habitat that could occur as a result of the Project. Below we provide a brief description of the types of sound sources that would be generated by the project, the general impacts from these types of activities, and an analysis of the anticipated impacts on marine mammals from the project, with consideration of the proposed mitigation measures.

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: Au and Hastings, 2008; Richardson *et al.,* 1995; Urick, 1983; as well as the Discovery of Sound in the Sea (DOSITS) website at *https://www.dosits.org.* Sound is a vibration that travels as an acoustic wave through a medium such as a gas, liquid, or solid. Sound waves alternately compress and decompress the medium as the wave travels. These compressions and decompressions are detected as changes in pressure by aquatic life and man-made sound receptors such as hydrophones (underwater microphones). In water, sound waves radiate in a manner similar to ripples on the surface of a pond and may be either directed in a beam (narrow beam or directional sources) or sound beams may radiate in all directions (omnidirectional sources).

Sound travels in water more efficiently than almost any other form of energy, making the use of acoustics ideal for the aquatic environment and its inhabitants. In seawater, sound travels at roughly 1,500 meters per second (m/s). In-air, sound waves travel much more slowly, at about 340 m/s. However, the speed of sound can vary by a small amount based on characteristics of the transmission medium, such as water temperature and salinity. Sound travels in water more efficiently than almost any other form of energy, making the use of acoustics ideal for the aquatic environment and its inhabitants. In seawater, sound travels at roughly 1,500 m/s. In-air, sound waves travel much more slowly, at about 340 m/s. However, the speed of sound can vary by a small amount based on characteristics of the transmission medium, such as water temperature and salinity.

The basic components of a sound wave 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.

The intensity (or amplitude) of sounds is measured in dB, which is a relative unit of measurement that is used to express the ratio of one value of a power or field to another. Decibels are measured on a logarithmic scale, so a small change in dB corresponds to large changes in sound pressure. For example, a 10-dB increase is a ten-fold increase in acoustic power. A 20-dB increase is then a hundred-fold increase in power and a 30-dB increase is a thousand-fold increase in power. However, a ten-fold increase in acoustic power does not mean that the sound is perceived as being 10 times louder. Decibels are a relative unit comparing two pressures; therefore, a reference pressure must always be indicated. For underwater sound, this is 1 microPascal (μPa). For in-air sound, the reference pressure is 20 microPascal (μPa). The amplitude of a sound can be presented in various ways; however, NMFS typically considers three metrics. In this proposed IHA, all decibel levels are referenced to (re) 1μPa.

Sound exposure level (SEL) represents the total energy in a stated frequency band over a stated time interval or event and considers both amplitude and duration of exposure (represented as dB re 1 μPa^2 -s). SEL is a cumulative metric; it can be accumulated over a single pulse (for pile driving this is often referred to as single-strike SEL; SEL_{ss}) or calculated over periods containing multiple pulses (SEL_{cum}). Cumulative SEL represents the total energy accumulated by a receiver over a defined time window or during an event. The SEL metric is useful because it allows sound exposures of different durations to be related to one another in terms of total acoustic energy. The duration of a sound event and the number of pulses, however, should be specified as there is no accepted standard duration over which the summation of energy is measured.

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.

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. Along with SEL, this metric is used in evaluating the potential for permanent threshold shift (PTS) and temporary threshold shift (TTS).

Sounds can be either impulsive or non-impulsive. 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 NMFS *et al.* (2018) and Southall *et al.* (2007, 2019a) for an in-depth discussion of these concepts. Impulsive sound sources (*e.g.,* airguns, explosions, gunshots, sonic booms, impact pile driving) produce signals that are brief (typically considered to be less than 1 second), broadband, atonal transients (American National Standards Institute (ANSI), 1986; ANSI, 2005; Harris, 1998; National Institute for Occupational Safety and Health (NIOSH), 1998; International Organization for Standardization (ISO), 2003) and occur either as isolated events or repeated in some succession. Impulsive sounds are all characterized by a relatively rapid rise from ambient pressure to a maximal pressure value followed by a rapid decay period that may include a period of diminishing, oscillating maximal and minimal pressures, and generally have an increased capacity to induce physical injury as compared with sounds that lack these features. Impulsive sounds are typically intermittent in nature.

Non-impulsive 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-impulsive sounds can be transient signals of short duration but without the essential properties of pulses (*e.g.,* rapid rise time). Examples of non-impulsive sounds include those produced by vessels, aircraft, machinery operations such as drilling or dredging, vibratory pile driving, and active sonar systems. Sounds are also characterized by their temporal component. Continuous sounds are those whose sound pressure level remains above that of the ambient sound with negligibly small fluctuations in level (NIOSH, 1998; ANSI, 2005) while intermittent sounds are defined as sounds with interrupted levels of low or no sound (NIOSH, 1998). NMFS identifies Level B harassment thresholds based on if a sound is continuous or intermittent.

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 Hz and 50 kHz (International Council for the Exploration of the Sea (ICES), 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 dB from day to day (Richardson *et al.,* 1995). The result is that, depending on the source type and its intensity, sound from a specified activity may be a negligible addition to the local environment or could form a distinctive signal that may affect marine mammals. Human-generated sound is a significant contributor to the acoustic environment in the project location.

Potential Effects of Underwater Sound on Marine Mammals

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. Broadly, underwater sound from active acoustic sources, such as those in the Project, 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.,* 2003; Nowacek *et al.,* 2007; Southall *et al.,* 2007; Götz *et al.,* 2009). 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).

In general, the degree of effect of an acoustic exposure is intrinsically related to the signal characteristics, received level, distance from the source, and duration of the sound exposure, in addition to the contextual factors of the receiver (*e.g.,* behavioral state at time of exposure, age class, *etc.*). In general, sudden, high-level sounds can cause hearing loss as can longer exposures to lower-level sounds. Moreover, any temporary or permanent loss of hearing will occur almost exclusively for noise within an animal's hearing range. We describe below the specific manifestations of acoustic effects that may occur based on the activities proposed by Vineyard Wind. 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 (at the greatest distance) 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 (closer to the receiving animal) corresponds with the area where the signal is audible to the animal and of sufficient intensity to elicit behavioral or physiological responsiveness. The 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.

Below, we provide additional detail regarding potential impacts on marine mammals and their habitat from noise in general, starting with hearing impairment, as well as from the specific activities Vineyard Wind plans to conduct, to the degree it is available (noting that there is limited information regarding the impacts of offshore wind construction on marine mammals).

Hearing Threshold Shift

Marine mammals exposed to high-intensity sound or to lower-intensity sound for prolonged periods can experience hearing threshold shift (TS), which NMFS defines as a change, usually an increase, in the threshold of audibility at a specified frequency or portion of an individual's hearing range above a previously established reference level expressed in decibels (NMFS, 2018). Threshold shifts can be permanent, in which case there is an irreversible increase in the threshold of audibility at a specified frequency or portion of an individual's hearing range or temporary, in which there is reversible increase in the threshold of audibility at a specified frequency or portion of an individual's hearing range and the animal's hearing threshold would fully recover over time (Southall *et al.,* 2019a). Repeated sound exposure that leads to TTS could cause PTS.

When PTS occurs, there can be physical damage to the sound receptors in the ear (*i.e.,* tissue damage) whereas TTS represents primarily tissue fatigue and is reversible (Henderson *et al.,* 2008). 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; Southall *et al.,* 2019a). 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. However, such relationships are assumed to be similar to those in humans and other terrestrial mammals. Noise exposure can result in either a permanent shift in hearing thresholds from baseline (a 40–dB threshold shift approximates a PTS onset; *e.g.,* Kryter *et al.,* 1966; Miller, 1974; Henderson *et al.,* 2008) or a temporary, recoverable shift in hearing that returns to baseline (a 6–dB threshold shift approximates a TTS onset; *e.g.,* Southall *et al.,* 2019a). Based on data from terrestrial mammals, a precautionary assumption is that the PTS thresholds, expressed in the unweighted peak sound pressure level metric (PK), for impulsive sounds (such as impact pile driving pulses) are at least 6 dB higher than the TTS thresholds and the weighted PTS cumulative sound exposure level thresholds are 15 (impulsive sound) to 20 (non-impulsive sounds) dB higher than TTS cumulative sound exposure level thresholds (Southall *et al.,* 2019a). Given the higher level of sound or longer exposure duration necessary to cause PTS as compared with TTS, PTS is less likely to occur as a result of these activities; however, it is possible, and a small amount has been proposed for authorization for several species.

TTS is the mildest form of hearing impairment that can occur during exposure to sound, with a TTS of 6 dB considered the minimum threshold shift clearly larger than any day-to-day or session-to-session variation in a subject's normal hearing ability (Schlundt *et al.,* 2000; Finneran *et al.,* 2000; Finneran *et al.,* 2002). 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. There is data on sound levels and durations necessary to elicit mild TTS for marine mammals, but recovery is complicated to predict and dependent on multiple factors.

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 depending on the degree of interference of marine mammals hearing. 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 (*e.g.,* for successful mother/calf interactions, consistent detection of prey) 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 (*Neophocaena asiaeorientalis*)) and six species of pinnipeds (northern elephant seal (*Mirounga angustirostris*), harbor seal, ring seal, spotted seal, bearded seal, and California sea lion (*Zalophus californianus*)) that were exposed to a limited number of sound sources (*i.e.,* mostly tones and octave-band noise with limited number of exposure to impulsive sources such as seismic airguns or impact pile driving) in laboratory settings (Southall *et al.,* 2019a). There is currently no data available on noise-induced hearing loss for mysticetes. For summaries of data on TTS or PTS in marine mammals or for further discussion of TTS or PTS onset thresholds, please see Southall *et al.* (2019a) and NMFS (2018).

Recent studies with captive odontocete species (bottlenose dolphin, harbor porpoise, beluga, and false killer whale) have observed increases in hearing threshold levels when individuals received a warning sound prior to exposure to a relatively loud sound (Nachtigall and Supin, 2013, 2015; Nachtigall *et al.,* 2016a–c, 2018; Finneran, 2018). These studies suggest that captive animals have a mechanism to reduce hearing sensitivity prior to impending loud sounds. Hearing change was observed to be frequency dependent and Finneran (2018) suggests hearing attenuation occurs within the cochlea or auditory nerve. Based on these observations on captive odontocetes, the authors suggest that wild animals may have a mechanism to self-mitigate the impacts of noise exposure by dampening their hearing during prolonged exposures of loud sound or if conditioned to anticipate intense sounds (Finneran, 2018; Nachtigall *et al.,* 2018).

Behavioral Effects

Exposure of marine mammals to sound sources can result in, but is not limited to, no response or any of the following observable responses: increased alertness; orientation or attraction to a sound source; vocal modifications; cessation of feeding; cessation of social interaction; alteration of movement or diving behavior; habitat abandonment (temporary or permanent); and in severe cases, panic, flight, stampede, or stranding, potentially resulting in death (Southall *et al.,* 2007). A review of marine mammal responses to anthropogenic sound was first conducted by Richardson (1995). More recent reviews address studies conducted since 1995 and focused on observations where the received sound level of the exposed marine mammal(s) was known or could be estimated (Nowacek *et al.,* 2007; DeRuiter *et al.,* 2013; Ellison *et al.,* 2012; Gomez *et al.,* 2016). Gomez *et al.* (2016) conducted a review of the literature considering the contextual information of exposure in addition to received level and found that higher received levels were not always associated with more severe behavioral responses and vice versa. Southall *et al.* (2021) states that results demonstrate that some individuals of different species display clear yet varied responses, some of which have negative implications while others appear to tolerate high levels and that responses may not be fully predictable with simple acoustic exposure metrics (*e.g.,* received sound level). Rather, the authors state that differences among species and individuals along with contextual aspects of exposure (*e.g.,* behavioral state) appear to affect response probability.

Behavioral responses to sound are highly variable and context-specific. Many different variables can influence an animal's perception of and response to (nature and magnitude) an acoustic event. An animal's prior experience with a sound or sound source affects whether it is less likely (habituation) or more likely (sensitization) to respond to certain sounds in the future (animals can also be innately predisposed to respond to certain sounds in certain ways) (Southall *et al.,* 2019a). Related to the sound itself, the perceived nearness of the sound, bearing of the sound (approaching vs. retreating), the similarity of a sound to biologically relevant sounds in the animal's environment (*i.e.,* calls of predators, prey, or conspecifics), and familiarity of the sound may affect the way an animal responds to the sound (Southall *et al.,* 2007; DeRuiter *et al.,* 2013). Individuals (of different age, gender, reproductive status, *etc.*) among most populations will have variable hearing capabilities, and differing behavioral sensitivities to sounds that will be affected by prior conditioning, experience, and current activities of those individuals. Often, specific acoustic features of the sound and contextual variables (*i.e.,* proximity, duration, or recurrence of the sound or the current behavior that the marine mammal is engaged in or its prior experience), as well as entirely separate factors, such as the physical presence of a nearby vessel, may be more relevant to the animal's response than the received level alone.

Overall, the variability of responses to acoustic stimuli depends on the species receiving the sound, the sound source, and the social, behavioral, or environmental contexts of exposure (*e.g.,* DeRuiter and Doukara, 2012). For example, Goldbogen *et al.* (2013a) demonstrated that individual behavioral state was critically important in determining response of blue whales to sonar, noting that some individuals engaged in deep (greater than 50 m) feeding behavior had greater dive responses than those in shallow feeding or non-feeding conditions. Some blue whales in the Goldbogen *et al.* (2013a) study that were engaged in shallow feeding behavior demonstrated no clear changes in diving or movement even when received levels were high (~160 dB re 1μPa (microPascal)) for exposures to 3–4 kHz sonar signals, while deep feeding and non-feeding whales showed a clear response at exposures at lower received levels of sonar and pseudorandom noise. Southall *et al.* (2011) found that blue whales had a different response to sonar exposure depending on behavioral state, more pronounced when deep feeding/travel modes than when engaged in surface feeding.

With respect to distance influencing disturbance, DeRuiter *et al.* (2013) examined behavioral responses of Cuvier's beaked whales to mid-frequency sonar and found that whales responded strongly at low received levels (89–127 dB re 1µPa) by ceasing normal fluking and echolocation, swimming rapidly away, and extending both dive duration and subsequent non-foraging intervals when the sound source was 3.4–9.5 km (2.1–5.9 mi) away. Importantly, this study also showed that whales exposed to a similar range of received levels (78–106 dB re 1µPa) from distant sonar exercises (118 km, or 73.3 mi, away) did not elicit such responses, suggesting that context may moderate reactions. Thus, distance from the source is an important variable in influencing the type and degree of behavioral response and this variable is independent of the effect of received levels (*e.g.,* DeRuiter *et al.,* 2013; Dunlop *et al.,* 2017a–b, 2018; Falcone *et al.,* 2017; Southall *et al.,* 2019a).

Ellison *et al.* (2012) outlined an approach to assessing the effects of sound on marine mammals that incorporates contextual-based factors. The authors recommend considering not just the received level of sound, but also the activity the animal is engaged in at the time the sound is received, the nature and novelty of the sound (*i.e.,* is this a new sound from the animal's perspective), and the distance between the sound source and the animal. They submit that this ''exposure context,'' as described, greatly influences the type of behavioral response exhibited by the animal. Forney *et al.* (2017) also point out that an apparent lack of response (*e.g.,* no displacement or avoidance of a sound source) may not necessarily mean there is no cost to the individual or population, as some resources or habitats may be of such high value that animals may choose to stay, even when experiencing stress or hearing loss. Forney *et al.* (2017) recommend considering both the costs of remaining in an area of noise exposure such as TTS, PTS, or masking, which could lead to an increased risk of predation or other threats or a decreased capability to forage, and the costs of displacement, including potential increased risk of vessel strike, increased risks of predation or competition for resources, or decreased habitat suitable for foraging, resting, or socializing. This sort of contextual information is challenging to predict with accuracy for ongoing activities that occur over large spatial and temporal expanses. However, distance is one contextual factor for which data exist to quantitatively inform a take estimate, and the method for predicting Level B harassment in this IHA does consider distance to the source. Other factors are often considered qualitatively in the analysis of the likely consequences of sound exposure where supporting information is available.

Behavioral change, such as disturbance manifesting in lost foraging time, in response to anthropogenic activities is often assumed to indicate a biologically significant effect on a population of concern. However, individuals may be able to compensate for some types and degrees of shifts in behavior, preserving their health and thus their vital rates and population dynamics. For example, New *et al.* (2013) developed a model simulating the complex social, spatial, behavioral, and motivational interactions of coastal bottlenose dolphins in the Moray Firth, Scotland, to assess the biological significance of increased rate of behavioral disruptions caused by vessel traffic. Despite a modeled scenario in which vessel traffic increased from 70 to 470 vessels a year (a six-fold increase in vessel traffic) in response to the construction of a proposed offshore renewables facility, the dolphins' behavioral time budget, spatial distribution, motivations, and social structure remained unchanged. Similarly, two bottlenose dolphin populations in Australia were also modeled over 5 years against a number of disturbances (Reed *et al.,* 2020) and results indicate that habitat/noise disturbance had little overall impact on population abundances in either location, even in the most extreme impact scenarios modeled. Friedlaender *et al.* (2016) provided the first integration of direct measures of prey distribution and density variables incorporated into across-individual analyses of behavior responses of blue whales to sonar and demonstrated a five-fold increase in the ability to quantify variability in blue whale diving behavior. These results illustrate that responses evaluated without such measurements for foraging animals may be misleading, which again illustrates the context-dependent nature of the probability of response.

The following subsections provide examples of behavioral responses that give an idea of the variability in behavioral responses that would be expected given the differential sensitivities of marine mammal species to sound, contextual factors, and the wide range of potential acoustic sources to which a marine mammal may be exposed. Behavioral responses that could occur for a given sound exposure should be determined from the literature that is available for each species, or extrapolated from closely related species when no information exists, along with contextual factors.

Avoidance and Displacement

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 (*Eschrichtius robustus*) and humpback whales are known to change direction—deflecting from customary migratory paths—in order to avoid noise from airgun surveys (Malme *et al.,* 1984; Dunlop *et al.,* 2018). Avoidance is qualitatively different from the flight response but also differs in the magnitude of the response (*i.e.,* directed movement, rate of travel, *etc.*). Avoidance may be short-term with animals returning to the area once the noise has ceased (*e.g.,* Malme *et al.,* 1984; Bowles *et al.,* 1994; Goold, 1996; Stone *et al.,* 2000; Morton and Symonds, 2002; Gailey *et al.,* 2007; Dähne *et al.,* 2013; Russel *et al.,* 2016). 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; Forney *et al.,* 2017). Avoidance of marine mammals during the construction of offshore wind facilities (specifically, impact pile driving) has been documented in the literature with some significant variation in the temporal and spatial degree of avoidance and with most studies focused on harbor porpoises as one of the most common marine mammals in European waters (*e.g.,* Tougaard *et al.,* 2009; Dähne *et al.,* 2013; Thompson *et al.,* 2013; Russell *et al.,* 2016; Brandt *et al.,* 2018).

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 and other odontocete species are uncommon. Harbor porpoises and harbor seals are considered to be behaviorally sensitive species (*e.g.,* Southall *et al.,* 2007) and the effects of wind farm construction in Europe on these species have been well documented. These species have received particular attention in European waters due to their abundance in the North Sea (Hammond *et al.,* 2002; Nachtsheim *et al.,* 2021). A summary of the literature on documented effects of wind farm construction on harbor porpoise and harbor seals is described below.

Brandt *et al.* (2016) summarized the effects of the construction of eight offshore wind projects within the German North Sea (*i.e.,* Alpha Ventus, BARD Offshore I, Borkum West II, DanTysk, Global Tech I, Meerwind Süd/Ost, Nordsee Ost, and Riffgat) between 2009 and 2013 on harbor porpoises, combining passive acoustic monitoring (PAM) data from 2010 to 2013 and aerial surveys from 2009 to 2013 with data on noise levels associated with pile driving. 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 (3.1–6.2 mi) of the pile driving site, with declines at up to 20–30 km (12.4–18.6 mi) of the pile driving site documented in some cases. Similar results demonstrating the long-distance displacement of harbor porpoises (18–25 km; 11.1–15.5 mi) and harbor seals (up to 40 km (24.9 mi)) during impact pile driving have also been observed during the construction at multiple other European wind farms (Tougaard *et al.,* 2009; Bailey *et al.,* 2010; Dähne *et al.,* 2013; Lucke *et al.,* 2012; Haelters *et al.,* 2015).

While harbor porpoises and seals tend to move several kilometers away from wind farm construction activities, the duration of displacement has been documented to be relatively temporary. In two studies at Horns Rev II using impact pile driving, harbor porpoise returned within 1 to 2 days following cessation of pile driving (Tougaard *et al.,* 2009; Brandt *et al.,* 2011). Similar recovery periods have been noted for harbor seals off England during the construction of four wind farms (Brasseur *et al.,* 2012; Hamre *et al.,* 2011; Hastie *et al.,* 2015; Russell *et al.,* 2016). In some cases, an increase in harbor porpoise activity has been documented inside wind farm areas following construction (*e.g.,* Lindeboom *et al.,* 2011). Other studies have noted longer term impacts after impact pile driving. Near Dogger Bank in Germany, harbor porpoises continued to avoid the area for over 2 years after construction began (Gilles *et al.,* 2009). Approximately 10 years after construction of the Nysted wind farm, harbor porpoise abundance had not recovered to the original levels previously seen, although the echolocation activity was noted to have been increasing when compared to the previous monitoring period (Teilmann and Carstensen, 2012). However, overall, there are no indications for a population decline of harbor porpoises in European waters (*e.g.,* Brandt *et al.,* 2016). Notably, where significant differences in displacement and return rates have been identified for these species, the occurrence of secondary project-specific influences such as use of mitigation measures (*e.g.,* bubble curtains, acoustic deterrent devices), or the manner in which species use the habitat in the LIA, are likely the driving factors of this variation.

NMFS notes that the aforementioned European studies involved installing much smaller monopiles than Vineyard Wind proposes to install (Brandt *et al.,* 2016) and, therefore we anticipate noise levels from impact pile driving to be louder. However, we do not anticipate any greater severity of response due to harbor porpoise and harbor seal habitat use off Massachusetts or population-level consequences similar to European findings. In many cases, harbor porpoises and harbor seals are resident to the areas where European wind farms have been constructed. However, off Massachusetts, harbor porpoises and seals are more transient, and a very small percentage of the harbor seal population are only seasonally present with no rookeries established (Hayes *et al.,* 2022). In summary, we anticipate that harbor porpoise and harbor seals will likely respond to pile driving by moving several kilometers away from the source but return to typical habitat use patterns when pile driving ceases.

Some avoidance behavior of other marine mammal species has been documented to be dependent on distance from the source. As described above, DeRuiter *et al.* (2013) noted that distance from a sound source may moderate marine mammal reactions in their study of Cuvier's beaked whales (an acoustically sensitive species), which showed the whales swimming rapidly and silently away when a sonar signal was 3.4–9.5 km (2.1–5.9 mi) away while showing no such reaction to the same signal when the signal was 118 km (73.3 mi) away even though the received levels were similar. Tyack *et al.* (1983) conducted playback studies of Surveillance Towed Array Sensor System (SURTASS) low-frequency active (LFA) sonar in a gray whale migratory corridor off California. Similar to NARWs, gray whales migrate close to shore (approximately +2 km (+1.2 mi)) and are low-frequency hearing specialists. The LFA sonar source was placed within the gray whale migratory corridor (approximately 2 km (1.2 mi) offshore) and offshore of most, but not all, migrating whales (approximately 4 km (2.5 mi) offshore). These locations influenced received levels and distance to the source. For the inshore playbacks, not unexpectedly, the louder the source level of the playback (*i.e.,* the louder the received level), whale avoided the source at greater distances. Specifically, when the source levels were 170 and 178 dB rms, whales avoided the inshore source at ranges of several hundred meters, similar to avoidance responses reported by Malme *et al.* (1983, 1984). Whales exposed to source levels of 185 dB rms demonstrated avoidance levels at ranges of +1 km (+0.6 mi). Responses to the offshore source broadcasting at source levels of 185 and 200 dB, avoidance responses were greatly reduced. While there was observed deflection from course, in no case did a whale abandon its migratory behavior.

The signal context of the noise exposure has been shown to play an important role in avoidance responses. In a 2007–2008 Bahamas study, playback sounds of a potential predator—a killer whale—resulted in a similar but more pronounced reaction in beaked whales (an acoustically sensitive species), which included longer inter-dive intervals and a sustained straight-line departure of more than 20 km (12.4 mi) from the area (Boyd *et al.,* 2008; Southall *et al.,* 2009; Tyack *et al.,* 2011). In contrast, the sounds produced by pile driving activities do not have signal characteristics similar to predators. Therefore, we would not expect such extreme reactions to occur. Southall *et al.* (2011) found that blue whales had a different response to sonar exposure depending on behavioral state, more pronounced when deep feeding/travel modes than when engaged in surface feeding.

One potential consequence of behavioral avoidance is the altered energetic expenditure of marine mammals because energy is required to move and avoid surface vessels or the sound field associated with active sonar (Frid and Dill, 2002). Most animals can avoid that energetic cost by swimming away at slow speeds or speeds that minimize the cost of transport (Miksis-Olds, 2006), as has been demonstrated in Florida manatees (Miksis-Olds, 2006). Those energetic costs increase, however, when animals shift from a resting state, which is designed to conserve an animal's energy, to an active state that consumes energy the animal would have conserved had it not been disturbed. Marine mammals that have been disturbed by anthropogenic noise and vessel approaches are commonly reported to shift from resting to active behavioral states, which would imply that they incur an energy cost.

Forney *et al.* (2017) detailed the potential effects of noise on marine mammal populations with high site fidelity, including displacement and auditory masking, noting that a lack of observed response does not imply absence of fitness costs and that apparent tolerance of disturbance may have population-level impacts that are less obvious and difficult to document. Avoidance of overlap between disturbing noise and areas and/or times of particular importance for sensitive species may be critical to avoiding population-level impacts because (particularly for animals with high site fidelity) there may be a strong motivation to remain in the area despite negative impacts. Forney *et al.* (2017) stated that, for these animals, remaining in a disturbed area may reflect a lack of alternatives rather than a lack of effects.

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, but observations of flight responses to the presence of predators have occurred (Connor and Heithaus, 1996; Frid and Dill, 2002). 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, beaked whale strandings (Cox *et al.,* 2006; D'Amico *et al.,* 2009). 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. Flight responses of marine mammals have been documented in response to mobile high intensity active sonar (*e.g.,* Tyack *et al.,* 2011; DeRuiter *et al.,* 2013; Wensveen *et al.,* 2019), and more severe responses have been documented when sources are moving towards an animal or when they are surprised by unpredictable exposures (Watkins, 1986; Falcone *et al.,* 2017). Generally speaking, however, marine mammals would be expected to be less likely to respond with a flight response to stationery pile driving (which they can sense is stationery and predictable), unless they are within the area ensonified above behavioral harassment thresholds at the moment the pile driving begins (Watkins, 1986; Falcone *et al.,* 2017).

Diving and Foraging

Changes in dive behavior in response to noise exposure can vary widely. They may consist of increased or decreased dive times and surface intervals as well as changes in the rates of ascent and descent during a dive (*e.g.,* Frankel and Clark, 2000; Costa *et al.,* 2003; Ng and Leung, 2003; Nowacek *et al.,* 2004; Goldbogen *et al.,* 2013a; Goldbogen *et al.,* 2013b). Variations in dive behavior may reflect interruptions in biologically significant activities (*e.g.,* foraging) or they may be of little biological significance. Variations in dive behavior may also expose an animal to potentially harmful conditions (*e.g.,* increasing the chance of ship-strike) or may serve as an avoidance response that enhances survivorship. The impact of a variation in diving resulting from an acoustic exposure depends on what the animal is doing at the time of the exposure, the type and magnitude of the response, and the context within which the response occurs (*e.g.,* the surrounding environmental and anthropogenic circumstances).

Nowacek *et al.* (2004) reported disruptions of dive behaviors in foraging NARWs when exposed to an alerting stimulus, an action, they noted, that could lead to an increased likelihood of ship strike. The alerting stimulus was in the form of an 18-minute exposure that included three 2-minute signals played three times sequentially. This stimulus was designed with the purpose of providing signals distinct to background noise that serve as localization cues. However, the whales did not respond to playbacks of either right whale social sounds or vessel noise, highlighting the importance of the sound characteristics in producing a behavioral reaction. Although source levels for the proposed pile driving activities may exceed the received level of the alerting stimulus described by Nowacek *et al.* (2004), proposed mitigation strategies (further described in the Proposed Mitigation section) will reduce the severity of response to proposed pile driving activities. Converse to the behavior of NARWs, Indo-Pacific humpback dolphins have been observed to dive for longer periods of time in areas where vessels were present and/or approaching (Ng and Leung, 2003). In both of these studies, the influence of the sound exposure cannot be decoupled from the physical presence of a surface vessel, thus complicating interpretations of the relative contribution of each stimulus to the response. Indeed, the presence of surface vessels, their approach, and speed of approach, seemed to be significant factors in the response of the Indo-Pacific humpback dolphins (Ng and Leung, 2003). Low-frequency signals of the Acoustic Thermometry of Ocean Climate (ATOC) sound source were not found to affect dive times of humpback whales in Hawaiian waters (Frankel and Clark, 2000) or to overtly affect elephant seal dives (Costa *et al.,* 2003). They did, however, produce subtle effects that varied in direction and degree among the individual seals, illustrating the equivocal nature of behavioral effects and consequent difficulty in defining and predicting them.

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 cessation of secondary indicators of foraging (*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; Southall *et al.,* 2019b). An understanding 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 can facilitate the assessment of whether foraging disruptions are likely to incur fitness consequences (Goldbogen *et al.,* 2013b; Farmer *et al.,* 2018; Pirotta *et al.,* 2018a; Southall *et al.,* 2019a; Pirotta *et al.,* 2021).

Impacts on marine mammal foraging rates from noise exposure have been documented, though there is little data regarding the impacts of offshore turbine construction specifically. Several broader examples follow, and it is reasonable to expect that exposure to noise produced during the year that the proposed IHA would be effective could have similar impacts. Visual tracking, passive acoustic monitoring, and movement recording tags were used to quantify sperm whale behavior prior to, during, and following exposure to airgun arrays at received levels in the range 140–160 dB at distances of 7–13 km (4.3–8.1 mi), following a phase-in of sound intensity and full array exposures at 1–13 km (0.6–8.1 mi) (Madsen *et al.,* 2006; Miller *et al.,* 2009). Sperm whales did not exhibit horizontal avoidance behavior at the surface. However, foraging behavior may have been affected. The sperm whales exhibited 19 percent less vocal (buzz) rate during full exposure relative to post exposure, and the whale that was approached most closely had an extended resting period and did not resume foraging until the airguns had ceased firing. The remaining whales continued to execute foraging dives throughout exposure; however, swimming movements during foraging dives were 6 percent lower during exposure than during control periods (Miller *et al.,* 2009). Miller *et al.* (2009) noted that more data are required to understand whether the differences were due to exposure or natural variation in sperm whale behavior. Balaenopterid whales exposed to moderate low-frequency signals similar to the ATOC sound source demonstrated no variation in foraging activity (Croll *et al.,* 2001), whereas five out of six NARWs exposed to an acoustic alarm interrupted their foraging dives (Nowacek *et al.,* 2004). Although the received SPLs were similar in the latter two studies, the frequency, duration, and temporal pattern of signal presentation were different. These factors, as well as differences in species sensitivity, are likely contributing factors to the differential response. The noise generated by Vineyard Wind's proposed activities would at least partially overlap in frequency with signals described by Nowacek *et al.* (2004) and Croll *et al.* (2001). Blue whales exposed to mid-frequency sonar in the Southern California Bight were less likely to produce low-frequency calls usually associated with feeding behavior (Melcón *et al.,* 2012). However, Melcón *et al.* (2012) were unable to determine if suppression of low-frequency calls reflected a change in their feeding performance or abandonment of foraging behavior and indicated that implications of the documented responses are unknown. Further, it is not known whether the lower rates of calling actually indicated a reduction in feeding behavior or social contact since the study used data from remotely deployed, passive acoustic monitoring buoys. Results from the 2010–2011 field season of a behavioral response study of tagged blue whales in Southern California waters indicated that, in some cases and at low received levels, the whales responded to mid-frequency sonar but that those responses were mild and there was a quick return to their baseline activity (Southall *et al.,* 2011, 2012b, 2019).

Information on or estimates of the energetic requirements of the individuals and the relationship between prey availability, foraging effort and success, and the life history stage of the animal will help better inform a determination of whether foraging disruptions incur fitness consequences. Foraging strategies may impact foraging efficiency, such as by reducing foraging effort and increasing success in prey detection and capture, in turn promoting fitness and allowing individuals to better compensate for foraging disruptions. Surface feeding blue whales did not show a change in behavior in response to mid-frequency simulated and real sonar sources with received levels between 90 and 179 dB re 1 µPa, but deep feeding and non-feeding whales showed temporary reactions including cessation of feeding, reduced initiation of deep foraging dives, generalized avoidance responses, and changes to dive behavior (DeRuiter *et al.,* 2017; Goldbogen *et al.,* 2013b; Sivle *et al.,* 2015). Goldbogen *et al.* (2013b) indicate that disruption of feeding and displacement could impact individual fitness and health. However, for this to be true, we would have to assume that an individual whale could not compensate for this lost feeding opportunity by either immediately feeding at another location, by feeding shortly after cessation of acoustic exposure, or by feeding at a later time. There is no indication that individual fitness and health would be impacted by an activity that influences foraging disruption, particularly since unconsumed prey would likely still be available in the environment in most cases following the cessation of acoustic exposure.

Similarly, while the rates of foraging lunges decrease in humpback whales due to sonar exposure, there was variability in the response across individuals, with one animal ceasing to forage completely and another animal starting to forage during the exposure (Sivle *et al.,* 2016). In addition, almost half of the animals that demonstrated avoidance were foraging before the exposure, but the others were not; the animals that avoided while not feeding responded at a slightly lower received level and greater distance than those that were feeding (Wensveen *et al.,* 2017). These findings indicate the behavioral state of the animal and foraging strategies play a role in the type and severity of a behavioral response. For example, when the prey field was mapped and used as a covariate in examining how behavioral state of blue whales is influenced by mid-frequency sound, the response in blue whale deep-feeding behavior was even more apparent, reinforcing the need for contextual variables to be included when assessing behavioral responses (Friedlaender *et al.,* 2016).

Vocalizations and Auditory Masking

Marine mammals vocalize for different purposes and across multiple modes, such as whistling, production of echolocation clicks, calling, and singing. Changes in vocalization behavior in response to anthropogenic noise can occur for any of these modes and may result directly from increased vigilance or a startle response, or from a need to compete with an increase in background noise (see Erbe *et al.,* 2016 review on communication masking), the latter of which is described more below.

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) and blue whales increased song production (Di Iorio and Clark, 2009), while NARWs 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 or reduce sound production during production of aversive signals (Bowles *et al.,* 1994; Thode *et al.,* 2020; Cerchio *et al.,* 2014; McDonald *et al.,* 1995). Blackwell *et al.* (2015) showed that whales increased calling rates as soon as airgun signals were detectable before ultimately decreasing calling rates at higher received levels.

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, or navigation) (Richardson *et al.,* 1995; Erbe and Farmer, 2000; Tyack, 2000; Erbe *et al.,* 2016; Sorensen *et al.,* 2023). Masking occurs when the receipt of a sound is interfered with by another coincident sound at similar frequencies and at similar or higher intensity and may occur whether the sound is natural (*e.g.,* snapping shrimp, wind, waves, precipitation) or anthropogenic (*e.g.,* shipping, sonar, seismic exploration) in origin. The ability of a noise source to mask biologically important sounds depends on the characteristics of both the noise source and the signal of interest (*e.g.,* signal-to-noise ratio, temporal variability, direction), in relation to each other and to an animal's hearing abilities (*e.g.,* sensitivity, frequency range, critical ratios, frequency discrimination, directional discrimination, age, or TTS hearing loss), and existing ambient noise and propagation conditions.

Masking these acoustic signals can disturb the behavior of individual animals, groups of animals, or entire populations. Masking can lead to behavioral changes including vocal changes (*e.g.,* Lombard effect, increasing amplitude, or changing frequency), cessation of foraging or lost foraging opportunities, and leaving an area, to both signalers and receivers, in an attempt to compensate for noise levels (Erbe *et al.,* 2016) or because sounds that would typically have triggered a behavior were not detected. Even when animals attempt to compensate for masking, such as by increasing the amplitude or duration of their signals, this may still be insufficient to maintain behavioral coordination between individuals necessary for complex behaviors, foraging, and navigation (Sorensen *et al.,* 2023). In humans, significant masking of tonal signals occurs as a result of exposure to noise in a narrow band of similar frequencies. As the sound level increases, the detection of frequencies above those of the masking stimulus decreases. This principle is expected to apply to marine mammals as well because of common biomechanical cochlear properties across taxa.

Therefore, when the coincident (masking) sound is man-made, it may be considered harassment when disrupting behavioral patterns. It is important to distinguish TTS and PTS, which persist after the sound exposure, from masking, which only occurs during the sound exposure. Because masking (without resulting in threshold shift) 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; Matthews, 2017) 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; Cholewiak *et al.,* 2018).

The echolocation calls of toothed whales are subject to masking by high-frequency sound. Human data indicate low-frequency sound can mask high-frequency sounds (*i.e.,* upward masking). Studies on captive odontocetes by Au *et al.* (1974, 1985, 1993) indicate that some species may use various processes to reduce masking effects (*e.g.,* adjustments in echolocation call intensity or frequency as a function of background noise conditions). There is also evidence that the directional hearing abilities of odontocetes are useful in reducing masking at the high-frequencies these cetaceans use to echolocate, but not at the low-to-moderate frequencies they use to communicate (Zaitseva *et al.,* 1980). A study by Nachtigall and Supin (2008) showed that false killer whales adjust their hearing to compensate for ambient sounds and the intensity of returning echolocation signals.

Impacts on signal detection, measured by masked detection thresholds, are not the only important factors to address when considering the potential effects of masking. As marine mammals use sound to recognize conspecifics, prey, predators, or other biologically significant sources (Branstetter *et al.,* 2016), it is also important to understand the impacts of masked recognition thresholds (often called ''informational masking''). Branstetter *et al.* (2016) measured masked recognition thresholds for whistle-like sounds of bottlenose dolphins and observed that they are approximately 4 dB above detection thresholds (energetic masking) for the same signals. Reduced ability to recognize a conspecific call or the acoustic signature of a predator could have severe negative impacts. Branstetter *et al.* (2016) observed that if ''quality communication'' is set at 90 percent recognition the output of communication space models (which are based on 50 percent detection) would likely result in a significant decrease in communication range.

As marine mammals use sound to recognize predators (Allen *et al.,* 2014; Cummings and Thompson, 1971; Curé *et al.,* 2015; Fish and Vania, 1971), the presence of masking noise may also prevent marine mammals from responding to acoustic cues produced by their predators, particularly if it occurs in the same frequency band. For example, harbor seals that reside in the coastal waters off British Columbia are frequently targeted by mammal-eating killer whales. The seals acoustically discriminate between the calls of mammal-eating and fish-eating killer whales (Deecke *et al.,* 2002), a capability that should increase survivorship while reducing the energy required to attend to all killer whale calls. Similarly, sperm whales (Curé *et al.,* 2016; Isojunno *et al.,* 2016), long-finned pilot whales (Visser *et al.,* 2016), and humpback whales (Curé *et al.,* 2015) changed their behavior in response to killer whale vocalization playbacks; these findings indicate that some recognition of predator cues could be missed if the killer whale vocalizations were masked. The potential effects of masked predator acoustic cues depend on the duration of the masking noise and the likelihood of a marine mammal encountering a predator during the time that detection and recognition of predator cues are impeded.

Redundancy and context can also facilitate detection of weak signals. These phenomena may help marine mammals detect weak sounds in the presence of natural or manmade noise. Most masking studies in marine mammals present the test signal and the masking noise from the same direction. The dominant background noise may be highly directional if it comes from a particular anthropogenic source such as a ship or industrial site. Directional hearing may significantly reduce the masking effects of these sounds by improving the effective signal-to-noise ratio.

Masking affects both senders and receivers of acoustic signals and, at higher levels and longer duration, 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 sound pressure level (SPL)) in the world's ocean from pre-industrial periods, with most of the increase from distant commercial shipping (Hildebrand, 2009; Cholewiak *et al.,* 2018). All anthropogenic sound sources, but especially chronic and lower-frequency signals (*e.g.,* from commercial vessel traffic), contribute to elevated ambient sound levels, thus intensifying masking.

In addition to making it more difficult for animals to perceive and recognize acoustic cues in their environment, anthropogenic sound presents separate challenges for animals that are vocalizing. When they vocalize, animals are aware of environmental conditions that affect the ''active space'' (or communication space) of their vocalizations, which is the maximum area within which their vocalizations can be detected before it drops to the level of ambient noise (Brenowitz, 2004; Brumm *et al.,* 2004; Lohr *et al.,* 2003). Animals are also aware of environmental conditions that affect whether listeners can discriminate and recognize their vocalizations from other sounds, which is more important than simply detecting that a vocalization is occurring (Brenowitz, 1982; Brumm *et al.,* 2004; Dooling, 2004; Marten and Marler, 1977; Patricelli and Blickley, 2006). Most species that vocalize have evolved with an ability to adjust their vocalizations to increase the signal-to-noise ratio, active space, and recognizability/distinguishability of their vocalizations in the face of temporary changes in background noise (Brumm *et al.,* 2004; Patricelli and Blickley, 2006). Vocalizing animals can adjust their vocalization characteristics such as the frequency structure, amplitude, temporal structure, and temporal delivery (repetition rate), or ceasing to vocalize.

Many animals will combine several of these strategies to compensate for high levels of background noise. Anthropogenic sounds that reduce the signal-to-noise ratio of animal vocalizations; increase the masked auditory thresholds of animals listening for such vocalizations; or reduce the active space of an animal's vocalizations impair communication between animals. Most animals that vocalize have evolved strategies to compensate for the effects of short-term or temporary increases in background or ambient noise on their songs or calls. Although the fitness consequences of these vocal adjustments are not directly known in all instances, like most other trade-offs animals must make, some of these strategies likely come at a cost (Patricelli and Blickley, 2006; Noren *et al.,* 2017; Noren *et al.,* 2020). Shifting songs and calls to higher frequencies may also impose energetic costs (Lambrechts, 1996).

Marine mammals are also known to make vocal changes in response to anthropogenic noise. In cetaceans, vocalization changes have been reported from exposure to anthropogenic noise sources such as sonar, vessel noise, and seismic surveying (*e.g.,* Gordon *et al.,* 2003; Di Iorio and Clark, 2009; Hatch *et al.,* 2012; Holt *et al.,* 2009, 2011; Lesage *et al.,* 1999; McDonald *et al.,* 2009; Parks *et al.,* 2007; Risch *et al.,* 2012; Rolland *et al.,* 2012), as well as changes in the natural acoustic environment (Dunlop *et al.,* 2014). Vocal changes can be temporary or can be persistent. For example, model simulation suggests that the increase in starting frequency for the NARW upcall over the last 50 years resulted in increased detection ranges between right whales. The frequency shift, coupled with an increase in call intensity by 20 dB, led to a call detectability range of less than 3 km (1.9 mi) to over 9 km (5.6 mi) (Tennessen and Parks, 2016). Holt *et al.* (2009) measured killer whale call source levels and background noise levels in the 1 to 40 kHz band and reported that the whales increased their call source levels by 1-dB SPL for every 1-dB SPL increase in background noise level. Similarly, another study on St. Lawrence River belugas reported a similar rate of increase in vocalization activity in response to passing vessels (Scheifele *et al.,* 2005). Di Iorio and Clark (2009) showed that blue whale calling rates vary in association with seismic sparker survey activity, with whales calling more on days with surveys than on days without surveys. They suggested that the whales called more during seismic survey periods as a way to compensate for the elevated noise conditions.

In some cases, these vocal changes may have fitness consequences, such as an increase in metabolic rates and oxygen consumption, as observed in bottlenose dolphins when increasing their call amplitude (Holt *et al.,* 2015). A switch from vocal communication to physical, surface-generated sounds such as pectoral fin slapping or breaching was observed for humpback whales in the presence of increasing natural background noise levels, indicating that adaptations to masking may also move beyond vocal modifications (Dunlop *et al.,* 2010).

While these changes all represent possible tactics by the sound-producing animal to reduce the impact of masking, the receiving animal can also reduce masking by using active listening strategies such as orienting to the sound source, moving to a quieter location, or reducing self-noise from hydrodynamic flow by remaining still. The temporal structure of noise (*e.g.,* amplitude modulation) may also provide a considerable release from masking through comodulation masking release (a reduction of masking that occurs when broadband noise, with a frequency spectrum wider than an animal's auditory filter bandwidth at the frequency of interest, is amplitude modulated) (Branstetter and Finneran, 2008; Branstetter *et al.,* 2013). Signal type (*e.g.,* whistles, burst-pulse, sonar clicks) and spectral characteristics (*e.g.,* frequency modulated with harmonics) may further influence masked detection thresholds (Branstetter *et al.,* 2016; Cunningham *et al.,* 2014).

Masking is more likely to occur in the presence of broadband, relatively continuous noise sources, such as vessels. Several studies have shown decreases in marine mammal communication space and changes in behavior as a result of the presence of vessel noise. For example, right whales were 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) as well as increasing the amplitude (intensity) of their calls (Parks, 2009, 2011). Clark *et al.* (2009) observed that right whales' communication space decreased by up to 84 percent in the presence of vessels due to an increase in ambient noise from vessels in proximity to the whales. Cholewiak *et al.* (2018) also observed loss in communication space in Stellwagen National Marine Sanctuary for NARWs, fin whales, and humpback whales with increased ambient noise and shipping noise. Although humpback whales off Australia did not change the frequency or duration of their vocalizations in the presence of ship noise, their source levels were lower than expected based on source level changes to wind noise, potentially indicating some signal masking (Dunlop, 2016). Multiple delphinid species have also been shown to increase the minimum or maximum frequencies of their whistles in the presence of anthropogenic noise and reduced communication space (*e.g.,* Holt *et al.,* 2009, 2011; Gervaise *et al.,* 2012; Williams *et al.,* 2013; Hermannsen *et al.,* 2014; Papale *et al.,* 2015; Liu *et al.,* 2017). While masking impacts are not a concern from lower intensity, higher frequency HRG surveys, some degree of masking would be expected in the vicinity of turbine pile driving and concentrated support vessel operation.

However, pile driving is an intermittent sound and would not be continuous throughout the day.

Habituation and Sensitization

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). Habituation is considered 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 having a neutral or positive outcome (Bejder *et al.,* 2009). Animals are most likely to habituate to sounds that are predictable and unvarying. 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.

Both habituation and sensitization require an ongoing learning process. 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; National Research Council (NRC), 2003; Wartzok *et al.,* 2003; Southall *et al.,* 2019b). Controlled experiments with captive marine mammals have shown pronounced behavioral reactions, including avoidance of loud sound sources (*e.g.,* Ridgway *et al.,* 1997; Finneran *et al.,* 2003; Houser *et al.,* 2013a–b; Kastelein *et al.,* 2018). Observed responses of wild marine mammals to loud impulsive 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; Richardson *et al.,* 1995; Nowacek *et al.,* 2007; Tougaard *et al.,* 2009; Brandt *et al.,* 2011, 2012, 2014, 2018; Dähne *et al.,* 2013; Russell *et al.,* 2016).

Stone (2015) reported data from at-sea observations during 1,196 airgun surveys from 1994 to 2010. When large arrays of airguns (considered to be 500 cubic inches (in^3) or more) were firing, lateral displacement, more localized avoidance, or other changes in behavior were evident for most odontocetes. However, significant responses to large arrays were found only for the minke whale and fin whale. Behavioral responses observed included changes in swimming or surfacing behavior with indications that cetaceans remained near the water surface at these times. Behavioral observations of gray whales during an airgun survey monitored whale movements and respirations before, during, and after seismic surveys (Gailey *et al.,* 2016). Behavioral state and water depth were the best ''natural'' predictors of whale movements and respiration, and after accounting for natural variation, none of the response variables were significantly associated with survey or vessel sounds. 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.

Physiological 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.,* Selye, 1950; Moberg and Mench, 2000). In many cases, an animal's first, and sometimes most economical response (in terms of energetic costs) 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 sufficiently 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 specifically in wild populations (*e.g.,* Lusseau and Bejder, 2007; Romano *et al.,* 2002a; Rolland *et al.,* 2012). 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 NARWs.

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, 2017). Respiration naturally varies with different behaviors, and variations in respiration 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. Mean exhalation rates of gray whales at rest and while diving were found to be unaffected by seismic surveys conducted adjacent to the whale feeding grounds (Gailey *et al.,* 2007). Studies with captive harbor porpoises show increased respiration rates upon introduction of acoustic alarms (Kastelein *et al.,* 2001, 2006a) and emissions for underwater data transmission (Kastelein *et al.,* 2005). However, exposure of the same acoustic alarm to a striped dolphin under the same conditions did not elicit a response (Kastelein *et al.,* 2006a), 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.

Stranding

The definition for a stranding under the MMPA is that: (A) a marine mammal is dead and is (i) on a beach or shore of the United States, or (ii) in waters under the jurisdiction of the United States (including any navigable waters); or (B) a marine mammal is alive and is (i) on a beach or shore of the United States and is unable to return to the water, (ii) on a beach or shore of the United States and, although able to return to the water, is in need of apparent medical attention, or (iii) in the waters under the jurisdiction of the United States (including any navigable waters), but is unable to return to its natural habitat under its own power or without assistance (16 U.S.C. 1421h).

Marine mammal strandings have been linked to a variety of causes, such as illness from exposure to infectious agents, biotoxins, or parasites; starvation; unusual oceanographic or weather events; or anthropogenic causes including fishery interaction, ship strike, entrainment, entrapment, sound exposure, or combinations of these stressors sustained concurrently or in series. There have been multiple events worldwide in which marine mammals (primarily beaked whales, or other deep divers) have stranded coincident with relatively nearby activities utilizing loud sound sources (primarily military training events), and five in which mid-frequency active sonar has been more definitively determined to have been a contributing factor.

There are multiple theories regarding the specific mechanisms responsible for marine mammal strandings caused by exposure to loud sounds. One primary theme is the behaviorally mediated responses of deep-diving species (odontocetes), in which their startled response to an acoustic disturbance: (1) affects ascent or descent rates, the time they stay at depth or the surface, or other regular dive patterns that are used to physiologically manage gas formation and absorption within their bodies, such that the formation or growth of gas bubbles damages tissues or causes other injury; or (2) results in their flight to shallow areas, enclosed bays, or other areas considered ''out of habitat,'' in which they become disoriented and physiologically compromised. For more information on marine mammal stranding events and potential causes, please see the Stranding and Mortality discussion in NMFS' proposed rule for the Navy's Training and Testing Activities in the Hawaii-Southern California Training and Testing Study Area (83 FR 29872, 29928; June 26, 2018).

The construction activities proposed by Vineyard Wind (*i.e.,* pile driving) are not expected to result in marine mammal strandings. Of the strandings documented to date worldwide, NMFS is not aware of any being attributed to pile driving. While vessel strikes could kill or injure a marine mammal (which may then eventually strand), the required mitigation measures would reduce the potential for take from these activities to de minimis levels (see Proposed Mitigation section for more details). As described above, no mortality or serious injury is anticipated or proposed to be authorized from any Project activities.

Potential Effects of Disturbance on Marine Mammal Fitness

The different ways that marine mammals respond to sound are sometimes indicators of the ultimate effect that exposure to a given stimulus will have on the well-being (survival, reproduction, *etc.*) of an animal. There are numerous data relating the exposure of terrestrial mammals from sound to effects on reproduction or survival, and data for marine mammals continues to grow. Several authors have reported that disturbance stimuli may cause animals to abandon nesting and foraging sites (Sutherland and Crockford, 1993); may cause animals to increase their activity levels and suffer premature deaths or reduced reproductive success when their energy expenditures exceed their energy budgets (Daan *et al.,* 1996; Feare, 1976; Mullner *et al.,* 2004); or may cause animals to experience higher predation rates when they adopt risk-prone foraging or migratory strategies (Frid and Dill, 2002). Each of these studies addressed the consequences of animals shifting from one behavioral state (*e.g.,* resting or foraging) to another behavioral state (*e.g.,* avoidance or escape behavior) because of human disturbance or disturbance stimuli.

Attention is the cognitive process of selectively concentrating on one aspect of an animal's environment while ignoring other things (Posner, 1994). Because animals (including humans) have limited cognitive resources, there is a limit to how much sensory information they can process at any time. The phenomenon called ''attentional capture'' occurs when a stimulus (usually a stimulus that an animal is not concentrating on or attending to) ''captures'' an animal's attention. This shift in attention can occur consciously or subconsciously (for example, when an animal hears sounds that it associates with the approach of a predator) and the shift in attention can be sudden (Dukas, 2002; van Rij, 2007). Once a stimulus has captured an animal's attention, the animal can respond by ignoring the stimulus, assuming a ''watch and wait'' posture, or treat the stimulus as a disturbance and respond accordingly, which includes scanning for the source of the stimulus or ''vigilance'' (Cowlishaw *et al.,* 2004).

Vigilance is an adaptive behavior that helps animals determine the presence or absence of predators, assess their distance from conspecifics, or to attend cues from prey (Bednekoff and Lima, 1998; Treves, 2000). Despite those benefits, however, vigilance has a cost of time; when animals focus their attention on specific environmental cues, they are not attending to other activities 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 (Saino, 1994; Beauchamp and Livoreil, 1997; Fritz *et al.,* 2002; Purser and Radford, 2011). Animals will spend more time being vigilant, which may translate to less time foraging or resting, when disturbance stimuli approach them more directly, remain at closer distances, have a greater group size (*e.g.,* multiple surface vessels), or when they co-occur with times that an animal perceives increased risk (*e.g.,* when they are giving birth or accompanied by a calf).

The primary mechanism by which increased vigilance and disturbance appear to affect the fitness of individual animals is by disrupting an animal's time budget and, as a result, reducing the time they might spend foraging and resting (which increases an animal's activity rate and energy demand while decreasing their caloric intake/energy). In a study of northern resident killer whales off Vancouver Island, exposure to boat traffic was shown to reduce foraging opportunities and increase traveling time (Holt *et al.,* 2021). A simple bioenergetics model was applied to show that the reduced foraging opportunities equated to a decreased energy intake of 18 percent while the increased traveling incurred an increased energy output of 3–4 percent, which suggests that a management action based on avoiding interference with foraging might be particularly effective.

On a related note, many animals perform vital functions, such as feeding, resting, traveling, and socializing, on a diel cycle (24-hour cycle). Behavioral reactions to noise exposure (such as disruption of critical life functions, displacement, or avoidance of important habitat) are more likely to be significant for fitness if they last more than one diel cycle or recur on subsequent days (Southall *et al.,* 2007). Consequently, a behavioral response lasting less than 1 day and not recurring on subsequent days is not considered particularly severe unless it could directly affect reproduction or survival (Southall *et al.,* 2007). It is important to note the difference between behavioral reactions lasting or recurring over multiple days and anthropogenic activities lasting or recurring over multiple days. For example, just because certain activities last for multiple days does not necessarily mean that individual animals will be either exposed to those activity-related stressors (*i.e.,* sonar) for multiple days or further exposed in a manner that would result in sustained multi-day substantive behavioral responses. However, special attention is warranted where longer-duration activities overlay areas in which animals are known to congregate for longer durations for biologically important behaviors.

There are few studies that directly illustrate the impacts of disturbance on marine mammal populations. Lusseau and Bejder (2007) present data from three long-term studies illustrating the connections between disturbance from whale-watching boats and population-level effects in cetaceans. In Shark Bay, Australia, the abundance of bottlenose dolphins was compared within adjacent control and tourism sites over three consecutive 4.5-year periods of increasing tourism levels. Between the second and third time periods, in which tourism doubled, dolphin abundance decreased by 15 percent in the tourism area and did not change significantly in the control area. In Fiordland, New Zealand, two populations (Milford and Doubtful Sounds) of bottlenose dolphins with tourism levels that differed by a factor of seven were observed and significant increases in traveling time and decreases in resting time were documented for both. Consistent short-term avoidance strategies were observed in response to tour boats until a threshold of disturbance was reached (average of 68 minutes between interactions), after which the response switched to a longer-term habitat displacement strategy. For one population, tourism only occurred in a part of the home range. However, tourism occurred throughout the home range of the Doubtful Sound population and once boat traffic increased beyond the 68-minute threshold (resulting in abandonment of their home range/preferred habitat), reproductive success drastically decreased (increased stillbirths) and abundance decreased significantly (from 67 to 56 individuals in a short period).

In order to understand how the effects of activities may or may not impact species and stocks of marine mammals, it is necessary to understand not only what the likely disturbances are going to be but how those disturbances may affect the reproductive success and survivorship of individuals, and then how those impacts to individuals translate to population-level effects. Following on the earlier work of a committee of the U.S. NRC (NRC, 2005), New *et al.* (2014), in an effort termed the Potential Consequences of Disturbance (PCoD), outlined an updated conceptual model of the relationships linking disturbance to changes in behavior and physiology, health, vital rates, and population dynamics. This framework is a four-step process progressing from changes in individual behavior and/or physiology, to changes in individual health, then vital rates, and finally to population-level effects. In this framework, behavioral and physiological changes can have direct (acute) effects on vital rates, such as when changes in habitat use or increased stress levels raise the probability of mother-calf separation or predation; indirect and long-term (chronic) effects on vital rates, such as when changes in time/energy budgets or increased disease susceptibility affect health, which then affects vital rates; or no effect to vital rates (New *et al.,* 2014).

Since the PCoD general framework was outlined and the relevant supporting literature compiled, multiple studies developing state-space energetic models for species with extensive long-term monitoring (*e.g.,* southern elephant seals, NARWs, Ziphiidae beaked whales, and bottlenose dolphins) have been conducted and can be used to effectively forecast longer-term, population-level impacts from behavioral changes. While these are very specific models with very specific data requirements that cannot yet be applied broadly to project-specific risk assessments for the majority of species, they are a critical first step towards being able to quantify the likelihood of a population level effect. Since New *et al.* (2014), several publications have described models developed to examine the long-term effects of environmental or anthropogenic disturbance of foraging on various life stages of selected species (*e.g.,* sperm whale, Farmer *et al.,* 2018; California sea lion, McHuron *et al.,* 2018; blue whale, Pirotta *et al.,* 2018a; humpback whale, Dunlop *et al.,* 2021). These models continue to add to refinement of the approaches to the PCoD framework. Such models also help identify what data inputs require further investigation. Pirotta *et al.* (2018b) provides a review of the PCoD framework with details on each step of the process and approaches to applying real data or simulations to achieve each step.

Despite its simplicity, there are few complete PCoD models available for any marine mammal species due to a lack of data available to parameterize many of the steps. To date, no PCoD model has been fully parameterized with empirical data (Pirotta *et al.,* 2018a) due to the fact they are data intensive and logistically challenging to complete. Therefore, most complete PCoD models include simulations, theoretical modeling, and expert opinion to move through the steps. For example, PCoD models have been developed to evaluate the effect of wind farm construction on the North Sea harbor porpoise populations (*e.g.,* King *et al.,* 2015; Nabe-Nielsen *et al.,* 2018). These models include a mix of empirical data, expert elicitation (King *et al.,* 2015) and simulations of animals' movements, energetics, and/or survival (New *et al.,* 2014; Nabe-Nielsen *et al.,* 2018).

PCoD models may also be approached in different manners. Dunlop *et al.* (2021) modeled migrating humpback whale mother-calf pairs in response to seismic surveys using both a forwards and backwards approach. While a typical forwards approach can determine if a stressor would have population-level consequences, Dunlop *et al.* demonstrated that working backwards through a PCoD model can be used to assess the most unfavorable scenario for an interaction of a target species and stressor. This method may be useful for future management goals when appropriate data becomes available to fully support the model. In another example, harbor porpoise PCoD model investigating the impact of seismic surveys on harbor porpoise included an investigation on underlying drivers of vulnerability. Harbor porpoise movement and foraging were modeled for baseline periods and then for periods with seismic surveys as well; the models demonstrated that temporal (*i.e.,* seasonal) variation in individual energetics and their link to costs associated with disturbances was key in predicting population impacts (Gallagher *et al.,* 2021).

Behavioral change, such as disturbance manifesting in lost foraging time, in response to anthropogenic activities is often assumed to indicate a biologically significant effect on a population of concern. However, as described above, individuals may be able to compensate for some types and degrees of shifts in behavior, preserving their health and thus their vital rates and population dynamics. For example, New *et al.* (2013) developed a model simulating the complex social, spatial, behavioral, and motivational interactions of coastal bottlenose dolphins in the Moray Firth, Scotland, to assess the biological significance of increased rate of behavioral disruptions caused by vessel traffic. Despite a modeled scenario in which vessel traffic increased from 70 to 470 vessels a year (a six-fold increase in vessel traffic) in response to the construction of a proposed offshore renewables' facility, the dolphins' behavioral time budget, spatial distribution, motivations, and social structure remain unchanged. Similarly, two bottlenose dolphin populations in Australia were also modeled over 5 years against a number of disturbances (Reed *et al.,* 2020), and results indicated that habitat/noise disturbance had little overall impact on population abundances in either location, even in the most extreme impact scenarios modeled.

By integrating different sources of data (*e.g.,* controlled exposure data, activity monitoring, telemetry tracking, and prey sampling) into a theoretical model to predict effects from sonar on a blue whale's daily energy intake, Pirotta *et al.* (2021) found that tagged blue whales' activity budgets, lunging rates, and ranging patterns caused variability in their predicted cost of disturbance. This method may be useful for future management goals when appropriate data becomes available to fully support the model. Harbor porpoise movement and foraging were modeled for baseline periods and then for periods with seismic surveys as well; the models demonstrated that the seasonality of the seismic activity was an important predictor of impact (Gallagher *et al.,* 2021).

In their table 1, Keen *et al.* (2021) summarize the emerging themes in PCoD models that should be considered when assessing the likelihood and duration of exposure and the sensitivity of a population to disturbance (see table 1 from Keen *et al.,* 2021, below). The themes are categorized by life history traits (movement ecology, life history strategy, body size, and pace of life), disturbance source characteristics (overlap with biologically important areas, duration and frequency, and nature and context), and environmental conditions (natural variability in prey availability and climate change). Keen *et al.* (2021) then summarize how each of these features influence an assessment, noting, for example, that individual animals with small home ranges have a higher likelihood of prolonged or year-round exposure, that the effect of disturbance is strongly influenced by whether it overlaps with biologically important habitats when individuals are present, and that continuous disruption will have a greater impact than intermittent disruption.

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; Wilson *et al.,* 2020; Harwood and Booth, 2016; King *et al.,* 2015; McHuron *et al.,* 2018; National Academies of Sciences, Engineering, and Medicine (NAS), 2017; New *et al.,* 2014; Pirotta *et al.,* 2018a; Southall *et al.,* 2007; Villegas-Amtmann *et al.,* 2015). As described through this notice for the proposed IHA, NMFS expects that any behavioral disturbance that would occur due to animals being exposed to construction activity would be of a relatively short duration, with behavior returning to a baseline state shortly after the acoustic stimuli ceases or the animal moves far enough away from the source. Given this, and NMFS' evaluation of the available PCoD studies, and the required mitigation discussed later, any such behavioral disturbance resulting from Vineyard Wind's activities is 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. Marine mammals may temporarily avoid the immediate area but are not expected to permanently abandon the area or their migratory or foraging behavior. Impacts to breeding, feeding, sheltering, resting, or migration are not expected nor are shifts in habitat use, distribution, or foraging success.

Potential Effects From Vessel Strike

Vessel collisions with marine mammals, also referred to as vessel strikes or ship strikes, can result in death or serious injury of the animal. Wounds resulting from ship strike may include massive trauma, hemorrhaging, broken bones, or propeller lacerations (Knowlton and Kraus, 2001). An animal at the surface could be struck directly by a vessel, a surfacing animal could hit the bottom of a vessel, or an animal just below the surface could be cut by a vessel's propeller. Superficial strikes may not kill or result in the death of the animal. Lethal interactions are typically associated with large whales, which are occasionally found draped across the bulbous bow of large commercial ships upon arrival in port. Although smaller cetaceans are more maneuverable in relation to large vessels than are large whales, they may also be susceptible to strike. The severity of injuries typically depends on the size and speed of the vessel (Knowlton and Kraus, 2001; Laist *et al.,* 2001; Vanderlaan and Taggart, 2007; Conn and Silber, 2013), although Kelley *et al.* (2020) found, through the use of a simple biophysical model, that large whales can be seriously injured or killed by vessels of all sizes. Impact forces increase with speed, as does the probability of a strike at a given distance (Silber *et al.,* 2010; Gende *et al.,* 2011).

The most vulnerable marine mammals are those that spend extended periods of time at the surface in order to restore oxygen levels within their tissues after deep dives (*e.g.,* the sperm whale). In addition, some baleen whales seem generally unresponsive to vessel sound, making them more susceptible to vessel collisions (Nowacek *et al.,* 2004). These species are primarily large, slow-moving whales. Marine mammal responses to vessels may include avoidance and changes in dive pattern (NRC, 2003).

An examination of all known ship strikes from all shipping sources (civilian and military) indicates vessel speed is a principal factor in whether a vessel strike occurs and, if so, whether it results in injury, serious injury, or mortality (Knowlton and Kraus, 2001; Laist *et al.,* 2001; Jensen and Silber, 2003; Pace and Silber, 2005; Vanderlaan and Taggart, 2007; Conn and Silber, 2013). In assessing records in which vessel speed was known, Laist *et al.* (2001) found a direct relationship between the occurrence of a whale strike and the speed of the vessel involved in the collision. The authors concluded that most deaths occurred when a vessel was traveling in excess of 13 kn.

Jensen and Silber (2003) detailed 292 records of known or probable ship strikes of all large whale species from 1975 to 2002. Of these, vessel speed at the time of collision was reported for 58 cases. Of these 58 cases, 39 (or 67 percent) resulted in serious injury or death (19 of those resulted in serious injury as determined by blood in the water, propeller gashes or severed tailstock, and fractured skull, jaw, vertebrae, hemorrhaging, massive bruising, or other injuries noted during necropsy and 20 resulted in death). Operating speeds of vessels that struck various species of large whales ranged from 2 to 51 kn. The majority (79 percent) of these strikes occurred at speeds of 13 kn or greater. The average speed that resulted in serious injury or death was 18.6 kn. Pace and Silber (2005) found that the probability of death or serious injury increased rapidly with increasing vessel speed.

Specifically, the predicted probability of serious injury or death increased from 45 to 75 percent as vessel speed increased from 10 to 14 kn and exceeded 90 percent at 17 kn. Higher speeds during collisions result in greater force of impact and also appear to increase the chance of severe injuries or death. While modeling studies have suggested that hydrodynamic forces pulling whales toward the vessel hull increase with increasing speed (Clyne, 1999; Knowlton *et al.,* 1995), this is inconsistent with Silber *et al.* (2010), which demonstrated that there is no such relationship (*i.e.,* hydrodynamic forces are independent of speed).

In a separate study, Vanderlaan and Taggart (2007) analyzed the probability of lethal mortality of large whales at a given speed, showing that the greatest rate of change in the probability of a lethal injury to a large whale as a function of vessel speed occurs between 8.6 and 15 kn. The chances of a lethal injury decline from approximately 80 percent at 15 kn to approximately 20 percent at 8.6 kn. At speeds below 11.8 kn, the chances of lethal injury drop below 50 percent, while the probability asymptotically increases toward 100 percent above 15 kn.

The Jensen and Silber (2003) report notes that the Large Whale Ship Strike Database represents a minimum number of collisions, because the vast majority probably goes undetected or unreported. In contrast, the Project's personnel are likely to detect any strike that does occur because of the required personnel training and lookouts, along with the inclusion of PSOs (as described in the Proposed Mitigation section), and they are required to report all ship strikes involving marine mammals.

There are no known vessel strikes of marine mammals by any offshore wind energy vessel in the United States. Given the extensive mitigation and monitoring measures (see the Proposed Mitigation and Proposed Monitoring and Reporting section) that would be required of Vineyard Wind, NMFS believes that a vessel strike is not likely to occur.

Potential Effects to Marine Mammal Habitat

Vineyard Wind's proposed activities could potentially affect marine mammal habitat through impacts on the prey species of marine mammals (through noise, oceanographic processes, or reef effects), acoustic habitat (sound in the water column), water quality, and biologically important habitat for marine mammals.

Effects on Prey

Sound may affect marine mammals through impacts on the abundance, behavior, or distribution of prey species (*e.g.,* crustaceans, cephalopods, fish, and 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 and Mann, 1999; Fay, 2009). The most likely effects on fishes exposed to loud, intermittent, low-frequency sounds are behavioral responses (*i.e.,* flight or avoidance). Short duration, sharp sounds (such as pile driving or airguns) can cause overt or subtle changes in fish behavior and local distribution. The reaction of fish to acoustic sources depends on the physiological state of the fish, past exposures, motivation (*e.g.,* feeding, spawning, migration), and other environmental factors. Key impacts to fishes may include behavioral responses, hearing damage, barotrauma (pressure-related injuries), and mortality. While it is clear that the behavioral responses of individual prey, such as displacement or other changes in distribution, can have direct impacts on the foraging success of marine mammals, the effects on marine mammals of individual prey that experience hearing damage, barotrauma, or mortality is less clear, though obviously population scale impacts that meaningfully reduce the amount of prey available could have more serious impacts.

Fishes, like other vertebrates, have a variety of different sensory systems to glean information from ocean around them (Astrup and Mohl, 1993; Astrup, 1999; Braun and Grande, 2008; Carroll *et al.,* 2017; Hawkins and Johnstone, 1978; Ladich and Popper, 2004; Ladich and Schulz-Mirbach, 2016; Mann, 2016; Nedwell *et al.,* 2004; Popper *et al.,* 2003, 2005). 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) (terrestrial vertebrates generally only detect pressure). Most marine fishes primarily detect particle motion using the inner ear and lateral line system while some fishes possess additional morphological adaptations or specializations that can enhance their sensitivity to sound pressure, such as a gas-filled swim bladder (Braun and Grande, 2008; Popper and Fay, 2011).

Hearing capabilities vary considerably between different fish species with data only available for just over 100 species out of the 34,000 marine and freshwater fish species (Eschmeyer and Fong, 2016). In order to better understand acoustic impacts on fishes, fish hearing groups are defined by species that possess a similar continuum of anatomical features, which result in varying degrees of hearing sensitivity (Popper and Hastings, 2003). There are four hearing groups defined for all fish species (modified from Popper *et al.,* 2014) within this analysis, and they include: fishes without a swim bladder (*e.g.,* flatfish, sharks, rays, *etc.*); fishes with a swim bladder not involved in hearing (*e.g.,* salmon, cod, pollock, *etc.*); fishes with a swim bladder involved in hearing (*e.g.,* sardines, anchovy, herring, *etc.*); and fishes with a swim bladder involved in hearing and high-frequency hearing (*e.g.,* shad and menhaden). Most marine mammal fish prey species would not be likely to perceive or hear mid- or high-frequency sonars. While hearing studies have not been done on sardines and northern anchovies, it would not be unexpected for them to have hearing similarities to Pacific herring (up to 2–5 kHz) (Mann *et al.,* 2005). Currently, less data are available to estimate the range of best sensitivity for fishes without a swim bladder.

In terms of physiology, multiple scientific studies have documented a lack of mortality or physiological effects to fish from exposure to low- and mid-frequency sonar and other sounds (Halvorsen *et al.,* 2012a; Jørgensen *et al.,* 2005; Juanes *et al.,* 2017; Kane *et al.,* 2010; Kvadsheim and Sevaldsen, 2005; Popper *et al.,* 2007, 2016; Watwood *et al.,* 2016). Techer *et al.* (2017) exposed carp in floating cages for up to 30 days to low-power 23 and 46 kHz source without any significant physiological response. Other studies have documented either a lack of TTS in species whose hearing range cannot perceive sonar (such as Navy sonar), or for those species that could perceive sonar-like signals, any TTS experienced would be recoverable (Halvorsen *et al.,* 2012a; Ladich and Fay, 2013; Popper and Hastings, 2009a, 2009b; Popper *et al.,* 2014; Smith, 2016). Only fishes that have specializations that enable them to hear sounds above about 2,500 Hz (2.5 kHz), such as herring (Halvorsen *et al.,* 2012a; Mann *et al.,* 2005; Mann, 2016; Popper *et al.,* 2014), would have the potential to receive TTS or exhibit behavioral responses from exposure to mid-frequency sonar. In addition, any sonar induced TTS to fish whose hearing range could perceive sonar would only occur in the narrow spectrum of the source (*e.g.,* 3.5 kHz) compared to the fish's total hearing range (*e.g.,* 0.01 to 5 kHz).

In terms of behavioral responses, Juanes *et al.* (2017) discuss the potential for negative impacts from anthropogenic noise on fish, but the authors' focus was on broader based sounds, such as ship and boat noise sources. Watwood *et al.* (2016) also documented no behavioral responses by reef fish after exposure to mid-frequency active sonar. Doksaeter *et al.* (2009, 2012) reported no behavioral responses to mid-frequency sonar (such as naval sonar) by Atlantic herring; specifically, no escape reactions (vertically or horizontally) were observed in free swimming herring exposed to mid-frequency sonar transmissions. Based on these results (Doksaeter *et al.,* 2009, 2012; Sivle *et al.,* 2012), Sivle *et al.* (2014) created a model in order to report on the possible population-level effects on Atlantic herring from active sonar. The authors concluded that the use of sonar poses little risk to populations of herring regardless of season, even when the herring populations are aggregated and directly exposed to sonar. Finally, Bruintjes *et al.* (2016) commented that fish exposed to any short-term noise within their hearing range might initially startle but would quickly return to normal behavior.

Pile driving noise during construction is of particular concern as the very high sound pressure levels could potentially prevent fish from reaching breeding or spawning sites, finding food, and acoustically locating mates. A playback study in west Scotland revealed that there was a significant movement response to the pile driving stimulus in both species at relatively low received sound pressure levels (sole: 144–156 dB re 1μPa Peak; cod: 140–161 dB re 1 μPa Peak, particle motion between 6.51×10^3 and 8.62×10^4 m/s^2 peak) (Mueller-Blenkle *et al.,* 2010). The swimming speed of sole increased significantly during the playback of construction noise when compared to the playbacks of before and after construction. While not statistically significant, cod also displayed a similar behavioral response during before, during, and after construction playbacks. However, cod demonstrated a specific and significant freezing response at the onset and cessation of the playback recording. In both species, indications were present displaying directional movements away from the playback source. During wind farm construction in the eastern Taiwan Strait, type 1 soniferous fish chorusing showed a relatively lower intensity and longer duration while type 2 chorusing exhibited higher intensity and no changes in its duration. Deviation from regular fish vocalization patterns may affect fish reproductive success, cause migration, augmented predation, or physiological alterations.

Occasional behavioral reactions to activities that produce underwater noise sources are unlikely to cause long-term consequences for individual fish or populations. The most likely impact to fish from impact and vibratory pile driving activities at the LIAs would be temporary behavioral avoidance of the area. 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. 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.

Occasional behavioral reactions to activities that produce underwater noise sources are unlikely to cause long-term consequences for individual fish or populations. The most likely impact to fish from impact pile driving activities at the LIA would be temporary behavioral avoidance of the area. 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. 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.

As described in the Proposed Mitigation section below, Vineyard Wind would utilize a sound attenuation device which would reduce potential for injury to marine mammal prey. Other fish that experience hearing loss as a result of exposure to impulsive sound sources may have a reduced ability to detect relevant sounds such as predators, prey, or social vocalizations. However, PTS has not been known to occur in fishes and any hearing loss in fish may be as temporary as the timeframe required to repair or replace the sensory cells that were damaged or destroyed (Popper *et al.,* 2005, 2014; Smith, 2006). It is not known if damage to auditory nerve fibers could occur, and if so, whether fibers would recover during this process. In addition, most acoustic effects, if any, are expected to be short-term and localized. Long-term consequences for fish populations, including key prey species within the LIA, would not be expected.

Required soft-starts would allow prey and marine mammals to move away from the source prior to any noise levels that may physically injure prey and the use of the noise attenuation devices would reduce noise levels to the degree any mortality or injury of prey is also minimized. Use of bubble curtains, in addition to reducing impacts to marine mammals, for example, is a key mitigation measure in reducing injury and mortality of ESA-listed salmon on the U.S. west coast. However, we recognize some mortality, physical injury and hearing impairment in marine mammal prey may occur, but we anticipate the amount of prey impacted in this manner is minimal compared to overall availability. Any behavioral responses to pile driving by marine mammal prey are expected to be brief. We expect that other impacts, such as stress or masking, would occur in fish that serve as marine mammals prey (Popper *et al.,* 2019); however, those impacts would be limited to the duration of impact pile driving, and, if prey were to move out the area in response to noise, these impacts would be minimized.

In addition to fish, prey sources such as marine invertebrates could potentially be impacted by noise stressors as a result of the proposed activities. However, most marine invertebrates' ability to sense sounds is limited. Invertebrates appear to be able to detect sounds (Pumphrey, 1950; Frings and Frings, 1967) and are most sensitive to low-frequency sounds (Packard *et al.,* 1990; Budelmann and Williamson, 1994; Lovell *et al.,* 2005; Mooney *et al.,* 2010). Data on response of invertebrates such as squid, another marine mammal prey species, to anthropogenic sound is more limited (de Soto, 2016; Sole *et al.,* 2017). Data suggest that cephalopods are capable of sensing the particle motion of sounds and detect low frequencies up to 1–1.5 kHz, depending on the species, and so are likely to detect airgun noise (Kaifu *et al.,* 2008; Hu *et al.,* 2009; Mooney *et al.,* 2010; Samson *et al.,* 2014). Sole *et al.* (2017) reported physiological injuries to cuttlefish in cages placed at-sea when exposed during a controlled exposure experiment to low-frequency sources (315 Hz, 139 to 142 dB re 1 μPa^2; 400 Hz, 139 to 141 dB re 1 μPa^2).

Fewtrell and McCauley (2012) reported squids maintained in cages displayed startle responses and behavioral changes when exposed to seismic airgun sonar (136–162 re 1 μPa^2 × s). Jones *et al.* (2020) found that when squid (*Doryteuthis pealeii*) were exposed to impulse pile driving noise, body pattern changes, inking, jetting, and startle responses were observed and nearly all squid exhibited at least one response. However, these responses occurred primarily during the first eight impulses and diminished quickly, indicating potential rapid, short-term habituation.

Cephalopods have a specialized sensory organ inside the head called a statocyst that may help an animal determine its position in space (orientation) and maintain balance (Budelmann, 1992). Packard *et al.* (1990) showed that cephalopods were sensitive to particle motion, not sound pressure, and Mooney *et al.* (2010) demonstrated that squid statocysts act as an accelerometer through which particle motion of the sound field can be detected. Auditory injuries (lesions occurring on the statocyst sensory hair cells) have been reported upon controlled exposure to low-frequency sounds, suggesting that cephalopods are particularly sensitive to low-frequency sound (Andre *et al.,* 2011; Sole *et al.,* 2013). Behavioral responses, such as inking and jetting, have also been reported upon exposure to low-frequency sound (McCauley *et al.,* 2000; Samson *et al.,* 2014). Squids, like most fish species, are likely more sensitive to low-frequency sounds and may not perceive mid- and high-frequency sonars.

With regard to potential impacts on zooplankton, McCauley *et al.* (2017) found that exposure to airgun noise resulted in significant depletion for more than half the taxa present and that there were two to three times more dead zooplankton after airgun exposure compared with controls for all taxa, within 1 km (0.6 mi) of the airguns. However, the authors also stated that in order to have significant impacts on r-selected species (*i.e.,* those with high growth rates and that produce many offspring) such as plankton, the spatial or temporal scale of impact must be large in comparison with the ecosystem concerned, and it is possible that the findings reflect avoidance by zooplankton rather than mortality (McCauley *et al.,* 2017). In addition, the results of this study are inconsistent with a large body of research that generally finds limited spatial and temporal impacts to zooplankton as a result of exposure to airgun noise (*e.g.,* Dalen and Knutsen, 1987; Payne, 2004; Stanley *et al.,* 2011). Most prior research on this topic, which has focused on relatively small spatial scales, has showed minimal effects (*e.g.,* Kostyuchenko, 1973; Booman *et al.,* 1996; Sætre and Ona, 1996; Pearson *et al.,* 1994; Bolle *et al.,* 2012).

A modeling exercise was conducted as a follow-up to the McCauley *et al.* (2017) study (as recommended by McCauley *et al.,* 2017), in order to assess the potential for impacts on ocean ecosystem dynamics and zooplankton population dynamics (Richardson *et al.,* 2017). Richardson *et al.* (2017) found that a full-scale airgun survey would impact copepod abundance within the survey area, but that effects at a regional scale were minimal (2 percent decline in abundance within 150 km (93.2 mi) of the survey area and effects not discernible over the full region). The authors also found that recovery within the survey area would be relatively quick (3 days following survey completion) and suggest that the quick recovery was due to the fast growth rates of zooplankton, and the dispersal and mixing of zooplankton from both inside and outside of the impacted region. The authors also suggest that surveys in areas with more dynamic ocean circulation in comparison with the study region and/or with deeper waters (*i.e.,* typical offshore wind locations) would have less net impact on zooplankton.

Notably, a recently described study produced results inconsistent with those of McCauley *et al.* (2017). Researchers conducted a field and laboratory study to assess if exposure to airgun noise affects mortality, predator escape response, or gene expression of the copepod *Calanus finmarchicus* (Fields *et al.,* 2019). Immediate mortality of copepods was significantly higher, relative to controls, at distances of 5 m or less from the airguns. Mortality 1 week after the airgun blast was significantly higher in the copepods placed 10 m from the airgun but was not significantly different from the controls at a distance of 20 m from the airgun. The increase in mortality, relative to controls, did not exceed 30 percent at any distance from the airgun. Moreover, the authors caution that even this higher mortality in the immediate vicinity of the airguns may be more pronounced than what would be observed in free-swimming animals due to increased flow speed of fluid inside bags containing the experimental animals. There were no sub-lethal effects on the escape performance, or the sensory threshold needed to initiate an escape response, at any of the distances from the airgun that were tested. Whereas McCauley *et al.* (2017) reported an SEL of 156 dB at a range of 509–658 m, with zooplankton mortality observed at that range, Fields *et al.* (2019) reported an SEL of 186 dB at a range of 25 m, with no reported mortality at that distance.

Airguns and impact pile driving are similar in that they both produce impulsive and intermittent noise and typically have higher source levels than other sources (*e.g.,* vibratory driving). We anticipate marine mammal prey exposed to impact pile driving would demonstrate similar physical consequences and behavioral impacts compared to exposure to airguns; however, the spatial extent of these impacts during impact pile driving is dependent upon source levels and use of noise attenuation systems (NAS) such as double bubble curtains, such that lower source levels and use of NAS are expected to further minimize impacts that would occur otherwise.

The presence of large numbers of turbines has been shown to impact meso- and sub-meso-scale water column circulation, which can affect the density, distribution, and energy content of zooplankton and thereby, their availability as marine mammal prey. Topside, atmospheric wakes result in wind speed reductions influencing upwelling and downwelling in the ocean while underwater structures such as WTG and ESP foundations may cause turbulent current wakes, which impact circulation, stratification, mixing, and sediment resuspension (Daewel *et al.,* 2022). Overall, the presence of structures such as wind turbines is, in general, likely to result in certain oceanographic effects in the marine environment and may alter marine mammal prey, such as aggregations and distribution of zooplankton through changing the strength of tidal currents and associated fronts, changes in stratification, primary production, the degree of mixing, and stratification in the water column (Chen *et al.,* 2021; Johnson *et al.,* 2021; Christiansen *et al.,* 2022; Dorrell *et al.,* 2022).

Turbine operations for the previously installed 47 WTG monopile foundations commenced in 2023. Vineyard Wind intends to install 15 WTG monopile foundations, and it is possible that turbines would become operational by the end of the IHA effective period. As described below (see *Potential Effects from Offshore Wind Farm Operational Noise* section), there is scientific uncertainty around the scale of oceanographic impacts (meters to kilometers) associated with turbine operation. The Project is located offshore of Massachusetts, and although the LIA does overlap with key winter foraging grounds for NARWs (Leiter *et al.,* 2017; Quintana-Rizzo *et al.,* 2021; O'Brien *et al.,* 2022; Pendleton *et al.,* 2022), nearby habitat may provide higher foraging value should NARW prey be affected in the LIA during construction, and the amount of pile driving time with only 15 piles remaining to be installed is expected to be limited, thereby limiting potential impacts on prey aggregation. In addition, the proposed seasonal restriction on pile driving from January through May would reduce impacts to NARW prey during the time that they are more likely to be foraging. The LIA does not overlap but is in proximity to seasonal foraging grounds for fin whales, minke whales, and sei whales. Generally speaking, and depending on the extent, impacts on prey could impact the distribution of marine mammals in an area, potentially necessitating additional energy expenditure to find and capture prey. However, at the temporal and spatial scales anticipated for this activity, any such impacts on prey are not expected to impact the reproduction or survival of any individual marine mammals. Although studies assessing the impacts of offshore wind development on marine mammals are limited, the repopulation of wind energy areas by harbor porpoises (Brandt *et al.,* 2016; Lindeboom *et al.,* 2011) and harbor seals (Lindeboom *et al.,* 2011; Russell *et al.,* 2016) following the installation of wind turbines are promising. Overall, any impacts to marine mammal foraging capabilities due to effects on prey aggregation from the turbine presence and operation during the effective period of the proposed IHA is likely to be limited. In general, impacts to marine mammal prey species are expected to be relatively minor and temporary due to the expected short daily duration of individual pile driving events and the relatively small areas being affected.

Reef Effects

The presence of monopile foundations and scour protection will result in a conversion of the existing sandy bottom habitat to a hard bottom habitat with areas of vertical structural relief. This could potentially alter the existing habitat by creating an ''artificial reef effect'' that results in colonization by assemblages of both sessile and mobile animals within the new hard-bottom habitat (Wilhelmsson *et al.,* 2006; Reubens *et al.,* 2013; Bergström *et al.,* 2014; Coates *et al.,* 2014). This colonization by marine species, especially hard-substrate preferring species, can result in changes to the diversity, composition, and/or biomass of the area thereby impacting the trophic composition of the site (Wilhelmsson *et al.,* 2010; Krone *et al.,* 2013; Bergström *et al.,* 2014; Hooper *et al.,* 2017; Raoux *et al.,* 2017; Harrison and Rousseau, 2020; Taormina *et al.,* 2020; Buyse *et al.,* 2022a; ter Hofstede *et al.,* 2022).

Artificial structures can create increased habitat heterogeneity important for species diversity and density (Langhamer, 2012). The monopile WTG foundations will extend through the water column, which may serve to increase settlement of meroplankton or planktonic larvae on the structures in both the pelagic and benthic zones (Boehlert and Gill, 2010). Fish and invertebrate species are also likely to aggregate around the foundations and scour protection which could provide increased prey availability and structural habitat (Boehlert and Gill, 2010; Bonar *et al.,* 2015). Further, instances of species previously unknown, rare, or nonindigenous to an area have been documented at artificial structures, changing the composition of the food web and possibly the attractability of the area to new or existing predators (Adams *et al.,* 2014; de Mesel, 2015; Bishop *et al.,* 2017; Hooper *et al.,* 2017; Raoux *et al.,* 2017; van Hal *et al.,* 2017; Degraer *et al.,* 2020; Fernandez-Betelu *et al.,* 2022). Notably, there are examples of these sites becoming dominated by marine mammal prey species, such as filter-feeding species and suspension-feeding crustaceans (Andersson and Öhman, 2010; Slavik *et al.,* 2019; Hutchison *et al.,* 2020; Pezy *et al.,* 2020; Mavraki *et al.,* 2022).

Numerous studies have documented significantly higher fish concentrations including species like cod and pouting (*Trisopterus luscus*), flounder (*Platichthys flesus*), eelpout (*Zoarces viviparus*), and eel (*Anguilla anguilla*) near in-water structures than in surrounding soft bottom habitat (Langhamer and Wilhelmsson, 2009; Bergström *et al.,* 2013; Reubens *et al.,* 2013). In the German Bight portion of the North Sea, fish were most densely congregated near the anchorages of jacket foundations, and the structures extending through the water column were thought to make it more likely that juvenile or larval fish encounter and settle on them (Rhode Island Coastal Resources Management Council, 2010; Krone *et al.,* 2013). In addition, fish can take advantage of the shelter provided by these structures while also being exposed to stronger currents created by the structures, which generate increased feeding opportunities and decreased potential for predation (Wilhelmsson *et al.,* 2006). The presence of the foundations and resulting fish aggregations around the foundations is expected to be a long-term habitat impact, but the increase in prey availability could potentially be beneficial for some marine mammals.

Water Quality

Temporary and localized reduction in water quality will occur as a result of pile driving activities. These activities will disturb bottom sediments and may cause a temporary increase in suspended sediment in the LIA. Currents should quickly dissipate any raised total suspended sediment (TSS) levels, and levels should return to background levels once the project activities in that area cease. No direct impacts on marine mammals are anticipated due to increased TSS and turbidity; however, turbidity within the water column has the potential to reduce the level of oxygen in the water and irritate the gills of prey fish species in the LIA. However, turbidity plumes associated with the project would be temporary and localized, and fish in the LIA would be able to move away from and avoid the areas where plumes may occur. Therefore, it is expected that the impacts on prey fish species from turbidity, and therefore on marine mammals, would be minimal and temporary.

Equipment used by Vineyard Wind within the LIA, including ships and other marine vessels, potentially aircrafts, and other equipment, are also potential sources of by-products (*e.g.,* hydrocarbons, particulate matter, heavy metals). All equipment is properly maintained in accordance with applicable legal requirements. All such operating equipment meets Federal water quality standards, where applicable. Given these requirements, impacts to water quality are expected to be minimal.

Acoustic Habitat

Acoustic habitat is the soundscape, which encompasses all of the sound present in a particular location and time, as a whole when considered from the perspective of the animals experiencing it. Animals produce sound for, or listen for sounds produced by, conspecifics (communication during feeding, mating, and other social activities), other animals (finding prey or avoiding predators), and the physical environment (finding suitable habitats, navigating). Together, sounds made by animals and the geophysical environment (*e.g.,* produced by earthquakes, lightning, wind, rain, waves) make up the natural contributions to the total acoustics of a place. These acoustic conditions, termed acoustic habitat, are one attribute of an animal's total habitat.

Soundscapes are defined and influenced by the total contribution of anthropogenic sound. This may include incidental emissions from sources such as vessel traffic or may be intentionally introduced to the marine environment for data acquisition purposes (as in the use of airgun arrays) or for Navy training and testing purposes (as in the use of sonar and explosives and other acoustic sources). Anthropogenic noise varies widely in its frequency, content, duration, and loudness. These characteristics greatly influence the potential habitat-mediated effects to marine mammals (please also see the previous discussion on Masking), which may range from local effects for brief periods of time to chronic effects over large areas and for long durations. Depending on the extent of effects to habitat, animals may alter their communications signals (thereby potentially expending additional energy) or miss acoustic cues (either conspecific or adventitious). Problems arising from a failure to detect cues are more likely to occur when noise stimuli are chronic and overlap with biologically relevant cues used for communication, orientation, and predator/prey detection (Francis and Barber, 2013). For more detail on these concepts, see: Barber *et al.,* 2009; Pijanowski *et al.,* 2011; Francis and Barber, 2013; Lillis *et al.,* 2014.

The term ''listening area'' refers to the region of ocean over which sources of sound can be detected by an animal at the center of the space. Loss of communication space concerns the area over which a specific animal signal, used to communicate with conspecifics in biologically important contexts (*e.g.,* foraging, mating), can be heard, in noisier relative to quieter conditions (Clark *et al.,* 2009). Lost listening area concerns the more generalized contraction of the range over which animals would be able to detect a variety of signals of biological importance, including eavesdropping on predators and prey (Barber *et al.,* 2009). Such metrics do not, in and of themselves, document fitness consequences for the marine animals that live in chronically noisy environments. Long-term population-level consequences mediated through changes in the ultimate survival and reproductive success of individuals are difficult to study, and particularly so underwater. However, it is increasingly well documented that aquatic species rely on qualities of natural acoustic habitats, with researchers quantifying reduced detection of important ecological cues (*e.g.,* Francis and Barber, 2013; Slabbekoorn *et al.,* 2010) as well as survivorship consequences in several species (*e.g.,* Simpson *et al.,* 2014; Nedelec *et al.,* 2014).

Potential Effects From Offshore Wind Farm Operational Noise

Although this proposed IHA primarily covers the noise produced from construction activities relevant to the Vineyard Wind Offshore Wind Project offshore wind facility, operational noise was a consideration in NMFS' analysis of the project, as turbines may become operational within the effective dates of the IHA (if issued).

In both newer, quieter, direct-drive systems and older generation, geared turbine designs, recent scientific studies indicate that operational noise from turbines is on the order of 110 to 125 dB re 1 μPa root-mean-square sound pressure level (SPL_{rms}) at an approximate distance of 50 m (Tougaard *et al.,* 2020). Recent measurements of operational sound generated from wind turbines (direct drive, 6 MW, jacket foundations) at Block Island wind farm (BIWF) indicate average broadband levels of 119 dB at 50 m from the turbine, with levels varying with wind speed (HDR, *Inc.,* 2019). Interestingly, measurements from BIWF turbines showed operational sound had fewer tonal components compared to European measurements of turbines with gear boxes.

Tougaard *et al.* (2020) further stated that the operational noise produced by WTGs is static in nature and lower than noise produced by passing ships. This is a noise source in this region to which marine mammals are likely already habituated. Furthermore, operational noise levels are likely lower than those ambient levels already present in active shipping lanes, such that operational noise would likely only be detected in very close proximity to the WTG (Thomsen *et al.,* 2006; Tougaard *et al.,* 2020). Similarly, recent measurements from a wind farm (3–MW turbines) in China found that above 300 Hz, turbines produced sound that was similar to background levels (Zhang *et al.,* 2021). Other studies by Jansen and de Jong (2016) and Tougaard *et al.* (2009) determined that, while marine mammals would be able to detect operational noise from offshore wind farms (again, based on older 2–MW models) for several kilometers, they expected no significant impacts on individual survival, population viability, marine mammal distribution, or the behavior of the animals considered in their study (harbor porpoises and harbor seals). In addition, Madsen *et al.* (2006) found the intensity of noise generated by operational wind turbines to be much less than the noises present during construction, although this observation was based on a single turbine with a maximum power of 2 MW.

More recently, Stöber and Thomsen (2021) used monitoring data and modeling to estimate noise generated by more recently developed, larger (10–MW) direct-drive WTGs. Their findings, similar to Tougaard *et al.* (2020), demonstrate that there is a trend that operational noise increases with turbine size. Their study predicts broadband source levels could exceed 170-dB SPL_{rms} for a 10–MW WTG; however, those noise levels were generated based on geared turbines whereas newer turbines operate with direct drive technology. The shift from using gear boxes to direct drive technology is expected to reduce the levels by 10 dB. The findings in the Stöber and Thomsen (2021) study have not been experimentally validated, though the modeling (using largely geared turbines) performed by Tougaard *et al.* (2020) yields similar results for a hypothetical 10–MW WTG.

Recently, Holme *et al.* (2023) cautioned that the Tougaard *et al.* (2020) and Stöber and Thomsen (2021) studies extrapolated levels for larger turbines should be interpreted with caution since both studies relied on data from smaller turbines (0.45 to 6.15 MW) collected over a variety of environmental conditions. Holme et al. (2023) demonstrated that the model presented in Tougaard *et al.* (2020) tends to potentially overestimate levels (up to approximately 8 dB) measured to those in the field, especially with measurements closer to the turbine for larger turbines. Holme *et al.* (2023) measured operational noise from larger turbines (6.3 and 8.3 MW) associated with three wind farms in Europe and found no relationship between turbine activity (power production, which is proportional to the blade's revolutions per minute) and noise level, though it was noted that this missing relationship may have been masked by the area's relatively high ambient noise sound levels. Sound levels (rms) of a 6.3–MW direct-drive turbine were measured to be 117.3 dB at a distance of 70 m. However, measurements from 8.3 MW turbines were inconclusive as turbine noise was deemed to have been largely masked by ambient noise.

Finally, operational turbine measurements are available from the Coastal Virginia Offshore Wind (CVOW) pilot pile project, where two 7.8 m monopile WTGs were installed (HDR, 2023). Compared to BIWF, levels at CVOW were higher (10–30 dB) below 120 Hz, believed to be caused by the vibrations associated with the monopile structure, while above 120 Hz levels were consistent among the two wind farms.

Overall, noise from operating turbines would raise ambient noise levels in the immediate vicinity of the turbines; however, the spatial extent of increased noise levels would be limited. Vineyard Wind did not request, and NMFS is not proposing to authorize, take incidental to operational noise from WTGs. Therefore, the topic is not discussed or analyzed further herein. However, NMFS proposes to require Vineyard Wind to measure operational noise levels.

Estimated Take of Marine Mammals

This section provides an estimate of the number of incidental takes proposed for authorization through the IHA, which will inform NMFS' consideration of ''small numbers,'' the negligible impact determinations, and impacts on subsistence uses.

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).

Proposed takes would primarily be by Level B harassment, as noise from pile driving has the potential to result in disruption of marine mammal behavioral patterns. Impacts such as masking and TTS can contribute to the disruption of behavioral patterns and are accounted for within those takes proposed for authorization. There is also some potential for high frequency species (harbor porpoise) and phocids (harbor seal and gray seal) to experience a limited amount of auditory injury (PTS; Level A harassment) primarily because predicted auditory injury zones are large enough and these species are cryptic enough that the potential for PTS cannot be fully discounted. For mysticetes, the Level A harassment $ER95_{percent}$ ranges are also large (0.0043 km to 3.191 km); however, the extensive marine mammal mitigation and monitoring proposed by Vineyard Wind, and which would be required by NMFS, as well as natural avoidance behaviors is expected to reduce the potential for PTS to discountable levels. Nevertheless, Vineyard Wind has requested, and NMFS proposes to authorize a small amount of Level A harassment incidental to installing piles (table 11). Auditory injury is unlikely to occur for mid-frequency species as thresholds are higher and PTS zones are very close to the pile such that PTS is unlikely to occur. While NMFS is proposing to authorize Level A harassment and Level B harassment, the proposed mitigation and monitoring measures are expected to, in some cases, avoid,and minimize overall the severity of the taking to the extent practicable (see Proposed Mitigation and Proposed Monitoring and Reporting sections).

As described previously, no serious injury or mortality is anticipated or proposed to be authorized incidental to the specified activity. Even without mitigation, pile driving activities are unlikely to directly cause marine mammal mortality or serious injury. There is no documented case wherein pile driving resulted in marine mammal mortality or stranding and the scientific literature demonstrates that the most likely behavioral response to pile driving (or similar stimulus source) is avoidance and temporary cessation of behaviors such as foraging or socialization (see *Avoidance and Displacement* in Potential Effects of Specified Activities on Marine Mammals and Their Habitat section). While, in general, there is a low probability that mortality or serious injury of marine mammals could occur from vessel strikes, the mitigation and monitoring measures contained within this proposed rule are expected to avoid vessel strikes (see Proposed Mitigation section). No other activities have the potential to result in mortality or serious injury.

For acoustic impacts, 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) the number of days of activities. We note that while these factors can contribute to a basic calculation to provide an initial prediction of potential 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 estimates.

As described below, there are multiple methods available to estimate the density or number of a given species in the area appropriate to inform the take estimate. For each species and activity, the largest value resulting from the three take estimation methods described below (*i.e.,* density-based, PSO-based, or mean group size) was carried forward as the amount of take proposed for authorization, by Level B harassment. The amount of take proposed for authorization, by Level A harassment, reflects the density-based exposure estimates and, for some species and activities, consideration of other data such as mean group size.

Below, we describe NMFS' acoustic thresholds, acoustic and exposure modeling methodologies, marine mammal density calculation methodology, occurrence information, and the modeling and methodologies applied to estimate take for the Project's proposed construction activities. NMFS considered all information and analysis presented by Vineyard Wind, as well as all other applicable information and, based on the best available science, concurs that the estimates of the types and amounts of take for each species and stock are reasonable, and is proposing to authorize the amount requested. NMFS notes the take estimates described herein for foundation installation can be considered conservative because the estimates do not reflect the implementation of clearance and shutdown zones for any marine mammal species or stock.

Acoustic Thresholds

NMFS recommends the use of acoustic thresholds that identify the received level of underwater sound above which exposed marine mammals are likely to be behaviorally harassed (Level B harassment) or to incur PTS of some degree (Level A harassment). A summary of all NMFS' thresholds can be found at *https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-acoustic-technical-guidance.*

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 or exposure context (*e.g.,* frequency, predictability, duty cycle, duration of the exposure, signal-to-noise ratio, distance to the source, ambient noise, and the receiving animal's hearing, motivation, experience, demography, behavior at time of exposure, life stage, depth) and can be difficult to predict (*e.g.,* Southall *et al.,* 2007, 2021; Ellison *et al.,* 2012). Based on what the available science indicates and the practical need to use a threshold based on a metric that is both predictable and measurable for most activities, NMFS typically uses a generalized acoustic threshold based on received level to estimate the onset of behavioral harassment.

NMFS generally predicts that marine mammals are likely to be taken in a manner considered to be Level B harassment when exposed to underwater anthropogenic noise above root-mean-squared pressure received levels (RMS SPL) of 120 dB (referenced to 1 micropascal (re 1 μPa)) for continuous (*e.g.,* vibratory pile driving, drilling) and above RMS SPL 160 dB re 1 μPa for non-explosive impulsive (*e.g.,* seismic airguns) or intermittent (*e.g.,* scientific sonar) sources. Generally speaking, Level B harassment take estimates based on these thresholds are expected to include any likely takes by TTS as, in most cases, the likelihood of TTS occurs at closer distances from the source. TTS of a sufficient degree can manifest as behavioral harassment, as reduced hearing sensitivity and the potential reduced opportunities to detect important signals (conspecific communication, predators, prey) may result in changes in behavior patterns that would not otherwise occur.

The proposed Project's construction activities include the use of impulsive sources (*e.g.,* impact pile driving), and therefore the 160-dB re 1 μPa (rms) threshold is applicable to our analysis.

Level A Harassment

NMFS' Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0, Technical Guidance; NMFS, 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). 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). As described above, Vineyard Wind's proposed activities include the use of impulsive sources. NMFS' thresholds identifying the onset of PTS are provided in table 5. The references, analysis, and methodology used in the development of the thresholds are described in NMFS' 2018 Technical Guidance, which may be accessed at: *https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-acoustic-technical-guidance.*

TABLE 5—PTS ONSET THRESHOLDS

[NMFS, 2018]

Hearing group	PTS onset thresholds * (received level)	
	Impulsive	Non-impulsive
Low-Frequency (LF) Cetaceans	$L_{p,0\text{-}pk,flat}$: 219 dB; $L_{E,p,\ LF,24h}$: 183 dB	$L_{E,p,\ LF,24h}$: 199 dB.
Mid-Frequency (MF) Cetaceans	$L_{p,0\text{-}pk,flat}$: 230 dB; $L_{E,p,\ MF,24h}$: 185 dB	$L_{E,p,\ MF,24h}$: 198 dB.
High-Frequency (HF) Cetaceans	$L_{p,0\text{-}pk,flat}$: 202 dB; $L_{E,p,HF,24h}$: 155 dB	$L_{E,p,\ HF,24h}$: 173 dB.
Phocid Pinnipeds (PW) (Underwater)	$L_{p,0\text{-}pk,flat}$: 218 dB; $L_{E,p,PW,24h}$: 185 dB	$L_{E,p,PW,24h}$: 201 dB.
Otariid Pinnipeds (OW) (Underwater)	$L_{p,0\text{-}pk,flat}$: 232 dB; $L_{E,p,OW,24h}$: 203 dB	$L_{E,p,OW,24h}$: 219 dB.

* Dual metric 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 are recommended for consideration.

Note: Peak sound pressure level ($L_{p,0\text{-}pk}$) has a reference value of 1 μPa, and weighted cumulative sound exposure level ($L_{E,p}$) has a reference value of 1μPa²s. In this table, thresholds are abbreviated to be more reflective of International Organization for Standardization standards (ISO, 2017). The subscript "flat" is being included to indicate peak sound pressure are flat weighted or unweighted within the generalized hearing range of marine mammals (*i.e.,* 7 Hz to 160 kHz). 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 weighted 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 thresholds will be exceeded.

Below, we describe the assumptions and methodologies used to estimate take, in consideration of acoustic thresholds and appropriate marine mammals density and occurrence information, for WTG monopile installation. Resulting distances to thresholds, densities and occurrence (*i.e.,* PSO sightings, group size) data used, exposure estimates (as relevant to the analysis), and activity-specific take estimates can be found below.

Acoustic and Exposure Modeling

During the 2023 Vineyard Wind pile installation activities, Vineyard Wind conducted a sound field verification (SFV) study to compare with model results of the 2018 modeling (Küsel *et al.,* 2024). The SFV study included acoustic monitoring of the impact installation of 12 monopile foundations from June 6 through September 7, 2023. Five of the 12 acoustically monitored monopiles were determined to be representative of the noise attenuation system (NAS) configuration and maintenance schedule that would be proposed for the remaining 15 monopiles to be installed in 2024. These five representative monopiles (piles 7, 8, 10, 11, and 12 in the Vineyard Wind SFV Monitoring Report) were monitored using a double bubble curtain (DBBC) and Hydrosound Damper System (HSD), which has been proposed for use as the noise attenuation system setup for the remaining 15 monopiles. Vineyard Wind also followed an enhanced bubble curtain maintenance schedule for these five monopiles; this maintenance schedule would also be used for the remaining 15 monopiles to be installed in 2024 (see the Vineyard Wind Enhanced BBC Technical Memo). Peak (pk), SEL, and RMS SPL received distances for each acoustically monitored pile are reported in the VW1 SFV Final Report Appendix A (Küsel *et al.,* 2024) For additional details on how acoustic ranges were derived from SFV measurements, see the VW1 SFV Final Report sections 2.3 and 3.3 (Küsel *et al.,* 2024). JASCO modeled a maximum range to the Level A harassment threshold of 3.191 km (1.99 mi) with 6-dB attenuation (for low-frequency cetaceans) (Küsel *et al.,* 2024).

In addition to the 15 piles being installed under the same noise attenuation scenario as the 5 aforementioned representative piles, they are also anticipated to be installed under similar pile driving specifications and in a similar acoustic environment. Table 6 describes the key piling assumptions and proposed impact pile driving schedule for 2024. These assumptions and schedule are based upon the 2023 piling and hammer energy schedule for installing monopiles. Vineyard Wind expects installation of the 15 remaining piles will necessitate similar operations. Further, as described in detail in section 6.1 of Vineyard Wind's application, the water depth and bottom type are similar throughout the Lease Area and therefore sound propagation in the LIA is not expected to differ from where the SFV data were collected in 2023.

TABLE 6—KEY PILING ASSUMPTIONS AND HAMMER ENERGY SCHEDULE FOR MONOPILE INSTALLATION

Pile type	Project component	Max hammer energy (kJ)	Number of hammer strikes	Max piling time duration per pile (min)	Number piles/day
9.6-m monopile	WTG	4,000	2,884–4,329 (average 3,463) [a]	117	1

[a] The number of hammer strikes represent the range of strikes needed to install the 12 monopiles for which SFV was conducted in 2023.

Vineyard Wind compared the acoustic ranges to the Level A harassment and Level B harassment thresholds derived from the 2018 acoustic modeling (Pyć *et al.,* 2018) to the maximum ranges with absorption for the five representative monopiles acoustically monitored in 2023. They applied the greater results to the analysis in their application and NMFS has included that approach in this proposed IHA. The maximum measured range to PTS thresholds of the five representative monopiles was less than the maximum 2018 modeled ranges for all hearing groups, assuming 6 dB of attenuation (table 7), with the exception of high-frequency cetaceans (although Vineyard Wind attributes this extended range to non-piling noise (Vineyard Wind, 2023)). Therefore, Vineyard Wind based the expected distance to the Level A harassment threshold and associated estimated take analysis on the 2018 modeled data.

TABLE 7—MODELED AND MEASURED RANGES TO SEL_{cum} PTS THRESHOLDS FOR MARINE MAMMAL HEARING GROUPS

Marine mammal hearing group	Modeled range to SEL_{cum} PTS threshold (km) [a]	Measured maximum range to SEL_{cum} PTS threshold (km) [b]
Low-frequency cetaceans	3.191	2.37
Mid-frequency cetaceans	0.043	0.01
High-frequency cetaceans	0.071	0.2
Phocid pinnipeds	0.153	0.1

[a] Based upon modeling conducted for the 2023 IHA (Pyć *et al.,* 2018)
[b] Based upon the five representative monopiles from the Vineyard Wind 2023 construction campaign (Küsel *et al.,* 2024).

The maximum range with absorption to the Level B harassment threshold for acoustically monitored piles was 5.72 km (3.6 mi) (pile 13, AU–38; Küsel *et al.,* 2024), which was greater than the 2018 modeled distance to the Level B harassment threshold of 4.1 km (2.5 mi) (Pyć *et al.,* 2018). Therefore, Vineyard Wind based the expected distance to the Level B harassment threshold and associated estimated take analysis on the 5.72-km acoustically monitored distance.

In 2018, Vineyard Wind conducted animat modeling to estimate take, by Level A harassment (PTS), incidental to the project. In order to best evaluate the SEL_{cum} harassment thresholds for PTS, it is necessary to consider animal movement, as the results are based on how sound moves through the environment between the source and the receiver. Applying animal movement and behavior within the modeled noise fields provides the exposure range, which allows for a more realistic indication of the distances at which PTS acoustic thresholds are reached that considers the accumulation of sound over different durations (note that in all cases the distance to the peak threshold is less than the SEL-based threshold). As described above, Vineyard Wind based the Level A harassment estimated take analysis on the modeled Level A harassment acoustic ranges and therefore appropriately used the results of the JASCO's Animal Simulation Model Including Noise Exposure (JASMINE) animal movement modeling conducted for the 2023 IHA (86 FR 33810, June 25, 2021). Sound exposure models like JASMINE use simulated animals (also known as ''animats'') to forecast behaviors of animals in new situations and locations based upon 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 animats and their pathways are not known prior to a project; therefore, a repeated random sampling technique (*i.e.,* Monte Carlo) is used to estimate exposure probability with many animats and randomized starting positions. The combined exposure history of all animats gives a probability density function of exposure during the Project.

Since the time that the JASMINE animal movement modeling was conducted for the 2023 IHA (86 FR 33810, June 25, 2021), no new behavior data is available that would have changed how animats move in time and space in that model and, therefore, NMFS has determined that the JASMINE outputs from the 2018 modeling effort are reasonable for application here. However, the post processing calculations used more recent density data (table 8). The mean number of modeled animats exposed per day with installation of one 9.6-m monopile were scaled by the maximum monthly density for the LIA (Roberts *et al.,* 2023) for each species (table 8) to estimate the real-world number of animats of each species that could be exposed per day in the LIA. This real-world number of animals was multiplied by the expected number of days of pile installation (15 days) to derive a total take estimate by Level A harassment for each species. The number of potential exposures by Level A harassment was estimated for each species using the following equation:

Density-based exposure estimate of Level A harassment = number of animats exposed above the Level A harassment threshold× ((mean maximum monthly density (animals/km²)/modeled 2018 density (animats/km²))×number of days (15).

To estimate the amount of take by Level B harassment incidental to installing the remaining 15 piles, Vineyard Wind applied a static method (*i.e.,* did not conduct animal movement modeling). Vineyard Wind calculated the Level B harassment ensonified area using the following equation:

$A = 3.14 \times r^2$,

where A is equal to the ensonified area and r is equal to the radial distance to the Level B harassment threshold from the pile driving source ($r_{\text{Level B harassment}}$ = 5.72 km).

The ensonified area (102.7 km²) was multiplied by the mean maximum monthly density estimate (table 8) and expected number of days of pile driving (15 days) to determine a density-based take estimate for each species. The number of potential exposures by Level B harassment was estimated for each species using the following equation:

Density-based exposure estimate of Level B harassment = ensonified area (km²) × maximum mean monthly density estimate (animals/km²) × number of days (15).

Density and Occurrence and Take Estimation

In this section we provide information about marine mammal density, presence, and group dynamics that informed the take calculations for the proposed activities. Vineyard Wind applied the 2022 Duke University Marine Geospatial Ecology Laboratory Habitat-based Marine Mammal Density Models for the U.S. Atlantic (Duke Model-Roberts *et al.,* 2016, 2023) to estimate take from foundation installation. The models estimate absolute density (individuals/km²) by statistically correlating sightings reported on shipboard and aerial surveys with oceanographic conditions. For most marine mammal species, densities are provided on a monthly basis. Where monthly densities are not available (*e.g.,* pilot whales), annual densities are provided. Moreover, some species are represented as guilds (*e.g.,* seals (representing *Phocidae* spp., primarily harbor and gray seals) and pilot whales (representing short-finned and long-finned pilot whales)).

The Duke habitat-based density models delineate species' density into 5 × 5 km (3.1 × 3.1 mi) grid cells. Vineyard Wind calculated mean monthly densities by using a 10-km buffered polygon around the remaining WTG foundations to be installed and overlaying this buffered polygon on the density maps. The 10-km buffer defines the area around the LIA used to calculate mean species density. Mean monthly density for each species was determined by calculating the unweighted mean of all 5 × 5 km grid cells (partially or fully) within the buffered polygon. The unweighted mean refers to using the entire 5 × 5 km (3.1 × 3.1 mi) grid cell for each cell used in the analysis, and was not weighted by the proportion of the cell overlapping with the density perimeter if the entire grid cell was not entirely within the buffer zone polygon. Vineyard Wind calculated densities for each month, except for species for which annual density data only was available (*e.g.,* long-finned pilot whale). Vineyard Wind used maximum monthly density from June to December for density-based calculations.

The density models (Roberts *et al.,* 2023) provided density for pilot whales and seals as guilds. Based upon habitat and ranging patterns (Hayes *et al.,* 2023), all pilot whales occurring in the LIA are expected to be long-finned pilot whales. Therefore, all pilot whale density estimates are assumed to represent long-finned pilot whales. Seal guild density was divided into species-specific densities based upon the proportions of each species observed by PSOs during 2016 and 2018–2021 site characterizations surveys within SNE (ESS Group, 2016; Vineyard Wind 2018, 2019, 2023a–f). Of the 181 seals identified to species and sighted within the WDA, 162 were gray seals and 19 were harbor seals. The equation below shows how the proportion of each seal species sighted was calculated to compute density for seals.

$P_{\text{seal species}} = N_{\text{seal species}}/\text{Number}_{\text{total seals identified}}$,

where P represents density and N represents number of seals.

These calculations resulted in proportions of 0.895 for gray seals and 0.105 for harbor seals. The proportion for each species was then multiplied by the maximum monthly density for the seal guild (table 8) to determine the species-specific densities used in take calculations.

The density models (Roberts *et al.,* 2023) also do not distinguish between bottlenose dolphin stocks and only provide densities for bottlenose dolphins as a species. However, as described above, based upon ranging patterns (Hayes *et al.,* 2023), only the Western North Atlantic offshore stock of bottlenose dolphins is expected to occur in the LIA. Therefore, it is expected that the bottlenose dolphin density estimate is entirely representative of this stock. Maximum mean monthly density estimates and month of the maximum estimate is provided in table 8 below.

TABLE 8—MAXIMUM MEAN MONTHLY MARINE MAMMAL DENSITY ESTIMATES (ANIMALS PER km²) CONSIDERING A 10-km BUFFER AROUND THE LIMITED INSTALLATION AREA

Species	Maximum mean density	Maximum density month
NARW *	0.0043	December.
Fin whale *	0.0036	July.
Humpback whale	0.0022	June.
Minke whale	0.018	June.
Sei whale *	0.0008	November.
Sperm whale *	0.0008	September.
Atlantic white-sided dolphin	0.0204	June.
Bottlenose dolphin [a]	0.008	August.
Common dolphin	0.1467	September.
Long-finned pilot whale [b]	0.001	N/A.

TABLE 8—MAXIMUM MEAN MONTHLY MARINE MAMMAL DENSITY ESTIMATES (ANIMALS PER km²) CONSIDERING A 10-km BUFFER AROUND THE LIMITED INSTALLATION AREA—Continued

Species	Maximum mean density	Maximum density month
Risso's dolphin	0.0013	December.
Harbor porpoise	0.0713	December.
Seals (gray and harbor) [c]	0.1745	May.

Note: * denotes species listed under the ESA.
[a] Density estimate represents the Northwestern Atlantic offshore stock of bottlenose dolphins.
[b] Only annual densities were available for the pilot whale guild.
[c] Gray and harbor seals represented as a guild.

For some species, PSO survey and construction data for SNE (ESS Group, 2016; Vineyard Wind, 2018, 2019, 2023a–f) and mean group size data compiled from the Atlantic Marine Assessment Program for Protected Species (AMAPPS) (Palka *et al.,* 2017, 2021) indicate that the density-based exposure estimates may be insufficient to account for the number of individuals of a species that may be encountered during the planned activities. Hence, consideration of local PSO and AMAPPS data is required to ensure the potential for take is adequately assessed.

In cases where the density-based Level B harassment exposure estimate for a species was less than the mean group size-based exposure estimate, the take request was increased to the mean group size (in some cases multiple groups were assumed) and rounded to the nearest integer (table 9). For all cetaceans, with the exception of NARWs, Vineyard Wind used the mean of the spring, summer, and fall AMAPPS group sizes for each species for the RI/MA WEA as shown in tables 2–2, 2–3, and 2–4 in Palka *et al.* (2021) appendix III. These seasons were selected as they would represent the time period in which pile driving activities would take place. Mean group sizes for cetacean species derived from RI/WEA AMAPPS data is shown below in table 9. However, NARW seasonal group sizes for the RI/MA WEA were not available through the AMAPPS dataset (Palka *et al.,* 2021). Vineyard Wind calculated mean group size for NARWs using data from the northeast (NE) shipboard surveys as provided in table 6–5 of Palka *et al.* (2021). Vineyard Wind calculated mean group size by dividing the number of individual right whales sighted (4) by the number of right whale groups (2) (Palka *et al.,* 2021). The NE shipboard surveys were conducted during summer (June 1 through August 31) and fall (September 1 through November 30) seasons (Palka *et al.,* 2021).

For seals, mean group size data was also not available for the RI/MA WEA through AMAPPS (Palka *et al.,* 2021). Vineyard Wind used 2010–2013 AMAPPS NE shipboard and aerial survey at-sea seal sightings for gray and harbor seals, as well as unidentified seal sightings from spring, summer, and fall to calculate mean group size for gray and harbor seals (table 19–1, Palka *et al.,* 2017). To calculate mean group size for seals, Vineyard Wind divided the total number of animals sighted by the total number of sightings. As the majority of the sightings were not identified to species, Vineyard Wind calculated a single group size for all seal species (table 9).

Additional detail regarding the density and occurrence as well as the assumptions and methodology used to estimate take is included below and in section 6.2 of the ITA application. Mean group sizes used in take estimates, where applicable, for all activities are provided in table 9.

TABLE 9—MEAN MARINE MAMMAL GROUP SIZES USED IN TAKE ESTIMATE CALCULATIONS

Species	Mean group size	Source
NARW *	2	Table 6–5 of Palka *et al.,* 2021.
Fin whale *	1.2	Palka *et al.,* 2021.
Humpback whale	1.2	Palka *et al.,* 2021.
Minke whale	1.4	Palka *et al.,* 2021.
Sei whale *	1	Palka *et al.,* 2021.
Sperm whale *	2	Palka *et al.,* 2021.
Atlantic white-sided dolphin	21.7	Palka *et al.,* 2021.
Bottlenose dolphin	11.7	Palka *et al.,* 2021.
Common dolphin	30.8	Palka *et al.,* 2021.
Long-finned pilot whale	12.3	Palka *et al.,* 2021.
Risso's dolphin	1.8	Palka *et al.,* 2021.
Harbor porpoise	2.9	Palka *et al.,* 2021.
Seals (gray and harbor)	1.4	Table 19–1 of Palka *et al.,* 2017.

Note: * denotes species listed under the ESA.

Vineyard Wind also looked at PSO survey data (June through October 2023) in the LIA collected during Vineyard Wind I construction activities and calculated a daily sighting rate for species to compare with density-based take estimates and average group size estimates from AMAPPS (table 9). The number of animals of each species sighted from all survey vessels with active PSOs was divided by the sum of all PSO monitoring days (77 days) to calculate the mean number of animals of each species sighted (see table 11 in the ITA application). However, for each species, the PSO data-based exposure estimate was less than the density-based exposure estimate (see table 14 in the ITA application) and, therefore, density-based exposure estimates were not adjusted according to PSO data-based exposure estimates.

Here we present the amount of take requested by Vineyard Wind and proposed to be authorized. To estimate take, Vineyard Wind use the pile installation construction schedule shown in table 6, assuming 15 total days of monopile installation. NMFS has reviewed these methods to estimate take and agrees with this approach. The proposed take numbers in table 11, appropriately consider SFV measurements collected in 2023 and represent the maximum amount of take that is reasonably expected to occur.

TABLE 10—MODELED LEVEL A HARASSMENT AND LEVEL B HARASSMENT ACOUSTIC EXPOSURE ESTIMATES

Species	Density-based exposure estimate	
	Level A harassment	Level B harassment
NARW *[a]	0.503	6.6
Fin whale *	0.598	5.5
Humpback whale	1.11	3.4
Minke whale	0.372	27.7
Sei whale *	0.144	1.2
Sperm whale *	0	1.2
Atlantic white-sided dolphin	0	31.4
Bottlenose dolphin	0	12.3
Common dolphin	0	226
Long-finned pilot whale	0	1.5
Risso's dolphin	0	2
Harbor porpoise	2.758	109.8
Gray Seal	0	240.8
Harbor seal	0.028	28.2

Note: * denotes species listed under the ESA.
[a] Although modeling shows a very low but non-zero exposure estimate for take by Level A harassment, mitigation measures will be applied to ensure there is no take by Level A harassment of this species.

TABLE 11—PROPOSED AUTHORIZED TAKES

[by Level A harassment and Level B harassment]

Species	NMFS stock abundance	Proposed take by Level A harassment	Proposed take by Level B harassment	Total proposed take	Percent of stock abundance
NARW *[a]	338	0	7	7	2.07
Fin whale *	6,802	1	6	7	0.1
Humpback whale	1,396	2	4	6	0.43
Minke whale	21,968	1	28	29	0.13
Sei whale *	6,292	1	2	3	0.05
Sperm whale *	4,349	0	2	2	0.05
Atlantic white-sided dolphin	93,233	0	32	32	0.03
Bottlenose dolphin	62,851	0	13	13	0.02
Common dolphin[b c]	172,974	0	462	462	0.27
Long-finned pilot whale[b]	39,215	0	13	13	0.03
Risso's dolphin	35,215	0	2	2	0.001
Harbor porpoise	95,543	3	110	113	0.19
Gray Seal	27,300	0	241	241	0.88
Harbor seal	61,336	1	29	30	0.05

Note: * denotes species listed under the ESA.
[a] Although modeling shows a very low but non-zero exposure estimate for take by Level A harassment, mitigation measures will be applied to ensure there is no take by Level A harassment of this species.
[b] Proposed take by Level B harassment adjusted according to mean group size.
[c] Proposed take by Level B harassment is based upon the assumption that one group of common dolphins (30.8 dolphins; see table 9) would be encountered per each of the 15 days of pile driving.

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 the activity, and other means of effecting the least practicable impact on the species or stock and its habitat, paying particular attention to rookeries, mating grounds, and areas of similar significance, and on the availability of the 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 the 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 effect the least practicable adverse impact on species or stocks and their habitat, as well as subsistence uses where applicable, NMFS considers 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 (*e.g.,* soft-start, establishing shutdown zones). Additional measures have also been incorporated to account for the fact that the proposed construction activities would occur offshore. In addition, several measures proposed for this IHA (*i.e.,* seasonal restrictions, vessel strike avoidance, and clearance and shutdown zones) are more rigorous than measures previously incorporated into the 2023 IHA.

Generally speaking, the mitigation measures considered and proposed to be required here fall into three categories: (1) temporal (seasonal and daily) work restrictions, (2) real-time measures (shutdown, clearance, and vessel strike avoidance), and (3) noise attenuation/reduction measures. Seasonal work restrictions are designed to avoid or minimize operations when marine mammals are concentrated or engaged in behaviors that make them more susceptible or make impacts more likely, in order to reduce both the number and severity of potential takes, and are effective in reducing both chronic (longer-term) and acute effects. Real-time measures, such as implementation of shutdown and clearance zones, as well as vessel strike avoidance measures, are intended to reduce the probability or severity of harassment by taking steps in real time once a higher-risk scenario is identified (*e.g.,* once animals are detected within an impact zone). Noise attenuation measures, such as bubble curtains, are intended to reduce the noise at the source, which reduces both acute impacts, as well as the contribution to aggregate and cumulative noise that may result in longer-term chronic impacts. Below, we also describe the required training, coordination, and vessel strike avoidance measures that apply to foundation installation and vessel use.

Training and Coordination

NMFS requires all Vineyard Wind's employees and contractors conducting activities on the water, including, but not limited to, all vessel captains and crew, to be trained in marine mammal detection and identification, communication protocols, and all required measures to minimize impacts on marine mammals and support Vineyard Wind's compliance with the IHA, if issued. Additionally, all relevant personnel and the marine mammal species monitoring team(s) are required to participate in joint, onboard briefings prior to the beginning of project activities. The briefing must be repeated whenever new relevant personnel (*e.g.,* new PSOs, construction contractors, relevant crew) join the project before work commences. During this training, Vineyard Wind is required to instruct all project personnel regarding the authority of the marine mammal monitoring team(s). For example, pile driving personnel are required to immediately comply with any call for a delay or shut down by the Lead PSO. Any disagreement between the Lead PSO and the project personnel must only be discussed after delay or shutdown has occurred. In particular, all captains and vessel crew must be trained in marine mammal detection and vessel strike avoidance measures to ensure marine mammals are not struck by any project or project-related vessel.

Prior to the start of in-water construction activities, Vineyard Wind would conduct training for construction and vessel personnel and the marine mammal monitoring team (PSO and PAM operators) to explain responsibilities, communication procedures, marine mammal detection and identification, mitigation, monitoring, and reporting requirements, safety and operational procedures, and authorities of the marine mammal monitoring team(s). A description of the training program must be provided to NMFS at least 60 days prior to the initial training before in-water activities begin. Vineyard Wind would provide confirmation of all required training documented on a training course log sheet and reported to NMFS OPR prior to initiating project activities.

NARW Awareness Monitoring

Vineyard Wind would be required to use available sources of information on NARW presence, including daily monitoring of the Right Whale Sightings Advisory System, U.S. Coast Guard very high-frequency (VHF) Channel 16, WhaleAlert, and the PAM system throughout each day to receive notifications of any Slow Zones (*i.e.,* Dynamic management areas (DMAs) and/or acoustically-triggered slow zones) to provide situational awareness for vessel operators, PSOs, and PAM operators. The marine mammal monitoring team must monitor these systems at least every 4 hours. Maintaining daily awareness and coordination affords increased protection of NARWs by understanding NARW presence in the area through ongoing visual and passive acoustic monitoring efforts and opportunities (outside of Vineyard Wind's efforts), and allows for planning of construction activities, when practicable, to minimize potential impacts on NARWs.

Vessel Strike Avoidance Measures

This proposed IHA contains numerous vessel strike avoidance measures that reduce the risk that a vessel and marine mammal could collide. While the likelihood of a vessel strike is generally low, they are one of the most common ways that marine mammals are seriously injured or killed by human activities. Therefore, enhanced mitigation and monitoring measures are required to avoid vessel strikes, to the extent practicable. While many of these measures are proactive, intending to avoid the heavy use of vessels during times when marine mammals of particular concern may be in the area, several are reactive and occur when a project personnel sights a marine mammal. Vineyard Wind would be required to comply with these measures except under circumstances when doing so would create an imminent and serious threat to a person or vessel or to the extent that a vessel is unable to maneuver and, because of the inability to maneuver, the vessel cannot comply.

While underway, Vineyard Wind's personnel would be required to monitor for and maintain a minimum separation distance from marine mammals and operate vessels in a manner that reduces the potential for vessel strike. Regardless of the vessel's size or speed, all vessel operators, crews, and dedicated visual observers (*i.e.,* PSO or trained crew member) must maintain a vigilant watch for all marine mammals and slow down, stop their vessel, or alter course (as appropriate) to avoid striking any marine mammal. The dedicated visual observer, required on all transiting vessels and equipped with suitable monitoring technology (*e.g.,* binoculars, night vision devices), must be located at an appropriate vantage point for ensuring vessels are maintaining required vessel separation distances from marine mammals (*e.g.,* 500 m from NARWs).

All of the project-related vessels would be required to comply with existing NMFS vessel speed restrictions for NARWs, and additional speed and approach restrictions measures within this IHA. All vessels must reduce speed to 10 kn or less when traveling in a DMA, Slow Zone or when a NARW is observed or acoustically detected. Reducing vessel speed is one of the most effective, feasible options available to reduce the likelihood of and effects from a vessel strike. Numerous studies have indicated that slowing the speed of vessels reduces the risk of lethal vessel collisions, particularly in areas where right whales are abundant and vessel traffic is common and otherwise traveling at high speeds (Vanderlaan and Taggart, 2007; Conn and Silber, 2013; Van der Hoop *et al.,* 2014; Martin *et al.,* 2015; Crum *et al.,* 2019).

When NMFS vessel speed restrictions are not in effect and a vessel is traveling at greater than 10 kn (18.5 km/hr), in addition to the required dedicated visual observer, Vineyard Wind would be required to monitor the crew transfer vessel transit corridor (the path crew transfer vessels take from port to any work area) in real-time with PAM prior to and during transits.

All project vessels, regardless of size, must maintain the following minimum separation zones: 500 m from NARWs; 100 m from sperm whales and non-NARW baleen whales; and 50 m from all delphinid cetaceans and pinnipeds (an exception is made for those species that approach the vessel such as bow-riding dolphins) (table 12). All reasonable steps must be taken to not violate minimum separation distances. If any of these species are sighted within their respective minimum separation zone, the underway vessel must turn away from the animal and shift its engine to neutral (if safe to do so) and the engines must not be engaged until the animal(s) have been observed to be outside of the vessel's path and beyond the respective minimum separation zone. If a NARW is observed at any distance by any project personnel or acoustically detected, project vessels must reduce speeds to 10 kn and turn away from the animal. Additionally, in the event that any project-related vessel, regardless of size, observes any large whale (other than a NARW) within 500 m of an underway vessel, the vessel is required to immediately reduce speeds to 10 kn or less and turn away from the animal.

TABLE 12—VESSEL STRIKE AVOIDANCE SEPARATION ZONES

Marine mammal species	Vessel separation zone (m)
NARW	500
Other ESA-listed species and non-NARW large whales	100
Other marine mammals [a]	50

[a] With the exception of seals and delphinid(s) from the genera *Delphinus, Lagenorhynchus, Stenella,* or *Tursiops,* as described below.

Any marine mammal observed by project personnel must be immediately communicated to any on-duty PSOs, PAM operator(s), and all vessel captains. Any NARW or large whale observation or acoustic detection by PSOs or PAM operators must be conveyed to all vessel captains. All vessels would be equipped with an AIS and Vineyard Wind must report all Maritime Mobile Service Identity (MMSI) numbers to NMFS OPR prior to initiating in-water activities. Vineyard Wind has submitted an updated NMFS-approved NARW Vessel Strike Avoidance Plan, which NMFS is reviewing for alignment with the measures proposed herein.

Given the extensive vessel strike avoidance measures coupled with the limited amount of work associated with the project, NMFS has determined that Vineyard Wind's compliance with these proposed measures would reduce the likelihood of vessel strike to discountable levels.

Seasonal and Daily Restrictions

Temporal restrictions in places where marine mammals are concentrated, engaged in biologically important behaviors, and/or present in sensitive life stages are effective measures for reducing the magnitude and severity of human impacts. The temporal restrictions proposed here are built around NARW protection. Based upon the best scientific information available (Roberts *et al.,* 2023), the highest densities of NARWs in the specified geographic region are expected during the months of January through May, with an increase in density starting in December. However, NARWs may be present in the specified geographic region throughout the year.

NMFS is proposing to require seasonal work restrictions to minimize risk of noise exposure to the NARWs incidental to pile driving activities to the extent practicable. These seasonal work restrictions are expected to reduce the number of takes of NARWs and further reduce vessel strike risk. These seasonal restrictions also afford protection to other marine mammals that are known to use the LIA with greater frequency during winter months, including other baleen whales. As described previously, no impact pile driving activities may occur January 1 through May 31, and pile driving in December must be avoided to the maximum extent practicable and only if enhanced monitoring is undertaken and NMFS approves.

Vineyard Wind proposed to install no more than one pile per day and only initiate impact pile driving during daylight hours. Vineyard Wind would not be able to initiate pile driving later than 1.5 hours after civil sunset or continue pile driving after or 1 hour before civil sunrise. However, if Vineyard Wind determines that they must initiate pile driving after the aforementioned time frame, they must submit a sufficient nighttime pile driving plan for NMFS review and approval to do so. A sufficient nighttime pile driving plan would demonstrate that proposed detection systems would be capable of detecting marine mammals, particularly large whales, at distances necessary to ensure mitigation measures are effective.

Noise Attenuation Systems

Vineyard Wind would be required to employ noise abatement systems (NAS), also known as noise attenuation systems, during all foundation installation activities to reduce the sound pressure levels that are transmitted through the water in an effort to reduce acoustic ranges to the Level A harassment and Level B harassment acoustic thresholds and minimize, to the extent practicable, any acoustic impacts resulting from these activities. Vineyard Wind proposes and NMFS is proposing to require Vineyard Wind to use a double bubble curtain (DBBC) and Hydro Sound damper (HSD) in addition to an enhanced big bubble curtain (BBC) maintenance schedule. The refined NAS design (DBBC + HSD + enhanced bubble curtain (BC) maintenance schedule) used during the 2023 construction activities would be used on the 15 remaining piles to minimize noise levels. A single bubble curtain, alone or in combination with another NAS device, may not be used for pile driving as received SFV data reveals this approach is unlikely to attenuate sound sufficiently to be consistent with the target sound reduction of 6 dB, in which the expected ranges to the Level A harassment and Level B harassment isopleths are based upon.

Two categories of NAS exist: primary and secondary. A primary NAS would be used to reduce the level of noise produced by foundation installation activities at the source, typically through adjustments to the equipment (*e.g.,* hammer strike parameters). Primary NAS are still evolving and will be considered for use during mitigation efforts when the NAS has been demonstrated as effective in commercial projects. However, as primary NAS are not fully effective at eliminating noise, a secondary NAS would be employed. The secondary NAS is a device or group of devices that would reduce noise as it is transmitted through the water away from the pile, typically through a physical barrier that would reflect or absorb sound waves and therefore reduce the distance the higher energy sound propagates through the water column. Together, these systems must reduce noise levels to those not exceeding expected ranges to Level A harassment and Level B harassment isopleths corresponding to those modeled assuming 6-dB sound attenuation, pending results of SFV (see *Sound Field Verification* section below).

Noise abatement systems, such as bubble curtains, are 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 *et al.,* 2016; Koschinski and Lüdemann, 2013). Bubble curtains vary in terms of the sizes of the bubbles; those with larger bubbles tend to perform a bit better and more reliably, particularly when deployed with two separate rings (Bellmann, 2014; Koschinski and Lüdemann, 2013; Nehls *et al.,* 2016). Encapsulated bubble systems (*i.e.,* 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.

For example, Dähne *et al.* (2017) found that single bubble curtains that reduce sound levels by 7 to 10 dB reduced the overall sound level by approximately 12 dB when combined as a double bubble curtain for 6-m steel monopiles in the North Sea. During installation of monopiles (consisting of approximately 8-m in diameter) for more than 150 WTGs in comparable water depths (>25 m) and conditions in Europe indicate that attenuation of 10 dB is readily achieved (Bellmann, 2019; Bellmann *et al.,* 2020) using single BBCs for noise attenuation. When a DBBC is used (noting a single BC is not allowed), Vineyard Wind would be required to maintain numerous operational performance standards, including the enhanced BBC maintenance protocol (Vineyard Wind Enhanced BBC Technical Memo, 2023). These standards are defined in the proposed IHA and include, but are not limited to, a requirement that construction contractors train personnel in the proposed balancing of airflow to the bubble ring; and a requirement that Vineyard Wind submit a performance test and maintenance report to NMFS within 72 hours following the performance test. Corrections to the attenuation device to meet regulatory requirements must occur prior to use during foundation installation activities. In addition, a full maintenance check (*e.g.,* manually clearing holes) must occur prior to each pile being installed.

The HSD system Vineyard Wind proposes to use would be employed, in coordination with the DBBC, as a near-field attenuation device close to the monopiles (Küsel *et al.,* 2024). Vineyard Wind has also proposed to follow a DBBC enhanced maintenance protocol, which was used during the 2023 Vineyard Wind pile installation activities. The DBBC enhanced maintenance protocol includes an adjustment from typical bubble curtain operations to drill hoses after every deployment to maximize performance in siltier sediments which are present in the Lease Area. The DBBC enhanced maintenance protocol also includes DBBC hose inspection and clearance, pressure testing of DBBC hoses, visual inspection of DBBC performance, and minimizing disturbance of the DBBC hoses on the seafloor.

Should SFV identify that distances to NMFS harassment isopleths are louder than expected, Vineyard Wind would be required to adjust the NAS, or conduct other measures to reduce noise levels, such that distances to thresholds are not exceeded.

Clearance and Shutdown Zones

NMFS is proposing to require the establishment of both clearance and shutdown zones during impact pile driving. The purpose of ''clearance'' of a particular zone is to minimize potential instances of auditory injury and more severe behavioral disturbances by delaying the commencement of an activity if marine mammals are near the activity. The purpose of a ''shutdown'' is to prevent a specific acute impact, such as auditory injury or severe behavioral disturbance of sensitive species, by halting the activity. Due to the increased density of NARWs during the months of November and December, more stringent clearance and shutdown mitigation measures are proposed for these months.

All relevant clearance and shutdown zones during project activities would be monitored by NMFS-approved PSOs and PAM operators. PAM would be conducted at least 24 hours in advance of any pile driving activities. At least one PAM operator would review data from at least 24 hours prior to foundation installation (to increase situational awareness) and actively monitor hydrophones for 60 minutes prior to commencement of these activities. Any sighting or acoustic detection of a NARW would trigger a delay to commencing pile driving and shutdown.

Prior to the start of pile driving activities, Vineyard Wind would be required to ensure designated areas (*i.e.,* clearance zones, table 13) are clear of marine mammals before commencing activities to minimize the potential for and degree of harassment. Three on-duty PSOs would monitor from the pile driving support vessel and two PSO support vessels, each with three PSOs on board, before (60 minutes), during, and after (30 minutes) all pile driving. PSOs must visually monitor clearance zones for marine mammals for a minimum of 60 minutes, where the zone must be confirmed free of marine mammals at least 30 minutes directly prior to commencing these activities. The minimum visibility zone, defined as the area over which PSOs must be able to visually detect marine mammals, would extend 4,000 m for monopile installation from the pile being driven (table 13), and must be visible for 60 minutes. The minimum visibility zone corresponds to the modeled Level A harassment distance for low-frequency cetaceans plus twenty percent, and rounded up to the nearest 0.5 km. The minimum visibility zone must be visually cleared of marine mammals. If this zone is obscured to the degree that effective monitoring cannot occur, pile driving must be delayed. Minimum visibility zone and clearance zones are defined and provided in table 13 for all species.

From December 1 to 31, a vessel-based survey would be used to confirm the clearance zone (10 km PAM clearance zone (6.2 mi); table 13) is clear of NARWs prior to pile driving. The survey would be supported by a team of nine PSOs coordinating visual monitoring across two PSO support vessels and the pile driving platform. The two PSO support vessels, each with three active on-duty PSOs, would be positioned at the same distance on either side of the pile driving vessel. Each PSO support vessel would transit along a steady course along parallel track lines in opposite directions. Each transect line would be surveyed at a similar speed, not to exceed 10 kn, and would last for approximately 30 minutes to 1 hour. If a NARW is sighted at any distance during the vessel-based survey, pile driving would be delayed until the following day unless an additional vessel-based survey with additional transects are conducted to determine the clearance zone is clear of NARWs. Further details on PSO support vessel monitoring efforts are described in the Vineyard Wind application section 11, table 17.

Once pile driving activity begins, any marine mammal entering their respective shutdown zone would trigger the activity to cease. In the case of pile driving, the shutdown requirement may be waived if is not practicable due to imminent risk of injury or loss of life to an individual or risk of damage to a vessel that creates risk of injury or loss of life for individuals, or if the lead engineer determines there is pile refusal or pile instability.

In situations when shutdown is called for, but Vineyard Wind determines shutdown is not practicable due to aforementioned emergency reasons, reduced hammer energy must be implemented when the lead engineer determines it is practicable. Specifically, pile refusal or pile instability could result in the inability to shut down pile driving immediately. Pile refusal occurs when the pile driving sensors indicate the pile is approaching refusal, and a shut-down would lead to a stuck pile which then poses an imminent risk of injury or loss of life to an individual, or risk of damage to a vessel that creates risk for individuals. Pile instability occurs when the pile is unstable and unable to stay standing if the piling vessel were to ''let go.'' During these periods of instability, the lead engineer may determine a shut-down is not feasible because the shut-down combined with impending weather conditions may require the piling vessel to ''let go'' which then poses an imminent risk of injury or loss of life to an individual, or risk of damage to a vessel that creates risk for individuals. Vineyard Wind must document and report to NMFS all cases where the emergency exemption is taken.

After shutdown, impact pile driving may be reinitiated once all clearance zones are clear of marine mammals for the minimum species-specific periods, or, if required to maintain pile stability, impact pile driving may be reinitiated but must be used to maintain stability. From June 1 to October 31, if pile driving has been shut down due to the presence of a NARW, pile driving must not restart until the NARW has not been visually or acoustically detected for 30 minutes. Upon re-starting pile driving, soft-start protocols must be followed if pile driving has ceased for 30 minutes or longer. From November 1 to December 31, if pile driving has been shut down or delayed due to the presence of three or more NARWs, pile driving will be postponed until the next day. Shutdown zones vary by species and are shown in table 13 below.

TABLE 13—MINIMUM VISIBILITY, CLEARANCE, SHUTDOWN, AND LEVEL B HARASSMENT ZONES, IN METERS (m), DURING IMPACT PILE DRIVING

Monitoring zones	NARWs [a]	Other mysticetes/ sperm whales (m) [b]	Pilot whales, harbor porpoises, and delphinids (m) [b]	Pinnipeds (m) [b]
Minimum Visibility Zone [c]	4,000			
Visual Clearance Zone	Any distance from PSOs	500	160	160
PAM Clearance Zone	10,000	500	160	160
Visual Shutdown Zone	Any distance	500	160	160
PAM Monitoring Zone [d]	10,000	500	160	160
Distance to Level B Harassment Threshold	5,720			

[a] From December 1 to December 31, vessel based surveys using two PSO support vessels would confirm that the 10-km (6.2-mi) PAM clearance zone is clear of NARWs. If three or more NARWs are sighted in November or December, pile driving will be delayed for 24 hours.

[b] Pile driving may commence when either the marine mammal has voluntarily left the respective clearance zone and has been visually confirmed beyond that clearance zone, or when 30 minutes (NARWs (June-October), other non-NARW mysticetes, sperm whales, pilot whales, Risso's dolphins) or 15 minutes (all other delphinids and pinnipeds)have elapsed without re-detection.

[c] Minimum visibility zone is the minimum distance that must be visible prior to initiating pile driving, as determined by the lead PSO. The minimum visibility zone corresponds to the Level A harassment distance for low-frequency cetaceans plus twenty percent, and rounded up to the nearest 0.5 km

[d] The PAM system must be capable of detecting NARWs at 10 km during pile driving. The system should also be designed to detect other marine mammals to the maximum extent practicable; however, it is not required these other species be detected out to 10 km given higher frequency calls and echolocation clicks are not typically detectable at large distances.

For any other in-water construction heavy machinery activities (*e.g.,* trenching, cable laying, *etc.*), if a marine mammal is on a path towards or comes within 10 m (32.8 ft) of equipment, Vineyard Wind would be required to delay or cease operations until the marine mammal has moved more than 10 m on a path away from the activity to avoid direct interaction with equipment.

Soft-start

The use of a soft-start procedure is believed to provide additional protection to marine mammals by warning them or providing them with a chance to leave the area prior to the hammer operating at full capacity. Soft-start typically involves initiating hammer operation at a reduced energy level (relative to full operating capacity) followed by a waiting period. Vineyard Wind would be required to utilize a soft-start protocol for impact pile driving of monopiles by performing four to six single hammer strikes at less than 40 percent of the maximum hammer energy followed by at least a 1-minute delay before the subsequent hammer strikes. This process shall be conducted at least tjree times (*e.g.,* four to six single strikes, delay, four to six single strikes, delay, four to six single strikes, delay) for a minimum of 20 minutes. NMFS notes that it is difficult to specify a reduction in energy for any given hammer because of variation across drivers and installation conditions. Vineyard Wind will reduce energy based on consideration of site-specific soil properties and other relevant operational considerations.

Soft start would be required at the beginning of each day's activity and at any time following a cessation of activity of 30 minutes or longer. Prior to soft-start, the operator must receive confirmation from the PSO that the clearance zone is clear of any marine mammals.

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

Proposed Monitoring and Reporting

In order to issue an IHA for an activity, section 101(a)(5)(D) of the MMPA states that NMFS must set forth requirements pertaining to the monitoring and reporting of such taking. NMFS' MMPA implementing regulations at 50 CFR 216.104(a)(13) indicate that requests for authorization 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 while conducting the activities. 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 activity; or (4) biological or behavioral context of exposure (*e.g.,* age, calving or feeding areas);
- Individual marine mammal responses (behavioral or physiological) to acoustic stressors (acute, chronic, or cumulative), other stressors, or cumulative impacts from multiple stressors;
- How anticipated responses to stressors impact either: (1) long-term fitness and survival of individual marine mammals; or (2) populations, species, or stocks;
- Effects on marine mammal habitat (*e.g.,* marine mammal prey species, acoustic habitat, or other important physical components of marine mammal habitat); and,
- Mitigation and monitoring effectiveness.

Separately, monitoring is also regularly used to support mitigation implementation, which is referred to as mitigation monitoring, and monitoring plans typically include measures that both support mitigation implementation and increase our understanding of the impacts of the activity on marine mammals.

Protected Species Observer and PAM Operator Requirements

PSOs are trained professionals who are tasked with visual monitoring for marine mammals during pile driving activities. The primary purpose of a PSO is to carry out the monitoring, collect data, and, when appropriate, call for the implementation of mitigation measures. Visual monitoring by NMFS-approved PSOs would be conducted at a minimum of 60 minutes before, during, and 30 minutes after all proposed impact pile driving activities. In addition to visual observations, NMFS would require Vineyard Wind to conduct PAM using NMFS-approved PAM operators during impact pile driving and vessel transit. PAM would also be conducted for 24 hours in advance and during impact pile driving activities. Visual observations and acoustic detections would be used to support the mitigation measures (*e.g.,* clearance zones). To increase understanding of the impacts of the activity on marine mammals, PSOs must record all incidents of marine mammal occurrence at any distance from the piling locations. PSOs would document all behaviors and behavioral changes, in concert with distance from an acoustic source.

NMFS proposes to require PAM conducted by NMFS-approved PAM operators, following a standardized measurement, processing methods, reporting metrics, and metadata standards for offshore wind. PAM alongside visual data collection is valuable to provide the most accurate record of species presence as possible, and these two monitoring methods are well understood to provide best results when combined together (*e.g.,* Barlow and Taylor, 2005; Clark *et al.,* 2010; Gerrodette *et al.,* 2011; Van Parijs *et al.,* 2021). Acoustic monitoring (in addition to visual monitoring) increases the likelihood of detecting marine mammals within the shutdown and clearance zones of project activities, which when applied in combination with required shutdowns helps to further reduce the risk of marine mammals being exposed to sound levels that could otherwise result in acoustic injury or more intense behavioral harassment.

The exact configuration and number of PAM systems depends on the size of the zone(s) being monitored, the amount of noise expected in the area, and the characteristics of the signals being monitored. More closely spaced hydrophones would allow for more directionality, and perhaps, range to the vocalizing marine mammals; although, this approach would add additional costs and greater levels of complexity to the project. Larger baleen cetacean species (*i.e.,* mysticetes), which produce loud and lower-frequency vocalizations, may be able to be heard with fewer hydrophones spaced at greater distances. However, smaller cetaceans (such as mid-frequency delphinids or odontocetes) may necessitate more hydrophones and to be spaced closer together given the shorter range of the shorter, mid-frequency acoustic signals (*e.g.,* whistles and echolocation clicks). The configuration for collecting the required marine mammal data will be based upon the acoustic data acquisition methods used during the 2023 Vineyard Wind construction campaign (Küsel *et al.,* 2024).

NMFS does not formally administer any PSO or PAM operator training program or endorse specific providers but would approve PSOs and PAM operators that have successfully completed courses that meet the curriculum and trainer requirements. All PSOs and PAM operators must have successfully attained a bachelor's degree from an accredited college or university with a major in one of the natural sciences, a minimum of 30 semester hours or equivalent in the biological sciences, and at least one undergraduate course in math or statistics. The educational requirements may be waived if the PSO or PAM operator has acquired the relevant skills through alternate experience. Requests for such a waiver shall be submitted to NMFS and must include written justification. Alternate experience that may be considered includes, but is not limited to: (1) secondary education and/or experience comparable to PSO and/or PAM operator duties; (2) previous work experience conducting academic, commercial, or government-sponsored marine mammal surveys; and (3) previous work experience as a PSO/PAM operator (PSOs/PAM operators must be in good standing and demonstrate good performance of PSO/PAM operator duties). All PSOs and PAM operators must have successfully completed a relevant training course within the last 5 years, including obtaining a certificate of course completion that would be submitted to NMFS.

For prospective PSOs and PAM operators not previously approved, or for PSOs and PAM operators whose approval is not current, NMFS must review and approve PSO and PAM operator qualifications. Vineyard Wind would be required to submit PSO and PAM operator resumes for approval at least 60 days prior to PSO and PAM operator use. Resumes must include information related to relevant education, experience, and training, including dates, duration, location, and description of prior PSO and/or PAM experience, and be accompanied by relevant documentation of successful completion of necessary training. Should Vineyard Wind require additional PSOs or PAM operators throughout the project, Vineyard Wind must submit a subsequent list of pre-approved PSOs and PAM operators to NMFS at least 15 days prior to planned use of that PSO or PAM operator. PSOs and PAM operators must have previous experience observing marine mammals and must have the ability to work with all required and relevant software and equipment.

PAM operators are responsible for obtaining NMFS approval. To be approved as a PAM operator, the person must meet the following qualifications: The PAM operator must demonstrate that they have prior experience with real-time acoustic detection systems and/or have completed specialized training for operating PAM systems and detecting and identifying Atlantic Ocean marine mammal sounds, in particular, NARW sounds, humpback whale sounds, and how to deconflict them from similar NARW sounds, and other co-occurring species' sounds in the area including sperm whales. The PAM operator must be able to distinguish between whether a marine mammal or other species sound is detected, possibly detected, or not detected, and similar terminology must be used across companies/projects. Where localization of sounds or deriving bearings and distance are possible, the PAM operators need to have demonstrated experience in using this technique. PAM operators must be independent observers (*i.e.,* not construction personnel), and must demonstrate experience with relevant acoustic software and equipment. PAM operators must have the qualifications and relevant experience/training to safely deploy and retrieve equipment and program the software, as necessary. PAM operators must be able to test software and hardware functionality prior to operation, and PAM operators must have evaluated their acoustic detection software using the PAM Atlantic baleen whale annotated data set available at National Centers for Environmental Information (NCEI) and provide evaluation/performance metric. PAM operators must also be able to review and classify acoustic detections in real-time (prioritizing NARWs and noting detection of other cetaceans) during the real-time monitoring periods.

NMFS may approve PSOs and PAM operators as conditional or unconditional. An unconditionally approved PSO or PAM operator is one who has completed training within the last 5 years and attained the necessary experience (*i.e.,* demonstrate experience with monitoring for marine mammals at clearance and shutdown zone sizes similar to those produced during the respective activity). A conditionally approved PSO or PAM operator may be one who has completed training in the last 5 years but has not yet attained the requisite field experience.

Conditionally approved PSOs and PAM operators would be paired with an unconditionally approved PSO (or PAM operator, as appropriate) to ensure that the quality of marine mammal observations and data recording is kept consistent. Additionally, impact pile driving activities would require PSOs and/or PAM operator monitoring to have a lead on duty. The visual PSO field team, in conjunction with the PAM team (*i.e.,* marine mammal monitoring team) would have a lead member (designated as the ''Lead PSO'' or ''Lead PAM operator'') who would be required to meet the unconditional approval standard. Lead PSO or PAM operators must also have a minimum of 90 days in a northwestern Atlantic Ocean offshore environment performing the role (either visual or acoustic), with the conclusion of the most recent relevant experience not more than 18 months previous. A PSO may be trained and/or experienced as both a PSO and PAM operator and may perform either duty, pursuant to scheduling requirements (and vice versa).

PSOs must have visual acuity in both eyes (with correction of vision being permissible) sufficient enough to discern moving targets on the water's surface with the ability to estimate the target size and distance (binocular use is allowable), ability to conduct field observations and collect data according to the assigned protocols, and the ability to communicate orally, by radio, or in-person, with project personnel to provide real-time information on marine mammals observed in the area. All PSOs must be trained in northwestern Atlantic Ocean marine mammal identification and behaviors and must be able to conduct field observations and collect data according to assigned protocols. Additionally, PSOs must have the ability to work with all required and relevant software and equipment necessary during observations.

Vineyard Wind must work with the selected third-party PSO and PAM operator provider to ensure PSOs and PAM operators have all equipment (including backup equipment) needed to adequately perform necessary tasks. For PSOs, this includes, but is not limited to, accurate determination of distance and bearing to observed marine mammals, and to ensure that PSOs are capable of calibrating equipment as necessary for accurate distance estimates and species identification. PSO equipment, at a minimum, shall include:

- At least one thermal (infrared) imaging device suited for the marine environment;
- Reticle binoculars (*e.g.,* 7 × 50) of appropriate quality (at least one per PSO, plus backups);
- Global positioning units (GPS) (at least one plus backups);
- Digital cameras with a telephoto lens that is at least 300 mm or equivalent on a full-frame single lens reflex (SLR) (at least one plus backups).

The camera or lens should also have an image stabilization system;

• Equipment necessary for accurate measurement of distances to marine mammal;

• Compasses (at least one plus backups);

• Means of communication among vessel crew and PSOs; and,

• Any other tools deemed necessary to adequately and effectively perform PSO tasks.

At least two PSOs on the pile driving vessel must be equipped with functional Big Eye binoculars (*e.g.,* 25 × 150; 2.7 view angle; individual ocular focus; height control), Big Eye binocular would be pedestal mounted on the deck at the best vantage point that provides for optimal sea surface observation and PSO safety. PAM operators must have the appropriate equipment (*i.e.,* a computer station equipped with a data collection software system available wherever they are stationed) and use a NMFS-approved PAM system to conduct monitoring. The equipment specified above may be provided by an individual PSO, the third-party PSO provider, or the operator, but Vineyard Wind is responsible for ensuring PSOs have the proper equipment required to perform the duties specified in the IHA. Reference materials must be available aboard all project vessels for identification of protected species.

PSOs and PAM operators would not be permitted to exceed 4 consecutive watch hours on duty at any time, would have a 2-hour (minimum) break between watches, and would not exceed a combined watch schedule of more than 12 hours in a 24-hour period. If the schedule includes PSOs and PAM operators on-duty for 2-hour shifts, a minimum 1-hour break between watches would be allowed.

The PSOs would be responsible for monitoring the waters surrounding the pile driving site to the farthest extent permitted by sighting conditions, including pre-start clearance and shutdown zones, prior to, during, and following foundation installation activities. Monitoring must be done while free from distractions and in a consistent, systematic, and diligent manner. If PSOs cannot visually monitor the minimum visibility zone of 4 km (2.5 mi) prior to foundation pile driving at all times using the required equipment, pile driving operations must not commence or must shutdown if they are currently active. All PSOs must be located at the best vantage point(s) on any platform, as determined by the Lead PSO, in order to obtain 360-degree visual coverage of the entire clearance and shutdown zones, and as much of the Level B harassment zone as possible. PAM operators may be located on a vessel or remotely on-shore, and must assist PSOs in ensuring full coverage of the clearance and shutdown zones. The PAM operator must monitor to and past the clearance zones for large whales.

All on-duty PSOs must remain in real-time contact with the on-duty PAM operator(s). PAM operators must immediately communicate all acoustic detections of marine mammals to PSOs, including any determination regarding species identification, distance, and bearing (where relevant) relative to the pile being driven and the degree of confidence (*e.g.,* possible, probable detection) in the determination. The PAM operator must inform the Lead PSO(s) on duty of animal detections approaching or within applicable ranges of interest to the activity occurring via the data collection software system (*i.e.,* Mysticetus or similar system) who must be responsible for requesting that the designated crewmember implement the necessary mitigation procedures (*i.e.,* delay). All on-duty PSOs and PAM operator(s) must remain in contact with the on-duty construction personnel responsible for implementing mitigations (*e.g.,* delay to pile driving) to ensure communication on marine mammal observations can easily, quickly, and consistently occur between all on-duty PSOs, PAM operator(s), and on-water Project personnel. It would be the responsibility of the PSO(s) on duty to communicate the presence of marine mammals as well as to communicate the action(s) that are necessary to ensure mitigation and monitoring requirements are implemented as appropriate.

At least three PSOs (on the pile driving vessel) and one PAM operator would be on-duty and actively monitoring for marine mammals 60 minutes before, during, and 30 minutes after foundation installation in accordance with a NMFS-approved PAM Plan. PAM would also be conducted for at least 24 hours prior to foundation pile driving activities, and the PAM operator must review all detections from the previous 24-hour period prior to pile driving activities to increase situational awareness. Throughout the year (June through December), at least three PSOs would also be on-duty and actively monitoring from PSO support vessels. There would be at least two PSO support vessels with on-duty PSOs during any pile driving activities from June through December.

In addition to monitoring duties, PSOs and PAM operators are responsible for data collection. The data collected by PSO and PAM operators and subsequent analysis provide the necessary information to inform an estimate of the amount of take that occurred during the project, better understand the impacts of the project on marine mammals, address the effectiveness of monitoring and mitigation measures, and to adaptively manage activities and mitigation in the future. Data reported includes information on marine mammal sightings, activity occurring at time of sighting, monitoring conditions, and if mitigative actions were taken.

For all visual monitoring efforts and marine mammal sightings, NMFS proposes that the following information must be collected and reported to NMFS OPR: the date and time that monitored activity begins or ends, the construction activities occurring during each observation period, the watch status (*i.e.,* sighting made by PSO on/off effort, opportunistic, crew, alternate vessel/platform), the PSO who sighted the animal, the time of sighting; the weather parameters (*e.g.,* wind speed, percent cloud cover, visibility), the water conditions (*e.g.,* Beaufort sea state, tide state, water depth); all marine mammal sightings, regardless of distance from the construction activity; species (or lowest possible taxonomic level possible), the pace of the animal(s), the estimated number of animals (minimum/maximum/high/low/best), the estimated number of animals by cohort (*e.g.,* adults, yearlings, juveniles, calves, group composition, *etc.*), the description (*i.e.,* as many distinguishing features as possible of each individual seen, including length, shape, color, pattern, scars or markings, shape and size of dorsal fin, shape of head, and blow characteristics), the description of any marine mammal behavioral observations (*e.g.,* observed behaviors such as feeding or traveling) and observed changes in behavior, including an assessment of behavioral responses thought to have resulted from the specific activity, the animal's closest distance and bearing from the pile being driven and estimated time entered or spent within the Level A harassment and/or Level B harassment zone(s), use of noise attenuation device(s), and specific phase of activity (*e.g.,* soft-start for pile driving, active pile driving, *etc.*), the marine mammal occurrence in Level A harassment or Level B harassment zones, the description of any mitigation-related action implemented, or mitigation-related actions called for but not implemented, in response to the sighting (*e.g.,* delay, shutdown, *etc.*) and time and location of the action, and other human activity in the area.

On May 19, 2023, Vineyard Wind submitted a Pile Driving Monitoring

Plan for the 2023 IHA, including an Alternative Monitoring Plan, which was approved by NMFS. The Plan included details regarding PSO and PAM monitoring protocols and equipment proposed for use. More specifically, the PAM portion of the plan included a description of all proposed PAM equipment, addressed how the proposed passive acoustic monitoring must follow standardized measurement, processing methods, reporting metrics, and metadata standards for offshore wind as described in ''NOAA and BOEM Minimum Recommendations for Use of Passive Acoustic Listening Systems in Offshore Wind Energy Development Monitoring and Mitigation Programs'' (Van Parijs *et al.,* 2021). This plan also identified the efficacy of the technology at detecting marine mammals in the clearance and shutdown zones under all of the various conditions anticipated during construction, including varying weather conditions, sea states, and in consideration of the use of artificial lighting. Vineyard Wind would be required to submit an updated Foundation Installation Pile Driving Marine Mammal Monitoring Plan to NMFS Office of Protected Resources for review, and the Plan must be approved by NMFS prior to the start of foundation pile driving.

Sound Field Verification

Vineyard Wind would be required to conduct thorough SFV measurements during impact pile driving activity associated with the installation of, at minimum, the first monopile foundation and abbreviated SFV measurements during impact installation of the remaining monopiles to demonstrate noise levels are at or below those measured during the 2023 Vineyard Wind construction campaign (Küsel *et al.,* 2024). NMFS recognizes that the SFV data collected in 2023 occurred in warmer weather months and that water temperature can affect the sound speed profile and, thus, propagation rates. Therefore, if impact pile driving takes place in December, thorough SFV measurements must be conducted during impact pile driving activity associated with the installation of, at minimum, the first monopile foundation. Subsequent SFV measurements would also be required should larger piles be installed or if additional piles are driven that are anticipated to produce louder sound fields than those previously measured (*e.g.,* higher hammer energy, greater number of strikes, *etc.*). The measurements and reporting associated with SFV can be found in the IHA. The proposed requirements are extensive to ensure monitoring is conducted appropriately and the reporting frequency is such that Vineyard Wind would be required to make adjustments quickly (*e.g.,* add additional sound attenuation) to ensure marine mammals are not experiencing noise levels above those considered in this analysis. For recommended SFV protocols for impact pile driving, please consult ISO 18406 ''Underwater acoustics—Measurement of radiated underwater sound from percussive pile driving'' (2017). Vineyard Wind would be required to submit an updated SFV plan to NMFS Office of Protected Resources for review, and the Plan must be approved by NMFS prior to the start of foundation pile driving.

For any pile driving activities, they would also be required to submit interim and final SFV data results to NMFS and make corrections to the noise attenuation systems in the case that any SFV measurements demonstrate noise levels are above those expected assuming 6 dB of attenuation. These frequent and immediate reports would allow NMFS to better understand the sound fields to which marine mammals are being exposed and require immediate corrective action should they be misaligned with anticipated noise levels within our analysis.

Reporting

Prior to any construction activities occurring, Vineyard Wind would provide a report to NMFS OPR that demonstrates that all Vineyard Wind personnel, which includes the vessel crews, vessel captains, PSOs, and PAM operators have completed all required training. NMFS would require standardized and frequent reporting from Vineyard Wind during the active period of the IHA. All data collected relating to the Project would be recorded using industry-standard software (*e.g.,* Mysticetus or a similar software) installed on field laptops and/ or tablets. Vineyard Wind would be required to submit weekly, monthly, annual, and situational reports. Vineyard Wind must review SFV results within 24 hours to determine whether measurements exceeded modeled (Level A harassment) and expected (Level B harassment) thresholds.

Vineyard Wind must provide the initial results of the SFV measurements to NMFS OPR in an interim report after each foundation installation event as soon as they are available and prior to a subsequent foundation installation, but no later than 48 hours after each completed foundation installation event. The report must include, at minimum: hammer energies/schedule used during pile driving, including the total number of strikes and the maximum hammer energy, peak sound pressure level (SPL_{pk}), root-mean-square sound pressure level that contains 90 percent of the acoustic energy (SPL_{rms}), and sound exposure level (SEL, in single strike for pile driving, $SEL_{ss,}$), for each hydrophone, including at least the maximum, arithmetic mean, minimum, median (L50) and L5 (95 percent exceedance) statistics for each metric; estimated marine mammal Level A harassment and Level B harassment isopleths, calculated using the maximum-over-depth L5 (95 percent exceedance level, maximum of both hydrophones) of the associated sound metric, comparison of 2023 measured results against the measured marine mammal Level A harassment and Level B harassment acoustic isopleths, estimated transmission loss coefficients, pile identifier name, location of the pile and each hydrophone array in latitude/ longitude, depths of each hydrophone, one-third-octave band single strike SEL spectra, if filtering is applied, full filter characteristics, and hydrophone specifications including the type, model, and sensitivity. Vineyard Wind would also be required to report any immediate observations which are suspected to have a significant impact on the results including but not limited to: observed noise mitigation system issues, obstructions along the measurement transect, and technical issues with hydrophones or recording devices. If any in-situ calibration checks for hydrophones reveal a calibration drift greater than 0.75 dB, pistonphone calibration checks are inconclusive, or calibration checks are otherwise not effectively performed, Vineyard Wind would be required to indicate full details of the calibration procedure, results, and any associated issues in the 48-hour interim reports.

Vineyard Wind must review abbreviated SFV results for each pile within 24 hours of completion of the foundation installation (inclusive of pile driving and any drilling), and, assuming measured levels at 750 m did not exceed the thresholds defined during thorough SFV, does not need to take any additional action. Results of abbreviated SFV must be submitted with the weekly pile driving report.

The final results of SFV measurements from each foundation installation must be submitted as soon as possible, but no later than 90 days following completion of each event's SFV measurements. The final reports must include all details prescribed above for the interim report as well as, at minimum, the following: the peak sound pressure level (SPL_{pk}), the root-mean-square sound pressure level that contains 90 percent of the acoustic energy (SPL_{rms}), the single strike sound exposure level (SEL_{ss}), the integration time for SPL_{rms}, the spectrum, and the 24-hour cumulative SEL extrapolated from measurements at all hydrophones. The final report must also include at least the maximum, mean, minimum, median (L_{50}) and L_5 (95 percent exceedance) statistics for each metric, the SEL and SPL power spectral density and/or one-third octave band levels (usually calculated as decidecade band levels) at the receiver locations should be reported, the sound levels reported must be in median, arithmetic mean, and L_5 (95 percent exceedance) (*i.e.,* average in linear space), and in dB, range of transmission loss coefficients, the local environmental conditions, such as wind speed, transmission loss data collected on-site (or the sound velocity profile), baseline pre- and post-activity ambient sound levels (broadband and/or within frequencies of concern), a description of depth and sediment type, as documented in the Construction and Operation Plan (COP), at the recording and foundation installation locations, the extents of the measured Level A harassment and Level B harassment zone(s), hammer energies required for pile installation and the number of strikes per pile, the hydrophone equipment and methods (*i.e.,* recording device, bandwidth/sampling rate; distance from the pile where recordings were made; the depth of recording device(s)), a description of the SFV measurement hardware and software, including software version used, calibration data, bandwidth capability and sensitivity of hydrophone(s), any filters used in hardware or software, any limitations with the equipment, and other relevant information; the spatial configuration of the noise attenuation device(s) relative to the pile, a description of the noise abatement system and operational parameters (*e.g.,* bubble flow rate, distance deployed from the pile, *etc.*), and any action taken to adjust the noise abatement system. A discussion which includes any observations which are suspected to have a significant impact on the results including but not limited to: observed noise mitigation system issues, obstructions along the measurement transect, and technical issues with hydrophones or recording devices.

If at any time during the project Vineyard Wind becomes aware of any issue(s) that may (to any reasonable subject-matter expert, including the persons performing the measurements and analysis) call into question the validity of any measured Level A harassment or Level B harassment isopleths to a significant degree, which were previously transmitted or communicated to NMFS OPR, Vineyard Wind must inform NMFS OPR within 1 business day of becoming aware of this issue or before the next pile is driven, whichever comes first.

Weekly Report—During foundation installation activities, Vineyard Wind would be required to compile and submit weekly marine mammal monitoring reports for foundation installation pile driving to NMFS OPR that document the daily start and stop of all pile driving activities, the start and stop of associated observation periods by PSOs, details on the deployment of PSOs, a record of all detections of marine mammals (acoustic and visual), any mitigation actions (or if mitigation actions could not be taken, provide reasons why), and details on the noise abatement system(s) (*e.g.,* system type, distance deployed from the pile, bubble rate, *etc.*). Weekly reports will be due on Wednesday for the previous week (Sunday to Saturday). The weekly reports are also required to identify which turbines become operational and when (a map must be provided).

Monthly Report—Vineyard Wind would be required to compile and submit monthly reports to NMFS OPR that include a summary of all information in the weekly reports, including project activities carried out in the previous month, vessel transits (number, type of vessel, and route), number of piles installed, all detections of marine mammals, and any mitigative actions taken. Monthly reports would be due on the 15th of the month for the previous month. The monthly report would also identify which turbines become operational and when (a map must be provided).

Final Annual Reporting—Vineyard Wind would be required to submit its draft annual report to NMFS OPR on all visual and acoustic monitoring conducted under the IHA within 90 calendar days of the completion of activities occurring under the IHA. A final annual report must be prepared and submitted within 60 calendar days following receipt of any NMFS comments on the draft report. Information contained within this report is described at the beginning of this section.

Situational Reporting—Specific situations encountered during the Project would require immediate reporting. For instance, if a NARW is sighted with no visible injuries or entanglement at any time by project PSOs or project personnel, Vineyard Wind must immediately report the sighting to NMFS as soon as possible or within 24 hours after the initial sighting. All NARW acoustic detections within a 24-hour period should be collated into one spreadsheet and reported to NMFS as soon as possible but must be reported within 24 hours. Vineyard Wind should report sightings and acoustic detections by downloading and completing the Real-Time NARW Reporting Template spreadsheet found here: *https://www.fisheries.noaa.gov/resource/document/template-datasheet-real-time-north-atlantic-right-whale-acoustic-and-visual.* Vineyard Wind would save the completed spreadsheet as a ''.csv'' file and email it to NMFS Northeast Fisheries Science Center Protected Resources Division (NEFSC–PRD (*ne.rw.survey@noaa.gov*), NMFS Greater Atlantic Regional Fisheries Office (GARFO)-PRD (*nmfs.gar.incidental-take@noaa.gov*), and NMFS OPR (*pr.itp.monitoringreports@noaa.gov*). If the sighting is in the southeast (North Carolina through Florida), sightings should be reported via the template and to the Southeast Hotline 877–WHALE–HELP (877–942–5343) with the observation information provided below (PAM detections are not reported to the Hotline). If Vineyard Wind is unable to report a sighting through the spreadsheet within 24 hours, Vineyard Wind should call the relevant regional hotline (Greater Atlantic Region [Maine through Virginia] Hotline 866–755–6622; Southeast Hotline 877–WHALE–HELP) with the observation information provided below. Observation information would include: the time (note time format), date (MM/DD/YYYY), location (latitude/longitude in decimal degrees; coordinate system used) of the observation, number of whales, animal description/certainty of observation (follow up with photos/video if taken), reporter's contact information, and lease area number/project name, PSO/personnel name who made the observation, and PSO provider company (if applicable). If Vineyard Wind is unable to report via the template or the regional hotline, Vineyard Wind would enter the sighting via the WhaleAlert app (*https://www.whalealert.org/*). If this is not possible, the sighting should be reported to the U.S. Coast Guard via channel 16. The report to the Coast Guard must include the same information as would be reported to the hotline (see above). PAM detections would not be reported to WhaleAlert or the U.S. Coast Guard. If a non-NARW large whale is observed, Vineyard Wind would be required to report the sighting via WhaleAlert app (*https://www.whalealert.org/*) as soon as possible but within 24 hours.

In the event that personnel involved in the Project discover a stranded, entangled, injured, or dead marine mammal, Vineyard Wind must immediately report the observation to NMFS. If in the Greater Atlantic Region (Maine through Virginia), call the NMFS Greater Atlantic Stranding Hotline (866–755–6622), and if in the Southeast Region (North Carolina through Florida) call the NMFS Southeast Stranding Hotline (877–WHALE–HELP, 877–942–5343). Separately, Vineyard Wind must report the incident within 24 hours to NMFS OPR (*PR.ITP.MonitoringReports@noaa.gov*) and, if in the Greater Atlantic Region to the NMFS GARFO (*nmfs.gar.incidental-take@noaa.gov*) or if in the Southeast Region, to the NMFS Southeast Regional Office (SERO; *secmammalreports@noaa.gov*). Note, the stranding hotline may request the report be sent to the local stranding network response team. The report must include contact information (*e.g.,* name, phone number, *etc.*), time, date, and location (*i.e.,* specify coordinate system) of the first discovery (and updated location information, if known and applicable), species identification (if known) or description of the animal(s) involved, condition of the animal(s) (including carcass condition if the animal is dead), observed behaviors of the animal(s) (if alive), photographs or video footage of the animal(s) (if available), and general circumstances under which the animal was discovered.

If the injury, entanglement, or death was caused by a project activity, Vineyard Wind would be required to immediately cease all activities until NMFS OPR is able to review the circumstances of the incident and determine what, if any, additional measures are appropriate to ensure compliance with the terms of the IHA. NMFS OPR may impose additional measures to minimize the likelihood of further prohibited take and ensure MMPA compliance consistent with the adaptive management provisions. Vineyard Wind could not resume their activities until notified by NMFS OPR.

In the event of a suspected or confirmed vessel strike of a marine mammal by any vessel associated with the Project or other means by which Project activities caused a non-auditory injury or death of a marine mammal, Vineyard Wind must immediately report the incident to NMFS. If in the Greater Atlantic Region (Maine through Virginia), call the NMFS Greater Atlantic Stranding Hotline (866–755–6622), and if in the Southeast Region (North Carolina through Florida) call the NMFS Southeast Stranding Hotline (877–WHALE–HELP, 877–942–5343). Separately, Vineyard Wind must immediately report the incident to NMFS OPR (*PR.ITP.MonitoringReports@noaa.gov*) and, if in the Greater Atlantic Region to the NMFS GARFO (*nmfs.gar.incidental-take@noaa.gov*) or if in the Southeast Region, to the NMFS SERO (*secmammalreports@noaa.gov*). The report must include time, date, and location (*i.e.,* specify coordinate system)) of the incident, species identification (if known) or description of the animal(s) involved (*i.e.,* identifiable features including animal color, presence of dorsal fin, body shape and size, *etc.*), vessel strike reporter information (name, affiliation, email for person completing the report), vessel strike witness (if different than reporter) information (*e.g.,* name, affiliation, phone number, platform for person witnessing the event, *etc.*), vessel name and/or MMSI number; vessel size and motor configuration (inboard, outboard, jet propulsion), vessel's speed leading up to and during the incident, vessel's course/heading and what operations were being conducted (if applicable), part of vessel that struck marine mammal (if known), vessel damage notes, status of all sound sources in use at the time of the strike, if the marine mammal was seen before the strike event, description of behavior of the marine mammal before the strike event (if seen) and behavior immediately following the strike, description of avoidance measures/requirements that were in place at the time of the strike and what additional measures were taken, if any, to avoid strike, environmental conditions (*e.g.,* wind speed and direction, Beaufort sea state, cloud cover, visibility, *etc.*) immediately preceding the strike, estimated (or actual, if known) size and length of marine mammal that was struck, if available, description of the presence and behavior of any other marine mammals immediately preceding the strike, other animal-specific details if known (*e.g.,* length, sex, age class), behavior or estimated fate of the marine mammal post-strike (*e.g.,* dead, injured but alive, injured and moving, external visible wounds (linear wounds, propeller wounds, non-cutting blunt-force trauma wounds), blood or tissue observed in the water, status unknown, disappeared), to the extent practicable, any photographs or video footage of the marine mammal(s), and, any additional notes the witness may have from the interaction. For any numerical values provided (*i.e.,* location, animal length, vessel length, *etc.*), please provide if values are actual or estimated.

Vineyard Wind would be required to immediately cease activities until the NMFS OPR is able to review the circumstances of the incident and determine what, if any, additional measures are appropriate to ensure compliance with the terms of the IHA. NMFS OPR may impose additional measures to minimize the likelihood of further prohibited take and ensure MMPA compliance. Vineyard Wind may not resume their activities until notified by NMFS OPR.

Sound Field Verification—Vineyard Wind would be required to submit interim SFV reports after each foundation installation within 48 hours. A final SFV report for all monopile foundation installation monitoring would be required within 90 days following completion of acoustic monitoring.

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 impacts or responses (*e.g.,* intensity, duration), the context of any impacts or responses (*e.g.,* critical reproductive time or location, foraging impacts affecting energetics), 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' 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 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).

In the Estimated Take section, we estimated the maximum number of takes by Level A harassment and Level B harassment that could occur from Vineyard Wind's specified activities based on the methods described. The impact that any given take would have is dependent on many case-specific factors that need to be considered in the negligible impact analysis (*e.g.,* the context of behavioral exposures such as duration or intensity of a disturbance, the health of impacted animals, the status of a species that incurs fitness-level impacts to individuals, *etc.*). In this notice of proposed IHA, we evaluate the likely impacts of the harassment takes that are proposed to be authorized in the context of the specific circumstances surrounding these predicted takes. We also collectively evaluate this information, as well as other more taxa-specific information and mitigation measure effectiveness, in group-specific discussions that support our negligible impact conclusions for each stock. As described above, no serious injury or mortality is expected or proposed to be authorized for any species or stock.

We base our analysis and preliminary negligible impact determination on the number of takes that are proposed to be authorized, and extensive qualitative consideration of other contextual factors that influence the degree of impact of the takes on the affected individuals and the number and context of the individuals affected.

To avoid repetition, we provide some general analysis in this Negligible Impact Analysis and Determination section that applies to all the species listed in table 3 given that some of the anticipated effects of Vineyard Wind's construction activities on marine mammals are expected to be relatively similar in nature. Where there are meaningful differences between species or stocks—as is the case of the NARW—they are included as separate subsections below.

Last, we provide a negligible impact determination for each species or stock, providing species or stock-specific information or analysis where appropriate, for example for NARWs given the population status. Organizing our analysis by grouping species or stocks that share common traits or that would respond similarly to effects of Vineyard Wind's activities, and then providing species- or stock-specific information allows us to avoid duplication while ensuring that we have analyzed the effects of the specified activities on each affected species or stock.

As described previously, no serious injury or mortality is anticipated or proposed to be authorized in this IHA. Any Level A harassment proposed to be authorized would be in the form of auditory injury (*i.e.,* PTS). For all species, the amount of take proposed to be authorized represents the maximum amount of Level A harassment and Level B harassment that is reasonably expected to occur.

Behavioral Disturbance

In general, NMFS anticipates that impacts on an individual that has been harassed are likely to be more intense when exposed to higher received levels and for a longer duration (though this is in no way a strictly linear relationship for behavioral effects across species, individuals, or circumstances) and less severe impacts result when exposed to lower received levels and for a brief duration. However, there is also growing evidence of the importance of contextual factors such as distance from a source in predicting marine mammal behavioral response to sound—*i.e.,* sounds of a similar level emanating from a more distant source have been shown to be less likely to evoke a response of equal magnitude (DeRuiter and Doukara, 2012; Falcone *et al.,* 2017). As described in the Potential Effects of Specified Activities on Marine Mammals and their Habitat section, the intensity and duration of any impact resulting from exposure to Vineyard Wind's activities is dependent upon a number of contextual factors including, but not limited to, sound source frequencies, whether the sound source is moving towards the animal, hearing ranges of marine mammals, behavioral state at time of exposure, status of individual exposed (*e.g.,* reproductive status, age class, health) and an individual's experience with similar sound sources. Southall *et al.* (2021), Ellison *et al.* (2012) and Moore and Barlow (2013), among others, emphasize the importance of context (*e.g.,* behavioral state of the animals, distance from the sound source) in evaluating behavioral responses of marine mammals to acoustic sources. Level B Harassment of marine mammals may consist of behavioral modifications (*e.g.,* avoidance, temporary cessation of foraging or communicating, changes in respiration or group dynamics, masking) and may include auditory impacts in the form of temporary hearing loss. In addition, some of the lower-level physiological stress responses (*e.g.,* change in respiration, change in heart rate) discussed previously would likely co-occur with the behavioral modifications, although these physiological responses are more difficult to detect, and fewer data exist relating these responses to specific received levels of sound. Take by Level B harassment, then, may have a stress-related physiological component as well; however, we would not expect Vineyard Wind's pile driving activities to produce conditions of long-term and continuous exposure to noise leading to long-term physiological stress responses in marine mammals that could affect reproduction or survival.

In the range of behavioral effects that might be expected to be part of a response that qualifies as an instance of Level B harassment (which by nature of the way it is modeled/counted, occurs within 1 day), the less severe end might include exposure to comparatively lower levels of a sound, at a greater distance from the animal, for a few or several minutes. A less severe exposure of this nature could result in a behavioral response such as avoiding an area that an animal would otherwise have chosen to move through or feed in for some amount of time or breaking off one or a few feeding bouts. More severe effects could occur if an animal gets close enough to the source to receive a comparatively higher level, is exposed continuously to one source for a longer time or is exposed intermittently to different sources throughout a day. Such effects might result in an animal having a more severe flight response and leaving a larger area for a day or more or potentially losing feeding opportunities for a day. However, such severe behavioral effects are expected to occur infrequently.

Many species perform vital functions, such as feeding, resting, traveling, and socializing on a diel cycle (24-hour cycle). Behavioral reactions to noise exposure, when taking place in a biologically important context, such as disruption of critical life functions, displacement, or avoidance of important habitat, are more likely to be significant if they last more than 1 day or recur on subsequent days (Southall *et al.,* 2007) due to diel and lunar patterns in diving and foraging behaviors observed in many cetaceans (Baird *et al.,* 2008; Barlow *et al.,* 2020; Henderson *et al.,* 2016; Schorr *et al.,* 2014). It is important to note the water depth in the LIA is shallow (ranging up to 37 to 49.5 m), so deep diving species such as sperm whales are not expected to be engaging in deep foraging dives when exposed to noise above NMFS harassment thresholds during the specified activities. Therefore, we do not anticipate impacts to deep foraging behavior to be impacted by the specified activities.

It is also important to identify that the estimated number of takes does not necessarily equate to the number of individual animals Vineyard Wind expects to harass (which is lower), but rather to the instances of take (*i.e.,* exposures above the Level B harassment thresholds) that may occur. Some individuals of a species may experience recurring instances of take over multiple days throughout the year while some members of a species or stock may experience one exposure as they move through an area, which means that the number of individuals taken is smaller than the total estimated takes. In short, for species that are more likely to be migrating through the area and/or for which only a comparatively smaller number of takes are predicted (*e.g.,* some of the mysticetes), it is more likely that each take represents a different individual whereas for non-migrating species with larger amounts of predicted take, we expect that the total anticipated takes represent exposures of a smaller number of individuals of which some would be taken across multiple days.

Impact pile driving for foundation installation is anticipated to have the greatest impacts. For these reasons, impacts are proposed to be minimized through implementation of mitigation measures, including use of a sound attenuation system, soft-starts, the implementation of clearance zones that would facilitate a delay to pile driving commencement, and implementation of shutdown zones. All these measures are designed to avoid or minimize harassment. For example, given sufficient notice through the use of soft-start, marine mammals are expected to move away from a sound source that is disturbing prior to becoming exposed to very loud noise levels. The requirement to couple visual monitoring and PAM before and during all foundation installation will increase the overall capability to detect marine mammals compared to one method alone.

Occasional, milder behavioral reactions are unlikely to cause long-term consequences for individual animals or populations, and even if some smaller subset of the takes is in the form of a longer (several hours or a day) and more severe response, if they are not expected to be repeated over numerous or sequential days, impacts to individual fitness are not anticipated. Also, the effect of disturbance is strongly influenced by whether it overlaps with biologically important habitats when individuals are present—avoiding biologically important habitats will provide opportunities to compensate for reduced or lost foraging (Keen *et al.,* 2021). Nearly all studies and experts agree that infrequent exposures of a single day or less are unlikely to impact an individual's overall energy budget (Farmer *et al.,* 2018; Harris *et al.,* 2017; King *et al.,* 2015; National Academy of Science, 2017; New *et al.,* 2014; Southall *et al.,* 2007; Villegas-Amtmann *et al.,* 2015).

Temporary Threshold Shift

TTS is one form of Level B harassment that marine mammals may incur through exposure to US Wind's activities and, as described earlier, the proposed takes by Level B harassment may represent takes in the form of direct behavioral disturbance, TTS, or both. As discussed in the Potential Effects of Specified Activities on Marine Mammals and their Habitat section, in general, TTS can last from a few minutes to days, be of varying degree, and occur across different frequency bandwidths, all of which determine the severity of the impacts on the affected individual, which can range from minor to more severe. Impact pile driving is a broadband noise sources but generates sounds in the lower frequency ranges (with most of the energy below 1–2 kHz, but with a small amount energy ranging up to 20 kHz); therefore, in general and all else being equal, we would anticipate the potential for TTS is higher in low-frequency cetaceans (*i.e.,* mysticetes) than other marine mammal hearing groups and would be more likely to occur in frequency bands in which they communicate. However, we would not expect the TTS to span the entire communication or hearing range of any species given that the frequencies produced by these activities do not span entire hearing ranges for any particular species. Additionally, though the frequency range of TTS that marine mammals might sustain would overlap with some of the frequency ranges of their vocalizations, the frequency range of TTS from Vineyard Wind's pile driving activities would not typically span the entire frequency range of one vocalization type, much less span all types of vocalizations or other critical auditory cues for any given species. In addition, the proposed mitigation measures further reduce the potential for TTS in mysticetes.

Generally, both the degree of TTS and the duration of TTS would be greater if the marine mammal is exposed to a higher level of energy (which would occur when the peak dB level is higher or the duration is longer). The threshold for the onset of TTS was discussed previously (see Estimated Take). An animal would have to approach closer to the source or remain in the vicinity of the sound source appreciably longer to increase the received SEL, which would be unlikely considering the proposed mitigation and the nominal speed of the receiving animal relative to the stationary sources such as impact pile driving. The recovery time of TTS is also of importance when considering the potential impacts from TTS. In TTS laboratory studies (as discussed in Potential Effects of Specified Activities on Marine Mammals and Their Habitat), some using exposures of almost an hour in duration or up to 217 SEL, almost all individuals recovered within 1 day (or less, often in minutes), and we note that while the pile driving activities last for hours a day, it is unlikely that most marine mammals would stay in the close vicinity of the source long enough to incur more severe TTS. Overall, given the few instances in which any individual might incur TTS, the low degree of TTS and the short anticipated duration, and the unlikely scenario that any TTS would overlap the entirety of an individual's critical hearing range, it is unlikely that TTS (of the nature expected to result from the project's activities) would result in behavioral changes or other impacts that would impact any individual's (of any hearing sensitivity) reproduction or survival.

Permanent Threshold Shift

NMFS proposes to authorize a very small amount of take by PTS to some marine mammal individuals. The numbers of proposed takes by Level A harassment are relatively low for all marine mammal stocks and species (table 11). We anticipate that PTS may occur from exposure to impact pile driving, which produces sounds that are both impulsive and primarily concentrated in the lower frequency ranges (below 1 kHz) (David, 2006; Krumpel *et al.,* 2021).

There are no PTS data on cetaceans and only one instance of PTS being induced in older harbor seals (Reichmuth *et al.,* 2019). However, available TTS data (of mid-frequency hearing specialists exposed to mid- or high-frequency sounds (Southall *et al.,* 2007, 2019; NMFS, 2018)) suggest that most threshold shifts occur in the frequency range of the source up to one octave higher than the source. We would anticipate a similar result for PTS. Further, no more than a small degree of PTS is expected to be associated with any of the incurred Level A harassment, given it is unlikely that animals would stay in the close vicinity of a source for a duration long enough to produce more than a small degree of PTS.

PTS would consist of minor degradation of hearing capabilities occurring predominantly at frequencies one-half to one octave above the frequency of the energy produced by pile driving (*i.e.,* the low-frequency region below 2 kHz) (Cody and Johnstone, 1981; McFadden, 1986; Finneran, 2015), not severe hearing impairment. If hearing impairment occurs from impact pile driving, 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. In addition, during impact pile driving, given sufficient notice through use of soft-start prior to implementation of full hammer energy during impact pile driving, marine mammals are expected to move away from a sound source that is disturbing prior to it resulting in severe PTS.

Auditory Masking or Communication Impairment

The potential impacts of masking on an individual are similar to those discussed for TTS (*e.g.,* decreased ability to communicate, forage effectively, or detect predators), but an important difference is that masking only occurs during the period of the signal, versus TTS, which continues beyond the duration of the signal. Also, though masking can result from the sum of exposure to multiple signals, none of these signals might individually cause TTS. Fundamentally, masking is referred to as a chronic effect because one of the key potential harmful components of masking is the fact that an animal would have reduced ability to hear or interpret critical cues. This becomes much more likely to cause a problem the longer it is occurring. Inherent in the concept of masking is the fact that the potential for the effect is only present during the times that the animal and the source are in close enough proximity for the effect to occur (and further, this time period would need to coincide with a time that the animal was utilizing sounds at the masked frequency).

As our analysis has indicated, we expect that impact pile driving may occur for several, albeit intermittent, hours per day, for multiple days. Masking is fundamentally more of a concern at lower frequencies (which are pile driving dominant frequencies), because low-frequency signals propagate significantly further than higher frequencies and because they are more likely to overlap both the narrower low-frequency calls of mysticetes, as well as many non-communication cues related to fish and invertebrate prey, and geologic sounds that inform navigation. As mentioned above (see Description of Marine Mammals in the Area of Specified Activities), the LIA does not overlap critical habitat or BIAs for any species, and temporary avoidance of the pile driving area by marine mammals would likely displace animals to areas of sufficient habitat. In summary, the nature of Vineyard Wind's activities, paired with habitat use patterns by marine mammals, does not support the likelihood of take due to masking effects or that masking would have the potential to affect reproductive success or survival, and are we not proposing to authorize such take.

Impact on Habitat and Prey

Construction activities may result in fish and invertebrate mortality or injury very close to the source, and Vineyard Wind's activities may cause some fish to leave the area of disturbance. It is anticipated that any mortality or injury would be limited to a very small subset of available prey and the implementation of mitigation measures such as the use of a noise attenuation system during impact pile driving would further limit the degree of impact. Behavioral changes in prey in response to construction activities could temporarily impact marine mammals' foraging opportunities in a limited portion of the foraging range but, because of the relatively small area of the habitat that may be affected at any given time (*e.g.,* around a pile being driven) and the temporary nature of the disturbance on prey species, the impacts to marine mammal habitat are not expected to cause significant or long-term negative consequences. There is no indication that displacement of prey would impact individual fitness and health, particularly since unconsumed prey would likely still be available in the environment in most cases following the cessation of acoustic exposure.

Cable presence is not anticipated to impact marine mammal habitat, as these would be buried, and any electromagnetic fields emanating from the cables are not anticipated to result in consequences that would impact marine mammals' prey to the extent they would be unavailable for consumption. Although many species of marine mammal prey can detect electromagnetic fields, previous studies have shown little impacts on habitat use (Hutchinson *et al.,* 2018). Burying the cables and the inclusion of protective shielding on cables will also minimize any impacts of electromagnetic fields on marine mammal prey.

The presence of wind turbines within the Lease Area could have longer-term impacts on marine mammal habitat, as the project would result in the persistence of the structures within marine mammal habitat for more than 30 years. For piscivorous marine mammal species, the presence of structures could result in a beneficial reef effect which may lead to increases in the availability of prey. However, turbine presence and operation is, generally likely to result in certain oceanographic effects in the marine environment, and may adversely alter aggregations and distribution of marine mammal zooplankton prey through changing the strength of tidal currents and associated fronts, changes in stratification, primary production, the degree of mixing, and stratification in the water column (Chen *et al.,* 2021; Johnson *et al.,* 2021; Christiansen *et al.,* 2022; Dorrell *et al.,* 2022). In the recently released BOEM and NOAA Fisheries North Atlantic Right Whale Strategy (BOEM *et al.,* 2024), the agencies identify the conceptual pathway by which changes to ocean circulation could potentially lead to fitness reduction of North Atlantic right whales, who primarily forage on copepods (see figure 2). As described in the *Potential Effects to Marine Mammal Habitat* section, there is uncertainty regarding the intensity (or magnitude) and spatial extent of turbine operation impacts on marine mammals habitat, including planktonic prey. Recently, a National Academy of Sciences, Engineering, and Medicine panel of independent experts concluded that the impacts of offshore wind operations on North Atlantic right whales and their habitat in the Nantucket Shoals region is uncertain due to the limited data available at this time and recognized what data is available is largely based on models from the North Sea that have not been validated by observations (NAS, 2023). The report also identifies that major oceanographic changes have occurred to the Nantucket Shoals region over the past 25 years and it will be difficult to isolate from the much larger variability introduced by natural and other anthropogenic sources (including climate change).

As discussed in the Description of the Specified Activity section, this IHA addresses the take incidental to the installation of 15 foundations, which will gradually become operational following construction completion. While there are likely to be oceanographic impacts from the presence of operating turbines, meaningful oceanographic impacts relative to stratification and mixing that would significantly affect marine mammal foraging and prey over large areas in key foraging habitats, resulting in the reproduction or survival of any individual marine mammals, are not anticipated from the Vineyard Wind activities covered under this proposed IHA, yet are likely to be comparatively minor, if impacts do occur.

Mitigation To Reduce Impacts on All Species

The proposed IHA includes a variety of mitigation measures designed to minimize impacts on all marine mammals, with a focus on NARWs (the latter is described in more detail below). For impact pile driving of foundation piles, 10 overarching mitigation measures are proposed, which are intended to reduce both the number and intensity of marine mammal takes: (1) seasonal/time of day work restrictions; (2) use of multiple PSOs to visually observe for marine mammals (with any detection within specifically designated zones triggering a delay or shutdown); (3) use of PAM to acoustically detect marine mammals, with a focus on detecting baleen whales (with any detection within designated zones triggering delay or shutdown); (4) implementation of clearance zones; (5) implementation of shutdown zones; (6) use of soft-start; (7) use of noise attenuation technology; (8) maintaining situational awareness of marine mammal presence through the requirement that any marine mammal sighting(s) by Vineyard Wind's personnel must be reported to PSOs; (9) sound field verification monitoring; and (10) Vessel Strike Avoidance measures to reduce the risk of a collision with a marine mammal and vessel.

The Proposed Mitigation section discusses the manner in which the required mitigation measures reduce the magnitude and/or severity of the take of marine mammals, including the following. For activities with large harassment isopleths, Vineyard Wind would be required to reduce the noise levels generated to the lowest levels practicable. Use of a soft-start during impact pile driving will allow animals to move away from (*i.e.,* avoid) the sound source prior to applying higher hammer energy levels needed to install the pile (Vineyard Wind would not use a hammer energy greater than necessary to install piles). Clearance zone and shutdown zone implementation, which are required when marine mammals are within given distances associated with certain impact thresholds for all activities, would reduce the magnitude and severity of marine mammal take. Additionally, the use of multiple PSOs, PAM, and maintaining awareness of marine mammal sightings reported in the region would aid in detecting marine mammals that would trigger the implementation of the mitigation measures.

Mysticetes

Five mysticete species (comprising five stocks) of cetaceans (NARW, humpback whale, fin whale, sei whale, and minke whale) may be taken by harassment. These species, to varying extents, utilize the specific geographic region, including the LIA, for the purposes of migration, foraging, and socializing. Mysticetes are in the low-frequency hearing group.

Behavioral data on mysticete reactions to pile driving noise are scant. Kraus *et al.* (2019) predicted that the three main impacts of offshore wind farms on marine mammals would consist of displacement, behavioral disruptions, and stress. Broadly, we can look to studies that have focused on other noise sources such as seismic surveys and military training exercises, which suggest that exposure to loud signals can result in avoidance of the sound source (or displacement if the activity continues for a longer duration in a place where individuals would otherwise have been staying, which is less likely for mysticetes in this area), disruption of foraging activities (if they are occurring in the area), local masking around the source, associated stress responses, and impacts to prey, as well as TTS or PTS in some cases.

Mysticetes encountered in the LIA are expected to be migrating through and/or engaged in foraging behavior. The extent to which an animal engages in these behaviors in the area is species-specific and varies seasonally. Many mysticetes are expected to predominantly be migrating through the LIA towards or from primary feeding habitats (*e.g.,* Cape Cod Bay, Great South Channel, and Gulf of St. Lawrence). While we have acknowledged above that mortality, hearing impairment, or displacement of mysticete prey species may result locally from impact pile driving, given the very short duration of and broad availability of prey species in the area and the availability of alternative suitable foraging habitat for the mysticete species most likely to be affected, any impacts on mysticete foraging are expected to be minor. Whales temporarily displaced from the LIA are expected to have sufficient remaining feeding habitat available to them, and would not be prevented from feeding in other areas within the biologically important feeding habitats, including to the east near Nantucket Shoals. In addition, any displacement of whales or interruption of foraging bouts would be expected to be relatively temporary in nature.

The potential for repeated exposures of individuals is dependent upon their residency time, with migratory animals unlikely to be exposed on repeated occasions and animals remaining in the area more likely to be exposed more than once. For mysticetes, where relatively low numbers of species-specific take by Level B harassment are predicted (compared to the abundance of each mysticete species or stock; see table 11) and movement patterns suggest that individuals would not necessarily linger in a particular area for multiple days, each predicted take likely represents an exposure of a different individual; with perhaps a subset of takes for a few species potentially representing a few repeated of a limited number of individuals across multiple days. In other words, the behavioral disturbance to any individual mysticete would, therefore, be expected to most likely occur within a single day, or potentially across a few days, and therefore would not be expected to impact the animal's fitness for reproduction or survival.

In general, the duration of exposures would not be continuous throughout any given day and pile driving would not occur on all consecutive days due to weather delays or any number of logistical constraints Vineyard Wind has identified. Species-specific analysis regarding potential for repeated exposures and impacts is provided below.

Humpback whales, minke whales, fin whales and sei whales are the mysticete species for which PTS is anticipated and proposed to be authorized. As described previously, PTS for mysticetes from some project activities may overlap frequencies used for communication, navigation, or detecting prey. However, given the nature and duration of the activity, the mitigation measures, and likely avoidance behavior, any PTS is expected to be of a small degree, would be limited to frequencies where pile driving noise is concentrated (*i.e.,* only a small subset of their expected hearing range) and would not be expected to impact individuals' fitness for reproductive success or survival.

NARWs

NARWs are listed as endangered under the ESA and as both depleted and strategic under the MMPA. As described in the Potential Effects to Marine Mammals and Their Habitat section, NARWs are threatened by a low population abundance, higher than average mortality rates, and lower than average reproductive rates. Recent studies have reported individuals showing high stress levels (*e.g.,* Corkeron *et al.,* 2017) and poor health, which has further implications on reproductive success and calf survival (Christiansen *et al.,* 2020; Stewart *et al.,* 2021, 2022). As described below, a UME has been designated for NARWs. Given this, the status of the NARW population is of heightened concern and, therefore, merits additional analysis and consideration.

This proposed IHA would authorize seven takes of NARW by Level B harassment only, which equates to approximately 2.1 percent of the stock's abundance, if each take were considered to be of a different individual. No Level A harassment, serious injury, or mortality is anticipated or proposed to be authorized for this species.

As described in the Description of Marine Mammals in the Area of Specified Activities section, NARWs are presently experiencing an ongoing UME (beginning in June 2017). Preliminary findings support human interactions, specifically vessel strikes and entanglements, as the cause of death for the majority of NARWs. Given the current status of the NARW, the loss of even one individual could significantly impact the population. Level B harassment of NARWs resulting from the Project's activities is expected to primarily be in the form of temporary avoidance of the immediate area of construction. Required mitigation measures will ensure the least practicable adverse impact and the proposed number of takes of NARWs would not exacerbate or compound the effects of the ongoing UME.

In general, NARWs in the LIA are expected to be engaging in migratory, feeding, and/or social behavior. Migrating NARWs would typically be moving through the LIA, rather than lingering for extended periods of time (thereby limiting the potential for repeat exposures); however, foraging whales may remain in the LIA, with an average residence time of 13 days between December and May (Quintana-Rizzo *et al.,* 2021). SNE, including the LIA, is part of a known migratory corridor for NARWs and may be a stopover site for migrating NARWs moving to or from southeastern calving grounds and northern foraging grounds. NARWs are primarily concentrated in the northeastern and southeastern sections of the Massachusetts Wind Energy Area (MA WEA) (*i.e.,* east of the LIA) during the summer (June-August) and winter (December-February) while distribution likely shifts to the west, closer to the LIA, into the Rhode Island/Massachusetts Wind Energy Area (RI/MA WEA) in the spring (March-May) (Quintana-Rizzo *et al.,* 2021). However, NARWs range outside of the LIA for their main feeding, breeding, and calving activities. It is important to note that there would be a restriction on impact pile driving activities from January through May, with pile driving only allowed in December with approval from NMFS and BOEM.

Foundation installation is of concern, given loud sound levels. However, as described above, foundation installation would only occur during times when, based on the best available scientific data, NARWs are less frequently encountered and less likely to be engaged in critical foraging behavior (although NMFS recognizes NARWs may forage year-round in SNE). The potential types, severity, and magnitude of impacts are also anticipated to mirror that described in the general *Mysticetes* section above, including avoidance (the most likely outcome), changes in foraging or vocalization behavior, masking, a small amount of TTS, and temporary physiological impacts (*e.g.,* change in respiration, change in heart rate). Importantly, the effects of the activities are expected to be sufficiently low-level and localized to specific areas as to not meaningfully impact important behaviors such as migration and foraging for NARWs. As noted above, for NARWs, this IHA would authorize up to seven takes, by Level B harassment. These takes are expected to be in the form of temporary behavioral disturbance, such as slight displacement (but not abandonment) of migratory habitat or temporary cessation of feeding. Further, given many of these exposures are generally expected to occur to different individual right whales migrating through (*i.e.,* many individuals would not be impacted on more than 1 day in a year), with some subset potentially being exposed on no more than a few days within the year, they are unlikely to result in energetic consequences that could affect reproduction or survival of any individuals.

Overall, NMFS expects that any behavioral harassment of NARWs incidental to the specified activities would not result in changes to their migration patterns or foraging success, as only temporary avoidance of an area during construction is expected to occur. As described previously, NARWs migrate, forage, or socialize in the LIA but are not expected to remain in this habitat for extensive durations relative to core foraging habitats to the east, south of Nantucket and Martha's Vineyard, Cape Cod Bay, or the Great South Channel (Quintana-Rizzo *et al.,* 2021). Any temporarily displaced animals would be able to return to or continue to travel through the LIA and subsequently utilize this habitat once activities have ceased.

Although acoustic masking may occur in the vicinity of the foundation installation activities, based on the acoustic characteristics of noise associated with pile driving (*e.g.,* frequency spectra, short duration of exposure, NMFS expects masking effects to be minimal during impact pile driving). In addition, masking would likely only occur during the period of time that a NARW is in the relatively close vicinity of pile driving, which is expected to be intermittent within a day and confined to the months in which NARWs are at lower densities and primarily moving through the area. TTS,could also occur in some of the exposed animals, making it more difficult for those individuals to hear or interpret acoustic cues within the frequency range (and slightly above) of sound produced during impact pile driving; however, any TTS would likely be of low amount, limited duration, and limited to frequencies where most construction noise is centered (below 2 kHz). NMFS expects that right whale hearing sensitivity would return to pre-exposure levels shortly after migrating through the area or moving away from the sound source.

As described in the Potential Effects to Marine Mammals and Their Habitat section of this notice, the distance of the receiver from the source influences the severity of response, with greater distances typically eliciting less severe responses. NMFS recognizes NARWs migrating could be pregnant females (in the fall) and cows with older calves (in spring) and that these animals may slightly alter their migration course in response to any foundation pile driving; however, we anticipate that course diversion would be of small magnitude. Hence, while some avoidance of the pile-driving activities may occur, we anticipate any avoidance behavior of migratory NARWs would be similar to that of gray whales (Tyack *et al.,* 1983), on the order of hundreds of meters up to 1 to 2 km. This diversion from a migratory path otherwise uninterrupted by the project's activities is not expected to result in meaningful energetic costs that would impact annual rates of recruitment of survival. NMFS expects that NARWs would be able to avoid areas during periods of active noise production while not being forced out of this portion of their habitat.

NARW presence in the LIA is year-round. However, abundance during summer months is lower compared to the winter months with spring and fall serving as ''shoulder seasons'' wherein abundance waxes (fall) or wanes (spring). Even in consideration of recent habitat use and distribution shifts, Vineyard Wind would still be installing monopile foundations when the presence of NARWs is expected to be lower.

Given this year-round habitat usage, in recognition that where and when whales may actually occur during project activities is unknown as it depends on the annual migratory behaviors, NMFS is requiring a suite of mitigation measures designed to reduce impacts to NARWs to the maximum extent practicable. These mitigation measures (*e.g.,* seasonal/daily work restrictions, vessel separation distances, and reduced vessel speed) would not only avoid the likelihood of vessel strikes but also would minimize the severity of behavioral disruptions (*e.g.,* through sound reduction using attenuation systems and reduced temporal overlap of project activities and NARWs). This would help further ensure that takes by Level B harassment that are estimated to occur would not affect reproductive success or survivorship of individuals through detrimental impacts to energy intake or cow/calf interactions during migratory transit.

As described in the Description of Marine Mammals in the Area of Specified Activities section, the Vineyard Wind Offshore Wind Project is being constructed within the NARW migratory corridor BIA, which represents areas and months within which a substantial portion of a species or population is known to migrate. The area over which NARWs may be harassed is relatively small compared to the width of the migratory corridor. The width of the migratory corridor in this area is approximately 210.1 km (while the width of the Lease Area, at the longest point at which it crosses the BIA, is approximately 14.5 km). NARWs may be displaced from their normal path and preferred habitat in the immediate activity area (primarily from pile driving activities), however, we do not anticipate displacement to be of high magnitude (*e.g.,* beyond a few kilometers); therefore, any associated bio-energetic expenditure is anticipated to be small. Although NARWs may forage in the LIA, there are no known breeding or calving areas within the LIA. Prey species are mobile (*e.g.,* calanoid copepods can initiate rapid and directed escape responses) and are broadly distributed throughout the LIA. Therefore, any impacts to prey that may occur are also unlikely to impact marine mammals.

The most significant measure to minimize impacts to individual NARWs is the seasonal moratorium on all foundation installation activities from January 1 through May 31 and the limitation on these activities in December (*e.g.,* only work with approval from NMFS) when NARW abundance in the LIA is expected to be highest. NMFS also expects this measure to greatly reduce the potential for mother-calf pairs to be exposed to impact pile driving noise above the Level B harassment threshold during their annual spring migration through SNE from calving grounds to primary foraging grounds (*e.g.,* Cape Cod Bay). NMFS expects that the severity of any take of NARWs would be reduced due to the mitigation measures that would ensure that any exposures above the Level B harassment threshold would result in only short-term effects to individuals exposed.

Foundation installation may only begin in the absence of NARWs (based on visual and passive acoustic monitoring). Once foundation installation activities have commenced, NMFS anticipates NARWs would avoid the area, utilizing nearby waters to carry on pre-exposure behaviors. However, foundation installation activities must be shut down if a NARW is sighted at any distance or acoustically detected at any distance within the PAM monitoring zone, unless a shutdown is not feasible due to risk of injury or loss of life. Shutdown would be required anywhere if NARWs are detected within or beyond the Level B harassment zone, further minimizing the duration and intensity of exposure. These measures are designed to avoid PTS and also reduce the severity of Level B harassment, including the potential for TTS. While some TTS could occur, given the mitigation measures (*e.g.,* delay pile driving upon a sighting or acoustic detection and shutting down upon a sighting or acoustic detection), the potential for TTS to occur is low. NMFS anticipates that if NARWs go undetected and they are exposed to foundation installation noise, it is unlikely a NARW would approach the sound source locations to the degree that they would expose themselves to very high noise levels. This is because typical observed whale behavior demonstrates likely avoidance of harassing levels of sound where possible (Richardson *et al.,* 1985).

The clearance and shutdown measures are most effective when detection efficiency is maximized, as the measures are triggered by a sighting or acoustic detection. To maximize detection efficiency, NMFS would require the combination of PAM and visual observers. NMFS also would require communication protocols with other project vessels and other heightened awareness efforts (*e.g.,* daily monitoring of NARW sighting databases) such that as a NARW approaches the source (and thereby could be exposed to higher noise energy levels), PSO detection efficacy would increase, the whale would be detected, and a delay to commencing foundation installation or shutdown (if feasible) would occur. In addition, the implementation of a soft-start for impact pile driving would provide an opportunity for whales to move away from the source if they are undetected, reducing received levels.

As described above, no serious injury or mortality, or Level A harassment of NARWs is anticipated or proposed to be authorized. Extensive NARW-specific mitigation measures (beyond the robust suite required for all species) are expected to further minimize the amount and severity of Level B harassment.

Given the documented habitat use within the LIA, the seven instances of take by Level B harassment could include seven whales disturbed on one day each within the year, or it could represent a smaller number of whales impacted on 2 or 3 days, should NARWs briefly use the LIA as a ''stopover'' site and stay or swim in and out of the LIA for more than day. At any rate, any impacts to NARWs are expected to be in the form of lower level behavioral disturbance, given the extensive mitigation measures.

Given the magnitude and severity of the impacts discussed above, and in consideration of the required mitigation and other information presented, Vineyard Wind's activities are not expected to result in impacts on the reproduction or survival of any individuals, much less affect annual rates of recruitment or survival. For these reasons, we have determined that the take (by Level B harassment) anticipated and proposed to be authorized would have a negligible impact on the NARW.

Fin Whale

The fin whale is listed as endangered under the ESA, and the western North Atlantic stock is considered both depleted and strategic under the MMPA. No UME has been designated for this species or stock. No serious injury or mortality is anticipated or proposed to be authorized for this species.

This IHA would authorize up to seven takes, by harassment only, over the 1 year period. The maximum allowable take by Level A harassment and Level B harassment, is one and six, respectively (which equates to approximately 0.10 percent of the stock abundance, if each take were considered to be of a different individual). Given the close proximity of a fin whale feeding BIA (2,933 km^2) from March through October, and that SNE is generally considered a feeding area, it is likely that the seven takes could represent a few whales taken 2–3 times annually.

Level B harassment is expected to be in the form of behavioral disturbance, primarily avoidance of the LIA where foundation installation is occurring and some low-level TTS and masking that may limit the detection of acoustic cues for relatively brief periods of time. We anticipate any potential PTS would be minor (limited to a few dB), and any PTS or TTS would be concentrated at half or one octave above the frequency band of pile driving noise (most sound is below 2 kHz) which does not include the full predicted hearing range of fin whales. If TTS is incurred, hearing sensitivity would likely return to pre-exposure levels relatively shortly after exposure ends. Any masking or physiological responses would also be of low magnitude and severity for reasons described above.

Fin whales are present in the waters off of New England year-round and are one of the most frequently observed large whales and cetaceans in continental shelf waters, principally from Cape Hatteras, North Carolina in the Mid-Atlantic northward to Nova Scotia, Canada (Sergeant, 1977; Sutcliffe and Brodie, 1977; CETAP, 1982; Hain *et al.,* 1992; Geo-Marine, 2010; BOEM 2012; Edwards *et al.,* 2015; Hayes *et al.,* 2023). In SNE, fin whales densities are highest in the spring and summer months (Kraus *et al.,* 2016; Roberts *et al.,* 2023) though detections do occur in spring and fall (Watkins *et al.,* 1987; Clark and Gagnon, 2002; Geo-Marine, 2010; Morano *et al.,* 2012; Van Parijs *et al.,* 2023). However, fin whales feed more extensively in waters in the Great South Channel north to the Gulf Maine into the Gulf of St. Lawrence, areas north and east of the LIA (Hayes *et al.,* 2023).

As described previously, the LIA is in close proximity (approximately 8.0 km; 5.0 mi) to a small fin whale feeding BIA (2,933 km^2) east of Montauk Point, New York (figure 2.3 in LaBrecque *et al.,* 2015) that is active from March to October. Foundation installations have seasonal work restrictions (*i.e.,* spatial and temporal) such that the temporal overlap between the specified activities and the active BIA timeframe would exclude the months of March, April, and May. A separate larger year-round feeding BIA (18,015 km^2) located to the east in the southern Gulf of Maine does not overlap with the LIA and is located substantially further away (approximately 76.4 km (47.5 mi)), and would thus not be impacted by project activities. We anticipate that if foraging is occurring in the LIA and foraging whales are exposed to noise levels of sufficient strength, they would avoid the LIA and move into the remaining area of the feeding BIA that would be unaffected to continue foraging without substantial energy expenditure or, depending on the time of year, travel to the larger year-round feeding BIA.

Given the documented habitat use within the area, some of the individuals taken would likely be exposed on multiple days. However, low level impacts are generally expected from any fin whale exposure. Given the magnitude and severity of the impacts discussed above (including no more than seven takes over the course of the IHA, and a maximum allowable take by Level A harassment and Level B harassment of one and six, respectively) and in consideration of the required mitigation and other information presented, Vineyard Wind's activities are not expected to result in impacts on the reproduction or survival of any individuals, much less affect annual rates of recruitment or survival. For these reasons, we have determined that the take by harassment anticipated and proposed to be authorized will have a negligible impact on the western North Atlantic stock of fin whales.

Humpback Whale

The West Indies DPS of humpback whales is not listed as threatened or endangered under the ESA but the Gulf of Maine stock, which includes individuals from the West Indies DPS, is considered strategic under the MMPA. However, as described in the Description of Marine Mammals in the Area of Specified Activities section, humpback whales along the Atlantic Coast have been experiencing an active UME as elevated humpback whale mortalities have occurred along the Atlantic coast from Maine through Florida since January 2016. Of the cases examined, approximately 40 percent had evidence of human interaction (vessel strike or entanglement). Despite the UME, the relevant population of humpback whales (the West Indies breeding population, or DPS of which the Gulf of Maine stock is a part) remains stable at approximately 12,000 individuals and takes of humpback whales proposed for authorization would not exacerbate or compound the effects of the ongoing UME.

This IHA would authorize up to six takes by harassment only, over the 1 year period. The maximum allowable take by Level A harassment and Level B harassment is two and four, respectively (this equates to approximately 0.43 percent of the stock abundance, if each take were considered to be of a different individual). Given that feeding is considered the principal activity of humpback whales in SNE waters, these takes could represent a few whales exposed two or three times during the year.

In the western North Atlantic, humpback whales feed during spring, summer, and fall over a geographic range encompassing the eastern coast of the U.S. Feeding is generally considered to be focused in areas north of the LIA, including in a feeding BIA in the Gulf of Maine/Stellwagen Bank/Great South Channel, but has been documented off the coast of SNE and as far south as Virginia (Swingle *et al.,* 1993). Foraging animals tend to remain in the area for extended durations to capitalize on the food sources.

Assuming humpback whales who are feeding in waters within or surrounding the LIA behave similarly, we expect that the predicted instances of disturbance could consist of some individuals that may be exposed on multiple days if they are utilizing the area as foraging habitat. As with other baleen whales, if migrating, such individuals would likely be exposed to noise levels from the project above the harassment thresholds only once during migration through the LIA.

For all the reasons described in the *Mysticetes* section above, we anticipate any potential PTS and TTS would be concentrated at half or one octave above the frequency band of pile driving noise (most sound is below 2 kHz) which does not include the full predicted hearing range of baleen whales. If TTS is incurred, hearing sensitivity would likely return to pre-exposure levels relatively shortly after exposure ends. Any masking or physiological responses would also be of low magnitude and severity for reasons described above.

Given the magnitude and severity of the impacts discussed above (including no more than six takes over the course of the 1-year IHA, and a maximum allowable take by Level A harassment and Level B harassment of two and four, respectively), and in consideration of the proposed mitigation measures and other information presented, Vineyard Wind's activities are not expected to result in impacts on the reproduction or survival of any individuals, much less affect annual rates of recruitment or survival. For these reasons, we have determined that the take by harassment anticipated and proposed to be authorized will have a negligible impact on the Gulf of Maine stock of humpback whales.

Minke Whale

Minke whales are not listed under the ESA, and the Canadian East Coast stock is neither considered depleted nor strategic under the MMPA. There are no known areas of specific biological importance in or adjacent to the LIA. As described in the Description of Marine Mammals in the Area of Specified Activities section, a UME has been designated for this species but is pending closure. No serious injury or mortality is anticipated or proposed to be authorized for this species.

This IHA would authorize up to 1 take by Level A harassment and 28 takes by Level B harassment over the 1-year period (equating to approximately 0.13 percent of the stock abundance, if each take were considered to be of a different individual). As described in the Description of Marine Mammals in the Area of Specified Activities section, minke whales inhabit coastal waters during much of the year and are common offshore the U.S. eastern seaboard with a strong seasonal component in the continental shelf and in deeper, off-shelf waters (CETAP, 1982; Hayes *et al.,* 2022; Hayes *et al.,* 2023). Spring through fall are times of relatively widespread and common acoustic occurrence on the continental shelf. From September through April, minke whales are frequently detected in deep-ocean waters throughout most of the western North Atlantic (Clark and Gagnon, 2002; Risch *et al.,* 2014; Hayes *et al.,* 2023). Because minke whales are migratory and their known feeding areas are north and east of the LIA, including a feeding BIA in the southwestern Gulf of Maine and George's Bank, they would be more likely to be transiting through (with each take representing a separate individual), though it is possible that some subset of the individual whales exposed could be taken up to a few times during the effective period of the IHA.

As previously detailed in the Description of Marine Mammals in the Area of Specified Activities section, there is a UME for minke whales along the Atlantic coast, from Maine through South Carolina, with the highest number of deaths in Massachusetts, Maine, and New York. Preliminary findings in several of the whales have shown evidence of human interactions or infectious diseases. However, we note that the population abundance is greater than 21,000, and the take by harassment proposed to be authorized through this action is not expected to exacerbate the UME.

We anticipate the impacts of this harassment to follow those described in the general *Mysticetes* section above. Any potential PTS would be minor (limited to a few dB) and any PTS or TTS would be of short duration and concentrated at half or one octave above the frequency band of pile driving noise (most sound is below 2 kHz) which does not include the full predicted hearing range of minke whales. If TTS is incurred, hearing sensitivity would likely return to pre-exposure levels relatively shortly after exposure ends. Level B harassment would be temporary, with primary impacts being temporary displacement from the LIA but not abandonment of any migratory or foraging behavior.

Given the magnitude and severity of the impacts discussed above (including no more than 29 takes of the course of the 1-year IHA, and a maximum allowable take by Level A harassment and Level B harassment of 1 and 28, respectively), and in consideration of the proposed mitigation and other information presented, Vineyard Wind's activities are not expected to result in impacts on the reproduction or survival of any individuals, much less affect annual rates of recruitment or survival. For these reasons, we have determined that the take by harassment anticipated and proposed to be authorized will have a negligible impact on the Canadian Eastern Coastal stock of minke whales.

Sei Whale

Sei whales are listed as endangered under the ESA, and the Nova Scotia stock is considered both depleted and strategic under the MMPA. There are no known areas of specific biological importance in or adjacent to the LIA, and no UME has been designated for this species or stock. No serious injury or mortality is anticipated or proposed to be authorized for this species.

The IHA would authorize up to three takes by harassment over the 1-year period. The maximum allowable take by Level A harassment and Level B harassment is one and two, respectively (combined, this annual take (n=3) equates to approximately 0.05 percent of the stock abundance, if each take were considered to be of a different individual). As described in the Description of Marine Mammals in the Area of Specified Activities section, most of the sei whale distribution is concentrated in Canadian waters and seasonally in northerly United States waters, although they can occur year-round in SNE. Because sei whales are migratory and their known feeding areas are east and north of the LIA (*e.g.,* there is a feeding BIA in the Gulf of Maine), they would be more likely to be moving through (*i.e.,* not foraging) and considering this and the very low number of total takes, it is unlikely that any individual would be exposed more than once within the effective period of the IHA.

With respect to the severity of those individual takes by Level B harassment, we anticipate impacts to be limited to low-level, temporary behavioral responses with avoidance and potential masking impacts in the vicinity of the WTG installation to be the most likely type of response. Any potential PTS and TTS would likely be concentrated at half or one octave above the frequency band of pile driving noise (most sound is below 2 kHz), which does not include the full predicted hearing range of sei whales. Moreover, any TTS would be of a small degree. Any avoidance of the LIA due to the Project's activities would be expected to be temporary.

Given the magnitude and severity of the impacts discussed above (including no more than three takes of the course of the 1-year IHA, and a maximum allowable take by Level A harassment and Level B harassment, of one and two, respectively), and in consideration of the required mitigation and other information presented, Vineyard Wind's activities are not expected to result in impacts on the reproduction or survival of any individuals, much less affect annual rates of recruitment or survival. For these reasons, we have determined that the take by harassment anticipated and proposed to be authorized will have a negligible impact on the Nova Scotia stock of sei whales.

Odontocetes

In this section, we include information here that applies to all of the odontocete species and stocks addressed below. Odontocetes include dolphins, porpoises, and all other whales possessing teeth and we further divide them into the following subsections: sperm whales, dolphins and small whales, and harbor porpoises. These sub-sections include more specific information, as well as conclusions for each stock represented.

No serious injury or mortality is anticipated or proposed to be authorized. We anticipate that, given ranges of individuals (*i.e.,* that some individuals remain within a small area for some period of time) and non-migratory nature of some odontocetes in general (especially as compared to mysticetes), a larger subset of these takes are more likely to represent multiple exposures of some number of individuals than is the case for mysticetes, though some takes may also represent one-time exposures of an individual. While we expect animals to avoid the area during foundation installation, their habitat range is extensive compared to the area ensonified during these activities. As such, NMFS expects any avoidance behavior to be limited to the area near the sound source.

As described earlier, Level B harassment may include direct disruptions in behavioral patterns (*e.g.,* avoidance, changes in feeding or vocalizations), as well as those associated with stress responses or TTS. While masking could also occur during foundation installation, it would only occur in the vicinity of and during the duration of the activity, and would not generally occur in a frequency range that overlaps most odontocete communication or any echolocation signals. The proposed mitigation measures (*e.g.,* use of sound attenuation systems, implementation of clearance and shutdown zones) would also minimize received levels such that the expected severity of any behavioral response would be less than exposure to unmitigated noise exposure.

Any masking or TTS effects are anticipated to be of low severity. First, while the frequency range of pile driving falls within a portion of the frequency range of most odontocete vocalizations, odontocete vocalizations span a much wider range than the low frequency construction activities planned for the project. Also, as described above, recent studies suggest odontocetes have a mechanism to self-mitigate the impacts of noise exposure (*i.e.,* reduce hearing sensitivity), which could potentially reduce TTS impacts. Any masking or TTS is anticipated to be limited and would typically only interfere with communication within a portion of an odontocete's range and as discussed earlier, the effects would only be expected to be of a short duration and for TTS, a relatively small degree. Furthermore, odontocete echolocation occurs predominantly at frequencies significantly higher than low frequency construction activities. Therefore, there is little likelihood that threshold shift would interfere with feeding behaviors.

The waters off the coast of Massachusetts are used by several odontocete species. However, none except the sperm whale are listed under the ESA and there are no known habitats of particular importance. In general, odontocete habitat ranges are far-reaching along the Atlantic coast of the U.S. and the waters off of New England, including the LIA, do not contain any particularly unique odontocete habitat features.

Sperm Whale

Sperm whales are listed as endangered under the ESA, and the North Atlantic stock is considered both depleted and strategic under the MMPA. The North Atlantic stock spans the east coast out into oceanic waters well beyond the U.S. EEZ. Although listed as endangered, the primary threat faced by the sperm whale across its range (*i.e.,* commercial whaling) has been eliminated. Current potential threats to the species globally include vessel strikes, entanglement in fishing gear, anthropogenic noise, exposure to contaminants, climate change, and marine debris. There is no currently reported trend for the stock and although the species is listed as endangered under the ESA, there are no current related issues or events associated with the status of the stock that cause particular concern (*e.g.,* no UMEs). There are no known areas of biological importance (*e.g.,* critical habitat or BIAs) in or near the LIA. No mortality or serious injury is anticipated or proposed to be authorized for this species.

The IHA would authorize up to two takes by Level B harassment over the 1-year period, which equates to approximately 0.05 percent of the stock abundance. If sperm whales are present in the LIA during any Project activities, they will likely be only transient visitors, although foraging and social behavior may occur in the shallow waters off SNE (Westell *et al.,* 2024). However, the potential for TTS is low for reasons described in the general Odontocete section. If it does occur, any hearing shift would be small and of a short duration. Because foraging is expected to be rare in the LIA, TTS is not expected to interfere with foraging behavior.

Given the magnitude and severity of the impacts discussed above (including no more than two takes by Level B harassment over the course of the 1-year IHA, and in consideration of the required mitigation and other information presented, Vineyard Wind's activities are not expected to result in impacts on the reproduction or survival of any individuals, much less affect annual rates of recruitment or survival. For these reasons, we have determined that the take by Level B harassment anticipated and proposed to be authorized will have a negligible impact on the North Atlantic stock of sperm whales.

Dolphins and Small Whales (Including Delphinids)

The five species and stocks included in this group (which are indicated in table 3 in the Delphinidae family) are not listed under the ESA, and nor are they listed as depleted or strategic under the MMPA. There are no known areas of specific biological importance in or around the LIA. As described above for any of these species and no UMEs have been designated for any of these species. No serious injury or mortality is anticipated or proposed to be authorized for these species.

The five delphinid species (constituting five stocks) with takes proposed to be authorized for the Project are Atlantic white-sided dolphin, bottlenose dolphin, long-finned pilot whale, Risso's dolphin, and common dolphin. The IHA would allow for the total authorization of 3 to 462 takes (depending on species) by Level B harassment, over the 1-year period. Overall, this annual take equates to approximately 0.01 (Risso's dolphin) to up to 0.27 (common dolphin) percent of the stock abundance (if each take were considered to be of a different individual, which is not likely the case), depending on the species.

The number of takes, likely movement patterns of the affected species, and the intensity of any Level B harassment, combined with the availability of alternate nearby foraging habitat suggests that the likely impacts would not impact the reproduction or survival of any individuals. While delphinids may be taken on several occasions, none of these species are known to have small home ranges within the LIA or known to be particularly sensitive to anthropogenic noise. Some TTS can occur, but it would be limited to the frequency ranges of the activity and any loss of hearing sensitivity is anticipated to return to pre-exposure conditions shortly after the animals move away from the source or the source ceases.

Across these species, the maximum number of incidental takes, by Level B harassment (no Level A harassment is anticipated or proposed to be authorized), proposed to be authorized ranges between 3 (Risso's dolphin) to 462 (common dolphin). Though the estimated numbers of take are comparatively higher than the numbers for mysticetes, we note that for all species they are relatively low relative to the population abundance.

As described above for odontocetes broadly, given the number of estimated takes for some species and the behavioral patterns of odontocetes, we anticipate that some of these instances of take in a day represent multiple exposures of a smaller number of individuals, meaning the actual number of individuals taken is lower. Although some amount of repeated exposure to some individuals across a few days within the year is likely, the intensity of any Level B harassment combined with the availability of alternate nearby foraging habitat suggests that the likely impacts would not impact the reproduction or survival of any individuals.

Overall, the populations of all delphinid and small whale species and stocks for which we proposed to authorize take are stable (no declining population trends). None of these stocks are experiencing existing UMEs. No mortality, serious injury, or Level A harassment is anticipated or proposed to be authorized for any of these species. Given the magnitude and severity of the impacts discussed above and in consideration of the required mitigation and other information presented, as well as the status of these stocks, the specified activities are not expected to result in impacts on the reproduction or survival of any individuals, much less affect annual rates of recruitment or survival. For these reasons, we have determined that the take by harassment anticipated and proposed to be authorized will have a negligible impact on all of the following species and stocks: Atlantic white-sided dolphins, bottlenose dolphins, long-finned pilot whales, Risso's dolphins, and common dolphins.

Harbor Porpoise

Harbor porpoises are not listed as threatened or endangered under the ESA, and the Gulf of Maine/Bay of Fundy stock is neither considered depleted or strategic under the MMPA. The stock is found predominantly in northern United States coastal waters (less than 150 m depth) and up into Canada's Bay of Fundy (between New Brunswick and Nova Scotia). Although the population trend is not known, there are no UMEs or other factors that cause particular concern for this stock. No mortality or non-auditory injury are anticipated or proposed to be authorized for this stock.

The IHA would authorize up to 113 takes, by harassment only. The maximum allowable take by Level A harassment and Level B harassment would be 3 and 110, respectively (combined, this annual take (*n*=113) which equates to approximately 0.19 percent of the stock abundance, if each take were considered to be of a different individual). Given the number of takes, while many of the takes likely represent exposures of different individuals on 1 day a year, some subset of the individuals exposed could be taken up to a few times annually.

Regarding the severity of takes by Level A harassment and Level B harassment, because harbor porpoises are particularly sensitive to noise, it is likely that a fair number of the responses could be of a moderate nature, particularly to foundation installation. In response to foundation installation, harbor porpoises are likely to avoid the area during construction, as previously demonstrated in Tougaard *et al.* (2009) in Denmark, in Dahne *et al.* (2013) in Germany, and in Vallejo *et al.* (2017) in the United Kingdom, although a study by Graham *et al.* (2019) may indicate that the avoidance distance could decrease over time. However, foundation installation is scheduled to occur off the coast of Massachusetts and given alternative foraging areas, any avoidance of the area by individuals is not likely to impact the reproduction or survival of any individuals.

With respect to PTS and TTS, the effects on an individual are likely relatively low, given the frequency bands of pile driving (most energy below 2 kHz) compared to harbor porpoise hearing (150 Hz to 160 kHz, peaking around 40 kHz). Specifically, TTS is unlikely to impact hearing ability in their more sensitive hearing ranges or the frequencies in which they communicate and echolocate. We expect any PTS that may occur to be within the very low end of their hearing range where harbor porpoises are not particularly sensitive and any PTS would be of small magnitude. As such, any PTS would not interfere with key foraging or reproductive strategies necessary for reproduction or survival.

As discussed in Hayes *et al.* (2022), harbor porpoises are seasonally distributed. During fall (October through November) and spring (April through June), harbor porpoises are widely dispersed from New Jersey to Maine with lower densities farther north and south. During winter (January to March), intermediate densities of harbor porpoises can be found in waters off New Jersey to North Carolina and lower densities are found in waters off New York to New Brunswick, Canada. In non-summer months they have been seen from the coastline to deep waters (>1800 m; Westgate *et al.,* 1998), although the majority are found over the continental shelf. While harbor porpoises are likely to avoid the area during any of the project's construction activities, as demonstrated during European wind farm construction, the time of year in which most work would occur is when harbor porpoises are not in highest abundance, and any work that does occur would not result in the species' abandonment of the waters off of Massachusetts.

Given the magnitude and severity of the impacts discussed above, and in consideration of the required mitigation and other information presented, the specified activities are not expected to result in impacts on the reproduction or survival of any individuals, much less affect annual rates of recruitment or survival. For these reasons, we have determined that the take by harassment anticipated and proposed to be authorized will have a negligible impact on the Gulf of Maine/Bay of Fundy stock of harbor porpoises.

Phocids (Harbor Seals and Gray Seals)

The harbor seal and gray seal are not listed under the ESA, and neither the western North Atlantic stock of gray seal nor the western North Atlantic stock of harbor seal are considered depleted or strategic under the MMPA. There are no known areas of specific biological importance in or around the LIA. As described in the Description of Marine Mammals in the Area of Specified Activities section, a UME has been designated for harbor seals and gray seals and is described further below. No serious injury or mortality is anticipated or proposed to be authorized for this species.

For the 2 seal species, the IHA would authorize up to between 30 (harbor seals) and 241 (gray seals) takes, by harassment only. The maximum allowable take for harbor seals by Level A harassment and Level B harassment would be 1 and 29, respectively (combined, this take (*n*=30) equates to approximately 0.05 percent of the stock abundance, if each take were considered to be of a different individual). No takes by Level A harassment are anticipated or proposed to be authorized for gray seals. The maximum allowable take for gray seals by Level B harassment (241) equates to approximately 0.88 percent of the stock abundance, if each take were considered to be of a different individual). Though gray seals and harbor seals are considered migratory and no specific feeding areas have been defined for the area, while some of the takes likely represent exposures of different individuals on 1 day a year, it is likely that some subset of the individuals exposed could be taken a few times annually.

Harbor and gray seals occur in SNE waters most often from December through April. Seals are more likely to be close to shore, such that exposure to foundation installation would be expected to be at low levels. Known haulouts for seals occur along the shores of Massachusetts.

As described in the Potential Effects to Marine Mammals and Their Habitat section, construction of wind farms in Europe resulted in pinnipeds temporarily avoiding construction areas but returning within short time frames after construction was complete (Carroll *et al.,* 2010; Hamre *et al.,* 2011; Hastie *et al.,* 2015; Russell *et al.,* 2016; Brasseur *et al.,* 2012). Effects on pinnipeds that are taken by Level B harassment in the LIA would likely be limited to avoidance of the area reactions such as increased swimming speeds, increased surfacing time, or decreased foraging (if such activity were occurring). Most likely, individuals would simply move away from the sound source and be temporarily displaced from those areas (Lucke *et al.,* 2006; Edren *et al.,* 2010; Skeate *et al.,* 2012; Russell *et al.,* 2016). Given the low anticipated magnitude of impacts from any given exposure (*e.g.,* temporary avoidance), even repeated Level B harassment across a few days of some small subset of individuals, which could occur, is unlikely to result in impacts on the reproduction or survival of any individuals. Moreover, pinnipeds would benefit from the mitigation measures described in the Proposed Mitigation section.

As described above, noise from pile driving is mainly low frequency, and while any PTS and TTS that does occur would fall within the lower end of pinniped hearing ranges (50 Hz to 86 kHz), PTS and TTS would not occur at frequencies around 5 kHz where pinniped hearing is most susceptible to noise-induced hearing loss (Kastelein *et al.,* 2018). In summary, any PTS and TTS would be of small degree and not occur across the entire, or even most sensitive, hearing range. Hence, any impacts from PTS and TTS are likely to be of low severity and not interfere with behaviors critical to reproduction or survival.

Elevated numbers of harbor seal and gray seal mortalities were first observed in July 2018 and occurred across Maine, New Hampshire, and Massachusetts until 2020. Based on tests conducted so far, the main pathogen found in the seals belonging to that UME was phocine distemper virus, although additional testing to identify other factors that may be involved in this UME are underway. In 2022, a pinniped UME occurred in Maine with some harbor and gray seals testing positive for highly pathogenic avian influenza (HPAI) H5N1. Neither UME (alone or in combination) provides cause for concern regarding population-level impacts to any of these stocks. For harbor seals, the population abundance is over 61,000 and annual mortality/serious injury (M/SI) (*n*=339) is well below PBR (1,729) (Hayes *et al.,* 2023). The population abundance for gray seals in the United States is over 27,000, with an estimated overall abundance, including seals in Canada, of approximately 366,400 (Hayes *et al.,* 2023). In addition, the abundance of gray seals is likely increasing in the U.S. Atlantic, as well as in Canada (Hayes *et al.,* 2023).

Given the magnitude and severity of the impacts of the Vineyard Wind Project discussed above, and in consideration of the required mitigation and other information presented, Vineyard Wind's activities are not expected to result in impacts on the reproduction or survival of any individuals, much less affect annual rates of recruitment or survival. For these reasons, we have determined that the take by harassment anticipated and proposed to be authorized will have a negligible impact on harbor and gray seals.

Negligible Impact Determination

No mortality or serious injury is anticipated to occur or proposed to be authorized. As described in the analysis above, the impacts resulting from the project's activities cannot be reasonably expected to, and are not reasonably likely to, adversely affect any of the species or stocks through effects on annual rates of recruitment or survival. 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 mitigation and monitoring measures, NMFS preliminarily finds that the marine mammal take from the proposed activities would have a negligible impact on all affected marine mammal species or stocks.

Small Numbers

As noted previously, only incidental take of small numbers of marine mammals 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. When the predicted number of individuals to be taken is fewer than one-third of the species or stock abundance, the take is considered to be of small numbers. Additionally, other qualitative factors may be considered in the analysis, such as the temporal or spatial scale of the activities.

NMFS is authorizing incidental take by Level A harassment and/or Level B harassment of 14 species of marine mammals (with 14 managed stocks). The estimated number of instances of takes by combined Level A harassment and Level B harassment relative to the best available population abundance is less than one-third for all affected species and stocks. For 13 stocks, 1 percent or less of the stock abundance is proposed for take by harassment. Specific to the NARW, the estimated amount of take, which is by Level B harassment only (no Level A harassment is anticipated or authorized), is seven, or 2.07 percent of the stock abundance, assuming that each instance of take represents a different individual. Please see table 3 for information relating to this small numbers analysis.

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 would be taken relative to the population size of the 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

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

IHAs, NMFS consults internally whenever we propose to authorize take for endangered or threatened species, in this case with NOAA GARFO.

There are four marine mammal species under NMFS jurisdiction that are listed as endangered or threatened under the ESA that may taken, by harassment, incidental to construction of the project: the North Atlantic right, sei, fin, and sperm whale. NMFS issued a Biological Opinion on September 11, 2020, concluding that the issuance of the 2023 Vineyard Wind IHA is not likely to jeopardize the continued existence of threatened and endangered species under NMFS' jurisdiction and is not likely to result in the destruction or adverse modification of designated or proposed critical habitat. The Biological Opinion is available at *https://repository.library.noaa.gov/view/noaa/37556.*

The Permit and Conservation Division requested re-initiation of section 7 consultation with GARFO on the issuance of the Vineyard Wind proposed IHA for Phase 2 of the Vineyard Wind Offshore Wind Project. 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 impact pile driving of monopiles in the Vineyard Wind Offshore Wind Farm offshore of Massachusetts, provided the previously mentioned mitigation, monitoring, and reporting requirements are incorporated. A draft of the proposed IHA can be found at: *https://www.fisheries.noaa.gov/national/marine-mammal-protection/incidental-take-authorizations-other-energy-activities-renewable.*

Request for Public Comments

We request comment on our analyses, the proposed authorization, and any other aspect of this notice of proposed IHA for the proposed pile driving activities. Please include with your comments any supporting data or literature citations to help inform decisions on the request for this IHA.

Dated: April 15, 2024.

Kimberly Damon-Randall,

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

[FR Doc. 2024–08434 Filed 4–22–24; 8:45 am]

BILLING CODE 3510–22–P