DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

50 CFR Part 217

[Docket No. 230404–0092]

RIN 0648–BL97

Takes of Marine Mammals Incidental to Specified Activities; Taking Marine Mammals Incidental to the Empire Wind Project, Offshore New York

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

ACTION: Proposed rule; proposed letter of authorization; request for comments.

SUMMARY: NMFS has received a request from Empire Offshore Wind, LLC (Empire Wind), a 50/50 joint venture between Equinor and BP p.l.c., for Incidental Take Regulations (ITR) and an associated Letter of Authorization (LOA). The requested regulations would govern the authorization of take, by Level A harassment and/or Level B harassment, of small numbers of marine mammals over the course of 5 years (2024–2029) incidental to construction of the Empire Wind Project offshore New York in a designated lease area on the Outer Continental Shelf (OCS–A–512). Project activities likely to result in incidental take include impact pile driving, vibratory pile driving and removal, and site assessment surveys using high-resolution geophysical (HRG) equipment. As required by the Marine Mammal Protection Act (MMPA), NMFS requests comments on its proposed rule. NMFS will consider public comments prior to making any final decision on the promulgation of the requested incidental take authorization (ITA) and issuance of the LOA; agency responses to public comments will be summarized in the final notice of our decision. The proposed regulations, if issued, would be effective January 22, 2024, through January 21, 2029.

DATES: Comments and information must be received no later than May 15, 2023.

ADDRESSES: Submit all electronic public comments via the Federal e-Rulemaking Portal. Go to *www.regulations.gov* and enter NOAA–NMFS–2023–0053 in the Search box. Click on the ''Comment'' icon, complete the required fields, and enter or attach your comments.

Instructions: Comments sent by any other method, to any other address or individual, or received after the end of the comment period, may not be considered by NMFS. All comments received are a part of the public record and will generally be posted for public viewing on *www.regulations.gov* without change. All personal identifying information (*e.g.,* name, address), confidential business information, or otherwise sensitive information submitted voluntarily by the sender will be publicly accessible. NMFS will accept anonymous comments (enter ''N/A'' in the required fields if you wish to remain anonymous). Attachments to electronic comments will be accepted in Microsoft Word, Excel, or Adobe PDF file formats only.

FOR FURTHER INFORMATION CONTACT: Robert Pauline, Office of Protected Resources, NMFS, (301) 427–8401.

SUPPLEMENTARY INFORMATION:

Availability

A copy of Empire Wind's 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 above (see **FOR FURTHER INFORMATION CONTACT**).

Purpose and Need for Regulatory Action

This proposed rule, if issued, would provide a framework under authority of the MMPA (16 U.S.C. 1361 *et seq.*) to allow for the authorization of take of marine mammals incidental to construction of the Empire Wind Project within the Bureau of Ocean Energy Management (BOEM) Renewable Energy Lease Area OCS–A 512 and along export cable corridors to two landfall locations in New York. NMFS received a request from Empire Wind requesting 5-year regulations and a LOA that would authorize take of individuals of 17 species of marine mammals (two species by Level A harassment and Level B harassment and 17 species by Level B harassment only) incidental to Empire Wind's construction activities. No mortality or serious injury is anticipated or proposed for authorization. Please see the Estimated Take of Marine Mammals section for definitions of harassment.

Legal Authority for the Proposed Action

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, regulations are promulgated (when required), and public notice and an opportunity for public comment are provided.

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 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 below.

Section 101(a)(5)(A) of the MMPA and the implementing regulations at 50 CFR part 216, subpart I provide the legal basis for proposing and, if appropriate, issuing this rule containing five-year regulations and associated LOA. As directed by this legal authority, this proposed rule also establishes required mitigation, monitoring, and reporting requirements for Empire Wind's activities.

Summary of Major Provisions Within the Proposed Rule

The major provisions within this proposed rule are as follows:

- Establish a seasonal moratorium on impact pile driving during the months of highest North Atlantic right whale (*Eubalaena glacialis*) presence in the project area (January 1–April 30);
- Require both visual and passive acoustic monitoring by trained, NOAA Fisheries-approved Protected Species Observers (PSOs) and Passive Acoustic Monitoring (PAM) operators before, during, and after the in-water construction activities;
- Require the use of sound attenuation device(s) during all impact pile driving to reduce noise levels;
- Delay the start of pile driving if a North Atlantic right whale is observed at any distance by PSOs or acoustically detected;
- Delay the start of pile driving if other marine mammals are observed entering or within their respective clearance zones;

• Shut down pile driving (if feasible) if a North Atlantic right whale is observed or if other marine mammals enter their respective shut down zones;
• Implement sound field verification requirements during impact pile driving to measure in situ noise levels for comparison against the model results;
• Implement soft-starts for impact pile driving and use the least hammer energy possible;
• Require PSOs to continue to monitor for the presence of marine mammals for 30 minutes after any impact pile driving occurs;
• Implement ramp-up for HRG site characterization survey equipment;
• Increase awareness of North Atlantic right whale presence through monitoring of the appropriate networks and Channel 16, as well as reporting any sightings to the sighting network;
• Implement various vessel strike avoidance measures; and
• Implement best management practices during fisheries monitoring surveys such as removing gear from the water if marine mammals are considered at-risk or are interacting with gear.

Under Section 105(a)(1) of the MMPA, failure to comply with these requirements or any other requirements in a regulation or permit implementing the MMPA may result in civil monetary penalties. Pursuant to 50 CF 216.106, violations may also result in suspension or withdrawal of the Letter of Authorization (LOA) for the project. Knowing violations may result in criminal penalties, under Section 105(b) of the MMPA.

National Environmental Policy Act (NEPA)

To comply with the National Environmental Policy Act of 1969 (NEPA; 42 U.S.C. 4321 *et seq.*) and NOAA Administrative Order (NAO) 216–6A, NMFS must evaluate the review our proposed action (*i.e.,* promulgation of regulations and subsequent issuance of a 5-year LOA) and alternatives with respect to potential impacts on the human environment.

Accordingly, NMFS proposes to adopt the Bureau of Ocean Energy Management's (BOEM's) Environmental Impact Statement (EIS), provided our independent evaluation of the document finds that it includes adequate information analyzing the effects of promulgating the proposed regulations and LOA issuance on the human environment. NMFS is a cooperating agency on BOEM's EIS. BOEM's draft EIS (Empire Wind Draft Environmental Impact Statement (DEIS) for Commercial Wind Lease OCS–A 512) was made available for public comment on November 18, 2022 (87 FR 69330), beginning the 60-day comment period ending on January 17, 2023. The draft EIS can be found at: *https://www.boem.gov/renewable-energy/state-activities/empire-wind.* Additionally, BOEM held three virtual public hearings on December 7, 2022, December 13, 2022 and December 15, 2022.

Information contained within Empire Wind's ITA application and this proposed rule collectively provide the environmental information related to these proposed regulations and associated 5-year LOA for public review and comment. NMFS will review all comments submitted in response to this proposed rule prior to concluding the NEPA process or making a final decision on the requested 5-year ITA and LOA.

Fixing America's Surface Transportation Act (FAST–41)

This project is covered under Title 41 of the Fixing America's Surface Transportation Act, or ''FAST–41''. FAST–41 includes a suite of provisions designed to expedite the environmental review for covered infrastructure projects, including enhanced interagency coordination as well as milestone tracking on the public-facing Permitting Dashboard. FAST–41 also places a 2-year limitations period on any judicial claim that challenges the validity of a Federal agency decision to issue or deny an authorization for a FAST–41 covered project. 42 U.S.C. 4370m–6(a)(1)(A).

Empire Wind's proposed project is listed on the Permitting Dashboard (*https://www.permits.performance.gov/*), where milestones and schedules related to the environmental review and permitting for the project can be found: *https://www.permits.performance.gov/permitting-project/empire-wind-energy-project.*

Summary of Request

On December 7, 2021, Empire Wind submitted a request for the promulgation of regulations and issuance of an associated 5-year LOA to take marine mammals incidental to construction activities associated with implementation of the Empire Wind Project offshore of New York in BOEM Lease Area OCS–A–0512. Empire Wind's request is for the incidental, but not intentional, taking of a small number of 17 marine mammal species (comprising 18 stocks) by Level B harassment (for all 18 stocks) and by Level A harassment (for two species or stocks). Neither Empire Wind, nor NMFS, expect serious injury or mortality to result from the specified activities nor is any proposed for authorization.

In response to our comments, and following extensive information exchange with NMFS, Empire Wind submitted a final, revised application on July 28, 2022, that NMFS deemed adequate and complete on August 11, 2022. In June 2022, new scientific information was released regarding marine mammal densities (Robert and Halpin, 2022). In response, Empire Wind submitted a final addendum to the application on January 25, 2023, which included revised marine mammal densities and take estimates based on Roberts and Halpin 2022. The addendum also identified a revision to the density calculation methodology. Both of these revisions were recommended by NMFS. Empire Wind requests the regulations and subsequent LOA be valid for 5 years beginning in the first quarter of 2024 (January 22) through the first quarter of 2029 (January 21). Neither Empire Wind nor NMFS expects serious injury or mortality to result from the specified activities. Empire Wind's complete application and associated addendum are available on NMFS' website at: *https://www.fisheries.noaa.gov/action/incidental-take-authorization-empire-offshore-wind-llc-construction-empire-wind-project-ew1?check_logged_in=1.*

On September 9, 2022, NMFS published a notice of receipt (NOR) of the application in the **Federal Register** (87 FR 55409), requesting comments and soliciting information related to Empire Wind's request during a 30-day public comment period. During the NOR public comment period, NMFS received comment letters from an environmental non-governmental organization (Responsible Offshore Development Alliance) and a corporate entity (Allco Renewable Energy Limited). NMFS has reviewed all submitted material and has taken these into consideration during the drafting of this proposed rulemaking.

NMFS previously issued three Incidental Harassment Authorizations (IHAs) to Equinor and its predecessors for the taking of marine mammals incidental to marine site characterization surveys (using HRG equipment) of the Empire Wind Lease Area (OCS–A 0512) and cable corridors (these were not issued to Empire Wind as this subsidiary of Equinor had not yet been established). On April 24, 2018, NMFS issued an IHA to Statoil Wind U.S. LLC, effective from April 24, 2018, through April 23, 2019 (83 FR 19532; May 3, 2018) which included Lease

Area OCS–A 512 and associated cable route corridors. Since the initial IHA was issued, Statoil Wind U.S. LLC changed the name under which the company operates to Equinor. A renewal IHA was issued to Equinor and was effective from April 25, 2019 through April 24, 2020 (84 FR 18801) which covered the same area. A new IHA was issued to Equinor on September 25, 2020 (85 FR 60424) and was effective from September 20, 2020, to September 19, 2021 which included OCS–A 512 and associated cable routes.

To date, Equinor, the parent company of Empire Wind, has complied with all IHA requirements (*e.g.,* mitigation, monitoring, and reporting) of these IHAs. Information regarding Equinor's take estimates and monitoring results may be found in the Estimated Take of Marine Mammals section, and the full monitoring reports can be found on NMFS' website: *https://www.fisheries.noaa.gov/national/marine-mammal-protection/incidental-take-authorizations-other-energy-activities-renewable.*

On August 1, 2022, NMFS announced proposed changes to the existing North Atlantic right whale vessel speed regulations to further reduce the likelihood of mortalities and serious to endangered right whales from vessel collisions, which are a leading cause of the species' decline and a primary factor in an ongoing Unusual Mortality Event (87 FR 46921). Should a final vessel speed rule be issued and become effective during the effective period of this ITA (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. The responsibility to comply with the applicable requirements of any vessel speed rule would become effective immediately upon the effective date of any final vessel speed rule and, when notice is published of the effective date, NMFS would also notify Empire Wind if the measures in the speed rule were to supersede any of the measures in the MMPA authorization such that they were not longer required.

Description of the Specified Activity

Overview

Empire Wind proposes to construct and operate two offshore wind projects within OCS–A 0512: Empire Wind 1 (EW 1; western portion of Lease Area) and Empire Wind 2 (EW 2; eastern portion of Lease Area) (Figure 1). Combined the two projects would produce a total of approximately 2,076 megawatts (MW) of renewable energy to New York. EW 1 (816 MW) and EW 2 (1,260 MW) will be electrically isolated and independent of each other and each will be connected to their own points of interconnection (POIs) via individual submarine export cable routes.

Empire Wind's project would consist of several different types of permanent offshore infrastructure, including wind turbine generators (WTGs) and associated foundations, offshore substations (OSSs), inter-array cables, submarine export cables and scour protection. Specifically, activities to construct the project include the installation of up to 147 WTGs and two OSSs by impact pile driving (total of 149 foundations). Additional activities would include cable installation, site preparation activities (*e.g.,* dredging), HRG surveys, installation of cofferdams or casing pipes supported by goal post piles, removal of berthing piles and performing marina bulkhead work; and conducting several types of fishery and ecological monitoring surveys. Multiple vessels would transit within the project area and between ports and the wind farm to perform the work and transport crew, supplies, and materials. All offshore cables will connect to onshore export cables, substations, and grid connections on Long Island and Brooklyn, New York. Marine mammals exposed to elevated noise levels during impact and vibratory pile driving or site characterization surveys may be taken by Level A harassment and/or Level B harassment depending on the specified activity.

Activities Not Considered in Empire Wind's Request for Authorization

During construction, Empire Wind will receive equipment and materials to be staged and loaded onto installation vessels at one or more existing third-party port facilities. Empire Wind not yet finalized the selection of all facilities, although they will include the South Brooklyn Marine Terminal (SBMT) in Brooklyn, New York. SBMT has been selected as the location for export cable landfall and the onshore substation for EW 1. Empire Wind also has leased portions of SBMT for EW 1 and EW 2 for laydown and staging of wind turbine blades, turbines, and nacelles; foundation transition pieces; or other facility parts during construction of the offshore wind farm.

The final port selection(s) for staging and construction will be determined based upon whether the ports are able to accommodate Empire Wind's schedule, workforce and equipment needs. Any port improvement construction activities to facilitate laydown and staging would be conducted by a separate entity and would serve the broader offshore wind industry in addition to the Empire Wind Project. Empire Wind would, therefore, not be the applicant for the authorization of marine mammal take incidental to these activities if an authorization for incidental take is warranted, and these activities are not analyzed further in this proposed rule.

Empire Wind is not planning on detonating any unexploded ordnance (UXO) or munitions and explosives of concern (MEC) during the effective period of the proposed rule, if issued. Hence, Empire Wind did not analyze or request take associated with this activity as it would not occur. Other means of removing UXO/MEC may occur (*e.g.,* lift and shift). As UXO/MEC detonation would not occur, it is not discussed further in this analysis.

Dates and Duration

Empire Wind anticipates that activities with the potential to result in harassment of marine mammals would occur throughout all five years of the proposed regulations which, if promulgated, would be effective from January 22, 2024 through January 21, 2029.

The estimated schedule, including dates and duration, for various activities is provided in Table 1. Detailed information about the activities themselves may be found in the Detailed Description of the Specific Activity subsection.

Empire Wind anticipates that 96 WTG monopiles will be installed in 2025 and the remaining 51 WTG monopiles will be installed in 2026. Specifically, installation of WTG monopiles is expected to begin in the second quarter of 2025 and end in the fourth quarter of 2025 for both EW 1 and EW 2. Installation of monopile foundations would resume in EW 2 in the second quarter of 2026 and end in the fourth quarter of that year. OSS foundation installation would occur in 2025 for both EW 1 and EW 2; however, topside work on the EW 2 OSS would occur in 2026 and 2025 and 2026 (EW 2). While Empire Wind currently anticipates adherence to this schedule, it is possible that foundations could be installed in later time periods (but within the 5-year effective period of the LOA) should permitting or scheduling delays occur).

Installation of foundation piles would not occur from January 1–April 30 in any given year. In addition, impact pile driving is not planned from December 1 through December 31 but could only occur if unanticipated delays due to weather or technical problems arise that necessitate extending pile driving into December in which case Empire Wind would notify NOAA Fisheries and BOEM in advance writing by September 1 that circumstances are expected to necessitate pile driving in December. Given this uncertainty, Empire Wind has included December into its analysis to be precautionary; however, pile driving is currently planned for May through November. Each monopile pile will require up to 3.5 hours of impact pile driving and each pin pile will require up to 5 hours of impact pile driving.

Either cofferdams or casing pipe and goal post installation may occur as part of cable landfall activities, but not both. EW 1 cable landfall work would occur sometime between Q1 to Q4 in 2024 while EW 2 cable landfall work would occur sometime between Q1 2024–Q4 2025. Depending on the construction method chosen, each cable landfall site would require 7–30 days of work. Exact dates and durations could shift depending on factors such as weather delays, procurement, or contracting issues

The anticipated activity schedule for all activities is shown in Table 1. Empire Wind anticipates that WTGs in EW 1 would become operational late in Q2 or early Q3 in 2026 while those in EW 2 would become operational in Q4 of 2027. Turbines would be commissioned individually by personnel on location, so the number of commissioning teams would dictate how quickly turbines would become operational.

TABLE 1—ESTIMATED ACTIVITY SCHEDULE TO CONSTRUCT AND OPERATE THE EMPIRE WIND PROJECT

Project activity	Expected timing EW 1	Expected timing EW 2
Submarine Export Cables	Q3 2024; Q3 2025	Q3–Q4 2025.
Offshore Substation Jacket Foundation and Topside	Q2 [1]–Q4 2025	Q2 [1]–Q4 2025; Q2 [1]–Q4 2026. [2]
Monopile Foundation Installation	Q2 [1]–Q4 2025	Q2 [1]–Q4 2025; Q2 [1]–Q4 2026.
WTG Installation	Q4 2025–Q2 2026	Q4 2026–Q3 2027.
Interarray Cables	Q2–Q4 2025	Q2–Q3 2026.
HRG Surveys	Q1 2024–Q4 2028	Q1 2024–Q4 2028.
Cable Landfall Construction	Q1–Q4 2024 [3]	Q1 2024–Q4 2025. [3]
Marina Activities	n/a	Q1–Q4 2024.
Barnum Channel Cable Bridge Construction	n/a	Q4 2024–Q2 2025.

Note: Project activities are anticipated to start no earlier than Q1 2024.
[1] Impact driving of foundation piles is prohibited between January 1 and April 30. During Q2 such activities could not start until May 1.
[2] EW 2 OSS jacket installation is planned for 2025, only EW 2 topside work is planned for 2026.
[3] While cable landfall construction could occur at any time during the time period identified would only occur for approximately 30 days.

Specific Geographic Region

Empire Wind would conduct activities in state waters and Federal waters within the designated Lease Area OCS–A 0512 (which covers approximately 321 square kilometers (km^2; 79,350 acres) and New York state waters (See Figure 1)). The Lease Area is located in the New York Bight, approximately 14 miles (mi; 12 nautical miles (nm); 22 km) south of Long Island, New York, and 19.5 mi (16.9 nm; 31.4 km) east of Long Branch, New Jersey. The New York Bight is a section of the northwestern Atlantic Ocean that extends along the United States East Coast between Cape May, New Jersey in the southwest, to Montauk Point, New York in the northeast. It includes the waters over the continental shelf and offshore to the shelf break. It is part of the larger Mid-Atlantic Bight, which spans from Cape Hatteras, North Carolina to Cape Cod, Massachusetts. A number of estuaries drain into the New York Bight and provide spawning and nursery areas for many of the diadromous and marine species that utilize the New York Bight. Important geological features of the area include the Hudson Shelf Valley and Hudson Canyon, which provide habitat for deep-sea coral that shelters benthic invertebrates and fish. Nutrient-rich water created by water-column stratification from spring through fall, known as the cold pool, plays an essential role in the ecosystem and supports high biodiversity and phytoplankton productivity. The average temperature of the cold pool has increased due to changes to ocean circulation. The cold pool has been decreasing over the last several decades with the smallest sizes associated with warmer years while area fish distributions have shifted north or offshore (Zoidis *et al.,* 2021). The geology and geomorphology in the New York Bight region are diverse with glacial deposits as a result of the Pleistocene Epoch sea level falls and rises, and more recent Flandrian transgression of sea level (Messina and Stoffer, 1996). Analysis of geophysical and geotechnical survey data collected across the Lease Area indicates the current geological conditions underlying the Lease Area are generally flat.

Water depths vary within the Lease Area from 24 m (78 ft) to 44 m (144 ft), with deeper water depths in the southeast portion of the Lease Area. From June to September, the average temperature of the upper (10–15 m) water column is higher, which can lead to a surface layer of increased sound speeds (Kusel *et al.* 2022). This creates a downward refracting environment in which propagating sound interacts with the seafloor more than in a well-mixed environment. Increased wind mixing combined with a decrease in solar energy during winter, from December through March, results in a sound speed profile that is more uniform with depth.

Sediments in the project area are characterized as predominantly sands and fine sands in the New York Bight area, which includes the Lease Area and most of the submarine export cable routes, to predominantly clays and silts in New York Bay, which includes a section of the EW 1 submarine export cable route. Impact pile driving would occur in a continental shelf environment characterized by predominantly fine to coarse grained sandy seabed sediments, with some clay content.

The EW 1 submarine export cable route exits the Lease Area from the northwestern edge of the Lease Area and will travel northwest through Raritan Bay to the EW 1 export cable landfall in

Brooklyn, New York. Current geological conditions underlying the EW 1 submarine export cable route trend with shoaling towards the shore, and with more significant variation in the bathymetry closer to shore, where dredging patterns influence the seabed. Water depths vary along the EW 1 submarine export cable route from 5.9 m (19.4 ft) to 31.7 m (104.0 ft). Several channels exist along the submarine export cable route, both natural and anthropogenic. The general gradient along the cable is less than 1 degree, although isolated gradients of up to five degrees exist along the near shore portion of the route.

The EW 2 submarine export cable route exits the Lease Area from the central portion of the Lease Area and travels in a northwestern direction in a relatively straight line until turning north to the EW 2 export cable landfall in Long Beach, New York. Conditions along the EW 2 submarine export cable route exhibit a general trend of shoaling towards the shore. Water depth variations range, in the current surveyed and interpreted portion of the route, from 21.5 m (70 ft) to 35.5 m (116 ft). The slope gradient along the EW 2 submarine export cable route reaches a maximum of 1 degree.

Impact pile driving activities to install monopile and the piled jacket foundations will occur within the proposed WTG and offshore substation layout within EW 1 (Figure 3 in application). The WTGs and offshore substations will be located in the Wind Farm Development Area (WFDA), which is a subset of the Lease Area. EW 1 is located in the northwest portion of the WFDA. Additionally, impact pile driving activities to install monopile and the piled jacket foundations will occur within the proposed WTG and offshore substation layout within EW 2 (Figure 3 in application). EW 2 is located in the southeast portion of the WFDA.

Cable Landfall activities for EW 1 would occur at the South Brooklyn Marine Terminal in Brooklyn, NY along the waterfront and adjacent to 1st Avenue/2nd Avenue (Figure 1 in Application). The EW 1 submarine export siting corridor itself begins on the northern edge of the EW 1 portion of the WFDA and extends northwest for approximately 40 nm (74 km). EW 2 landfall locations would occur at one of the following locations: Landfall A (Riverside Boulevard); EW 2 Landfall B (Monroe Boulevard); EW 2 Landfall C (Lido Beach West Town Park); or Landfall E (Laurelton Boulevard). The final location is still being determined. The EW 2 submarine export siting corridor itself begins on the northwest corner of the EW 2 portion of the WFDA and extends northwest for approximately 26 nm (48 km).

All marina activities, both the berthing pile removal and bulkhead work, would be conducted at the Onshore Substation C location along inshore Long Island on the Wreck Lead Channel. Wreck Lead Channel adjoins Reynolds Channel. Reynolds Channel's median salinity is 30–32 practical salinity units (PSU) and dissolved oxygen levels range from 6–12 milligrams per decilitre (mg/dL), decreasing seasonally with warming temperatures. The sediments in the New York Bight, outer harbor, and barrier islands region are composed primarily of sand, gravel, silt, and clay. Currents in the area are minimal and are expected to be similar to those reported at Rockaway Inlet, which vary between 0.0 and 1.0 knots.

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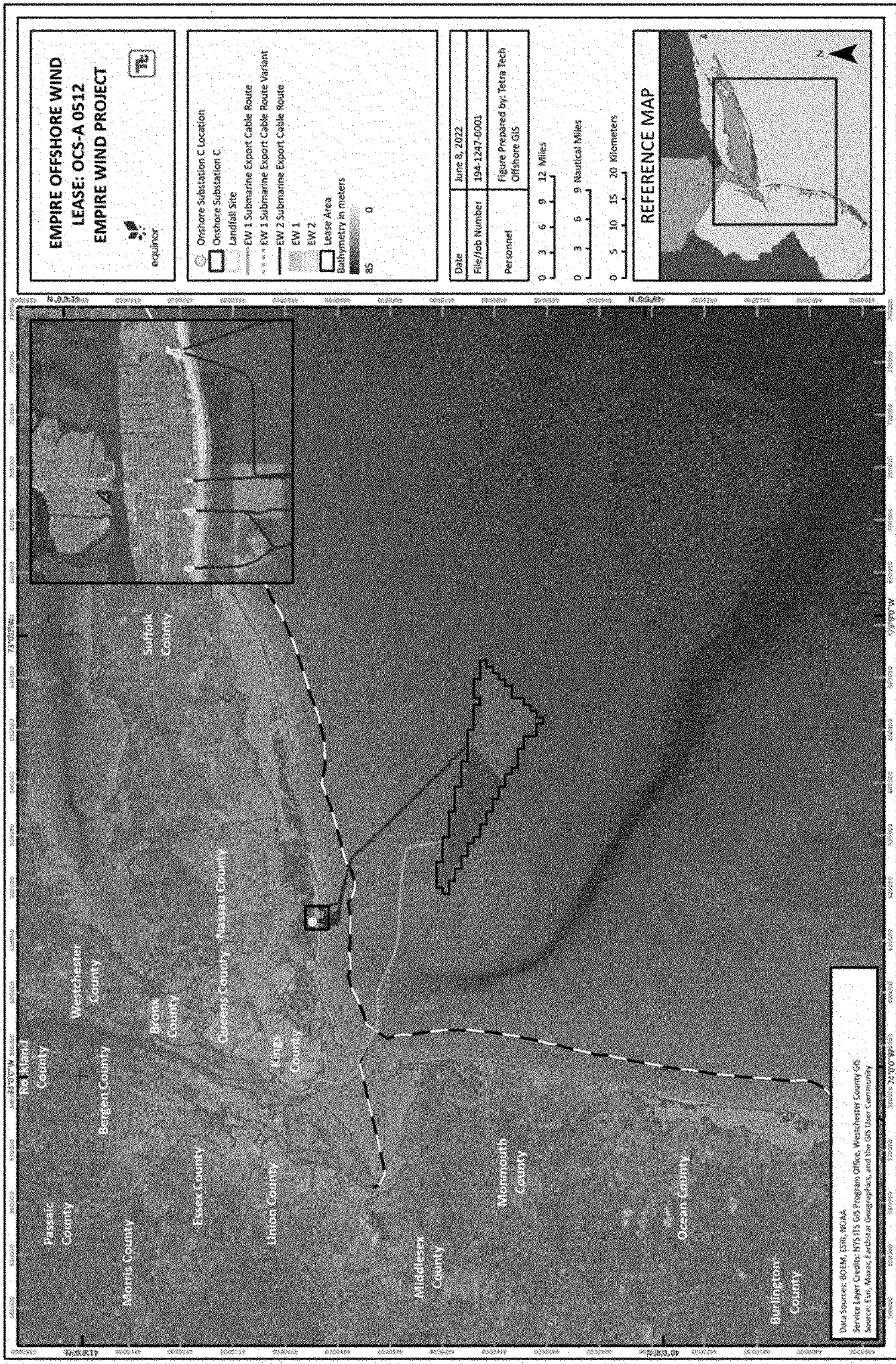

Figure 1. Empire Wind Project Location

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Detailed Description of Specific Activity

Below, we provide detailed descriptions of Empire Wind's activities, explicitly noting those that are anticipated to result in the take of marine mammals and for which incidental take authorization is requested. Additionally, a brief explanation is provided for those activities that are not expected to result in the take of marine mammals.

WTG and OSS Foundation Installation

As described above, Empire Wind would construct two independent projects under these proposed regulations: EW 1 and EW 2. In total, 147 WTGs would be installed. Turbine size includes either 9.6 or 11-m diameter piles driven to a penetration depth of 38 m or 55 m respectively. Both of the 9.6-m and 11-m piles would be installed using a 5,500 kilojoule (kJ) impact pile driver, although only up to 5,225 kJ would be necessary for the 9.6-m piles and up to 2,500 kJ would be used for 11-m piles. Empire Wind anticipates installing up to 57 WTG monopile foundations and 1 OSS jacket foundation for EW 1 and up to 90 WTG monopile foundations and 1 OSS jacket foundation for EW 2. Only one foundation is proposed to be installed via pile driving at a given time (*i.e.,* no concurrent foundation-specific pile driving activities are proposed) and there would be no overlap in pile driving activities between EW 1 and EW 2. WTGs turbines would be installed in clearly marked rows aligned with the dominant trawl directions when feasible. Minimum spacing of no less than 0.65 nm (1.2 km) in a north-south orientation will be maintained between WTGs. Additionally, the layout maintains a 1 nm setback from existing shipping lanes.

Monopile installation techniques are as follows. Once the installation vessel is in place, the steel pile is lifted into a vertical position and lowered onto the seabed. The steel pile is then driven into the seabed. Pile driving is conducted with the use of a large crane mounted hydraulic impact hammer being dropped, or driven, onto the top of a foundation pile, and driving it into the ground to a penetration depth of up to 38 m for 9.6-m piles and 55 m for 11-m piles. Each monopile pile will require a maximum of up to 3.5 hours of impact pile driving. All monopiles would be installed using impact hammers capable of reaching 5,500 kJ of energy. Typically, 9.6-m piles would require a maximum energy level of 2,300 kJ; however, there may be positions (up to 17) wherein the pile is difficult to drive due to seabed conditions. These difficult-to-drive piles would require hammer energies up to 5,225 kJ. Typically, 11-m piles require an energy level of up to 2,500 kJ. An additional hammer energy schedule was generated for difficult-to-drive monopiles (the difficult-to-drive hammer energy schedule was generated only for the 9.6-m diameter scenario as larger diameter monopiles could not be driven in difficult-to-drive conditions).

Installation of each monopile will include a 20-minute soft-start where lower hammer energy is used at the beginning of each pile installation. Following pile driving, the transition piece and secondary ancillary equipment are installed onto the steel pile. Only one foundation is proposed to be installed via pile driving at a given time and there will be no overlap in pile driving activities between EW 1 and EW 2.

Installation of the OSS foundations would be similar to WTG foundation installation. Pin piles (2.5 m) for jacket foundations would be installed via impact driving and would require the installation of up to 12 pin piles per OSS. Once the installation vessel is in place, the jacket structure is lifted from the vessel and lowered onto the seabed. The support piles are placed in the jacket structure and then driven into the seabed. The piles will be driven using the same methodology as described for monopiles. Each pin pile will require a maximum of up to 4.2 hours of impact pile driving. Pin piles at both OSSs would require use of a hammer with an energy level of 4,000 kJ. However, the maximum energy level would be 3,200 kJ at each location. The OSS 1 location would have a penetration depth of 56 m while OSS 2 would have a penetration depth of 47 m. Installation of each pin pile would include a 20-minute soft-start where lower hammer energy is used at the beginning of each pile installation. Following pile driving of the pin piles, the jacket structure is secured to the driven piles.

Seabed preparation will include installation of a filter layer prior to monopile installation and an armor layer after cable installation on each WTG location. The filter layer and armor layer are rock layers installed on the seabed to prevent scour due to flow increase around the monopiles. This activity would not have any impacts on marine mammals.

Foundation installation is scheduled for May through November in 2025 and 2026. Pile driving in December would not occur unless unforeseen circumstances arise. Foundation installation pile driving would not occur January 1–April 30 of any year. Pile driving would occur during daylight hours, only extending into night if Empire Wind starts installing a pile 1.5 hours prior to civil sunset.

Installation of WTG monopile foundations and OSS pin piles are anticipated to result in the take of marine mammals due to noise generated during pile driving. Therefore, Empire Wind has requested, and NMFS proposes to authorize, take (by Level A harassment and Level B harassment) of marine mammals incidental to foundation installation.

Cable Landfall Construction

To connect the offshore export cable to the onshore cable, Empire Wind proposes to conduct construction related activities at two cable landfall sites. The export cable landfall for the EW 1 export cables will occur at SBMT, located along the Brooklyn waterfront and adjacent to 1st Avenue/2nd Avenue. The cable landfall site for EW2 has not yet been chosen but will occur somewhere between Jones Beach to Long Beach, NY. Installation of the export cable landfall will be accomplished using a horizontal directional drilling (HDD) methodology. HDD operations for an export cable landfall originate from an onshore landfall location and exit a certain distance offshore, which is determined by the water depth contour, as well as total length considerations. To support this installation, both onshore and offshore work areas are required. The onshore work areas are typically located within the landfall parcels. Target transition depths of landfall HDD paths vary by the length of the HDD, up to approximately 80 ft (24 m). Once the onshore work area is set up, the HDD activities commence using a rig that drills a borehole underneath the surface. Once the drill for the HDDs exits onto the seafloor, the ducts in which the submarine cable will be installed are floated out to sea and then pulled back onshore within the drilled borehole. The offshore exit locations require some seafloor preparation to collect any drilling fluids that localize during HDD completion. Preparation will include excavation of pits at each offshore exit location. To facilitate the retaining of drilling fluids, Empire Wind may utilize a casing pipe supported by goal posts on the exit side from a jack-up barge or cofferdams (but not both). The jack-up barge will also house the drill rig.

If Empire Wind installs temporary cofferdams to facilitate transition of the export cable to the onshore cable, up to five cofferdams would be required (up to two cofferdams for EW 1 and three cofferdams for EW 2). Each cofferdam would be installed using vibratory driving over 3 days and removed over 3 days for a total of 6 days for each cofferdam (or 30 days total (5 cofferdams × 6 days of pile driving per cofferdam)). Empire Wind anticipates only 1 hour of pile driving would be required each day (30 hours total). The temporary offshore cofferdams will be constructed by installing up to 60 0.61-m (24-inch) steel sheet piles per cofferdam in a tight configuration around an area of up to 30 m by 30 m (100 ft by 100 ft). A total of up to five temporary cofferdams may be constructed (two cofferdams for EW 1 and three cofferdams for EW 2). Variation in the final cofferdam design is possible, with designs ranging from 30 to 40 sheet piles per cofferdam. To be conservative, up to 60 sheet piles per cofferdam have been accounted for in the modeling (see Estimated Take of Marine Mammals section). Sheet piles would be installed with a vibratory hammer. Vibratory pile drivers install piling into the ground by applying a rapidly alternating force to the pile. This is generally accomplished by rotating eccentric weights about shafts. Each rotating eccentric produces a force acting in a single plane and directed toward the centerline of the shaft. The weights are set off-center of the axis of rotation by the eccentric arm. If only one eccentric is used, in one revolution a force will be exerted in all directions, giving the system a good deal of lateral whip. To avoid this problem, the eccentrics are paired so the lateral forces cancel each other, leaving only axial force for the pile.

Seabed preparation may also be completed with installation of a cofferdam for each HDD and an excavation pit to remove material from the cofferdam. The pit would likely be excavated using a bucket—there are no acoustic impacts from this activity if it were to occur and therefore no potential for take.

An alternative to the use of cofferdams for the cable landfall would be the use of a casing pipe supported by up to 3 goal posts. The casing pipe at each landfall location would likely be a 42″ pipe installed with a pneumatic hammer. Empire Wind estimates it would take approximately 4 hours to install the casing pipe with a strike rate of 180 strikes/minute. Each goal post would consist of two piles for a total of 18 piles at each landfall location. Each goal post pile would be installed with an impact hammer requiring up to 2,000 strikes per pile over 2 hours. In total, up to 36 hours (18 piles × 2 hours per pile) of impact pile driving to install three goal posts may occur.

For the goal post installation process, a barge with necessary support equipment is first mobilized and anchored into position. The support equipment on the barge will include at least one crane, a hydraulic impact hammer mounted at the end of the crane hook or load block, and the piles to be driven. An additional crane or similar equipment may also be located on the support barge to aid in the handling of the goal post piles. For each HDD installation, it is estimated that three goal posts will need to be installed to support the casing pipe. Therefore, for each HDD installation there could be up to ten 12-inch piles. For each goal post, a total of two 12-inch steel piles must be driven to complete a single goal post installation, with 2,000 strikes per pile. The piles are installed by attaching the hydraulic hammer to the end of the pile, and lifting the hydraulic hammer with the crane, and swinging the pile into place for the goal post installation. The hydraulic hammer then drives the pile into the subsea floor by repeated percussive blows until the pile reaches a sufficient depth where enough strength to support the casing pipe is achieved. This process is repeated until all piles necessary for the goal post are installed.

HRG Surveys

Empire Wind would conduct HRG surveys in the EW 1 and EW 2 marine environment of the approximately 321 km^2 (79,350 acres) Lease Area and along the submarine export cable route corridors, inter-array cable locations, and export cable landfall sites. The HRG survey activities will include the following equipment summarized in Table 2, or comparable sources. HRG site characterization surveys would occur annually throughout the five years the rule and LOA would be effective.

Empire Wind would conduct HRG surveys within the lease area and the export cable corridor, including the cable landfall sites. The estimated distance of the daily vessel track line was determined using the estimated average speed of the vessel and the 24-hour operational period within each of the corresponding survey segments. Empire Wind proposes to use up to three vessels to conduct the surveys. The estimated daily vessel track for all vessels is approximately 177.792 km (110.475 mi) for 24-hour operations with a daily ensonified area of 17.8 km^2. The number of active survey vessel days ranges from 41 (in 2024) to 191 (in 2025). There would be an anticipated 483 survey days over the 5-year LOA period covering 85,872 km. The duration of each survey varies as described in Table 11 in the application. The survey schedule is based on 24-hour operations and includes estimated weather down time.

These surveys may utilize active acoustic equipment such as multibeam echosounders, side scan sonars, shallow penetration sub-bottom profilers (SBPs) (*e.g.,* Compressed High-Intensity Radiated Pulses (CHIRPs) non-parametric SBP), medium penetration sub-bottom profilers (*e.g.,* sparkers and boomers), ultra-short baseline positioning equipment, and marine magnetometers, some of which are expected to result in the take of marine mammals. Surveys would occur annually, with durations dependent on the activities occurring in that year (*i.e.,* construction years versus operational years).

Of the HRG equipment types proposed for use, only Shallow penetration sub-bottom profilers (SBPs) have the potential to result in take. SBPs would be used to map the near-surface stratigraphy (top 0 to 5 m (0 to 16 ft) of sediment below seabed). A CHIRP system emits sonar pulses that increase in frequency over time. The pulse length frequency range can be adjusted to meet project variables. These are typically mounted on the hull of the vessel or from a side pole. Boomers and sparkers would not be used during HRG surveys.

Table 2 identifies all the representative survey equipment that operate below 180 kilohertz (kHz) (*i.e.,* at frequencies that are audible and have the potential to disturb marine mammals) that may be used in support of planned geophysical survey activities. Equipment with operating frequencies above 180 kHz (*e.g.,* SSS, MBES) and equipment that does not have an acoustic output (*e.g.,* magnetometers) will also be used but are not discussed further because they are outside the general hearing range of marine mammals likely to occur in the project area. No harassment exposures can be reasonably expected from the operation of these sources; therefore, they are not considered further in this proposed action.

TABLE 2—SUMMARY OF REPRESENTATIVE HRG SURVEY EQUIPMENT

Representative HRG equipment [a]	Operating frequencies (kHz)	RMS source level	Peak source level	Primary beamwidth (degrees)	Pulse duration (milliseconds (ms))	Pulse repetition (Hz)
Kongsberg HiPAP 501/502 USBL	21—31	190	207	Omni	2	0.5–2

TABLE 2—SUMMARY OF REPRESENTATIVE HRG SURVEY EQUIPMENT—Continued

Representative HRG equipment [a]	Operating frequencies (kHz)	RMS source level	Peak source level	Primary beamwidth (degrees)	Pulse duration (milliseconds (ms))	Pulse repetition (Hz)
iXblue, IxSea GAPS Beacon System	8–16	188	194	Omni	10	1
Sonardyne Ranger 2 and Mini Ranger 2 USBL HPT 3000/5/7000	19–34	200	206	Omni	5	1
Reson Seabat T20P multibeam echosounder [a]	200–400	221	227	90	0.253	
Reson 7111	100	224	228	6	1.35	
Kongsberg EM2040Quad	200–400	-	-	-	-	
R2 Sonic 2026	170–450	191	221	1	1.115	
R2 Sonic 2024	200–700	-	-	-	-	
Klein 3900 SSS [a]	445–900	200	226	1.8	0.1	
EdgeTech DW106	1 to 6	194	197	Omni	<66	8
EdgeTech 424 [a]	4–20	180	186	122	4.8	
Innomar, SES–2000 compact	85–115	232	238	4	40	1
Innomar, SES–2000 Light & Light Plus	85–115	232	238	4	40	1
Innomar, SES–2000 Standard & Standard Plus	85–115	234	240	1–3.5	60	1.5
Innomar, SES–2000 Smart	90–110	229	235	5	40	0.5
Innomar, SES–2000 Medium–70	60–80	240	246	3	40	5
Teledyne Benthos Chirp III–TTV 170	2 to 7	219	225	100	60	15
Coda Octopus 3D	240–300	-	-	-	-	20

Note:

[a] Equipment specifications found in the 2016 Crocker and Fratantonio Report. Equipment selected would be the same or similar.

"-" indicates Empire Wind was unable to provide this information; however, it is not relevant to the analysis herein.

Based on the operating frequencies of some types of HRG survey equipment and the hearing ranges of the marine mammals that have the potential to occur in the Project Area, HRG survey activities will have the potential to result in Level B harassment of marine mammals. No Level A harassment is anticipated as a result of HRG survey activities.

Onshore Substation C Marina Activities

Construction activities will also be completed to facilitate the connection of the cables to Onshore Substation C, located inshore Long Island on the Wreck Lead Channel, as shown in Figure 1. Work includes removing berthing piles and bulkhead repair. Up to 130 12-inch diameter timber berthing piles would be removed using a combination of a crane and vibratory hammer, depending on the condition of the piles. Two piles would be removed each hour with up to 15 piles per day (7–8 hours per day) with approximately 130 piles removed over the course of two weeks for a total of approximately 65 hours. Vibratory installation of 24-inch z-type steel sheet piles would also occur at the marina bulkheads, consisting of 20 piles per day, with installation occurring for approximately 1 hour of noise generation time per day for 35 days.

The onshore substation will be used to transform and prepare the power received by the export cables from EW 2 for connection to the points of interconnection (POIs) in New York. SMBT Vibratory installation of sheet piles would also occur at the marina bulkheads, consisting of 20 piles per day, with installation occurring for approximately 1 hour of noise generation time per day for 35 days for a total of 700 sheet piles between Q1–Q4 for EW 1 and EW 2 in 2024 and between Q1–Q4 for EW 2 in 2025.

Barnums Channel Cable Bridge Activities

The cable bridge structure for EW 2 only requires two support columns (pile caps) located within the waterway to support the truss system, which will hold the cables above water. The support may be installed by a hammer, but other methods are under consideration. There could be up to six 1.5 ft (0.5 meter) diameter steel pipe piles per cap for a total of 12 steel pipe piles. The location is in an inland waterway near the Barrett Generation Station in an industrialized section of the island, where water depths are only 1 meter, therefore, marine mammals, including seals, are not expected. Sightings data support this assumption, as no sightings of seals have been recorded in the vicinity (OBIS 2023). No take is anticipated from this activity.

Cable Laying and Installation

Submarine export cables will be installed from specialized installation vessels/barges, which will install the cables from a turntable on the lay vessel/barge. One or several vessels might be used for the installation of the cables depending on a number of factors, such as seabed depth, depth of cable protection, distance to shore, and cable protection method to be used. There are several cable installation and burial methods being considered. Some activities will be performed before the installation of the cables, some during the installation of the cables, and some after the installation of the cables. Cable pre-lay activities may include pre-installation grapnel run, route clearance and boulder removal, pre-sweeping, dredging and pre-trenching. The cable burial methods being considered are plowing, jetting, trenching, and dredging. The equipment selected will depend on seabed conditions, the required burial depths, as well as the results of various cable burial studies. More than one installation and burial method may be selected per route and has the potential to be used pre-installation, during installation, and/or post-installation.

Installation of the submarine export cables is expected to take approximately four months for the EW 1 submarine export cables and approximately four months for the EW 2 submarine export cables. The actual installation schedule will be subject to seabed characteristics, installation vessel availability, seasonal restriction windows for protected species, and weather. Installation of the EW 1 and EW 2 submarine export cables may occur at the same time; however, any overlap in installation activities would not occur at the same stage (*i.e.,* pre-installation activities may commence for EW 2 while the cable lay and burial for EW 1 is being completed).

The noise levels generated from cable laying and installation work are low so the potential for take of marine mammals to result is discountable. Empire Wind is not requesting, and NMFS is not proposing to authorize, take associated with cable laying activities. Therefore, cable laying activities are not analyzed further in this document.

Vessel Operation

Multiple vessels will be in use during construction and operations. Empire Wind estimates that the Project will require approximately 18 vessels for construction of EW 1 and approximately 18 vessels for construction of EW 2. Vessels including barges, tugboats, crew transfer vessels, heavy transport vessels, and various supply vessels are expected to be utilized. Helicopters may also be used to provide site support (Table 3).

TABLE 3—PRELIMINARY SUMMARY OF OFFSHORE VESSELS FOR CONSTRUCTION

Foundations				Wind turbines	Offshore Substation Topside & Foundation	Submarine Export Cables	Interarray Cables	Scour Protection
Vessel	Description	Monopile	Piled Jacket		Substation Topside & Foundation			
Heavy lift vessel	Vessel for installation of foundations.	X	X	....	X	....	....	....
Monopile supply vessel	Vessel for transport of monopile foundations.	X	....	....	....	....	....	....
Wind turbine installation vessel.	Vessel for installation of wind turbine components.	....	....	X	....	....	....	....
Wind turbine supply vessel	Vessel for transport of wind turbine components.	....	....	X	....	....	....	....
Cable lay vessel/barge	Vessel for installation of submarine cables.	....	....	....	....	X	X	....
Heavy transport vessel	Vessel for transport of offshore substation topside.	X	X	....	X	....	....	....
Cable lay support vessel	Support vessel for cable lay operations.	....	....	....	....	X	X	....
Pre-lay grapnel run vessel	Vessel for seabed clearance along cable routes.	....	....	....	....	X	X	....
Fall pipe vessel	Vessel for installation of scour protection.	X	X	....	X	X	X	X
Crew transfer vessel	Vessel for transporting workers to and from shore.	X	X	X	X	X	X	....
Accommodation vessel	Vessel for worker accommodations.	....	....	....	X		....	....
Construction support vessel	Vessel for general construction support.	X	X	....	....	X	X	....
Tugboat	Vessel for transporting and maneuvering barges.	X	X	X	X	X	....	....
Barge	Vessel for transport of construction materials.	X	X	X	X	....	....	....
Safety vessel	Vessel for protection of construction areas.	X	X	....	....	X	X	....

Fisheries and Benthic Monitoring

Empire Wind will engage in various fisheries and benthic monitoring surveys that have been designed for the Project in accordance with recommendations set forth in ''Guidelines for Providing Information on Fisheries for Renewable Energy Development on the Atlantic Outer Continental Shelf'' (BOEM 2019). Empire Wind would conduct a number of surveys including trawl surveys, baited underwater video surveys, and hard bottom monitoring surveys.

Because the gear types and equipment used for benthic habitat monitoring, and Habcam surveys do not have components with which marine mammals are likely to interact (*i.e.,* become entangled in or hooked by), these activities are unlikely to have any impacts on marine mammals. Only trawl surveys, in general, have the potential to result in harassment to marine mammals. Empire Wind did not propose to implement mitigation measures to avoid take of marine mammals incidental to trawl surveys; however, NMFS has included them in this proposed rule (see Proposed Mitigation). With the implementation of those measures, NMFS does not anticipate, and is not proposing to authorize, take associated with fisheries and benthic monitoring surveys.

Description of Marine Mammals in the Area of Specified Activities

Thirty-eight marine mammal species under NMFS' jurisdiction have geographic ranges within the western North Atlantic OCS (Hayes *et al.,* 2022). However, for reasons described below, Empire Wind has requested, and NMFS proposes to authorize, take of 17 species (comprising 18 stocks) of marine mammals. Sections 3 and 4 of Empire Wind's application summarize available information regarding status and trends, distribution and habitat preferences, and behavior and life history of the potentially affected species (Empire Wind, 2022). NMFS fully considered all of this information, and we refer the reader to these descriptions in the application, incorporated here by reference, instead of reprinting the information. Additional information regarding population trends and threats may be found in NMFS's 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's website (*https://www.fisheries.noaa.gov/find-species).*

Of the 38 marine mammal species in the Atlantic OCS under NMFS' jurisdiction, 21 are not expected to be present or are considered rare or unexpected in the project area based on sighting and distribution data; they are, therefore, not discussed further beyond the explanation provided here. The following species are not expected to occur in the project area due to the location of preferred habitat outside the Empire Wind project area based on the best scientific information available: blue whale (*Balaenoptera musculus*), dwarf and pygmy sperm whales (*Kogia sima and K. breviceps*), northern bottlenose whale (*hyperoodon ampullatus*), cuvier's beaked whale (*Ziphius cavirostris*), four species of Mesoplodont beaked whales (*Mesoplodon densitostris, M. europaeus, M. mirus, and M. bidens*), killer whale (*Orcinus orca*), false killer whale (*Pseudorca crassidens*), pygmy killer whale (*Feresa attenuate*), melon-headed whale (*Peponocephala electra*), white-beaked dolphin (*Lagenorhynchus albirotris*), pantropical spotted dolphin (*Stenella attenuata*), Clymene dolphin (*Stenella clymene*), striped dolphin (*Stenella coeruleoalba*), spinner dolphin (*Stenella longirostris*), Fraser's dolphin (*Lagenodelphis hosei*), and rough-toothed dolphin (*Steno bredanensis*) and the hooded seal (*Cystophora cristata*).

In addition, Florida manatees (*Trichechus manatus;* a sub-species of the West Indian manatee) have been previously documented as an occasional visitor to the Northeast region during summer months. However, manatees are managed by the U.S. Fish and Wildlife Service and are not considered further in this document.

In anticipation of the Empire Wind Project, Equinor (prior to establishing its subsidiary, Empire Wind) conducted 12 monthly aerial digital surveys of Empire Wind Lease Area OCS–A 0512 in the New York Bight between November 2017 and October 2018 using APEM Inc.'s high-resolution camera system to capture digital still imagery. Raw counts and design-based abundance estimates of all species and incidental observations recorded during the surveys are presented here as well as information on species distribution, flight height and flight direction. The key findings from each of the monthly aerial digital surveys are summarized below. (Normandeau-APEM, 2019). Common dolphins were the most abundant marine mammal species recorded, with a peak count (n=68) in the May survey, followed by bottlenose dolphins, with a peak raw count (n=22) in the June survey. Harbor porpoises, minke whales and a single humpback whale were also recorded, as were three unidentified dolphins and three unidentified marine mammals. Marine mammals were recorded in peak numbers in spring. Equinor's required marine mammal monitoring report as part of HRG surveys covering Lease Area OCS–A 0512 and the associate export cable routes from September 20, 2020 through September 19, 2021 reported sightings of humpback whales, bottlenose dolphins, common dolphins, unidentifiable dolphin species, and harbor seals. Between April 19, 2019 through July 22, 2019, Equinor also observed fin whales, humpback whales, unidentified whales, common bottlenose dolphins, unidentifiable dolphins, and gray seals during HRG surveys. The lack of detections of any of the 22 species listed above during these surveys reinforces the fact that they are not expected to occur in the project area. As these species are not expected to occur in the project area during the proposed activities, Equinor did not request, and NMFS does not propose to authorize, take of these species, and they are not discussed further in this document.

Table 4 lists all species and stocks for which take is expected and proposed to be authorized for this action, 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 (16 U.S.C. 1362(20)), as described in NMFS's SARs. While no mortality is anticipated or proposed to be authorized, PBR and annual serious injury and mortality from anthropogenic sources are included here as gross indicators of the status of the species and other threats.

Marine mammal abundance estimates presented in this document represent the total number of individuals that make up a given stock or the total number estimated within a particular study or survey area. NMFS's stock abundance estimates for most species represent the total estimate of individuals within the geographic area, if known, that comprises that stock. For some species, this geographic area may extend beyond U.S. waters. All managed stocks in this region are assessed in NMFS's U.S. Atlantic and Gulf of Mexico SARs. All values presented in Table 4 are the most recent available at the time of publication and are available in NMFS' final 2021 SARs (Hayes *et al.,* 2022) and draft 2022 SARs available online at: *https://www.fisheries.noaa.gov/national/marine-mammal-protection/draft-marine-mammal-stock-assessment-reports.*

TABLE 4—MARINE MAMMAL SPECIES LIKELY TO OCCUR NEAR THE PROJECT AREA THAT MAY BE TAKEN BY EMPIRE WIND'S ACTIVITIES

Common name	Scientific name	Stock	ESA/MMPA status; strategic (Y/N) [1]	Stock abundance (CV, N_{min}, most recent abundance survey) [2]	PBR	Annual M/SI [3]
Order Artiodactyla—Cetacea—Superfamily Mysticeti (baleen whales)						
Family Balaenidae:						
North Atlantic right whale	*Eubalaena glacialis*	Western Atlantic	E, D, Y	338 (0; 332; 2020) [5]	0.7	8.1
Family Balaenopteridae (rorquals):						
Fin whale	*Balaenoptera physalus*	Western North Atlantic	E, D, Y	6,802 (0.24; 5,573; 2016)	11	1.8
Sei whale	*Balaenoptera borealis*	Nova Scotia	E, D, Y	6,292 (1.02; 3,098; 2016)	6.2	0.8
Minke whale	*Balaenoptera acutorostrata*	Canadian Eastern Coastal	-, -, N	21,968 (0.31; 17,002; 2016).	170	10.6
Humpback whale	*Megaptera novaeangliae*	Gulf of Maine	-, -, Y	1,396 (0; 1,380; 2016)	22	12.15

TABLE 4—MARINE MAMMAL SPECIES LIKELY TO OCCUR NEAR THE PROJECT AREA THAT MAY BE TAKEN BY EMPIRE WIND'S ACTIVITIES—Continued

Common name	Scientific name	Stock	ESA/MMPA status; strategic (Y/N) [1]	Stock abundance (CV, N_{min}, most recent abundance survey) [2]	PBR	Annual M/SI [3]
Superfamily Odontoceti (toothed whales, dolphins, and porpoises)						
Family Physeteridae:						
Sperm whale	*Physeter macrocephalus*	North Atlantic	E, D, Y	4,349 (0.28; 3,451; 2016)	3.9	0
Family Delphinidae:						
Atlantic white-sided dolphin	*Lagenorhynchus acutus*	Western North Atlantic	-, -, N	93,233 (0.71; 54,433; 2016).	544	27
Atlantic spotted dolphin	*Stenella frontalis*	Western North Atlantic	-, -, N	39,921 (0.27; 32,032; 2016).	320	0
Common bottlenose dolphin	*Tursiops truncatus*	Western North Atlantic Offshore	-, -, N	62,851 (0.23; 51,914; 2016).	519	28
		Migratory Coastal	-, -, N	6,639 (0.41; 4,759; 2016)	48	12.2–21.5
Long-finned pilot whales	*Globicephala melas*	Western North Atlantic	-, -, N	39,215 (0.3; 30,627; 2016).	306	29
Short-finned pilot whales	*Globicephala macrorhynchus*	Western North Atlantic	-, -, N	28,924 (0.24; 23,637; 2016).	236	136
Risso's dolphin	*Grampus griseus*	Western North Atlantic	-, -, N	35,215 (0.19; 30,051; 2016).	301	34
Common dolphin (short-beaked).	*Delphinus delphis*	Western North Atlantic	-, -, N	172,897 (0.21; 145,216; 2016).	1,452	390
Family Phocoenidae (porpoises):						
Harbor porpoise	*Phocoena phocoena*	Gulf of Maine/Bay of Fundy	-, -, N	95,543 (0.31; 74,034; 2016).	851	16
Order Carnivora—Superfamily Pinnipedia						
Family Phocidae (earless seals):						
Gray seal [4]	*Halichoerus grypus*	Western North Atlantic	-, -, N	27,300 (0.22; 22,785; 2016).	1,458	4,453
Harbor seal	*Phoca vitulina*	Western North Atlantic	-, -, N	61,336 (0.08; 57,637; 2018).	1,729	339
Harp seal [6]	*Pagophilus grownlandicus*	Western North Atlantic	-, -, N	7,600,000 (UNK, 7,100,000.	426,000	178,573

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

[2] NMFS marine mammal stock assessment reports online at: *www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-stock-assessments* (Hayes *et al.,* 2022). CV is the coefficient of variation; Nmin is the minimum estimate of stock abundance. In some cases, CV is not applicable.

[3] These values, found in NMFS' SARs, represent annual levels of human-caused mortality plus serious injury from all sources combined (*e.g.,* commercial fisheries, ship strike).

[4] NMFS' stock abundance estimate (and associated PBR value) applies to the U.S. population only. Total stock abundance (including animals in Canada) is approximately 451,431. The annual M/SI value given is for the total stock.

[5] On Monday, October 24, 2022, the North Atlantic Right Whale Consortium announced that the North Atlantic right whale population estimate for 2021 was 340 individuals. NMFS' website also indicates that less than 350 animals remain (*https://www.fisheries.noaa.gov/species/north-atlantic-right-whale*).

[6] Harp seals are rare in the region; however, stranding data suggest this species may be present during activities that may take marine mammals.

As indicated above, all 17 species and 18 stocks in Table 4 temporally and spatially co-occur with the activity to the degree that there is a potential for take. Four of the marine mammal species for which take is requested are listed as threatened or endangered under the ESA, including North Atlantic right, fin, sei, and sperm whales. In addition to what is included in Sections 3 and 4 of Empire Wind's application (*https://www.fisheries.noaa.gov/action/incidental-take-authorization-empire-offshore-wind-llc-construction-empire-wind-project-ew1?check_logged_in=1*), 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 (UME) and known important habitat areas, such as Biologically Important Areas (BIAs) (Van Parijs, 2015). There is no ESA-designated critical habitat for any species within the project area.

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 24, 2023, five UMEs in total are considered active, with four of these occurring along the U.S. Atlantic coast for various marine mammal species; of these, the most relevant to the Empire Wind Project are the right whale, humpback whale, and northeast pinniped UMEs, given the prevalence of these species in the project area. 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.*

Below we include additional 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. For the majority of species potentially present in the specific geographic region, NMFS has designated only a single generic stock (*e.g.,* ''western North Atlantic'') for management purposes. This includes the ''Canadian east coast'' stock of minke whales, which includes all minke whales found in U.S. waters 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. Any areas of known biological importance (including the BIAs identified in La Brecque *et al.,* 2015) that overlap spatially with the project area are addressed in the species sections below.

North Atlantic Right Whale

The North Atlantic right whale has been listed as Endangered since the ESA was enacted in 1973. They were recently uplisted from Endangered to Critically Endangered on the International Union for Conservation of Nature (IUCN) 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.,* 2021; Reed *et al.,* 2022). The Western Atlantic stock is considered depleted under the MMPA (Hayes *et al.* 2022). There is a recovery plan (NOAA Fisheries 2005) for the North Atlantic right whale, 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 North Atlantic right whale population had only a 2.8 percent recovery rate between 1990 and 2011, and an overall abundance decline of 29.7 percent from 2011–2020 (Hayes *et al.* 2022). Since 2010, the North Atlantic right whale population has been in decline (Pace *et al.,* 2017; Pace *et al.,* 2021), with a 40 percent decrease in calving rate (Kraus *et al.,* 2016; Moore *et al.,* 2021). North Atlantic right whale 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 five years, with 20 calves born, followed by 15 calves during the 2021–2022 calving season. However, mortalities continue to outpace births, and best estimates indicate fewer than 100 reproductively active females remain in the population.

The project area both spatially and temporally overlaps a portion of the migratory corridor BIA within which right whales migrate south to calving grounds generally in November and December, followed by a northward migration into feeding areas east and north of the project area in March and April (LaBrecque *et al.,* 2015; Van Parijs *et al.,* 2015).

In late fall (*i.e.,* November), a portion of the right whale population (including pregnant females) typically departs the feeding grounds in the North Atlantic, moves south along the migratory corridor BIA, including through the project area, to right whale calving grounds off Georgia and Florida. However, recent research indicates 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). The results of multistate temporary emigration capture-recapture modeling, based on sighting data collected over the past 22 years, indicate that 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).

Right whales are anticipated to occur in the proposed survey area year-round but with lower levels in the summer from July-September. (Estabrook *et al.,* 2021). Recent aerial surveys in the New York Bight showed right whales near the proposed survey area with the highest sighting rate in spring, followed by winter, preferring deeper waters near the shelf break (right whales observed in depths ranging from 33–1,041 m), but were observed throughout the survey area. No right whales were observed in summer months (Normandeau Associates and APEM, 2020; Zoidis *et al.,* 2021). Similarly, passive acoustic data collected from 2018 to 2020 in the New York Bight showed detections of right whales throughout the year. During the Year 3 survey period, North Atlantic right whales were detected in each month, except in February, March, and October 2020, with the most detections occurring in late fall through early spring. Seasonally, North Atlantic right whale acoustic presence was highest in the fall at sites that were closer to New York Harbor and during spring months at sites farthest from the Harbor (Zoidis *et al.,* 2021).

North Atlantic right whales present in the Empire Wind project area are primarily migrating through. Some opportunistic foraging may occur although core foraging habitat is located north of the project area in Southern New England, Gulf of Maine and Gulf of St. Lawrence. Right whales 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 right whale habitat-use patterns within the region over the same time period (Davis *et al.,* 2020; Meyer-Gutbrod *et al.,* 2022; Quintano-Rizzo *et al.,* 2021, O'Brien *et al.,* 2022).

Elevated right whale mortalities have occurred since June 7, 2017, along the U.S. and Canadian coast, with the leading category for the cause of death for this UME determined to be ''human interaction,'' specifically from entanglements or vessel strikes. As of February, 2023, there have been 36 confirmed mortalities and 22 seriously injured free-swimming whales for a total of 58. The UME also considers animals with sublethal injury or illness, also known as morbidity cases. There have been 39 bringing the total number of whales in the UME to 97. 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). More information about the North Atlantic right whale UME is available online at: *https://www.fisheries.noaa.gov/national/marine-life-distress/2017-2023-north-atlantic-right-whale-unusual-mortality-event.*

NMFS' regulations at 50 CFR part 224.105 designated nearshore waters of the Mid-Atlantic Bight as Mid-Atlantic U.S. Seasonal Management Areas (SMAs) for right whales in 2008. These specific SMAs were developed to reduce the threat of collisions between ships and right whales around their migratory route and calving grounds. The SMA southeast of Ports of New York/New Jersey is currently active from November 1 through April 30 of each year and may be used by right whales for feeding. As noted above, NMFS is proposing changes to the North Atlantic right whale speed rule (87 FR 46921; August 1, 2022). In addition, Dynamic Management Areas (DMAs) are areas of temporary protection established by NOAA Fisheries for particular marine mammal species, in an effort to respond to movements of high-risk whale species (such as right whale). These DMAs are determined by sighting reports made through vessel traffic in the larger Northern Atlantic and are communicated through marine communication systems and published on their website. The Right Whale Sighting Advisory System, a statutory requirement to reduce the risk of right whale collisions, is in place for any DMA. As noted above, NMFS is proposing changes to the North Atlantic right whale speed rule (87 FR 46921; August 1, 2022).

Fin Whale

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.* 2022). 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).

There are no fin whale BIAs in the immediate vicinity of the project area although a small feeding BIA is located approximately 140 km to the northeast offshore of Montauk Point, from March to October (Hain *et al.,* 1992; LaBrecque *et al.,* 2015).

Minke Whale

Minke whales are among the most widely distributed of all the baleen whales. They occur in the North Atlantic and North Pacific, from tropical to polar waters. Generally, they inhabit warmer waters during winter and travel north to colder regions in summer, while some animals migrate as far as the ice edge. There appears to be a strong seasonal component to minke whale distribution in the survey areas, in which spring to fall are times of relatively widespread and common occurrence while during winter the species appears to be largely absent (Waring *et al.,* 2016). Recent aerial surveys in the New York Bight area found that minke whales were observed throughout the survey area, with highest numbers sighting in the spring months (Normandeau Associates and APEM). Minke whales are primarily documented near the continental shelf offshore of New Jersey (Schwartz, 1962; Mead, 1975; Potter, 1979; Rowlett, 1980; Potter, 1984; Winn *et al.,* 1985, DoN, 2005). Acoustic recordings of minke whales have been detected north of the Lease survey area within the New York Bight during the fall (August to December) and winter (February to May) (Biedron *et al.,* 2009). Minke whales are most common off New Jersey in coastal waters in the spring and early summer as they move north to feeding ground in New England and fall as they migrate south (Geo-Marine, 2010). Geo-Marine (2010) observed four minke whales near the survey area and surrounding waters during winter and spring. A juvenile minke whale was sighted northwest of the Lease survey area near the New York Harbor in April 2007 (Hamazaki, 2002). Minke whale sightings off the coast of New Jersey were within water depths of 36 ft to 79 ft (11 m to 24 m) and temperatures ranging from 5.4 to 11.5 °C (47 °F) (Geo-Marine, 2010).

There are no minke whale BIAs in or near the project area. The closest is a feeding BIA identified in the southern and southwestern section of the Gulf of Maine from March through November, annually (LeBrecque *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 proposed project area, as minke whales may track warmer waters along the continental shelf while migrating (Risch *et al.,* 2014).

Since January 2017, elevated minke whale mortalities detected along the Atlantic coast from Maine through South Carolina resulted in the declaration of a UME. However, that UME is now nonactive with closure pending. During the active phase of the UME, a total of 140 strandings had been reported with 21 occurring in New York and 11 in New Jersey. Previous minke whale UMEs occurred in 2003 and 2005 (NOAA Fisheries 2018c). Full or partial necropsy examinations were conducted on more than 60 percent of the whales. Preliminary findings in several of the whales have shown evidence of human interactions or infectious disease, but these findings are not consistent across all of the whales examined, so more research is needed. More information is available at: *https://www.fisheries.noaa.gov/national/marine-life-distress/2017-2022-minke-whale-unusual-mortality-event-along-atlantic-coast.*

Humpback Whale

Humpback whales are a cosmopolitan species, found worldwide in all oceans, but 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 project area. Bettridge *et al.* (2015) estimated the size of the West Indies DPS population at 12,312 (95 percent CI 8,688–15,954) whales in 2004–05, 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).

The project area does not overlap any designated critical habitat, nor any identified BIAs or other known 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 (LeBrecque *et al.,* 2015). However, this BIA is located further east and north of, and thus does not overlap, the project area.

Four decades ago, humpback whales were infrequently sighted off the US mid-Atlantic states (USMA, New York, New Jersey, Delaware, Maryland, Virginia and North Carolina, CeTAP, 1982), but they are now regular visitors. Humpback whales are now frequently seen inside the New York-New Jersey harbor estuary and in the greater New York Bight (Brown *et al.,* 2018, 2019; King *et al.,* 2021; Zoidis *et al.,* 2021; Smith *et al.,* 2022). Based on a 2012–2018 dataset, mean occurrence was low (2.5 days), mean occupancy was 37.6 days, and 31.3 percent of whales returned from one year to the next (Brown *et al.,* 2022). Sightings of mother-calf pairs are rare in the New York Bight Area, suggesting that maternally directed fidelity may not be responsible for the presence of young whales in this area (Brown *et al.,* 2022).

Humpback whales belonging to the West Indies DPS typically feed in the waters between the Gulf of Maine and Newfoundland during spring, summer, and fall, but they have been observed feeding in other areas, such as off the coast of New York and New Jersey, including in close-proximity to the entrance of the Port of New York and New Jersey (Sieswerda *et al.,* 2015, Brown *et al.,* 2019).

Recent aerial surveys in the New York Bight observed humpback whales in the spring and winter, but sightings were reported year round in the area (Normandeau Associates and APEM, 2020). During 36 line-transect aerial surveys conducted systematically nearshore out to 120 nm from March 2017 to February 2020. Humpback whales preferred deeper waters near the shelf break, but were observed throughout the area. Additionally, passive acoustic data recorded humpback whales in the New York Bight throughout the year, but the presence was highest in the fall and summer months (Estabrook *et al.,* 2021). In addition, recent research has demonstrated a higher occurrence and foraging use of the New York Bight area by humpback whales than previously known.

Since January 2016, elevated humpback whale mortalities along the Atlantic coast from Maine to Florida led to the declaration of a UME. A total of 27 and 36 strandings have been reported in the waters off New Jersey and New York, respectively. Partial or full necropsy examinations have been conducted on approximately half of the 189 known cases (as of February 2023). Of the whales examined, about 50 percent had evidence of human interaction, either ship strike or entanglement. While a portion of the whales have shown evidence of pre-mortem vessel strike, this finding is not consistent across all whales examined and more research is needed. NOAA is consulting with researchers that are conducting studies on the humpback whale populations, and these efforts may provide information on changes in whale distribution and habitat use that could provide additional insight into how these vessel interactions occurred. More information is available at: *https://www.fisheries.noaa.gov/national/marine-life-distress/2016-2023-humpback-whale-unusual-mortality-event-along-atlantic-coast.*

Since December 1, 2022, the number of humpback strandings along the mid-Atlantic coast, including New York, has been elevated. In some cases, the cause of death is not yet known. In others, vessel strike has been deemed the cause of death. As the humpback whale population has grown, they are seen more often in the Mid-Atlantic. Along the New York/New Jersey shore, these whales may be following their prey which are reportedly close to shore this winter. These prey also attract fish that are of interest to recreational and commercial fishermen. This increases the number of boats in these areas. More whales in the water in areas traveled by boats of all sizes increases the risk of vessel strikes. Vessel strikes and entanglement in fishing gear are the greatest human threats to large whales.

Phocid Seals

Since June 2022, elevated numbers of harbor seal and gray seal mortalities have occurred across the southern and central coast of Maine. This event has been declared a UME. Preliminary testing of samples has found some harbor and gray seals positive for highly pathogenic avian influenza. While the UME is not occurring in the Empire Wind project area, the populations affected by the UME are the same as those potentially affected by the project.

The above event was preceded by a different UME, occurring from 2018–2020 (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: *www.fisheries.noaa.gov/new-england-mid-atlantic/marine-life-distress/2018–2020-pinniped-unusual-mortality-event-along.*

There are several seal haul-out sites in New York. Harbor seals generally predominate in the onshore haul-out sites but gray seals intermix and are present as well. There are 26 known haul-out sites on Long Island, New York (CRESLI, 2019). During surveys from 2004–2019, a total of 18,321 harbor seals were documented using these sites (CRESLI, 2019). While there are no known haul-out sites directly at or near the proposed nearshore activities (*i.e.,* cable landfall construction, marine activities), harbor seals will occur throughout the New York coastline and have potential to haul out at many beach sites. The only known and consistently used gray seal haul out locations are along the sandy shoals located closer to Monomoy Refuge and on Nantucket, both in Massachusetts (Kenney and Vigness-Raposa 2010). This species has been reported with greater frequency in waters south of Cape Cod in recent years, likely due to a population rebound in the Mid-Atlantic (Kenney and Vigness-Raposa 2010).

Marine Mammal Hearing

Hearing is the most important sensory modality for marine mammals underwater, and exposure to anthropogenic sound can have deleterious effects. To appropriately assess the potential effects of exposure to sound, it is necessary to understand the frequency ranges marine mammals are able to hear. Current data indicate that not all marine mammal species have equal hearing capabilities (*e.g.,* Richardson *et al.,* 1995; Wartzok and Ketten, 1999; Au and Hastings, 2008). To reflect this, Southall *et al.* (2007) recommended that marine mammals be divided into functional hearing groups based on directly measured or estimated hearing ranges on the basis of available behavioral response data, audiograms derived using auditory evoked potential techniques, anatomical modeling, and other data. Note that no direct measurements of hearing ability have been successfully completed for mysticetes (*i.e.,* low-frequency cetaceans). Subsequently, NMFS (2018) described generalized hearing ranges for these marine mammal hearing groups. Generalized hearing ranges were chosen based on the approximately 65 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 5.

TABLE 5—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.

TABLE 5—MARINE MAMMAL HEARING GROUPS—Continued
[NMFS, 2018]

Hearing group	Generalized hearing range *
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.

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

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

For more detail concerning these groups and associated frequency ranges, please see NMFS (2018) for a review of available information. Seventeen marine mammal species (14 cetacean species (6 mysticetes and 8 odontocetes) and 3 pinniped species (both phocid)) have the reasonable potential to co-occur with the proposed project activities (Table 4).

NMFS notes that in 2019, Southall *et al.* recommended new names for hearing groups that are widely recognized. However, this new hearing group classification does not change the weighting functions or acoustic thresholds (*i.e.,* the weighting functions and thresholds in Southall *et al.* (2019) are identical to NMFS 2018 Revised Technical Guidance). When NMFS updates our Technical Guidance, we will be adopting the updated Southall *et al.* (2019) hearing group classification.

Acoustic Habitat

Acoustic habitat is defined as distinguishable soundscapes inhabited by individual animals or assemblages of species, inclusive of both the sounds they create and those they hear (NOAA, 2016). All of the sound present in a particular location and time, considered as a whole, comprises a ''soundscape'' (Pijanowski *et al.,* 2011). When examined from the perspective of the animals experiencing it, a soundscape may also be referred to as ''acoustic habitat'' (Clark *et al.,* 2009, Moore *et al.,* 2012, Merchant *et al.,* 2015). High value acoustic habitats, which vary spectrally, spatially, and temporally, support critical life functions (feeding, breeding, and survival) of their inhabitants. Thus, it is important to consider acute (*e.g.,* stress or missed feeding/breeding opportunities) and chronic effects (*e.g.,* masking) of noise on important acoustic habitats. Effects that accumulate over long periods can ultimately result in detrimental impacts on the individual, stability of a population, or ecosystems that they inhabit.

Potential Effects to Marine Mammals and Their Habitat

This section includes a summary and discussion of the ways that components of the specified activity may impact marine mammals and their habitat. The Estimated Take 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 how those impacts on individuals are likely to impact marine mammal species or stocks. General background information on marine mammal hearing was provided previously (see the Description of Marine Mammals in the Area of the Specified Activities section). Here, the potential effects of sound on marine mammals are discussed.

Empire Wind has requested, and NMFS proposes to authorize, the taking of marine mammals incidental to construction activities associated with in the EW 1 and EW 2 project area. In their application, Empire Wind presented analyses of potential impacts to marine mammals from use of acoustic sources. NMFS both carefully reviewed the information provided by Empire Wind, as well as independently reviewed applicable scientific research and literature and other information to evaluate the potential effects of Empire Wind's activities on marine mammals.

The proposed activities would result in placement of up to 147 permanent monopiles foundations and two OSS jacket foundations in the marine environment. There are a variety of the types and degrees of effects to marine mammals, prey species, and habitat that could occur as a result from 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, *e.g.,* Au and Hastings (2008); Richardson *et al.* (1995); Urick (1983) as well as the Discovery of Sound in the Sea (DOSITS) website at *https://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 1500 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 1500 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 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 are measured in decibels (dB), which are 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 100-fold increase in power and a 30-dB increase is a 1000-fold increase in power. However, a ten-fold increase in acoustic power does not mean that the sound is perceived as being ten 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 rule, all decibel levels referenced to 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 PTS (permanent threshold shift) and TTS (temporary threshold shift).

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, 2019) 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 one second), broadband, atonal transients (ANSI, 1986, 2005; Harris, 1998; NIOSH, 1998; ISO, 2003) and occur either as isolated events or repeated in some succession. 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 (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, and sonar. 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 the 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 Empire Wind Project can potentially result in one or more of the following: temporary or permanent hearing impairment, non-auditory physical or physiological effects (*e.g.,* stress), behavioral disturbance, 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 Empire 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, as well as from the specific activities Empire 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 or cetaceans).

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 (permanent threshold shift; PTS), 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 (temporary threshold shift; TTS), 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.,* 2019). 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.,* 2019). Therefore, NMFS does not consider TTS to constitute auditory injury.

Relationships between TTS and PTS thresholds have not been studied in marine mammals, and there is no PTS data for cetaceans, but such relationships are assumed to be similar to those in humans and other terrestrial mammals. Noise exposure can result in either a permanent shift in hearing thresholds from baseline (PTS; 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.,* 2019). 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.,* 2019). 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, but 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.

Currently, TTS data only exist for four species of cetaceans (bottlenose dolphin, beluga whale (*Delphinapterus leucas*), harbor porpoise, and Yangtze finless porpoise (*Neophocoena asiaeorientalis*)) and 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.,* 2019). 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.* (2019), 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.,* 2016 a,b,c, Finneran, 2018, Nachtigall *et al.,* 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).

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.

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 (Nowacek *et al.,* 2007; DeRuiter *et al.,* 2012 and 2013; Ellison *et al.,* 2012; Gomez *et al.,* 2016; Southall *et al.,* 2021)) 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. 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.,* 2019). 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 not only on the species receiving the sound and the sound source, but also on the social, behavioral, or environmental contexts of exposure (*e.g.,* DeRuiter *et al.,* 2012). For example, Goldbogen *et al.* (2013) 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.* (2013) 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) 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 MF 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 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 away) did not elicit such responses, suggesting that context (in this case, distance) may moderate reactions. Thus, distance from the source is an important variable in influencing the type and degree of behavioral response and this is variable is independent of the effect of received levels (*e.g.,* DeRuiter *et al.,* 2013; Dunlop *et al.,* 2017a; Dunlop *et al.,* 2017b; Falcone *et al.,* 2017; Dunlop *et al.,* 2018; Southall *et al.,* 2019).

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 exists to potentially quantitatively inform a take estimate. Other factors are often considered qualitatively in the analysis of the likely consequences of sound exposure, where supporting information is available.

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 or 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.,* 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; Malme *et al.,* 1984). 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 previously noted in the literature, with some significant variation in the temporal and spatial degree of avoidance effects, 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 has 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 PAM data from 2010–2013 and aerial surveys from 2009–2013 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 of the pile driving site, with declines at up to 20–30 km of the pile driving site documented in some cases. Similar results demonstrating the long-distance displacement of harbor porpoises (18–25 km) and harbor seals (up to 40 km) during impact pile driving have also been observed during the construction at multiple other European wind farms

(Haleters *et al.,* 2015; Lucke *et al.,* 2012; Dähne *et al.,* 2013; Tougaard *et al.,* 2009; Bailey *et al.,* 2010).

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 on impact driving at Horns Rev II in the North Sea near Denmark, harbor porpoise returned within 1–2 days following cessation of pile driving (Tougaard *et al.,* 2009, Brandt *et al.,* 2011). Similar recovery periods have been noted for harbor seals off of England during the construction of four wind farms (Carroll *et al.,* 2010; Hamre *et al.,* 2011; Hastie *et al.,* 2015; Russell *et al.,* 2016; Brasseur *et al.,* 2010). For example, although there was no significant displacement during construction as a whole, Russell *et al.* (2016) found that displacement did occur during active pile driving at predicted received levels between 168 and 178 dB re 1μPa$_{(p-p)}$; however seal distribution returned to the pre-piling condition within two hours of cessation of pile driving. 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 two years after construction began (Gilles *et al.* 2009). Approximately ten 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 (ADDs)) or the manner in which species use the habitat in the project area are likely the driving factors of this variation.

NMFS notes the aforementioned studies from Europe involve pile driving much smaller piles than Empire Wind proposes to install and therefore we anticipate noise levels from impact pile driving to be louder. For this reason, we anticipate that the greater distances of displacement observed in harbor porpoise and harbor seals documented in Europe are likely to occur off of New York. However, we do not anticipate any greater severity of response due to harbor porpoise and harbor seal habitat use off of New York 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 of New York, harbor porpoises are transient (with higher abundances in winter when impact pile driving would not occur) and a very small percentage of the large harbor seal population are only seasonally present with no rookeries established. 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 away while showing no such reaction to the same signal when the signal was 118 km away even though the received levels were similar. Tyack *et al.* (1983) conducted playback studies of SURTASS low frequency active (LFA) sonar in a gray whale migratory corridor off California. Similar to North Atlantic right whales, gray whales migrate close to shore (approximately +2 kms) and are low frequency hearing specialists. The LFA sonar source was placed within the gray whale migratory corridor (approximately 2 km offshore) and offshore of most, but not all, migrating whales (approximately 4 km 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 level was 170 dB rms 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. 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 from the area (Boyd *et al.,* 2008; Southall *et al.,* 2009; Tyack *et al.,* 2011). Empire Wind does not anticipate, and NMFS is not proposing to authorize take of beaked whales and, moreover, the sounds produced by Empire Wind 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, although 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 either stationery pile driving (which they can sense is stationery and predictable) or significantly lower-level HRG surveys, unless they are within the area ensonified above behavioral harassment thresholds at the moment the source is turned on (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, 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 North Atlantic right whales 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 North Atlantic right whales, 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.,* 2006a; 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.,* 2013; Farmer *et al.,* 2018; Pirotta *et al.,* 2018; Southall *et al.,* 2019; 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 5-years the proposed rule 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 air gun arrays at received levels in the range 140–160 dB at distances of 7–13 km, following a phase-in of sound intensity and full array exposures at 1–13 km (Madsen *et al.,* 2006a; 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 air guns had ceased firing. The remaining whales continued to execute foraging dives throughout exposure; however, swimming movements during foraging dives were six percent lower during exposure than 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 North Atlantic right whales 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. Though the area ensonified by the HRG sources is significantly smaller than from construction, the source levels of both the proposed construction and HRG activities exceed the source levels of the signals described by Nowacek *et al.,* (2004) and Croll *et al.,* (2001), and noise generated by Empire Wind's activities at least partially overlap in frequency with the described signals. 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 in Southern California waters indicated that, in some cases and at low received levels, tagged blue 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; Southall *et al.,* 2012b, Southall *et al.,* 2019b).

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* μ*Pa,* 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, 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 (also see the *Potential Effects of Behavioral Disturbance on Marine Mammal Fitness* section) 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 increased song production (Di Iorio and Clark, 2009), while North Atlantic right whales have been observed to shift the frequency content of their calls upward while reducing the rate of calling in areas of increased anthropogenic noise (Parks *et al.,* 2007). In some cases, animals may cease 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 air gun 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). 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. 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, though, the detection of frequencies above those of the masking stimulus decreases also. 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 *et al.,* 2016) and may result in energetic or other costs as animals change their vocalization behavior (*e.g.,* Miller *et al.,* 2000; Foote *et al.,* 2004; Parks *et al.,* 2007; Di Iorio and Clark, 2009; Holt *et al.,* 2009). 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 depends 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 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 *et al.,* 2006). Most species that vocalize have evolved with an ability to make adjustments to 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 *et al.,* 2006). Vocalizing animals can make adjustments to 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 *et al.,* 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 (see the following for examples: Gordon *et al.,* 2003; Di Iorio and Clark, 2009; Hatch *et al.,* 2012; Holt *et al.,* 20098; Holt *et al.,* 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 North Atlantic right whale 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 to over 9 km (Tennessen and Parks, 2016). Holt *et al.* (2009) measured killer whale call source levels and background noise levels in the one to 40 kHz band and reported that the whales increased their call source levels by one dB SPL for every one 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; Parks *et al.,* 2011). Clark *et al.* (2009) observed that right whales' communication space decreased by up to 84 percent in the presence of vessels. Cholewiak *et al.* (2018) also observed loss in communication space in Stellwagen National Marine Sanctuary for North Atlantic right whales, 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 (for examples see: Holt *et al.,* 20098; Holt *et al.,* 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 a 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). Animals are most likely to habituate to sounds that are predictable and unvarying. It is important to note that habituation is appropriately considered as a ''progressive reduction in response to stimuli that are perceived as neither aversive nor beneficial,'' rather than as, more generally, moderation in response to human disturbance having a neutral or positive outcome (Bejder *et al.,* 2009). The opposite process is sensitization, when an unpleasant experience leads to subsequent responses, often in the form of avoidance, at a lower level of exposure. 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; 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; see also Richardson *et al.,* 1995; Nowacek *et al.,* 2007; Tougaard *et al.,* 2009; Brandt *et al.,* 2011, Brandt *et al.,* 2012, Dähne *et al.,* 2013; Brandt *et al.,* 2014; Russell *et al.,* 2016; Brandt *et al.,* 2018). Stone (2015a) reported data from at-sea observations during 1,196 airgun surveys from 1994 to 2010. When large arrays of airguns (considered to be 500 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 air gun survey monitored whale movements and respirations pre-, during-, and post-seismic survey (Gailey *et al.,* 2016). Behavioral state and water depth were the best 'natural' predictors of whale movements and respiration and after considering 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.,* Seyle, 1950; Moberg, 2000). In many cases, an animal's first and sometimes most economical (in terms of energetic costs) response is behavioral avoidance of the potential stressor. Autonomic nervous system responses to stress typically involve changes in heart rate, blood pressure, and gastrointestinal activity. These responses have a relatively short duration and may or may not have a significant long-term effect on an animal's fitness.

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

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

These and other studies lead to a reasonable expectation that some marine mammals will experience physiological stress responses upon exposure to acoustic stressors and that it is possible that some of these would be classified as ''distress.'' In addition, any animal experiencing TTS would likely also experience stress responses (NRC, 2003, 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; Kastelein *et al.,* 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.

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 is little quantitative marine mammal data relating the exposure of marine mammals from sound to effects on reproduction or survival, though data exists for terrestrial species to which we can draw comparisons for marine mammals. 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-hr 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 one day and not recurring on subsequent days is not considered particularly severe unless it could directly affect reproduction or survival (Southall *et al.,* 2007). 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.

As noted above, 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 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. National Research Council (NRC, 2005), New *et al.* (2014), in an effort termed the Potential Consequences of Disturbance (PCoD), outline 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 this 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, North Atlantic right whales, 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 effects. 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 ''worst case'' 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 predict 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 sixfold 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 five 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).

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; NAS 2017; New *et al.,* 2014; Pirotta *et al.,* 2018; Southall *et al.,* 2007; Villegas-Amtmann *et al.,* 2015). As described through this proposed rule, 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 Empire 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.

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). 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 knots.

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 knots. The majority (79 percent) of these strikes occurred at speeds of 13 knots or greater. The average speed that resulted in serious injury or death was 18.6 knots. 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 knots, and exceeded 90 percent at 17 knots. 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 knots. The chances of a lethal injury decline from approximately 80 percent at 15 knots to approximately 20 percent at 8.6 knots. At speeds below 11.8 knots, the chances of lethal injury drop below 50 percent, while the probability asymptotically increases toward 100 percent above 15 knots.

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, Empire Wind's personnel are likely to detect any strike that does occur because of the required personnel training and lookouts, along with the inclusion of Protected Species Observers (as described in the Proposed Mitigation section), and they are required to report all ship strikes involving marine mammals.

Given the extensive mitigation and monitoring measures (see the Proposed Mitigation and Proposed Monitoring and Reporting section) that would be required of Empire Wind, NMFS believes that a vessel strike is not likely to occur.

Potential Effects to Marine Mammal Habitat

Empire Wind's proposed activities could potentially affect marine mammal habitat through the introduction of impacts to 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. NMFS has preliminarily determined that the proposed project would not have adverse or long-term impacts on marine mammal habitat that would be expected to affect the reproduction or survival of any 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 *et al.,* 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 air guns) 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; Popper *et al.,* 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, 2009a). 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). A fifth group was designated for fish eggs and larvae. Most marine mammal fish prey species would not be likely to perceive or hear mid- or high-frequency HRG equipment used by Empire Wind during HRG surveys, but would perceive the noise from pile driving.

In terms of behavioral responses, Juanes *et al.* (2017) discuss the potential for negative impacts from anthropogenic noise on fish, but the author's 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; Doksaeter *et al.,* 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 (Mueller-Blenkle *et al.,* 2010). 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 µPaPeak, particle motion between 6.51 x 10–3 and 8.62 x1 0–4 m/s2 peak). Sole showed a significant increase in swimming speed during the playback period compared to before and after playback. Cod exhibited a similar reaction, yet results were not significant. Cod showed a significant freezing response at onset and cessation of playback. There were indications of directional movements away from the sound source in both species. The results further showed a high variability in behavioral reactions across individuals and a decrease of response with multiple exposures. During wind farm construction in Eastern Taiwan Strait in 2016, fish chorusing intensity and duration during construction were investigated. Two different types of fish chorusing were found to repeat over a diurnal pattern. In the 2 days after the pile driving, one type of chorusing showed lower intensity and longer duration, while the second type exhibited higher intensity and no changes in its duration. During the operational phases in 2017 and 2018, both choruses were longer in duration. Fish choruses have been associated with several behavioral functions. Deviation from regular fish vocalization patterns might affect fish reproductive success, cause migration, augmented predation, or physiological alterations (Siddagangaiah *et al.,* 2021).

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 project areas 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, any behavioral impacts are expected to be temporary and occur close to the activity given the relatively small areas being affected.

SPLs of sufficient strength have been known to cause fish auditory impairment, injury and mortality. Popper *et al.,* 2014 found that fish with or without air bladders could experience TTS at 186 dB SELcum. Mortality could occur for fish without swim bladders at >216 dB SELcum. Those with swim bladders or at the egg or larvae life stage, mortality was possible at >203 dB SELcum. Other studies found that 203 dB SELcum or above caused a physiological response in other fish species (Casper *et al.,* 2012, Halvorsen *et al.,* 2012a, Halvorsen *et al.,* 2012b, Casper *et al.,* 2013a; Casper *et al.,* 2013b). However, in most fish species, hair cells in the ear continuously regenerate and loss of auditory function likely is restored when damaged cells are replaced with new cells. Halvorsen *et al.* (2012a) showed that a TTS of 4–6 dB was recoverable within 24 hours for one species. Impacts would be most severe when the individual fish is close to the source and when the duration of exposure is long. Injury caused by barotrauma can range from slight to severe and can cause death, and is most likely for fish with swim bladders. Barotrauma injuries have been documented during controlled exposure to impact pile driving (Halvorsen *et al.,* 2012b; Casper *et al.,* 2013). As described in the Proposed Mitigation section below, Empire 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; Popper *et al.,* 2014; Smith *et al.,* 2006). It is not known if damage to auditory nerve fibers could occur, and if so, whether fibers would recover during this process.

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 marine mammal prey.

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 relatively 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 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.,* 2017b). 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 air gun 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 and 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 air gun sonar (136–162 *re 1* $\mu Pa^2 \cdot s$). 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. Packard *et al.* (1990) showed that cephalopods were sensitive to particle motion, not sound pressure, and Mooney *et al.* (2010) demonstrated that squid statocysts (specialized sensory organ inside the head called a statocyst that may help an animal determine its position in space (orientation) and maintain balance) act as an accelerometer through which particle motion of the sound field can be detected (Budelmann, 1992). 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.,* 2000b; 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 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.*), 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 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 one 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 sublethal 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.

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. The presence and operation of structures such as WTGs are, in general, likely to result in local and broader oceanographic effects in the marine environment, and may disrupt marine mammal prey such as dense aggregations and distribution of zooplankton through altering 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). However, the scale of impacts is difficult to predict and may vary from meters to hundreds of meters for local individual turbine impacts (Schultze *et al.,* 2020) to large-scale dipoles of surface elevation changes stretching hundreds of kilometers (Christiansen *et al.,* 2022).

Empire Wind intends to install up to 147 operational turbines over the duration of the proposed LOA. As described above, there is scientific uncertainty around the scale of oceanographic impacts (meters to kilometers) associated with turbine operation. However, the project area does not include key foraging grounds for marine mammals with planktonic diets (*e.g,* North Atlantic right whale). Overall, any impact to plankton aggregation, and hence availability as marine mammal prey, from turbine presence and operation during the effective period of the proposed rule is likely to be limited.

In general, impacts to marine mammal prey species are primarily expected to be relatively minor and temporary due to the relatively small areas being affected compared to available habitat. Some mortality of prey inside the bubble curtain may occur; however, this would be very limited. NMFS does not expect HRG acoustic sources to impact fish and most sources are likely outside the hearing range of the primary prey species in the project area.

These potential impacts on prey could impact the distribution of marine mammals within the project area, potentially necessitating additional energy expenditure to find and capture prey, but at the temporal and spatial scales anticipated for this activity 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 WTGs are promising. Overall, any impacts to marine mammal foraging capabilities due to effects on prey aggregation from Empire Wind turbine presence and operation during the effective period of the proposed rule, if issued, is likely to be limited and nearby habitat that is known to support marine mammal foraging would be unaffected by turbine operation.

Overall, the combined impacts of sound exposure and oceanographic impacts on marine mammal habitat resulting from the proposed activities would not be expected to have measurable effects on populations of marine mammal prey species. Prey species exposed to sound might move away from the sound source, experience TTS, experience masking of biologically relevant sounds, or show no obvious direct effects.

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 also defined by, and acoustic habitat 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 air gun 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 and 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.,* 2015).

Sound produced from construction activities in the Empire Wind project area may be widely dispersed or concentrated in small areas for varying periods. However, anthropogenic noise attributed to construction activities in the project area would not be interminable. There would be breaks between noise-generating activities on active pile driving days. Similarly, there would likely be periods of days or even weeks without construction-related underwater noise.

Although this proposed rulemaking primarily covers the noise produced from construction activities relevant to the Empire Wind offshore wind facility, operational noise was a consideration in NMFS' analysis of the project, as all turbines would become operational during the effective period of the proposed rule, if issued. Empire Wind anticipates that WTGs in EW 1 would become operational late in Q2 or early Q3 in 2026 while those in EW 2 would become operational in Q4 of 2027; the rule, if issued, would be effective until January 2029. Once operational, offshore wind turbines are known to produce continuous, non-impulsive underwater noise, primarily below 1 kHz (Tougaard *et al.,* 2020; Stöber and Thomsen, 2021).

In both newer, quieter, direct-drive systems (such as what has been proposed for Empire Wind) 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 piles) 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, 2019). Interestingly, measurements from BIWF turbines showed operational sound had less 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 at 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).

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; 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. 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. NMFS proposes to require Empire Wind to measure operational noise levels.

Water Quality

Temporary and localized reduction in water quality will occur as a result of in-water construction activities. Most of this effect will occur during pile driving and installation of the cables, including auxiliary work such as dredging and scour placement. These activities will disturb bottom sediments and may cause a temporary increase in suspended sediment in the project area. 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 is 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 proposed project area. However, turbidity plumes associated with the project would be temporary and localized, and fish in the proposed project area 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 Empire Wind within the project area, 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.

Reef Effects

The presence of monopile foundations, scour protection, and cable 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 WTG and OSS 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 (RI–CRMC, 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.

Estimated Take of Marine Mammals

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

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

Authorized takes would primarily be by Level B harassment, as noise from impact and vibratory pile driving and HRG surveys could result in behavioral disturbance of marine mammals that qualifies as take. Impacts such as masking and TTS can contribute to the disruption of behavioral patterns and are accounted for within those requested takes. There is also some potential for auditory injury (Level A harassment) of fin whales and minke whales due to the increased likelihood that they would be present during foundation installation than other mysticetes. North Atlantic right whales, sei whales, and humpback whales occur in very low densities in the project area during foundation installation activities. For mid-frequency, high-frequency, and phocid hearing groups, when the associated PTS zone sizes are considered (*e.g.,* Table 13 to Table 20), the potential for PTS from the noise produced by the project is negligible. Hence, Empire Wind did not request, and NMFS is not proposing to authorize Level A harassment of these hearing groups. While NMFS is proposing to authorize Level A harassment and Level B harassment, the proposed mitigation and monitoring measures are expected to minimize the amount and severity of such taking to the extent practicable (see Proposed Mitigation).

As described previously, no serious injury or mortality is anticipated or proposed to be authorized incidental to Empire Wind's specified activities. With or without mitigation, neither pile driving nor HRG surveys have the potential to directly cause marine mammal mortality or serious injury. While, in general, mortality and serious injury of marine mammals could occur from vessel strikes, the mitigation and monitoring measures contained within this proposed rule would avoid vessel strikes. 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 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.

In this case, as described below, there are multiple methods available to address density or occurrence and, 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 requested take, by Level B harassment. The amount of requested take, by Level A harassment, reflects the density-based exposure estimates and, for some species and activities, consideration of other data such as group size and the effectiveness of mitigation measures to avoid or minimize the potential for injury.

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

Marine Mammal Acoustic Thresholds

NMFS recommends the use of acoustic thresholds that identify the received level of underwater sound above which exposed marine mammals would be reasonably expected to be behaviorally harassed (equated to Level B harassment) or to incur PTS of some degree (equated to Level A harassment). 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 behaviorally harassed in a manner considered to be Level B harassment when exposed to underwater anthropogenic noise above the received root-mean-square sound pressure levels (RMS SPL) of 120 dB for continuous (*e.g.,* vibratory pile-driving, drilling) and above the received RMS SPL 160 dB for non-explosive intermittent (*e.g.,* impact pile driving, scientific sonar) sources (Table 6). Generally speaking, Level B harassment take estimates based on these behavioral harassment thresholds are expected to include any likely takes by TTS as, in most cases, the likelihood of TTS occurs at distances from the source less than those at which behavioral harassment is likely. 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 behavioral patterns that would not otherwise occur.

TABLE 6—UNDERWATER LEVEL B HARASSMENT ACOUSTIC THRESHOLDS

[NMFS, 2005]

Source type	Level B harassment threshold (RMS SPL)
Continuous	120 dB re 1 μPa.
Non-explosive impulsive or intermittent.	160 dB re 1 μPa.

Empire Wind's construction activities include the use of continuous (*e.g.,* vibratory pile driving), and intermittent (*e.g.,* impact pile driving, HRG acoustic sources) sources, and, therefore, the 120 and 160 dB *re 1* μ*Pa* (rms) thresholds are applicable.

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). Empire Wind's proposed activities include the use of both impulsive and non-impulsive sources.

These thresholds are provided in Table 7 below. The references, analysis, and methodology used in the development of the thresholds are described in NMFS' 2018 Technical Guidance, which may be accessed at: *www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-acoustic-technical-guidance.*

TABLE 7—ONSET OF PERMANENT THRESHOLD SHIFT (PTS)

[NMFS, 2018]

Hearing group	PTS onset thresholds * (received level)	
	Impulsive	Non-impulsive
Low-Frequency (LF) Cetaceans	*Cell 1:* $L_{p,0\text{-pk,flat}}$: 219 dB; $L_{E,p,LF,24h}$: 183 dB	*Cell 2:* $L_{E,p,LF,24h}$: 199 dB.
Mid-Frequency (MF) Cetaceans	*Cell 3:* $L_{p,0\text{-pk,flat}}$: 230 dB; $L_{E,p,MF,24h}$: 185 dB	*Cell 4:* $L_{E,p,MF,24h}$: 198 dB.
High-Frequency (HF) Cetaceans	*Cell 5:* $L_{p,0\text{-pk,flat}}$: 202 dB; $L_{E,p,HF,24h}$: 155 dB	*Cell 6:* $L_{E,p,HF,24h}$: 173 dB.
Phocid Pinnipeds (PW) (Underwater)	*Cell 7:* $L_{p,0\text{-pk.flat}}$: 218 dB; $L_{E,p,PW,24h}$: 185 dB	*Cell 8:* $L_{E,p,PW,24h}$: 201 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 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, in detail, the assumptions and methodologies used to estimate take, in consideration of acoustic thresholds and appropriate marine mammals density and occurrence information, for WTG and OSS foundation installation, cable landfall construction, marina activities, and HRG surveys. Resulting distances to thresholds, densities used, activity-specific exposure estimates (as relevant to the analysis), and activity-specific take estimates can be found in each activity subsection below. At the end of this section, we present the total annual and 5-year estimates that Empire Wind requested, and NMFS proposes to authorize, from all activities combined.

Acoustic and Exposure Modeling

As described above, predominant underwater noise associated with the construction of EW 1 and EW 2 results from installing monopile and jacket foundations using an impact hammer. Empire Wind employed JASCO to conduct acoustic and animal movement exposure modeling to better understand sound fields produced during these activities and to estimate exposures (Küsel *et al.,* 2022). The basic modeling approach is to characterize the sounds produced by the source, determine how the sounds propagate within the surrounding water column, and then estimate species-specific exposure probability by considering the range- and depth-dependent sound fields in relation to animal movement in simulated representative construction scenarios. Animal movement modeling was not conducted to estimate take for cable landfall construction, marina activities, and HRG surveys due to either their short duration or limited harassment zones.

JASCO's Pile Driving Source Model (PDSM), a physical model of pile vibration and near-field sound radiation (MacGillivray 2014), was used in conjunction with the GRLWEAP 2010 wave equation model (GRLWEAP, Pile Dynamics 2010) to predict source levels associated with impact pile driving activities (WTG and OSS foundation installation and casing pipe installation). The PDSM physical model computes the underwater vibration and sound radiation of a pile by solving the theoretical equations of motion for axial and radial vibrations of a cylindrical shell. This model is used to estimate the energy distribution per frequency (source spectrum) at a close distance from the source (10 m). Piles are modeled as a vertical installation using a finite-difference structural model of pile vibration based on thin-shell theory. To model the sound emissions from the piles, the force of the pile driving hammers also had to be modeled. The force at the top of each monopile and jacket foundation pile was computed using the GRLWEAP 2010 wave equation model (GRLWEAP; Pile Dynamics, 2010), which includes a large database of simulated hammers. The forcing functions from GRLWEAP were used as inputs to the finite difference model to compute the resulting pile vibrations. The sound radiating from the pile itself was simulated using a vertical array of discrete point sources. These models account for several parameters that describe the operation—pile type, material, size, and length—the pile driving equipment, and approximate pile penetration depth. The model assumed direct contact between the representative hammers, helmets, and piles (*i.e.,* no cushioning material).

Empire Wind modeled three WTG monopile scenarios: 9.6-m typical; 9.6-m difficult-to-drive; and 11-m typical. For each scenario, Empire Wind assumed various hammer energy schedules, including the hammer energies and number of strikes predicted at various penetration depths during the pile driving process and different soil conditions. Typical monopile foundation locations are those where the standard hammer energy would be sufficient to complete installation of the foundation to the target penetration depth. Difficult-to-drive foundation locations would require higher hammer energies and/or additional hammer strikes to complete foundation installation to the target penetration depth. Difficult-to-drive scenarios would only utilize 9.6-m piles as the larger 11-m piles could not be driven to target penetration depth in the soil conditions associated with difficult-to-drive turbine positions. Empire Wind estimates that a maximum of 17 total foundations may be difficult-to-drive (including as many as 7 difficult-to-drive foundations for EW 1 and as many as 10 difficult-to-drive foundations for EW 2). The actual number of difficult-to-drive piles will be informed by additional analysis of geotechnical data and other studies that will occur prior to construction but would not be greater than 17 foundations.

The amount of sound generated during pile driving varies with the energy required to drive piles to a desired depth and depends on the sediment resistance encountered. Sediment types with greater resistance require hammers that deliver higher energy strikes and/or an increased number of strikes relative to installations in softer sediment. Maximum sound levels usually occur during the last stage of impact pile driving where the greatest resistance is encountered (Betke, 2008). Empire Wind developed hammer energy schedules typical and difficult-to-drive 9.6-m piles and for three different seabed penetration depths for the 11-m diameter piles to represent the various soil conditions that may be encountered in the Lease Area (*i.e.,* normal soil conditions (identified as ''T1''), harder soil conditions (identified as ''R3''), and outlier softer soil conditions (identified as ''U3''). The maximum penetration depths for typical and difficult-to-drive 9.6-m piles (38 m (125 ft)); typical 11-m piles (55 m (180 ft)) and pin piles (56 m (184 ft) at OSS 1) were all carried forward as part of the modeling analysis.

One OSS foundation scenario was modeled; however, this scenario was modeled at two locations (representing locations in EW 1 and EW 2) resulting in two hammer schedules. Empire Wind anticipates the different locations will require different hammer schedules depending on site-specific soil conditions.

Key modeling assumptions for the WTG monopiles and OSS foundation pin piles are listed in Table 8 (additional modeling details and input parameters can be found in Küsel *et al.* (2022)). Hammer energy schedules for WTG monopiles (9.6 m and 11 m) and OSS foundation pin piles are provided in Table 9, Table 10, and Table 11 respectively.

TABLE 8—KEY PILING ASSUMPTIONS USED IN THE SOURCE MODELING

Foundation type	Modeled maximum impact hammer energy (kJ)	Pile length (m)	Pile wall thickness (mm)	Seabed penetration (m)	Number of piles per day
9.6 m Monopile	[4] 2,300/5,500	78.5	73–101	38	1–2
11 m Monopile R3 [1]	2,000	75.3	8.5	35	1–2
11 m Monopile T1 [2]	2,500	84.1	8.5	40	1–2
11 m Monopile U3 [3]	1,300	97.5	85	55	1–2
Jacket (2.5 m pin pile)	3,200	57–66	50	47–56	2–3

[1] R3 = harder soil conditions.
[2] T1 = normal soil conditions.
[3] U3 = softer soil conditions.
[4] Typical 2.300; difficult to drive 5,500.

TABLE 9—HAMMER ENERGY SCHEDULES FOR MONOPILES UNDER THE TWO PILE DRIVING SCENARIOS

[9.6-m Diameter Pile; IHC S–5500 hammer]

''Typical'' pile driving scenario (9.6-m diameter pile)			''Difficult-to-drive'' pile driving scenario (9.6-m diameter pile)		
Energy level (kJ)	Strike count	Pile penetration depth (m)	Energy level (kJ)	Strike count	Pile penetration depth (m)
Initial sink depth	0	2	Initial sink depth	0	2
450	1,607	12	450	1,607	12

TABLE 9—HAMMER ENERGY SCHEDULES FOR MONOPILES UNDER THE TWO PILE DRIVING SCENARIOS—Continued

[9.6-m Diameter Pile; IHC S–5500 hammer]

"Typical" pile driving scenario (9.6-m diameter pile)			"Difficult-to-drive" pile driving scenario (9.6-m diameter pile)		
Energy level (kJ)	Strike count	Pile penetration depth (m)	Energy level (kJ)	Strike count	Pile penetration depth (m)
800	731	5	800	731	5
1,400	690	4	1,400	690	4
1,700	1,050	6	1,700	1,050	6
2,300	1,419	9	2,300	1,087	4
5,500	0	0	5,500	2,000	5
Total	5,497	38	Total	7,615	38
Strike rate (strikes/min)	30		Strike rate (strikes/min)	30	

TABLE 10—HAMMER ENERGY SCHEDULE AND NUMBER OF STRIKES PER MONOPILES UNDER THREE PILE DRIVING SCENARIOS

[11 m Diameter pile; IHC S–5500 hammer]

Energy level (kJ)	R3-harder soil conditions		T1-normal soil conditions		U3-softer soil conditions	
	Strike count	Penetration depth	Strike count	Penetration depth	Strike count	Penetration depth
Initial Sink Depth		1		3		5
450					622	6
500	1168	14	1339	14		
750	433	3	857	6	2781	20
1000			632	4	1913	12
1100	265	2				
1300					2019	12
1500			1109	7		
2000	2159	15	326	2		
2500			656	4		
Totals	4025	35	4919	40	7335	55

TABLE 11—HAMMER ENERGY SCHEDULES FOR PIN PILES SUPPORTING THE JACKET FOUNDATION LOCATED AT OSS 1 AND OSS 2, WITH AN IHC S–4000 HAMMER

OSS 1 location			OSS 2 location		
Energy level (kJ)	Strike count	Pile penetration depth (m)	Energy level (kJ)	Strike count	Pile penetration depth (m)
Initial sink depth	0	8	Initial sink depth	0	5
500	1,799	30	500	1,206	22
750	1,469	12	750	1,153	9
2,000	577	4	1,100	790	7
3,200	495	2	3,200	562	4
Total	4,340	56	Total	3,711	47
Strike rate (strikes/min)	30		Strike rate (strikes/min)	30	

Sounds produced by installation of the 9.6- and 11-m monopiles were modeled at nine representative locations as shown in Figure 2 in Küsel *et al.* (2022). Sound fields from pin piles were modeled at the two planned jacket foundation locations, OSS 1 and OSS 2. Modeling locations are shown in Figure 8 in Küsel *et al.* (2022). The modeling locations were selected as they represent the range of soil conditions and water depths in the lease area. The monopiles were assumed to be vertical and driven to a maximum expected penetration depth of 38 m (125 ft) for 9.6-m piles and 55 m (180 ft) for 11-m piles. Jacket pin piles were assumed to be vertical and driven to a maximum expected penetration depth of 56 m (184 ft).

Empire Wind would employ a noise attenuation system during all impact pile driving of monopile and jacket foundations. Noise attenuation systems, such as bubble curtains, are sometimes used to decrease the sound levels radiated from a source. Hence, hypothetical broadband attenuation levels of 0 dB, 6 dB, 10 dB, 15 dB, and 20 dB were incorporated into the foundation source models to gauge effects on the ranges to thresholds given these levels of attenuation. Although five attenuation levels were evaluated, Empire Wind and NMFS anticipate that the noise attenuation system ultimately chosen will be capable of reliably reducing source levels by 10 dB; therefore, modeling results assuming 10-dB attenuation are carried forward in this analysis for monopile and jacket foundation installation. See the Proposed Mitigation section for more information regarding the justification for the 10-dB assumption.

To estimate sound propagation, JASCO's used the FWRAM (Küsel *et al.,* 2022, Appendix E.4) propagation model for foundation installation to combine the outputs of the source model with spatial and temporal environmental factors (*e.g.,* location, oceanographic conditions, and seabed type) to get time-domain representations of the sound signals in the environment and estimate sound field levels. FWRAM is based on the wide-angle parabolic equation (PE) algorithm (Collins 1993). Because the foundation pile is represented as a linear array and FWRAM employs the array starter method to accurately model sound propagation from a spatially distributed source (MacGillivray and Chapman, 2012), using FWRAM ensures accurate characterization of vertical directivity effects in the near-field zone (1 km). Due to seasonal changes in the water column, sound propagation is likely to differ at different times of the year. The speed of sound in seawater depends on the temperature T (degree celsius), salinity S (parts per thousand (ppt)), and depth D (m) and can be described using sound speed profiles. Oftentimes, a homogeneous or mixed layer of constant velocity is present in the first few meters. It corresponds to the mixing of surface water through surface agitation. There can also be other features, such as a surface channel, which corresponds to sound velocity increasing from the surface down. This channel is often due to a shallow isothermal layer appearing in winter conditions, but can also be caused by water that is very cold at the surface. In a negative sound gradient, the sound speed decreases with depth, which results in sound refracting downwards which may result in increased bottom losses with distance from the source. In a positive sound gradient, as is predominantly present in the winter season, sound speed increases with depth and the sound is, therefore, refracted upwards, which can aid in long distance sound propagation. To capture this variability, acoustic modeling was conducted using an average sound speed profile for a ''summer'' period including the months of May through November, and a ''winter'' period including December through April. FWRAM computes pressure waveforms via Fourier synthesis of the modeled acoustic transfer function in closely spaced frequency bands. Examples of decidecade spectral levels for each foundation pile type, hammer energy, and modeled location, using average summer sound speed profile are provided in Küsel *et al.* (2022).

To estimate the probability of exposure of animals to sound above NMFS' harassment thresholds during foundation installation, JASCO's Animal Simulation Model Including Noise Exposure (JASMINE) was used to integrate the sound fields generated from the source and propagation models described above with species-typical behavioral parameters (*e.g.,* dive patterns). Sound exposure models such as JASMINE use simulated animals (animats) to sample the predicted 3–D sound fields with movement rules derived from animal observations. Animats that exceed NMFS' acoustic thresholds are identified and the range for the exceedances determined. The output of the simulation is the exposure history for each animat within the simulation. An individual animat's sound exposure levels are summed over a specific duration, (24 hrs), to determine its total received acoustic energy (SEL) and maximum received PK and SPL. These received levels are then compared to the threshold criteria within each analysis period. The combined history of all animats gives a probability density function of exposure during the project. The number of animals expected to exceed the regulatory thresholds is determined by scaling the number of predicted animat exposures by the species-specific density of animals in the area. By programming animats to behave like marine species that may be present near the Empire Wind Lease Area, the sound fields are sampled in a manner similar to that expected for real animals. The parameters used for forecasting realistic behaviors (*e.g.,* diving, foraging, and surface times) were determined and interpreted from marine species studies (*e.g.,* tagging studies) where available, or reasonably extrapolated from related species (Küsel *et al.,* 2022).

As described in Section 2.6 of JASCO's acoustic modeling report for Empire Wind (Küsel *et al.,* 2022), for modeled animals that have received enough acoustic energy to exceed a given harassment threshold, the exposure range for each animal is defined as the closest point of approach (CPA) to the source made by that animal while it moved throughout the modeled sound field, accumulating received acoustic energy. The CPA for each of the species-specific animats during a simulation is recorded and then the CPA distance that accounts for 95 percent of the animats that exceed an acoustic impact threshold is determined. The $ER_{95\%}$ (95 percent exposure radial distance) is the horizontal distance that includes 95 percent of the CPAs of animats exceeding a given impact threshold. The $ER_{95\%}$ ranges are species-specific rather than categorized only by any functional hearing group, which allows for the incorporation of more species-specific biological parameters (*e.g.,* dive durations, swim speeds, etc.) for assessing the impact ranges into the model. Furthermore, because these $ER_{95\%}$ ranges are species-specific, they can be used to develop mitigation monitoring or shutdown zones.

Empire Wind also calculated acoustic ranges which represent the distance to a harassment threshold based on sound propagation through the environment (*i.e.,* independent of any receiver). As described above, applying animal movement and behavior within the modeled noise fields 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. Acoustic ranges ($R_{95\%}$) to the Level A harassment SELcum metric thresholds are considered overly conservative as the accumulation of acoustic energy does not account for animal movement and behavior and therefore assumes that animals are essentially stationary at that distance for the entire duration of the pile installation, a scenario that does not reflect realistic animal behavior. The acoustic ranges to the SEL_{cum} Level A harassment thresholds for WTG and OSS foundation installation can be found in Tables 16–18 in Empire Wind's application but will not be discussed further in this analysis. Because NMFS Level B harassment threshold is an instantaneous exposure, acoustic ranges are more relevant to the analysis and are used to derive mitigation and monitoring measures. Acoustic ranges to the Level B harassment threshold for each activity are provided in the activity-specific subsections below. The differences between exposure ranges and acoustic ranges for Level B harassment are minimal given it is an instantaneous method.

For vibratory pile driving of cofferdams, Empire Wind estimated source levels and frequency spectra assuming an 1,800 kilonewton (kN) vibratory force. Modeling was accomplished using adjusted one-third-octave band vibratory pile driving source levels cited for similar vibratory pile driving activities conducted during cofferdam installation for the Block Island Wind Farm (Tetra Tech, 2012; Schultz-von Glahn *et al.,* 2006). The assumed sound source level for vibratory pile driving corresponded to 195 dB SEL re 1 μPa. The frequency distribution of the vibratory pile driving sound source is displayed in Figure 5 in Küsel *et al.* (2022). The anticipated duration is 1 hour of active pile driving per day.

Underwater sound propagation modeling for cofferdam installation was completed using dBSea, a powerful software for the prediction of underwater noise in a variety of environments. The 3D model is built by importing bathymetry data and placing noise sources in the environment. Each source can consist of equipment chosen from either the standard or user defined databases. Noise mitigation methods may also be included. The user has control over the seabed and water properties including sound speed profile (SSP), temperature, salinity, and current.

The dBSeaPE solver makes use of the parabolic equation method, a versatile and robust method of marching the sound field out in range from the sound source. This method is one of the most widely used in the underwater acoustics community and offers excellent performance in terms of speed and accuracy in a range of challenging scenarios. For high frequencies, the dBSeaRay ray tracing solver is used, which forms a solution by tracing rays from the source to the receiver. Many rays leave the source covering a range of angles, and the sound level at each point in the receiving field is calculated by coherently summing the components from each ray. This is currently the only computationally efficient method at high frequencies. The underwater acoustic modeling analysis used a split solver, with dBSeaPE evaluating the 12.5 Hz to 800 Hz and dBSeaRay addressing 1,000 Hz to 20,000 Hz.

The acoustic modeling for impact hammering the casing pipe and goal posts and vibratory pile driving and removal associated with Onshore Substation C marina activities relied on NMFS' Multi-Species Calculator, available at: *https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-acoustic-technical-guidance,* which applies formulaic equations to predict distances to thresholds. Information on assumptions into the Multi-Species Calculator are provided in the activity specific sections below.

Marine Mammal Density and Occurrence

In this section we provide the information about marine mammal presence, density, or group dynamics that will inform the take calculations for all activities. Empire Wind applied the Duke University Marine Geospatial Ecology Laboratory 2022 marine mammal habitat-based density models (*https://seamap.env.duke.edu/models/Duke/EC/*) to estimate take from WTG and OSS foundation installation, cable landfall construction, and site characterization surveys (please see each activity subsection for these densities). For foundation installation, the width of the perimeter around the activity area used to select density data from the Duke models was based on the largest exposure range (typically the Level B harassment range) applicable to that activity and then rounded up to the nearest 5-km increment, (which reflects the spatial resolution of the Roberts and Halpin (2022) density models). All information provided by Empire Wind since submission of their adequate and complete application is contained within the final updated density and take addendum that they submitted to NMFS on January 25, 2023. The Updated Density and Take Estimation Memo is available at: *https://www.fisheries.noaa.gov/action/incidental-take-authorization-empire-offshore-wind-llc-construction-empire-wind-project-ew1?check_logged_in=1*.

The mean density for each month was determined by calculating the unweighted mean of all 5 x 5 km grid cells partially or fully within the analysis polygon (Roberts and Halpin, 2022). Densities were computed each month for an entire year to coincide with possible planned activities. In cases where monthly densities were unavailable (*i.e.,* long and short-finned pilot whales), annual mean densities were used instead. Additionally, Roberts and Halpin (2022) provide density for pilot whales as a guild that includes both species and, since it is very difficult to differentiate species at sea, take numbers for pilot whales are requested at the guild level. To obtain density estimates for long-finned and short-finned pilot whales to estimate exposures from foundation installation, the guild density from Roberts and Halpin (2022) was scaled by the relative stock sizes based on the best available abundance estimate from NOAA Fisheries SARs (Hayes *et al.,* 2021).

The equation below shows an example of how abundance scaling is applied to compute density for short-finned pilot whales.

$$D_{short\text{-}finned} = D_{both} \times N_{coastal} / (N_{short\text{-}finned} + N_{long\text{-}finned})$$

where:

D represents density and N represents abundance.

Similarly, densities are provided for seals as a guild consisting primarily of harbor and gray seals (Robert and Halpin 2022). Gray and harbor seal densities were scaled by relative NOAA Fisheries SARs (Hayes *et al.,* 2021) abundance to estimate exposures from foundation installation.

For some species and activities, observational data from Protected Species Observers (PSOs) aboard HRG and geotechnical survey vessels 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. A review of Empire Wind's PSO sightings data ranging from 2018–2021 for the Project Area indicated that exposure estimates based on the exposure modeling methodology for some species were likely underestimates for humpback whales, fin whales, and pilot whales. These findings are described in greater detail below.

For other less-common species, the predicted densities from Roberts and Halpin (2022) are very low and the resulting density-based exposure estimate is less than a single animal or a typical group size for the species. In such cases, the mean group size was considered as an alternative to the density-based or PSO data-based take estimates to account for potential impacts on a group during an activity. Mean group sizes for each species were calculated from recent aerial and/or vessel-based surveys, as shown in Table 12. Group size data were also used to estimate take from marina activities given there is no density data available for the area given its inshore location. Additional detail regarding the density and occurrence as well as the assumptions and methodology used to estimate take for specific activities is included in the activity-specific subsections below.

TABLE 12—AVERAGE MARINE MAMMAL GROUP SIZES

Marine mammal species	Average group size	Information source
North Atlantic right whale	1–2	Roberts and Halpin 2022.
Atlantic spotted dolphin	45	Kenney & Vigness-Raposa (2010).
Atlantic white-sided dolphin	52	Jefferson *et al.* (2015).
Bottlenose dolphin	15	Jefferson *et al.* (2015).
Common dolphin	30	Reeves *et al.* (2002).
Risso's dolphin	100	Jefferson *et al.* (2015).
Sperm whale	1	Barkaszi *et al.* 2019.

WTG and OSS Foundation Installation

Here we describe the results from the methodologies outlined above. We present exposure ranges to Level A harassment and Level B harassment thresholds, acoustic ranges to PTS peak and Level B harassment thresholds, densities, exposure estimates and take estimates from Empire Wind's WTG and OSS foundation installation following the aforementioned assumptions (*e.g.,* construction and hammer schedules).

Table 13 through Table 20 provide exposure ranges for the 9.5-m monopile (typical and difficult-to-drive), 11-m monopile, and OSS foundation pin piles, respectively, assuming 10 dB attenuation for summer and winter. Table 21 provides relevant acoustic ranges (PTS peak and Level B harassment). Of note, in some cases (*e.g.,* 9.6 m difficult-to-drive piles), distances to PTS peak thresholds exceed SELcum thresholds. However, those distances are small (less than 1 km) and only applicable to harbor porpoise. Please see tables 34–37 in Küsel *et al.* (2022) for more peak threshold modeling results.

TABLE 13—MAXIMUM EXPOSURE RANGES ($ER_{95\%}$) TO LEVEL A HARASSMENT PTS (SEL_{CUM}) AND LEVEL B HARASSMENT THRESHOLDS FROM IMPACT PILE DRIVING OF 9.6-m DIAMETER "TYPICAL" AND "DIFFICULT-TO-DRIVE" MONOPILE FOUNDATIONS (SUMMER), ASSUMING 10 dB ATTENUATION [b]

Species	"Typical" (in km)				"Difficult-to-drive" (in km)			
	One pile per day		Two piles per day		One pile per day		Two piles per day	
	Level A harassment (SEL; dB re 1 µPa2·s)	Level B harassment (dB re 1 µPa)	Level A harassment (dB re 1 µPa2·s)	Level B harassment (dB re 1 µPa)	Level A harassment (dB re 1 µPa2·s)	Level B harassment (dB re 1 µPa)	Level A harassment (dB re 1 µPa2·s)	Level B harassment (dB re 1 µPa)
LF:								
Fin Whale	0.86	3.18	0.94	3.09	1.35	4.74	1.84	4.51
Minke Whale [a]	0.22	3.13	0.54	3.02	0.89	4.46	0.90	4.45
Humpback Whale [a]	0.24	3.15	0.33	3.01	0.74	4.47	0.69	4.53
North Atlantic Right Whale [a]	0.33	2.89	0.47	2.87	1.09	4.33	1.13	4.30
Sei Whale [a]	0.43	3.09	0.54	3.07	1.04	4.47	1.21	4.52
MF:								
Atlantic White-sided Dolphin	0	2.98	0	2.94	0	4.24	0	4.30
Atlantic Spotted dolphin	0	0	0	0	0	0	0	0
Common Dolphin	0	3.07	0	2.92	0	4.48	0	4.42
Bottlenose Dolphin	0	2.46	0	2.41	0	3.77	0	3.83
Risso's Dolphin	0	3.07	0	2.93	0	4.73	0	4.41
Long-finned Pilot Whale	0	0	0	0	0	0	0	0
Short-Finned Pilot Whale	0	0	0	0	0	0	0	0
Sperm Whale	0	3.25	0	2.96	0	4.59	0	4.47
HF:								
Harbor Porpoise	0	3.07	0	3.05	0	4.52	0	4.37
PW:								
Gray Seal	0	3.33	<0.01	3.26	<0.01	4.91	<0.01	4.87
Harbor Seal	0	3.02	0	2.97	0	4.68	0	4.38

Note: LF = low-frequency cetaceans; MF = mid-frequency cetaceans; HF = high-frequency cetaceans; PW = pinnipeds in water.
[a] Species was considered as "migrating" in the analysis.
[b] The values here were found in Tables I–19, I–20, I–23, and I–24 in Küsel et al. (2022) (Appendix I).

TABLE 14—MAXIMUM EXPOSURE RANGES ($ER_{95\%}$) TO LEVEL A HARASSMENT PTS (SEL_{CUM}) AND LEVEL B HARASSMENT THRESHOLDS FROM IMPACT PILE DRIVING OF 9.6-m DIAMETER "TYPICAL" AND "DIFFICULT-TO-DRIVE" MONOPILE FOUNDATIONS (WINTER), ASSUMING 10 dB ATTENUATION [c]

Species	"Typical" (in km)				"Difficult-to-drive" (in km)			
	One pile per day		Two piles per day		One pile per day		Two piles per day	
	Level A harassment (SEL; dB re 1 μPa2·s)	Level B harassment (dB re 1 μPa)	Level A harassment (dB re 1 μPa2·s)	Level B harassment (dB re 1 μPa)	Level A harassment (dB re 1 μPa2·s)	Level B harassment (dB re 1 μPa)	Level A harassment (dB re 1 μPa2·s)	Level B harassment (dB re 1 μPa)
LF:								
Fin Whale	0.88	3.40	1.01	3.46	1.80	5.24	1.95	4.87
Minke Whale [a]	0.26	3.31	0.48	3.29	0.89	4.88	1.05	4.66
Humpback Whale [a]	0.24	3.38	0.36	3.31	0.74	5.10	0.83	5.07
North Atlantic Right Whale [a]	0.43	3.04	0.47	3.11	1.13	4.73	1.19	4.62
Sei Whale [a]	0.43	3.28	0.58	3.43	1.24	4.95	1.29	4.85
MF:								
Atlantic White-sided Dolphin	0	3.30	0	3.19	0	4.73	0	4.72
Atlantic Spotted dolphin	0	0	0	0	0	0	0	0
Common Dolphin	0	3.28	0	3.08	0	4.89	0	4.73
Bottlenose Dolphin	0	2.73	0	2.77	0	4.23	0	4.12
Risso's Dolphin	0	3.39	0	3.32	0	5.14	0	4.92
Long-finned Pilot Whale	0	0	0	0	0	0	0	0
Short-Finned Pilot Whale	0	0	0	0	0	0	0	0
Sperm Whale	0	3.40	0	3.19	0	4.96	0	4.92
HF:								
Harbor Porpoise	0	3.15	0	3.22	0	5.04	0	4.75
PW:								
Gray Seal	0	3.54	<0.01	3.50	<0.01	[b] 5.35	<0.01	5.19
Harbor Seal	0	3.28	0	3.29	0	4.93	0	4.71

Note: LF = low-frequency cetaceans; MF = mid-frequency cetaceans; HF = high-frequency cetaceans; PW = pinnipeds in water.
[a] Species was considered as "migrating" in the analysis.
[b] These values represent the maximum Level B.
[c] The values here were found in Tables I–21, I–22, I–25, and I–26 in Küsel et al. (2022) (Appendix I).

TABLE 15—EXPOSURE RANGES ($ER_{95\%}$) TO LEVEL A HARASSMENT (PTS (SEL_{CUM})) AND LEVEL B HARASSMENT THRESHOLDS FROM IMPACT PILE DRIVING 11-m DIAMETER MONOPILE FOUNDATIONS (SUMMER) IN NORMAL (T1) SOIL CONDITIONS, ASSUMING 10 dB ATTENUATION [b]

Species	Normal (T1) soil conditions (in km)			
	One pile per day		Two piles per day	
	Level A harassment (dB re 1 μPa2·s)	Level B harassment (dB re 1 μPa)	Level A harassment (dB re 1 μPa2·s)	Level B harassment (dB re 1 μPa)
LF:				
Fin Whale	0.87	3.32	0.83	3.16
Minke Whale [a]	0.17	3.10	0.35	2.98
Humpback Whale [a]	0.25	3.01	0.16	3.10
North Atlantic Right Whale [a]	0.20	3.09	0.44	2.93
Sei Whale [a]	0.44	3.19	0.27	3.26
MF:				
Atlantic White-sided Dolphin	0	2.97	0	2.98
Atlantic Spotted dolphin	0	0	0	0
Common Dolphin	0	3.08	0	2.94
Bottlenose Dolphin	0	2.60	0	2.62
Risso's Dolphin	0	3.21	0	3.11
Long-finned Pilot Whale	0	0	0	0
Short-Finned Pilot Whale	0	0	0	0
Sperm Whale	0	3.40	0	3.19
HF:				
Harbor Porpoise	0	3.06	0	3.04
PW:				
Gray Seal	0	3.39	0	3.40
Harbor Seal	0	3.25	0	3.09

Note: LF = low-frequency cetaceans; MF = mid-frequency cetaceans; HF = high-frequency cetaceans; PW = pinnipeds in water.
[a] Species was considered as "migrating" in the analysis.
[b] The values here were found in Tables I–31 and I–32 in Küsel et al. (2022) (Appendix I).

TABLE 16—EXPOSURE RANGES ($ER_{95\%}$) TO LEVEL A HARASSMENT (PTS (SEL_{CUM})) AND LEVEL B HARASSMENT THRESHOLDS FROM IMPACT PILE DRIVING OF 11-M DIAMETER MONOPILE FOUNDATIONS (WINTER) IN NORMAL (T1) SOIL CONDITIONS, ASSUMING 10 dB ATTENUATION [b]

Species	Normal (T1) soil conditions (in km)			
	One pile per day		Two piles per day	
	Level A harassment (dB re 1 µPa2·s)	Level B harassment Behavior (dB re 1 µPa)	Level A harassment (dB re 1 µPa2·s)	Level B harassment (dB re 1 µPa)
LF:				
Fin Whale	0.87	3.56	0.82	3.53
Minke Whale [a]	0.27	3.29	0.35	3.31
Humpback Whale [a]	0.25	3.24	0.16	3.40
North Atlantic Right Whale [a]	0.20	3.17	0.44	3.28
Sei Whale [a]	0.44	3.33	0.41	3.53
MF:				
Atlantic White-sided Dolphin	0	3.28	0	3.31
Atlantic Spotted dolphin	0	0	0	0
Common Dolphin	0	3.26	0	3.16
Bottlenose Dolphin	0	2.73	0	2.93
Risso's Dolphin	0	3.48	0	3.44
Long-finned Pilot Whale	0	0	0	0
Short-Finned Pilot Whale	0	0	0	0
Sperm Whale	0	3.48	0	3.35
HF:				
Harbor Porpoise	0	3.41	0	3.35
PW:				
Gray Seal	0	3.66	0	3.66
Harbor Seal	0	3.36	0	3.36

Note: LF = low-frequency cetaceans; MF = mid-frequency cetaceans; HF = high-frequency cetaceans; PW = pinnipeds in water.
[a] Species was considered as "migrating" in the analysis.
[b] The values here were found in Tables I–33 and I–34 in Küsel et al. (2022) (Appendix I).

TABLE 17—EXPOSURE RANGES ($ER_{95\%}$) TO PTS (SEL_{CUM}) AND LEVEL B HARASSMENT THRESHOLDS FROM IMPACT PILE DRIVING OF 11-M WTG MONOPILE FOUNDATIONS (SUMMER) IN SOFT (R3) AND SOFTER (U3) SOIL CONDITIONS, ASSUMING 10 dB ATTENUATION [b]

Species	Soft (R3) soil conditions (in km)					Softer (U3) soil conditions (in km)		
	One pile per day	Two piles per day				One pile per day	Two piles per day	
		Level A harassment (dB re 1 µPa2·s)	Level B harassment (dB re 1 µPa)	Level A harassment (dB re 1 µPa2·s)	Level B harassment (dB re 1 µPa)		Level A harassment (dB re 1 µPa2·s)	Level B harassment (dB re 1 µPa)
LF:								
Fin Whale	0.87	3.02	0.43	2.89	0.90	2.65	0.58	2.48
Minke Whale [a]	0.16	2.78	0.26	2.82	0.02	2.32	0.16	2.27
Humpback Whale [a]	0.14	2.68	0.15	2.79	<0.01	2.26	0.11	2.31
North Atlantic Right Whale [a]	0.20	2.72	0.37	2.67	0.37	2.21	0.28	2.20
Sei Whale [a]	0.31	2.96	0.27	2.91	0.13	2.33	0.23	2.47
MF:								
Atlantic White-sided Dolphin	0	2.75	0	2.73	0	2.24	0	2.23
Atlantic Spotted dolphin	0	0	0	0	0	0	0	0
Common Dolphin	0	2.86	0	2.76	0	2.38	0	2.41
Bottlenose Dolphin	0	2.29	0	2.32	0	1.92	0	1.95
Risso's Dolphin	0	2.86	0	2.79	0	2.41	0	2.40
Long-finned Pilot Whale	0	0	0	0	0	0	0	0
Short-Finned Pilot Whale	0	0	0	0	0	0	0	0
Sperm Whale	0	2.77	0	2.86	0	2.36	0	2.26
HF:								
Harbor Porpoise	0	2.76	0	2.73	0	2.19	0	2.28
PW:								
Gray Seal	0	2.87	0	3.01	0	2.60	<0.01	2.58
Harbor Seal	0	2.91	0	2.75	0	2.50	0	2.36

Note: LF = low-frequency cetaceans; MF = mid-frequency cetaceans; HF = high-frequency cetaceans; PW = pinnipeds in water.
[a] *Species was considered as "migrating" in the analysis.*
[b] *The values for U3 were found in Tables I–27 and I–28 in Küsel et al. (2022) (Appendix I). The values for R3 were found in Tables I–35 and I–36 in Küsel et al. (2022) (Appendix I).*

TABLE 18—EXPOSURE RANGES (ER**95%**) TO PTS (SEL**CUM**) AND LEVEL B HARASSMENT THRESHOLDS FROM IMPACT PILE DRIVING OF 11-M WTG MONOPILE FOUNDATIONS (WINTER) IN SOFT (R3) AND SOFTER (U3) SOIL CONDITIONS, ASSUMING 10 dB ATTENUATION [b]

Species	Soft (R3) soil conditions (in km)					Softer (U3) soil conditions (in km)		
	One pile per day	Two piles per day				One pile per day	Two piles per day	
		Level A harassment (dB re 1 μPa2·s)	Level B harassment (dB re 1 μPa)	Level A harassment (dB re 1 μPa2·s)	Level B harassment (dB re 1 μPa)		Level A harassment (dB re 1 μPa2·s)	Level B harassment (dB re 1 μPa)
LF:								
Fin Whale	0.87	3.17	0.48	3.14	0.89	2.71	0.82	2.54
Minke Whale [a]	0.19	3.12	0.28	3.02	0.20	2.50	0.23	2.59
Humpback Whale [a]	0.14	3.04	0.19	2.96	<0.01	2.46	0.11	2.54
North Atlantic Right Whale [a]	0.20	2.93	0.37	2.89	0.49	2.37	0.32	2.38
Sei Whale [a]	0.46	3.09	0.27	3.11	0.13	2.60	0.28	2.56
MF:								
Atlantic White-sided Dolphin	0	2.90	0	2.98	0	2.43	0	2.40
Atlantic Spotted dolphin	0	0	0	0	0	0	0	0
Common Dolphin	0	3.08	0	3.08	0	2.50	0	2.53
Bottlenose Dolphin	0	2.63	0	2.41	0	2.07	0	2.11
Risso's Dolphin	0	3.04	0	3.08	0	2.63	0	2.53
Long-finned Pilot Whale	0	0	0	0	0	0	0	0
Short-Finned Pilot Whale	0	0	0	0	0	0	0	0
Sperm Whale	0	3.10	0	3.04	0	2.60	0	2.38
HF:								
Harbor Porpoise	0	3.07	0	3.09	0	2.53	0	2.51
PW:								
Gray Seal	0	3.25	0	3.25	0	2.70	<0.01	2.67
Harbor Seal	0	3.09	0	3.03	0	2.58	0	2.54

Note: LF = low-frequency cetaceans; MF = mid-frequency cetaceans; HF = high-frequency cetaceans; PW = pinnipeds in water.
[a] Species was considered as ''migrating'' in the analysis.
[b] The values for U3 were found in Tables I–29 and I–30 in Küsel et al. (2022) (Appendix I). The values for R3 were found in Tables I–37 and I–38 in Küsel et al. (2022) (Appendix I).

As shown in the tables above, modeling results indicated that exposure ranges associated with the 9.6-m diameter typical monopile scenario were predominantly greater than for the 11-m diameter monopile scenarios. While larger diameter monopiles can be associated with greater resulting sound fields than smaller diameter piles, in this case, the 11-m diameter monopile scenarios resulted in smaller modeled acoustic ranges than the 9.6-m diameter monopile scenarios likely because the 11-m monopile would only be installed in softer sediments which would require less hammer energy and/or number of hammer strikes for installation than the 9.6-m diameter pile in harder sediments. Hence, the 9.6-m diameter monopile scenario was carried forward to the exposure analysis to be conservative, for all ''typical'' monopiles.

TABLE 19—EXPOSURE RANGES ($ER_{95\%}$) TO LEVEL A HARASSMENT (PTS (SEL_{CUM})) AND LEVEL B HARASSMENT THRESHOLDS FROM IMPACT PILE DRIVING OF 2.5-M DIAMETER OSS FOUNDATIONS (SUMMER), ASSUMING 10 dB ATTENUATION [b]

Species	OSS 1 foundation (in km)					OSS 2 foundation (in km)		
	Two pin piles per day	Three pin piles per day				Two pin piles per day	Three pin piles per day	
		Level A harassment (dB re 1 μPa2·s)	Level B harassment (dB re 1 μPa)	Level A harassment (dB re 1 μPa2·s)	Level B harassment (dB re 1 μPa)		Level A harassment (dB re 1 μPa2·s)	Level B harassment (dB re 1 μPa)
LF:								
Fin Whale	0	1.04	0	1.10	0	1.10	0	0.99
Minke Whale [a]	0	1.00	0	0.99	0	1.01	0	1.01
Humpback Whale [a]	0	1.02	0	1.02	0	0.94	0	0.93
North Atlantic Right Whale [a]	0	0.85	0	0.89	0	1.06	0	1.01
Sei Whale [a]	<0.01	1.08	<0.01	1.04	0	0.94	0	0.91
MF								
Atlantic White-sided Dolphin	0	0.98	0	0.98	0	0.82	0	0.84
Atlantic Spotted dolphin	0	0	0	0	0	0	0	0
Common Dolphin	0	1.03	0	1.03	0	0.96	0	0.96
Bottlenose Dolphin	0	0.82	0	0.81	0	0.72	0	0.74
Risso's Dolphin	0	1.08	0	1.05	0	0.87	0	0.86

TABLE 19—EXPOSURE RANGES ($ER_{95\%}$) TO LEVEL A HARASSMENT (PTS (SEL_{CUM})) AND LEVEL B HARASSMENT THRESHOLDS FROM IMPACT PILE DRIVING OF 2.5-M DIAMETER OSS FOUNDATIONS (SUMMER), ASSUMING 10 dB ATTENUATION [b]—Continued

Species	OSS 1 foundation (in km)					OSS 2 foundation (in km)		
	Two pin piles per day	Three pin piles per day				Two pin piles per day	Three pin piles per day	
		Level A harassment (dB re 1 µPa2·s)	Level B harassment (dB re 1 µPa)	Level A harassment (dB re 1 µPa2·s)	Level B harassment (dB re 1 µPa)		Level A harassment (dB re 1 µPa2·s)	Level B harassment (dB re 1 µPa)
Long-finned Pilot Whale	0	0	0	0	0	0	0	0
Short-Finned Pilot Whale	0	0	0	0	0	0	0	0
Sperm Whale	0	0.88	0	0.95	0	1.03	0	1.02
HF:								
Harbor Porpoise	0	0.95	0	1.02	0	0.94	0	0.92
PW:								
Gray Seal	0	1.15	0	1.14	0	0.78	0	0.77
Harbor Seal	0	1.12	0	0.99	0	1.05	0	1.04

Note: LF = low-frequency cetaceans; MF = mid-frequency cetaceans; HF = high-frequency cetaceans; PW = pinnipeds in water.
[a] Species was considered as "migrating" in the analysis.
[b] The values here were found in Tables I–39, I–40, I–43, and I–44 in Küsel et al. (2022) (Appendix I).

TABLE 20—EXPOSURE RANGES ($ER_{95\%}$) TO LEVEL A HARASSMENT (PTS (SEL_{CUM})) AND LEVEL B HARASSMENT THRESHOLDS FROM IMPACT PILE DRIVING OF 2.5-M DIAMETER OSS FOUNDATIONS (WINTER), ASSUMING 10 dB ATTENUATION [b]

Species	OSS 1 foundation (in km)					OSS 2 foundation (in km)		
	Two pin piles per day	Three pin piles per day				Two pin piles per day	Three pin piles per day	
		Level A harassment (dB re 1 µPa2·s)	Level B harassment (dB re 1 µPa)	Level A harassment (dB re 1 µPa2·s)	Level B harassment (dB re 1 µPa)		Level A harassment (dB re 1 µPa2·s)	Level B harassment (dB re 1 µPa)
LF:								
Fin Whale	0	1.08	0.18	1.04	0	1.10	0	0.99
Minke Whale [a]	0	1.01	0	1.01	0	1.06	0	1.03
Humpback Whale [a]	0	1.02	0	1.02	0	0.94	0	0.92
North Atlantic Right Whale [a]	0	0.79	0	0.88	0	1.06	0	1.04
Sei Whale [a]	0	1.08	<0.01	1.05	0	0.94	0	0.90
MF:								
Atlantic White-sided Dolphin	0	0.93	0	0.96	0	0.86	0	0.86
Atlantic Spotted dolphin	0	0	0	0	0	0	0	0
Common Dolphin	0	0.96	0	0.86	0	0.96	0	0.96
Bottlenose Dolphin	0	0.85	0	0.84	0	0.80	0	0.74
Risso's Dolphin	0	0.92	0	0.89	0	0.87	0	0.86
Long-finned Pilot Whale	0	0	0	0	0	0	0	0
Short-Finned Pilot Whale	0	0	0	0	0	0	0	0
Sperm Whale	0	0.91	0	0.89	0	1.03	0	1.02
HF:								
Harbor Porpoise	0	0.95	0	0.95	0	0.94	0	0.92
PW:								
Gray Seal	0	1.08	0	1.10	0	0.78	0	0.77
Harbor Seal	0	1.08	0	0.95	0	1.04	0	1.04

Note: LF = low-frequency cetaceans; MF = mid-frequency cetaceans; HF = high-frequency cetaceans; PW = pinnipeds in water.
[a] Species was considered as "migrating" in the analysis.
[b] The values here were found in Tables I–41, I–42, I–45, and I–46 in Küsel et al. (2022) (Appendix I).

TABLE 21—MAXIMUM ACOUSTIC RANGES ($R_{95\%}$) TO LEVEL A HARASSMENT (PTS (PEAK)) AND LEVEL B HARASSMENT THRESHOLDS (160 dB SPL) FOR 9.6-M WTG MONOPILE (TYPICAL AND DIFFICULT TO DRIVE SCENARIOS), 11-M WTG MONOPILE, AND 2.5-M OSS PIN PILES (SUMMER AND WINTER), ASSUMING 10-dB ATTENUATION

Foundation type	Modeled maximum impact hammer energy (kJ)	Marine mammal group	Level A harassment Pk (in km)		Level B harassment 160 dB SPL (in km)	
			$R_{95\%}$ (summer)	$R_{95\%}$ (winter)	$R_{95\%}$ (summer)	$R_{95\%}$ (winter)
WTG—9.6-m monopile	2,300 kJ (5,500 kJ)	LF:	– [b] (– [b])	– [b] (– [b])	3.51 [g] (5.05 [j])	3.77 [g] (5.49 [j])
		MF:	– [b] (– [b])	– [b] (– [b])		
		HF:	0.10 [c] (0.15 [d])	0.11 [c] (0.17 [d])		

TABLE 21—MAXIMUM ACOUSTIC RANGES ($R_{95\%}$) TO LEVEL A HARASSMENT (PTS (PEAK)) AND LEVEL B HARASSMENT THRESHOLDS (160 dB SPL) FOR 9.6-M WTG MONOPILE (TYPICAL AND DIFFICULT TO DRIVE SCENARIOS), 11-M WTG MONOPILE, AND 2.5-M OSS PIN PILES (SUMMER AND WINTER), ASSUMING 10-dB ATTENUATION—Continued

Foundation type	Modeled maximum impact hammer energy (kJ)	Marine mammal group	Level A harassment Pk (in km)		Level B harassment 160 dB SPL (in km)	
			$R_{95\%}$ (summer)	$R_{95\%}$ (winter)	$R_{95\%}$ (summer)	$R_{95\%}$ (winter)
		PW:	– [b] (– [b])	– [b] (– [b])		
WTG—11-m monopiles	2,500 kJ	LF:	– [b]	– [b]	[h] 3.64	[h] 3.92
		MF:	– [b]	– [b]		
		HF:	[e] 0.11	0.12 [e]		
		PW:	– [b]	– [b]		
OSS—2.5-m pin pile [a]	3,200 kJ	LF:	– [b]	– [b]	[i] 1.19	[i] 1.17
		MF:	– [b]	– [b]		
		HF:	[f] 0.01	[f] 0.01		
		PW:	– [b]	– [b]		

LF = low-frequency cetaceans; MF = mid-frequency cetaceans; HF = high-frequency cetaceans; PW = pinnipeds in water.
[a] Assumes a 2dB post-piling shift.
[b] A dash (–) indicates that the threshold was not exceeded.
[c] Found in Table H–11 in Küsel et al. (2022) (Appendix H).
[d] Found in Table H–47 in Küsel et al. (2022) (Appendix H).
[e] Found in Table H–31 in Küsel et al. (2022) (Appendix H).
[f] Found in Table H–51 in Küsel et al. (2022) (Appendix H).
[g] Found in Table H–343 in Küsel et al. (2022) (Appendix H).
[h] Found in Table H–439 in Küsel et al. (2022) (Appendix H).
[i] Found in Table H–495 in Küsel et al. (2022) (Appendix H).
[j] Found in Table H–479 in Küsel et al. (2022) (Appendix H).

Exposure estimates were calculated for marine mammals based on proposed construction schedules and resulting density calculations. As described above, Empire Wind applied densities within grid cells within the lease area and extending 10 km beyond the lease area. The resulting monthly densities used are provided in Table 22.

TABLE 22—MEAN MONTHLY MARINE MAMMAL DENSITY ESTIMATES WITHIN A 10 KM BUFFER AROUND OCS–A 0512 LEASE AREA

Species	Monthly densities (animals/ 100 km²) [1]	Annual mean											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Fin whale	0.172	0.139	0.113	0.137	0.174	0.171	0.157	0.1	0.055	0.04	0.038	0.13	0.119
Minke whale	0.071	0.06	0.072	0.936	1.485	0.803	0.198	0.107	0.066	0.111	0.026	0.059	0.333
Humpback whale	0.091	0.061	0.076	0.119	0.133	0.113	0.03	0.022	0.054	0.101	0.13	0.113	0.087
North Atlantic right whale	0.1	0.116	0.115	0.088	0.025	0.006	0.003	0.003	0.004	0.008	0.016	0.05	0.045
Sei whale	0.029	0.016	0.033	0.071	0.055	0.011	0.002	0.002	0.005	0.013	0.037	0.049	0.027
Atlantic white-sided dolphin	0.642	0.399	0.356	0.846	1.373	1.237	0.117	0.049	0.279	0.892	0.863	0.99	0.67
Atlantic spotted dolphin	0.001	0	0.001	0.003	0.01	0.019	0.033	0.072	0.177	0.26	0.133	0.013	0.06
Short-beaked common dolphin	5.664	1.852	1.246	2.457	3.474	2.835	1.566	1.917	1.623	3.495	7.244	9.177	3.546
Bottlenose dolphin	0.851	0.247	0.205	0.629	2.005	3.232	3.534	2.953	2.552	2.898	2.772	2.52	2.033
Risso's dolphin	0.042	0.005	0.003	0.021	0.034	0.014	0.014	0.007	0.008	0.01	0.056	0.186	0.033
Long-finned pilot whale	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028
Short-finned pilot whale	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021
Sperm whale	0.007	0.002	0.002	0.004	0.005	0.011	0.011	0.015	0.003	0	0.008	0.005	0.006
Harbor porpoise	5.469	5.73	5.916	7.066	2.421	0.347	0.435	0.215	0.13	0.144	0.342	3.757	2.664
Gray seals	4.762	4.505	3.689	4.337	5.968	1.093	0.071	0.049	0.104	0.684	1.625	4.407	2.608
Harbor seals	10.698	10.121	8.289	9.745	13.40	2.456	0.16	0.11	0.233	1.537	3.651	9.902	5.859

[1] Density estimates are from habitat-based density modeling of the entire Atlantic Exclusive Economic Zone (Roberts and Halpin, 2022).

Construction schedules (piles per day and number of days of pile driving per month) are an input into exposure calculations. However, they are difficult to predict because of factors like first year weather and installation variation related to drivability. Because it is hard to anticipate the installation schedule, a conservative approach was used to generate potential installation schedules for animal exposure calculation. Empire Wind assumed that a maximum of 24 monopiles could be installed per month, with a maximum of 96 WTG monopiles and two OSS foundations installed in the first year and the remaining 51 WTG monopile foundations installed in year 2. In Year 1, Empire Wind assumed that 24 monopiles would be installed in the four highest density months for each species during the May to December period and the two OSSs would be installed in the highest and second highest density months. Empire Wind also assumed that all 17 difficult-to-drive piles would be installed in the first year but the distribution would be spread relatively evenly among the four highest months (*i.e.,* four piles per month except the highest density month which assumed 5 difficult-to-drive piles for a total of 17 piles). In the second year, 24 monopiles would be installed in the two highest density months and the remaining 3 monopiles would be installed in the third highest density month. This approach is reflected in Table 23. Thus, each species was presumed to be exposed to the maximum amount of pile driving based on their monthly densities.

TABLE 23—MOST CONSERVATIVE CONSTRUCTION SCHEDULE FOR ESTIMATING LEVEL B HARASSMENT

[One monopile per day/two pin piles per day] [1]

Foundation type	Year 1				Year 2			
	Monthly density				Monthly density			
	Highest	Second	Third	Fourth	Highest	Second	Third	Fourth
WTG monopile—typical	19	20	20	20	24	24	3	0
WTG monopile—difficult	5	4	4	4	0	0	0	0
OSS 1 pin pile	0	6	0	0	0	0	0	0
OSS 2 pin pile	6	0	0	0	0	0	0	0
Total # of piles	30	30	24	24	24	24	3	0

[1] Maximum number of piles to be driven per month for each foundation type in each of the four highest density months for each species during May To December Period.

As described above, Empire Wind conducted exposure modeling to estimate potential exposures by Level A harassment and Level B harassment incidental to installation of WTG and OSS foundations. Tables 24 and 25 show calculated exposures for 2025 and 2026 respectively based on the methodologies and assumptions described above.

TABLE 24—CALCULATED EXPOSURES BY LEVEL A HARASSMENT AND LEVEL B HARASSMENT RESULTING FROM MONOPILE AND OSS FOUNDATION INSTALLATION IMPACT PILE DRIVING

[Year 1]

Hearing group	Species	Calculated take		Calculated take	Requested take	Requested take
		Level A harassment		Level B harassment	Level A harassment	Level B harassment
		LE	LpK	Lp[a]		
LF	Fin [b]	1.15	0	8.78	1	[c] 133
	Minke	3.72	0	65.05	4	65
	Humpback	0.36	<0.01	8.12	0	[c] 60
	North Atlantic Right Whale [b]	0.01	0	2.36	0	[f] 11
	Sei [b]	0.27	<0.01	2.78	0	3
MF	Atlantic white-sided dolphin	0	0	116.00	0	[f] 416
	Atlantic spotted dolphin	0	0	0	0	[d] 45
	Short-beaked common dolphin	0	0	902.19	0	[d] 3,600
	Bottlenose dolphin	0	0	226.02	0	[d] 1,800
	Risso's dolphin	0	0	5.96	0	[d] 100
	Pilot whales	0	0	0	0	[c] 161
	Sperm whale [b]	0	0	0.56	0	[d] 3
HF	Harbor porpoise	0	0.09	133.77	0	134
PW	Gray seal	0.17	0	162.46	0	162
	Harbor seal	0	0	356.44	0	356

Note: LF = low-frequency cetaceans; MF = mid-frequency cetaceans; HF = high-frequency cetaceans; PW = pinnipeds in water.

[a] NOAA Fisheries (2005).

[b] Listed as Endangered under the ESA.

[c] Requested take adjusted based on PSO sighting data from 2018–2021 (A.I.S., 2019; Alpine Ocean Seismic Survey, 2018; Gardline, 2021a,b; Geoquip Marine, 2021; Marine Ventures International, 2021; RPS, 2021; Smultea Environmental Sciences, 2019, 2020, 2021); 0.5 humpback whales per day, 1.11 fin whales per day, 1.34 pilot whales per day.

[d] Requested take adjusted based on 1 group size per year as follows: 3 sperm whales (Barkaszi *et al.,* 2019), 45 Atlantic spotted dolphins (Kenney and Vigness-Raposa, 2010), and 100 Risso's dolphins (Jefferson *et al.,* 2015).

[e] Requested take adjusted by 1 group size per day as follows: 30 short-beaked common dolphins (Reeves *et al.,* 2002), 15 bottlenose dolphins (Jefferson *et al.,* 2015).

[f] Requested take adjusted by 1 group size per month of 52 Atlantic white-sided dolphins (Jefferson *et al.,* 2015) and 1 (monthly density < 0.01) or 2 (monthly density > 0.01) of North Atlantic right whales (Roberts and Halpin, 2022).

TABLE 25—CALCULATED EXPOSURES BY LEVEL A AND LEVEL B HARASSMENT RESULTING FROM MONOPILE AND OSS FOUNDATION INSTALLATION IMPACT PILE DRIVING

[Year 2]

Hearing group	Species	Calculated take		Calculated take	Requested take	Requested take
		Level A harassment		Level B harassment	Level A harassment	Level B harassment
		LE	LpK	Lp [a]		
LF	Fin [b]	0.52	0	4.00	1	[c] 57
	Minke	2.18	0	47.73	2	48
	Humpback	0.14	0	3.82	0	[c] 26
	North Atlantic Right Whale [b]	0.05	0	1.57	[g] 0	[f] 11
	Sei [b]	0.16	0	1.66	0	2
MF	Atlantic white-sided dolphin	0	0	59.23	0	[f] 416
	Atlantic spotted dolphin	0	0	0	0	[d] 45
	Short-beaked common dolphin	0	0	560.75	0	[e] 1,530
	Bottlenose dolphin	0	0	110.28	0	[e] 765
	Risso's dolphin	0	0	4.09	0	[d] 100
	pilot whales	0	0	0	0	[c] 68
	Sperm whale [b]	0	0	0.29	0	[d] 3
HF	Harbor porpoise	0	0	98.43	0	98
PW	Gray seal	0	0	111.95	0	112
	Harbor seal	0	0	229.89	0	230

Note: LF = low-frequency cetaceans; MF = mid-frequency cetaceans; HF = high-frequency cetaceans; PW = pinnipeds in water.

[a] NOAA Fisheries (2005).

[b] Listed as Endangered under the ESA.

[c] Requested take adjusted based on PSO sighting data from 2018–2021 (A.I.S., 2019; Alpine Ocean Seismic Survey, 2018; Gardline, 2021a,b; Geoquip Marine, 2021; Marine Ventures International, 2021; RPS, 2021; Smultea Environmental Sciences, 2019, 2020, 2021); 0.5 humpback whales per day, 1.11 fin whales per day, 1.34 pilot whales per day.

[d] Requested take adjusted based on 1 group size per year as follows: 3 sperm whales (Barkaszi *et al.,* 2019), 45 Atlantic spotted dolphins (Kenney and Vigness-Raposa, 2010), and 100 Risso's dolphins (Jefferson *et al.,* 2015).

[e] Requested take adjusted by 1 group size per day as follows: 30 short-beaked common dolphins (Reeves *et al.,* 2002), 15 bottlenose dolphins (Jefferson *et al.,* 2015).

[f] Requested take adjusted by 1 group size per month of 52 Atlantic white-sided dolphins (Jefferson *et al.,* 2015) and 1 (when monthly density < 0.01) or 2 (when monthly density > 0.01) of North Atlantic right whales (Roberts and Halpin, 2022).

[g] Enhanced mitigation measures for NARWs would avoid take by Level A harassment.

A review of Empire Wind's PSO sightings data ranging from 2018–2021 for the Project Area indicated that exposure estimates based on the exposure modeling methodology above were likely an underestimate for humpback whales, fin whales, and pilot whales (A.I.S. 2019; Alpine Ocean Seismic Survey 2018; Gardline 2021a,b; Geoquip Marine 2021; Marine Ventures International 2021; RPS 2021; Smultea Environmental Sciences 2019, 2020, 2021). PSO sightings data were analyzed to determine the average number of each species sighted per day during high-resolution geophysical (HRG) surveys in the Project Area. Results indicated that the highest average sightings-per-day rate among PSO reports from 2018–2021 was 0.5 humpback whales (Smultea Environmental Sciences 2019), 1.11 fin whales (Alpine Ocean Seismic Survey 2018), and 1.34 pilot whales (Geoquip Marine 2021) sighted per day. These highest daily averages per day were then multiplied by the maximum potential number of days of pile driving associated with wind turbine and offshore substation foundation installation for these species. In the event that one monopile or one pin pile is installed per day, up to 120 days of pile driving (*i.e.,* 96 days of monopile installation and 24 days of pin pile installation) could occur in 2025 and up to 51 days of pile driving (*i.e.,* 51 days of monopile installation) could occur in 2026.

At a rate of 0.5 humpback whales per day, 120 days of pile driving in 2025 resulted in an estimated 60 takes by level B harassment in that year, and 51 days of pile driving in 2026 resulted in an estimated 25.5 (rounded to 26) takes by level B harassment in that year. Since these alternate estimates of take by Level B harassment for humpback whales are higher than numbers calculated based on the exposure analysis method described above. To be conservative, Empire Wind requested, and NMFS is proposing to authorize, take by Level B harassment of 60 humpback whales in 2025 and 26 whales in 2026 based on this alternate take calculation method.

At a rate of 1.11 fin whales per day, 120 days of pile driving in 2025 resulted in an estimated 133 takes by level B harassment in that year, and 51 days of pile driving in 2026 resulted in an estimated 56.6 (rounded to 57) takes by level B harassment in that year. Since these alternate estimates of take by Level B harassment for fin whales are higher than numbers calculated based on the exposure analysis method described above, Empire Wind has requested, and NMFS is proposing to authorize, take by Level B harassment for fin whales (133 in 2025; 57 in 2026) based on this alternate take calculation method.

At a rate of 1.34 pilot whales per day, 120 days of pile driving in 2025 resulted in an estimated 160.7 (rounded to 161) takes by level B harassment in that year, and 51 days of pile driving in 2026 resulted in an estimated 68 takes by level B harassment in that year. Since these alternate estimates of take by Level B harassment for pilot whales are higher than numbers calculated based on the exposure analysis method. Empire Wind has requested take by Level B harassment for pilot whales based on this alternate take calculation method. NMFS concurs with this assessment and is proposing to authorize the same number of takes by Level B harassment for 2025 (161) and 2026 (68).

For certain species for which the exposure modeling methodology described previously above may result in potential underestimates of take and Empire Wind's PSO sightings data were relatively low, adjustments to the take request were made based on the best available information on marine mammal group sizes to ensure conservatism. For species considered rare but still have the potential for occurrence in the Project Area, requested take by Level B harassment was adjusted to one group size per year. NMFS concurs with this assessment and is proposing to authorize take by Level B harassment of 3 sperm whales per year in 2025 and 2026 (Barkaszi *et al.* 2019); 45 Atlantic spotted dolphins per year in 2025 and 2026 (Kenney and Vigness-Raposa 2010); and 100 Risso's dolphins per year in 2025 and 2026 (100 individuals; Jefferson *et al.* 2015).

For species considered relatively common in the Project Area, requested take by Level B harassment was adjusted to one group size per month. These include Atlantic white-sided dolphins (52 individuals, Jefferson *et al.* 2015) and North Atlantic right whales. The group size determination for North Atlantic right whales was derived based on consultation with NOAA Fisheries. A group size of 1 animal was used for months with mean monthly densities less than 0.01, while a group size of 2 animals, reflective of the potential for a mother and calf, was used for months with mean monthly densities greater than 0.01 based on the Roberts and Halpin 2022 predictive densities. For the months when pile driving activities may occur (May through December), those criteria result in a group size of 1 animal for the months of June through October and 2 animals for the months of May, November, and December. This group size determination is intended to account for the potential presence of mother-calf pairs. Therefore, Empire Wind requested and NMFS is proposing to authorize 11 takes of North Atlantic right whale by Level B harassment per year in 2025 and 2026 and 416 takes of Atlantic white-sided dolphin by Level B harassment per year in 2025 and 2026.

For species considered common in the Project Area, requested takes by Level B harassment was adjusted to one group size per day. These include short-beaked common dolphins (30 individuals, Reeves *et al.* 2002), and bottlenose dolphins (15 individuals, Jefferson *et al.* 2015). Empire Wind has requested, and NMFS is proposing to authorize, 3,600 and 1,530 takes of short-beaked common dolphins by Level B harassment per year in 2025 and 2026. Empire Wind has also requested, and NMFS is proposing to authorize, 1,800 and 765 takes of bottlenose dolphins by Level B harassment per year in 2025 and 2026 respectively.

Cable Landfall Construction

As described in the Description of the Specified Activities section above, Empire Wind is considering two options to facilitate the transition of the offshore export cable to the onshore cable: (1) a cofferdam or (2) a casing pipe with goal posts. The general methodologies used to estimate take of marine mammals incidental to cable landfall construction activities is described above. Here we present details regarding those methodologies specific to these activities followed by the take NMFS proposes to authorize incidental to cable landfall construction.

Cofferdam Vibratory Driving—As many as two temporary cofferdams may be installed for EW 1 and as many as three temporary cofferdams may be installed for EW 2. Empire Wind assumed a source level of 195 dB SEL and 195 dB rms at 10 m (Schultz-von Glahn *et al.* 2006). As described above, propagation modeling was conducted using dBSea. Resulting distances to NMFS harassment isopleths for cofferdam installation are provided in Table 26 (note that very shallow water depths (3–4 m) at the cofferdam pile driving site is responsible for the limited acoustic propagation of vibratory driving noise.

TABLE 26—DISTANCES (METERS) TO THE LEVEL A AND LEVEL B HARASSMENT THRESHOLD ISOPLETHS FOR COFFERDAM VIBRATORY PILE DRIVING AND ESTIMATED AREA OF LEVEL B HARASSMENT ZONE

Location	PTS onset by hearing group (m)				Behavioral harassment	Area within estimated Level B harassment zone (km^2)
	LF (199 $L_{E,\ 24\ hr}$)	MF (198 $L_{E,\ 24\ hr}$)	HF (173 $L_{E,\ 24\ hr}$)	PW (201 $L_{E,\ 24\ hr}$)	ALL (120 SPL RMS)	
EW 1	122	0	44	62	1,985	2.679
EW 2	13	0	12	11	1,535	1.672

Note: LF = low-frequency cetaceans; MF = mid-frequency cetaceans; HF = high-frequency cetaceans; PW = pinnipeds in water.

To estimate take, Empire Wind averaged the maximum monthly densities by season as reported by Roberts and Halpin (2002): spring (March through May), summer (June through August), fall (September through November), and winter (December through February). To be conservative, the maximum average seasonal density for each species was then carried forward in the take calculations.

Empire Wind considered the ensonified areas and density estimates to calculate potential exposures (Table 27). However, for some species, group size data demonstrate that the density-based exposure calculations underestimate the potential for take. Hence, the amount of requested take varies from exposure estimates (Table 27). Given the noise from cofferdam installation would not extend beyond the 20-m isobath, where the coastal stock predominates, it is expected that only the coastal stock of bottlenose dolphins is likely to be taken by this activity. As the density models do not account for group size and the resulting calculated exposures were very small, the predicted take was increased to account for the exposure of one average-sized group per day each of bottlenose and common dolphins.

Due to the presence of several seal haul outs, Empire Wind determined the Roberts and Halpin (2022) density data likely underestimated potential seal occurrence; therefore, 10 Level B harassment seal takes per day were estimated, based on pinniped observations in New York City between 2011 and 2017 (Woo and Biolsi, 2018). For pinnipeds, because the seasonality of and habitat use by gray seals roughly overlaps with harbor seals, and the density data as presented by Roberts and Halpin (2022) do not differentiate between pinniped species, the estimated takes were split evenly between harbor and gray seals (Table 27). Note that any species in Table 27 where the calculated take was less than 0.5 animals, the proposed take was reduced to zero.

TABLE 27—AVERAGE MARINE MAMMAL DENSITIES, EXPOSURE ESTIMATES AND AMOUNT OF PROPOSED TAKE (IN PARENTHESES), BY LEVEL B HARASSMENT, FROM COFFERDAM VIBRATORY PILE DRIVING [f]

Species	EW 1 cofferdams (2024)		EW 2 cofferdams (2024–2025) totals		Total proposed take by Level B harassment
	Average seasonal density [a] (No./100 km²)	Calculated take (proposed take) by Level B harassment	Average seasonal density [a] (No/.100 km²)	Calculated take (proposed take) by Level B harassment	
North Atlantic Right Whale	0.073	0.020 (0)	0.073	0.020 (0)	0
Humpback Whale	0.099	0.030 (0)	0.099	0.030 (0)	0
Fin Whale	0.097	0.030 (0)	0.097	0.030 (0)	0
Sei Whale	0.030	0.010 (0)	0.030	0.010 (0)	0
Sperm Whale	0.006	0.000 (0)	0.006	0.000 (0)	
Minke Whale	0.526	0.170 (0)	0.526	0.160 (0)	0
Bottlenose dolphin (Western N.A. Northern Migratory Coastal Stock) [b]	6.299	2.030 (180)	6.299	1.900 (270)	450
Atlantic Spotted Dolphin	0.058	0.020 (0)	0.058	0.020 (0)	0
Short-beaked common dolphin [c]	2.837	0.910 (360)	2.837	0.850 (540)	900
Atlantic White-sided Dolphin	0.469	0.150 (0)	0.469	0.140 (0)	0
Risso's dolphin	0.034	0.010 (0)	0.034	0.010 (0)	0
Pilot whales spp. [d]	0.019	0.010 (0)	0.019	0.010 (0)	0
Harbor porpoise	3.177	1.020 (1)	3.177	0.960 (1)	2
Harbor seal [e]	13.673	2.200 (60)	13.673	2.060 (90)	150
Gray seal [e]	13.673	2.200 (60)	13.673	2.060 (90)	150

[a] Cetacean density values from Duke University (Roberts and Halpin, 2022).

[b] Bottlenose dolphin density values from Duke University (Roberts and Halpin, 2022) reported as "bottlenose" and not identified to stock. Given the noise from cofferdam installation would not extend beyond the 20 m isobath, where the coastal stock predominates, it is expected that all estimated takes by Level B harassment of bottlenose dolphins from cofferdam installation will accrue to the coastal stock. As Roberts and Halpin does not account for group size, the requested and proposed take was adjusted to account for one group size, 15 individuals (Jefferson *et al.,* 2015) per day (18 days) of bottlenose.

[c] As Roberts *et al.* does not account for group size, the estimated take was adjusted to account for one group size, 30 individuals (Reeves *et al.,* 2002) per day of each common dolphins.

[d] Pilot whale density values from Duke University (Roberts and Halpin, 2022) reported as "*Globicephala spp.*" and not species-specific.

[e] Pinniped density values from Duke University (Roberts and Halpin, 2022) are reported as "seals" and are not species-specific, therefore, 50 percent of expected takes by Level B harassment are expected to accrue to harbor seals and 50 percent to gray seals. Due to the presence of several seal haul outs in the area, requested and proposed level B harassment seal takes were calculated by estimating 10 individuals per day (9 days) (Woo and Biolsi, 2018), divided evenly between harbor seals and gray seals.

[f] Data not available for harp seals for which take was requested and is being proposed.

Casing Pipe and Goal Post Impact Pile Driving—Empire Wind estimated distances to NMFS thresholds using the optional User Spreadsheet tool. The casing pipe may be installed using a pneumatic hammer, hence the number of strikes considered is high. The goal posts would be installed with a traditional impact hammer. Parameters input into the user spreadsheet for casing pipe and goal post installation and removal are provided in Table 28.

TABLE 28—ESTIMATED SOURCE LEVELS (AT 10 m) AND INSTALLATION RATES FOR CASING PIPE AND GOAL POST INSTALLATION

Structure	dB SEL	dB rms	#strikes per pile	Piles per day	Transmission loss
Casing pipe	166	182	43,200	1	15 log.
Goal Posts	174	184	2,000	2	

Using NMFS' Multi-Species Calculator Tool and the assumptions provided above, Empire Wind calculated distances to PTS and Level B harassment thresholds from casing pipe and goal post installation. The resulting distances to NMFS thresholds are provided in Table 29.

TABLE 29—DISTANCES (METERS) TO THE LEVEL A AND LEVEL B HARASSMENT THRESHOLD ISOPLETH DISTANCES FOR CASING PIPE AND GOAL POST IMPACT PILE DRIVING

Scenario	PTS onset by hearing group (m)								Behavioral harassment SPL (m)
	LF		MF		HF		PW		
	peak	SEL	peak	SEL	peak	SEL	peak	SEL	
Pile	219	183	230	185	202	155	218	185	160
42" casing pipe	0.3	904.5	0.1	32.2	4.6	1,077.4	0.4	484	293
12-inch steel goal post	0	632.1	0	22.5	7.4	752.9	0	338.3	398.1

Note: LF = low-frequency cetaceans; MF = mid-frequency cetaceans; HF = high-frequency cetaceans; PW = pinnipeds in water.

As described above, either cofferdams or goal post and casing pipe installation may occur as part of cable landfall activities, but not both. For goal post installation, two hours per goal post (two piles), for 3 goal posts (6 piles) per HDD, for a total of 18 piles and 36 total hours of pile driving are anticipated. For cofferdams, there is 1 hour per day for 6 days (installation and removal) per cofferdam for a total of 18 hours pile driving anticipated. While modeled distances to the Level A harassment threshold for goal post pile driving were larger than for cofferdam vibratory driving based on the SEL_{cum} metric, it should be noted that modeled distances based on the SEL_{cum} metric are based on the assumption that an individual animal remains at that distance for the entire duration of pile driving in order to incur PTS. This is not considered realistic as marine mammals are highly mobile. As modeled distances to the Level B harassment threshold and zones of influence for Level B harassment were orders of magnitude larger for cofferdam vibratory driving compared to goal post pile driving (compare Table 26 to Table 29), the amount of take resulting from cofferdam vibratory driving activities were determined to be greater than that of the alternative goal post and casing pipe scenario. Therefore, to be conservative the cofferdam scenario was carried forward for the analysis of potential takes by harassment from cable landfall activities. As such, goal post pile driving is not analyzed further in this application.

Since the acoustic impact of the marina work was minimal and densities are not available for the specific inshore region where the activity will occur, potential take by harassment for marine mammals could not be calculated. Instead, to be conservative, 10 takes by Level B harassment of seals per day were estimated (Woo and Biolsi 2018), which were split evenly between harbor and gray seals.

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

Estimated Take = D × ZOI × (d)

Where:

D = average highest species density (number per km2)

ZOI = maximum ensonified area to MMPA threshold for impulsive noise (160 dB RMS 90 percent re 1 μPa)

d = number of days

The area ensonified to the Level B harassment threshold, as well as the projected duration of cofferdam installation and removal at each respective vibratory pile driving location, was then used to produce the results of take calculations provided in Table 27. It is expected to take three days to install and three days to remove each cofferdam. Therefore six days of vibratory pile driving/removal at each location were included. It should be noted that calculations do not take into account whether a single animal is harassed multiple times or whether each exposure is a different animal. Therefore, the numbers in Table 28 are the maximum number of animals that may be exposed to sound above relevant thresholds during vibratory pile driving (*i.e.,* Empire Wind assumes that each exposure event is a different animal).

For cofferdam exposure estimates, the Robert and Halpin (2022) densities were overlaid on the modeled Level B harassment zones to estimate exposures. The maximum monthly densities as reported by Roberts and Halpin (2022) were averaged by season over the duration of cofferdam installation/removal (spring (March through May), summer (June through August), fall (September through November), and winter (December through February)). To be conservative, the maximum average seasonal density for each species was then carried forward in the take calculations. Bottlenose dolphin density values from Duke University (Roberts and Halpin, 2022) are reported as ''bottlenose'' and not identified to stock. Given the noise from cofferdam installation would not extend beyond the 20-m isobath, where the coastal stock predominates, it is expected that all estimated takes by Level B harassment of bottlenose dolphins harassment from cofferdam installation will accrue to the coastal stock. As the density models do not account for group size, the estimated take was adjusted to account for one group size per day of each of bottlenose (group size of 15) and common dolphins (group size of 30) as shown in Table 27.

Marina Activities

Pile driving at the onshore substation C constitutes a small amount of work. Empire Wind assumed source levels during pile driving sheet piles at onshore substation C would be similar to that during installation of the cofferdams for cable landfall construction. Since densities are not available for the specific inshore region where the activity will occur, potential take by harassment for marine mammals using density could not be calculated. Instead, to be conservative, 10 takes by Level B harassment of seals per day (49 days) were estimated based on pinniped observations in New York City between 2011 and 2017 (Woo and Biolsi, 2018), which were split evenly between harbor and gray seals (Table 31). Similarly, the requested and proposed take of bottlenose dolphins was adjusted to account for one group size, 15 individuals (Jefferson *et al.,* 2015) per day for 49 days.

TABLE 30—DISTANCES (METERS) TO THE LEVEL A AND LEVEL B HARASSMENT THRESHOLD ISOPLETH DISTANCES FOR VIBRATORY DRIVING AT ONSHORE SUBSTATION C LOCATION MARINA

Location	PTS onset by hearing group				Behavioral response
	LF (199 $L_{E,\ 24hr}$)	MF (199 $L_{E,\ 24hr}$)	HF (199 $L_{E,\ 24hr}$)	PHOCID (199 $L_{E,\ 24hr}$)	All (120 SPL RMS)
Marina Bulkhead Work (Sheetpile installation)	43.2	3.8	63.8	26.2	1,000
Marina Berthing Pile Removal	43.5	3.9	64.3	26.5	1,600

TABLE 31—AVERAGE MARINE MAMMAL DENSITIES USED IN EXPOSURE ESTIMATES AND ESTIMATES OF POTENTIAL TAKES BY LEVEL B HARASSMENT FROM MARINA PILE DRIVING

Species	Marina work (2024)	
	Average seasonal density [a] (No./100 km^2)	Proposed take by level B harassment
Bottlenose dolphin (Western N.A. Northern Migratory Coastal Stock) [b]	6.299	735
Harbor seal [c]	13.673	245
Gray seal [c]	13.673	245

[a] Cetacean density values from Duke University (Roberts and Halpin, 2022).

[b] Bottlenose dolphin density values from Duke University (Roberts and Halpin, 2022) reported as "bottlenose" and not identified to stock. Given the noise from cofferdam installation would not extend beyond the 20 m isobath, where the coastal stock predominates, it is expected that all estimated takes by Level B harassment of bottlenose dolphins from cofferdam installation will accrue to the coastal stock. As Roberts and Halpin (2022) does not account for group size, the requested take was adjusted to account for one group size, 15 individuals (Jefferson *et al.,* 2015) per day of bottlenose.

[c] Pinniped density values from Duke University (Roberts and Halpin, 2022) are reported as "seals" and are not species-specific, therefore, 50 percent of expected takes by Level B harassment are expected to accrue to harbor seals and 50 percent to gray seals.

HRG Survey Activities

Empire Wind's proposed HRG survey activity includes the use of non-impulsive sources (*i.e.,* CHIRP SBPs) that have the potential to harass marine mammals. Of the list of equipment proposed in Table 2 (see Detailed Description of Specified Activities), USBL, MBES, SSS, and the Innomar SBP were removed from further analysis due to either the extremely low likelihood of the equipment resulting in marine mammal harassment (*i.e.,* USBL, MBES, select SSS) or due to negligible calculated isopleth distances corresponding to the Level B harassment threshold (<2 m) (*i.e.,* select SSS and Innomar SBP). No boomers or sparkers would be used.

Authorized takes would be by Level B harassment only in the form of disruption of behavioral patterns for individual marine mammals resulting from exposure to noise from certain HRG acoustic sources. Based primarily on the characteristics of the signals produced by the acoustic sources planned for use, Level A harassment is neither anticipated, even absent mitigation, nor proposed to be authorized. Therefore, the potential for Level A harassment is not evaluated further in this document. Empire Wind did not request, and NMFS is not proposing to authorize, take by Level A harassment incidental to HRG surveys. No serious injury or mortality is anticipated to result from HRG survey activities.

Specific to HRG surveys, in order to better consider the narrower and directional beams of the sources, NMFS has developed a tool for determining the sound pressure level (SPLrms) at the 160 dB isopleth for the purposes of estimating the extent of Level B harassment isopleths associated with HRG survey equipment (NMFS, 2020). This methodology incorporates frequency-dependent absorption and some directionality to refine estimated ensonified zones. Empire Wind used NMFS' methodology with additional modifications to incorporate a seawater absorption formula and account for energy emitted outside of the primary beam of the source. For sources that operate with different beam widths, the maximum beam width was used, and the lowest frequency of the source was used when calculating the frequency-dependent absorption coefficient.

The isopleth distances corresponding to the Level B harassment threshold for each type of HRG equipment with the potential to result in harassment of marine mammals were calculated per NOAA Fisheries' Interim Recommendation for Sound Source Level and Propagation Analysis for High Resolution Geophysical Sources. The distances to the 160 dB RMS re 1 μPa isopleth for Level B harassment are presented in Table 31. Please refer to Section 6.3.2 of the LOA application for a full description of the methodology and formulas used to calculate distances to the Level B harassment threshold.

TABLE 31—ISOPLETH DISTANCES CORRESPONDING TO THE LEVEL B HARASSMENT THRESHOLD FOR HRG EQUIPMENT

HRG survey equipment	Source level (SL_{RMS}) (dB re 1μPa)	Lateral distance (m) to Level B harassment threshold
Edgetech DW106	194	50.00

TABLE 31—ISOPLETH DISTANCES CORRESPONDING TO THE LEVEL B HARASSMENT THRESHOLD FOR HRG EQUIPMENT—Continued

HRG survey equipment	Source level (SL_{RMS}) (dB re 1µPa)	Lateral distance (m) to Level B harassment threshold
Edgetech 424	180	8.75
Teledyne Benthos Chirp III—TTV 170	219	50.05

The survey activities that have the potential to result in Level B harassment (160 $dB_{RMS90\ percent}$ re 1 µPa) include the noise produced by EdgeTech DW106, EdgeTech 424, or Teledyne Benthos Chirp III (see Table 31), of which the Teledyne Benthos Chirp III results in the greatest calculated distance to the Level B harassment criteria at 50.05 m (164 ft). Therefore, to be conservative, Empire Wind has applied the estimated distance of 50.05 m (164 ft) to the 160 $dB_{RMS90\ percent}$ re 1 µPa Level B harassment criteria as the basis for determining potential take from all HRG sources.

The basis for the take estimate is the number of marine mammals that would be exposed to sound levels in excess of the Level B harassment threshold (160 dB). Typically, this is determined by estimating an ensonified area for the activity, by calculating the area associated with the isopleth distance corresponding to the Level B harassment threshold. This area is then multiplied by marine mammal density estimates in the project area and then corrected for seasonal use by marine mammals, seasonal duration of Project-specific noise-generating activities, and estimated duration of individual activities when the maximum noise-generating activities are intermittent or occasional.

The estimated distance of the daily vessel track line was determined using the estimated average speed of the vessel and the 24-hour operational period within each of the corresponding survey segments. All noise-producing survey equipment is assumed to be operated concurrently. Using the distance of 50.05 m (164 ft) to the 160 $dB_{RMS90\ percent}$ re 1 µPa Level B harassment isopleth (Table 31), the estimated daily vessel track of approximately 177.792 km (110.475 mi) for 24-hour operations, inclusive of an additional circular area to account for radial distance at the start and end of a 24-hour cycle, estimates of the total area ensonified to the Level B harassment threshold per day of HRG surveys were calculated (Table 32).

TABLE 32—ESTIMATED NUMBER OF SURVEY DAYS, ESTIMATED SURVEY DISTANCE PER DAY, AND ESTIMATED DAILY ENSONIFIED AREA FOR HRG SURVEYS, FROM 2024 THROUGH 2029

Survey segment	Number of active survey vessel days	Estimated distance per day (km)	Calculated daily ensonfied area (km^2)
2024 Survey Effort	41	177.792	17.805
2025 Survey Effort	191		
2026 Survey Effort	150		
2027 Survey Effort	100		
2028–January 2029 Survey Effort	100		

As described in the LOA application, density data were mapped within the boundary of the Project Area (Figure 1 in the LOA application) using geographic information systems; these data were updated based on the revised data from Roberts and Halpin (2022) (Table 33). Maximum monthly densities as reported by Roberts and Halpin (2022) were averaged by season over the survey duration (for winter (December through February)), spring (March through May), summer (June through August), and fall (September through November)) for the entire HRG Project Area. To be conservative, the maximum average seasonal density within the HRG survey schedule, for each species, was then carried forward in the take calculations (Table 33).

TABLE 33—MARINE MAMMAL DENSITIES USED IN EXPOSURE ESTIMATES AND ESTIMATED TAKES BY LEVEL B HARASSMENT FROM HRG SURVEYS

Species	Average seasonal density [a] (No./100 km^2)	HRG survey 2024—calculated take (No.)	HRG survey 2025—calculated take (No.)	HRG survey 2026—calculated take (No.)	HRG survey 2027—calculated take (No.)	HRG survey 2028–January 2029—calculated take (No.)	Total requested take (No.)
North Atlantic Right Whale	0.073	0.532	2.480	1.948	1.298	0.605	7
Humpback	0.099	0.722	3.363	2.641	1.761	1.192	11
Fin	0.097	0.707	3.295	2.588	1.725	1.227	11
Sei	0.030	0.219	1.019	0.800	0.534	0.320	4
Sperm	0.006	0.044	0.204	0.160	0.107	0.071	0
Minke	0.526	3.836	17.870	14.034	9.356	3.468	54
Pilot whales *spp.* [d]	0.019	0.139	0.645	0.507	0.338	0.338	[b] 780
Bottlenose dolphin (Western N.A. Northern Migratory Coastal Stock) [b]	6.299	45.937	213.997	168.060	112.040	66.932	[c] 8,730

TABLE 33—MARINE MAMMAL DENSITIES USED IN EXPOSURE ESTIMATES AND ESTIMATED TAKES BY LEVEL B HARASSMENT FROM HRG SURVEYS—Continued

Species	Average seasonal density[a] (No./100 km^2)	HRG survey 2024—calculated take (No.)	HRG survey 2025—calculated take (No.)	HRG survey 2026—calculated take (No.)	HRG survey 2027—calculated take (No.)	HRG survey 2028–January 2029—calculated take (No.)	Total requested take (No.)
Atlantic White-sided Dolphin[d]	0.469	3.420	15.933	12.513	8.342	6.297	1,008
Short-beaked common dolphin[c]	2.837	20.689	96.382	75.693	50.462	31.501	17,460
Atlantic Spotted Dolphin[e]	0.058	0.423	1.970	1.547	1.032	0.338	225
Risso's dolphin	0.035	0.255	1.189	0.934	0.623	0.249	500
Harbor porpoise	3.177	23.169	107.933	84.764	56.509	28.762	330
Harbor seal[f]	13.673	48.859	232.258	182.401	121.601	85.102	708
Gray seal[f]	13.673	48.859	232.258	182.401	121.601	85.102	708

[a] Cetacean density values from Duke University (Roberts and Halpin, 2022).

[b] Requested take adjusted based on PSO sighting data from 2018–2021 (A.I.S., 2019; Alpine Ocean Seismic Survey, 2018; Gardline, 2021a, b; Geoquip Marine, 2021; Marine Ventures International, 2021; RPS, 2021; Smultea Environmental Sciences, 2019, 2020, 2021).

[c] Bottlenose dolphin density values from Duke University (Roberts and Halpin, 2022) reported as "bottlenose dolphin" and not identified to stock. HRG survey activities were not differentiated by region relative to the 20-m isopleth and therefore bottlenose takes are not identified to stock. As Roberts and Halpin does not account for group size, the estimated take was adjusted to account for one group size, 15 individuals (Jefferson *et al.,* 2015) per day of bottlenose dolphins and 30 individuals (Reeves *et al.,* 2002), per day of common dolphins.

[d] As Roberts and Halpin does not account for group size, the estimated take was adjusted to account for one group size, 52 individuals (Jefferson *et al.,* 2015) per month of Atlantic white-sided dolphins.

[e] As Roberts and Halpin does not account for group size, the estimated take was adjusted to account for one group size, 100 individuals (Jefferson *et al.,* 2015), per year of Risso's dolphins and 45 individuals (Kenney and Vigness-Raposa, 2010) per year of Atlantic spotted dolphins.

[f] Pinniped density values from Duke University (Roberts and Halpin, 2022) reported as "seals," so take allocated by 50 percent accrued to harbor seals and 50 percent accrued to gray seals.

The calculated exposure estimates based on the exposure modeling methodology described above were compared with the best available information on marine mammal group sizes, and with Empire Wind's PSO sightings data ranging from 2018–2021 for the Project Area, to ensure requested take numbers associated with HRG survey activities were conservative and based on best available information. As a result of this comparison, it was determined that the calculated number of potential takes by Level B harassment based on the exposure modeling methodology above may be underestimates for some species and therefore warranted adjustment to ensure conservatism in requested take numbers. Despite the relatively small modeled Level B harassment zone (50 m) for HRG survey activities, it was determined that adjustments to the requested numbers of take by Level B harassment for some dolphin species was warranted in some cases to be conservative, based on the expectation that dolphins may approach or bow ride near the survey vessel. No adjustments were made to take requests for large whale species as a result of HRG survey activities due to the relatively small Level B harassment zone (50 m) and the low likelihood that large whales would be encountered within such a short distance of the vessel except in rare circumstances.

For certain species for which the density-based methodology described above may result in potential underestimates of take and Empire Wind's PSO sightings data were relatively low, adjustments to the exposure estimates were made based on the best available information on marine mammal group sizes to ensure conservatism. For species considered common in the Project Area, requested takes by Level B harassment was adjusted to one group size per day of HRG surveys; these include bottlenose dolphins (15 individuals; Jefferson *et al.,* 2015) and common dolphins (30 individuals; Reeves *et al.,* 2002) (note that these adjustments to take estimates were made previously and are included in the LOA application). For species considered relatively common in the Project Area, requested takes by Level B harassment were adjusted to one group size per month of HRG surveys; these include Atlantic white-sided dolphins (52 individuals; Jefferson *et al.,* 2015). For species considered rare but that still have the potential for occurrence in the Project Area, requested takes by Level B harassment were adjusted to one group size per year of HRG surveys; these include Atlantic spotted dolphin (45 individuals; Kenney & Vigness-Raposa, 2010) and Risso's dolphin (100 individuals; Jefferson *et al.,* 2015). The requested take for pilot whales was adjusted based on PSO data by multiplying the maximum reported daily density (1.34 individuals; Geoquip Marine, 2021) by the annual days of operation.

Total Proposed Take Across All Activities

Level A harassment and Level B harassment proposed take numbers for the combined activities of impact pile driving (assuming 10-dB of sound attenuation) during the impact installation of monopile and OSS foundations, cable landfall and marina activities and removal and HRG surveys are shown in Table 34. NMFS also presents the 5-year total amount of take for each species in Table 35. The mitigation and monitoring measures provided in the Proposed Mitigation and Proposed Monitoring and Reporting sections are activity-specific and are designed to minimize acoustic exposures to marine mammal species.

The take numbers NMFS proposes for authorization (Table 34) are considered conservative (*i.e.,* somewhat higher than is most likely to occur) for the following key reasons:

- Proposed take numbers assume that up to one WTG monopile foundation and two pin piles for OSS foundations would be installed per day, by impact pile driving, to estimate the maximum potential for both Level A and Level B harassment. However, Empire Wind may install more than one monopile and more than two pin piles per day, completing the project more quickly. These proposed numbers also assumed that all foundations would be installed during the highest density months.
- The maximum number of sheet piles (n=300) for all temporary cofferdams (n=5) would be installed;
- The casing pipe and the maximum number of piles (n=18) necessary for all goal posts (n=3) would be installed;
- Proposed take numbers for the vibratory pile driving associated with temporary cofferdams assume the maximum number of sheet piles (n=300) would be installed;
- Proposed Level A harassment takes do not fully account for the likelihood that marine mammals would avoid a stimulus when possible before the individual accumulates enough acoustic

energy to potentially cause auditory injury, or the effectiveness of the proposed monitoring and mitigation measures (with exception of North Atlantic right whales, given the extensive mitigation measures proposed for this species).

Table 34 below depicts the proposed annual take for authorization over the length of the proposed authorization, given that specific activities are expected to occur within specific years. Empire Wind plans that all construction activities related to permanent structures (*i.e.,* monopile foundations and OSS foundations installation, cofferdams) would occur within the first two years of the project (2024–2025). HRG surveys are expected to occur, with varying effort, across all 5-years of the proposed rulemaking's effective duration. In addition to HRG surveys occurring during parts of Year 1 (2024) and Year 2 (2025), the entire durations of Year 3 (2026), Year 4 (2027), and Year 5 (2028–2029) are only expected to consist of HRG surveys as all construction-specific activities are expected to be completed by the start of Year 3. NMFS notes that while HRG surveys are expected to occur across all five years (2024–2029) of the effective period of the rulemaking (a total of 582 days across all 5 years), survey effort will vary. All activities are expected to be completed by 2029, equating to the five years of activities, as described in this preamble.

Table 34 shows the estimated take of each species for each year based on the planned distribution of activities. Tables 35 and 36 show the total take over five years and the maximum take proposed for authorization in any one year, respectively.

TABLE 34—PROPOSED LEVEL A HARASSMENT AND LEVEL B HARASSMENT TAKES FOR ALL ACTIVITIES PROPOSED TO BE CONDUCTED DURING THE CONSTRUCTION OF EMPIRE WIND PROJECT OVER 5 YEARS

Marine mammal species	NMFS stock abundance	Year 1		Year 2		Year 3		Year 4		Year 5	
		Level A harassment	Level B harassment	Level A harassment	Level B harassment	Level A harassment	Level B harassment	Level A harassment	Level B harassment	Level A harassment	Level B harassment
Mysticetes											
Fin Whale *	6,802	0	1	1	136	1	60	0	2	0	2
Humpback Whale	1,396	0	1	0	63	0	29	0	2	0	2
Minke Whale	21,968	0	4	4	83	0	62	2	9	0	3
North Atlantic Right Whale *	338	0	1	0	13	0	13	0	1	0	1
Sei Whale *	6,292	0	0	0	4	0	3	0	1	0	1
Odontocetes											
Atlantic Spotted Dolphin	39,921	0	45	0	90	0	90	0	1	0	1
Atlantic White-sided Dolphin	93,233	0	71	0	747	0	676	0	178	0	173
Bottlenose Dolphin [a]											
Western North Atlantic, Offshore	62,851	0	0	0	1,800	0	765	0	0	0	0
Western North Atlantic, Coastal	6,639	0	1,185	0	270	0	0	0	0	0	0
Western North Atlantic, Offshore and Coastal	....	0	615	0	2,865	0	2,250	0	1,500	0	1,500
Common Dolphin	172,974	0	2,130	0	9,870	0	6,030	0	3,000	0	3,000
Harbor Porpoise	95,543	0	25	0	243	0	183	0	57	0	57
Pilot Whales [b]	68,139	0	55	0	417	0	269	0	25	0	25
Risso's Dolphin	35,215	0	100	0	200	0	200	0	25	0	25
Sperm Whale *	1,180	0	0	0	3	0	3	0	0	0	0
Phocid (pinnipeds)											
Gray Seal [c]	27,300	0	445	0	484	0	294	0	122	0	122
Harbor Seal [c]	61,336	0	445	0	678	0	412	0	122	0	122
Harp Seal [d]	7.6 M	0	4	0	4	0	4	0	4	0	4

* Denotes species listed under the Endangered Species Act.

[a] Bottlenose dolphin density values from Duke University (Roberts and Halpin 2022) reported as ''bottlenose dolphin'' and not identified to stock. Given the noise from cofferdam installation would not extend beyond the 20-meter isobath, where the coastal stock predominates, all estimated takes by Level B harassment of bottlenose dolphins from cofferdam installation were attributed to the coastal stock. Takes from impact pile driving were attributed to each stock (coastal and offshore) according to delineation along the 20-meter isobath during the animat modeling process. Takes from HRG survey activities were not differentiated.

[b] Pilot whale density values from Duke University (Roberts and Halpin 2022) reported as ''Globicephala spp.'' and not species-specific.

[c] Pinniped density values from Duke University (Roberts and Halpin 2022) reported as ''seals'' and not species-specific, so take allocated by 50% accrued to harbor seals and 50% accrued to gray seals for cable landfall construction, marina construction, and HRG surveys. Scaling based on abundance was used for WTG and OSS foundation installation.

[d] Harp seal occurrence is anticipated to be rare. Anecdotal stranding data indicate only a few harp seals are sighted within the vicinity of the Project each year. Therefore, 4 harp seal Level B takes have been requested per year of the Project.

TABLE 35—TOTAL 5-YEAR PROPOSED TAKES OF MARINE MAMMALS (BY LEVEL A HARASSMENT AND LEVEL B HARASSMENT) FOR ALL ACTIVITIES PROPOSED TO BE CONDUCTED DURING THE CONSTRUCTION OF EMPIRE WIND PROJECT

Marine mammal species	NMFS stock abundance	5-Year totals		
		Proposed Level A harassment	Proposed Level B harassment	5-year sum (Level A harassment + Level B harassment)
Mysticetes				
Fin Whale *	6,802	2	201	203
Humpback Whale	1,396	0	97	97
Minke Whale	21,968	6	167	173

TABLE 35—TOTAL 5-YEAR PROPOSED TAKES OF MARINE MAMMALS (BY LEVEL A HARASSMENT AND LEVEL B HARASSMENT) FOR ALL ACTIVITIES PROPOSED TO BE CONDUCTED DURING THE CONSTRUCTION OF EMPIRE WIND PROJECT—Continued

Marine mammal species	NMFS stock abundance	5-Year totals		
		Proposed Level A harassment	Proposed Level B harassment	5-year sum (Level A harassment + Level B harassment)
North Atlantic Right Whale *	336	0	29	29
Sei Whale *	6,292	0	9	9
Odontocetes				
Atlantic Spotted Dolphin	39,921	0	227	227
Atlantic White-sided Dolphin	93,221	0	1,840	1,840
Bottlenose Dolphin (WNA Offshore)	62,851	0	2,565	2,563
Bottlenose Dolphin (Northern Migratory Coastal)	6,639	0	1,455	1,455
Bottlenose Dolphin (WNA Offshore and Northern Migratory Coastal)	69,490	0	8,730	8,730
Common Dolphin	172,974	0	24,030	24,030
Harbor Porpoise	95,543	0	565	565
Pilot Whales	68,139	0	552	552
Risso's Dolphin	35,215	0	700	700
Sperm Whale *	4,349	0	6	6
Phocid (pinnipeds)				
Gray Seal	27,300	0	1,467	1,467
Harbor Seal	61,336	0	1,779	1,779
Harp Seal [a]	UNK	0	20	20

* Denotes species listed under the Endangered Species Act.
[a] Harp seal occurrence is anticipated to be rare. Anecdotal stranding data indicate only a few harp seals are sighted within the vicinity of the Project each year. Therefore, 4 harp seal Level B harassment takes have been requested per year of the Project.

To inform both the negligible impact analysis and the small numbers determination, NMFS assesses the greatest amount of proposed take of marine mammals that could occur within any given year (which in the case of this rule is based on the predicted Year 1 for all species). In this calculation, the maximum estimated number of Level A harassment takes in any one year is summed with the maximum estimated number of Level B harassment takes in any one year for each species to yield the highest number of estimated take that could occur in any year (Table 36). Table 36 also depicts the amount of take proposed relative to each stock assuming that each individual is taken only once, which specifically informs the small numbers determination.

TABLE 36—MAXIMUM NUMBER OF PROPOSED TAKES (LEVEL A HARASSMENT AND LEVEL B HARASSMENT) THAT COULD OCCUR IN ANY ONE YEAR OF THE PROJECT RELATIVE TO STOCK POPULATION SIZE ASSUMING EACH TAKE IS OF A DIFFERENT INDIVIDUAL

Marine mammal species	NMFS stock abundance	Maximum annual take proposed for authorization			
		Maximum Level A harassment	Maximum Level B harassment	Maximum annual take [a]	Total percent stock taken based on maximum annual take [b]
Mysticetes					
Fin Whale *	6,802	1	136	137	2.01
Humpback Whale	1,396	0	63	63	4.51
Minke Whale	21,968	4	83	87	0.40
North Atlantic Right Whale *	336	0	13	13	3.87
Sei Whale *	6,292	0	4	4	0.06
Odontocetes					
Atlantic Spotted Dolphin	39,921	0	90	90	0.23
Atlantic White-sided Dolphin	93,221	0	747	747	0.80
Bottlenose Dolphin (WNA Offshore)	62,851	0	1,800	1,800	2.86
Bottlenose Dolphin (Northern Migratory Coastal)	6,639	0	1,185	1,185	17.84
Bottlenose Dolphin (WNA Offshore and Northern Migratory Coastal) [e]	69,490	0	2,865	2,865	4.12
Common Dolphin	172,974	0	9,870	9,870	5.71

TABLE 36—MAXIMUM NUMBER OF PROPOSED TAKES (LEVEL A HARASSMENT AND LEVEL B HARASSMENT) THAT COULD OCCUR IN ANY ONE YEAR OF THE PROJECT RELATIVE TO STOCK POPULATION SIZE ASSUMING EACH TAKE IS OF A DIFFERENT INDIVIDUAL—Continued

Marine mammal species	NMFS stock abundance	Maximum annual take proposed for authorization			
		Maximum Level A harassment	Maximum Level B harassment	Maximum annual take [a]	Total percent stock taken based on maximum annual take [b]
Harbor Porpoise	95,543	0	243	243	0.25
Pilot Whale *spp.*	68,139	0	58	58	0.09
Risso's Dolphin	35,215	0	200	200	0.57
Sperm Whale *	4,349	0	3	3	0.07
Phocid (pinnipeds)					
Gray Seal	27,300	0	484	484	1.78
Harbor Seal	61,336	0	678	678	1.10
Harp Seal	UNK	0	4	4	UNK

* Denotes species listed under the Endangered Species Act.

[a] Calculations of the maximum annual take are based on the maximum requested Level A harassment take in any one year + the total requested Level B harassment take in any one year.

[b] Calculations of percentage of stock taken are based on the maximum requested Level A harassment take in any one year + the total requested Level B harassment take in any one year and then compared against the best available abundance estimate. For this proposed action, the best available abundance estimates are derived from the NMFS Stock Assessment Reports (Hayes *et al.,* 2022).

[c] Bottlenose dolphin density values from Duke University (Roberts and Halpin, 2022) reported as "bottlenose dolphin" and not identified to stock. Given the noise from cofferdam installation would not extend beyond the 20-meter isobath, where the coastal stock predominates, all estimated takes by Level B harassment of bottlenose dolphins from cofferdam installation were attributed to the coastal stock. Takes from impact pile driving were attributed to each stock (coastal and offshore) according to delineation along the 20-meter isobath during the animat modeling process. Takes from HRG survey activities were not differentiated.

Proposed Mitigation

In order to promulgate a rulemaking under section 101(a)(5)(A) 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 ensure the least practicable adverse impact on species or stocks and their habitat, as well as subsistence uses where applicable, we carefully consider two primary factors:

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

(2) The practicability of the measures for applicant implementation, which may consider such things as cost, impact on operations, and, in the case of a military readiness activity, personnel safety, practicality of implementation, and impact on the effectiveness of the military readiness activity.

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. Modeling was performed to estimate harassment zones, which were used to inform mitigation measures for pile driving activities to minimize Level A harassment and Level B harassment to the extent practicable, while providing estimates of the areas within which Level B harassment might occur.

Generally speaking, the mitigation measures considered and proposed here fall into three categories: temporal (seasonal and daily) work restrictions, real-time measures (shutdown, clearance, and vessel strike avoidance), and 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 pre-clearance zones and 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 describe training, coordination, and vessel strike avoidance measures that apply to all activity types, and then in the following subsections we describe the measures that apply specifically to monopile foundation and OSS foundation installation, cable landfall and marina activities, and HRG surveys.

Training and Coordination

Empire Wind would be required to ensure that a copy of any issued LOA must be in the possession of its designees, all vessel operators, visual protected species observers (PSOs), passive acoustic monitoring (PAM) operator, pile driver operators, and any other relevant designees operating under the authority of the issued IHA.

Empire Wind would also be required to instruct all project personnel regarding the authority of the marine mammal monitoring team(s) (*i.e.,* PSOs and PAM operators). For example, the HRG acoustic equipment operator, pile driving personnel, etc., would be required to immediately comply with any call for a delay or shutdown by the Lead PSO. Any disagreement between the Lead PSO and the project personnel would only be discussed after delay or shutdown has occurred. Prior to initiation of pile driving or survey work (depending on activity), all crew members will undergo environmental training, a component of which will focus on the procedures for sighting and protection of marine mammals. All relevant personnel and the marine mammal monitoring team would be required to participate in joint, onboard briefings that would be led by Empire Wind project personnel and the Lead PSO prior to the beginning of project activities. This would serve to ensure that all relevant responsibilities, communication procedures, marine mammal monitoring and mitigation protocols, reporting protocols, safety, operational procedures, and ITA requirements are clearly understood by all involved parties. The briefing would be repeated whenever new relevant personnel (*e.g.,* new PSOs, acoustic source operators, relevant crew) join the operation before work commences.

Empire Wind would ensure that any visual observations of an ESA-listed marine mammal are communicated to PSOs and vessel captains during the concurrent use of multiple project-associated vessels (of any size; *e.g.,* construction surveys, crew/supply transfers, *etc.*). Any large whale sighted by a PSO or acoustically detected by a PAM operator as if it were a North Atlantic right whale, unless a PSO or PAM operator confirms it is another species of whale. If an individual from a species for which authorization has not been granted, or a species for which authorization has been granted but the authorized take number has been met, is observed entering or within the relevant Level B harassment zone for each specified activity, pile driving and HRG acoustic sources would be required to shut down immediately, unless shutdown would result in 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 be delayed if the activity has not commenced. Impact and vibratory pile driving and initiation of HRG acoustic sources must not commence or resume until the animal(s) has been confirmed to have left the relevant clearance zone or the observation time has elapsed with no further sightings. Any marine mammals observed within a clearance or shutdown zone must be allowed to remain in the area (*i.e.,* must leave of their own volition) prior to commencing pile driving activities or HRG surveys.

Before and when conducting any in-water construction activities and vessel operations, Empire Wind personnel would be required to use all available sources of information on North Atlantic right whale presence in or near the project area including daily monitoring of the Right Whale Sightings Advisory System, and monitoring of Coast Guard VHF Channel 16 throughout the day to receive notification of any sightings and/or information associated with any Slow Zones (*i.e.,* Dynamic Management Areas (DMAs) and/or acoustically-triggered slow zones) to provide situational awareness for both vessel operators and PSOs.

More information on vessel crew training requirements can be found in the *Vessel Strike Avoidance Measures* section below.

North Atlantic Right Whale Awareness Monitoring

Empire Wind must use available sources of information on North Atlantic right whale presence, including daily monitoring of the Right Whale Sightings Advisory System, WhaleAlert app, monitoring of Coast Guard VHF Channel 16 throughout each day to receive notifications of any sightings, and information associated with any regulatory management actions (*e.g.,* establishment of a zone identifying the need to reduce vessel speeds). Maintaining daily awareness and coordination affords increased protection of North Atlantic right whales by understanding North Atlantic right whale presence in the area through ongoing visual and passive acoustic monitoring efforts and opportunities (outside of Empire Wind's efforts), and allows for planning of construction activities, when practicable, to minimize potential impacts on North Atlantic right whales.

Protected Species Observers and PAM Operator Training

Empire Wind would employ NMFS-approved PSOs and PAM operators. PSOs would be required during all foundation installations, cable landfall and marina pile driving activities, and HRG surveys. PAM operators would be required during foundation installation. The PSO field team and PAM team would have a lead member (designated as the ''Lead PSO'' or ''PAM Lead'') who would have prior experience observing or detecting mysticetes, odontocetes and pinnipeds in the Northwestern Atlantic Ocean on other offshore projects requiring PSOs. Any remaining PSOs and PAM operators must have previous experience observing marine mammals during projects and must have the ability to work with all required and relevant software and equipment. New and/or inexperienced PSOs would be paired with an experienced PSO to ensure that the quality of marine mammal observations and data recording is kept consistent.

All PSOs and PAM operators would be required to complete a training program described under which will be provided to NOAA Fisheries for review and approval prior to the start of surveys. Confirmation of the training and understanding of the requirements will be documented on a training course log sheet. Signing the log sheet will certify that PSOs and PAM operators understand and will comply with the necessary mitigation and monitoring requirements.

More information on PSO and PAM operator requirements during each activity can be found in the Proposed Monitoring and Reporting section.

Vessel Strike Avoidance Measures

This proposed rule contains numerous vessel strike avoidance measures. Empire Wind will 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 (*e.g.,* due to towing, etc.). As part of vessel strike avoidance, the training program described above will be implemented. This training must occur prior to the start of construction activities. The training will include protected species identification training prior to the start of in-water construction activities. This training will cover information about marine mammals and other protected species known to occur or which have the potential to occur in the project area. It will include training on making observations in both good weather conditions (*i.e.,* clear visibility, low wind, and low sea state) and bad weather conditions (*i.e.,* fog, high winds and high sea states, in glare). Training will not only include identification skills, but will also include information and resources available regarding applicable Federal laws and regulations for protected species.

Empire Wind will abide by the following vessel strike avoidance measures:

• All Empire Wind vessels must comply with existing NMFS vessel speed restrictions, as applicable, for North Atlantic right whales;

• All vessel operators and crews 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;

• During any vessel transits within or to/from the Empire Wind project area, such as for crew transfers, an observer must be stationed at the best vantage point of the vessel(s) to ensure that the vessel(s) are maintaining the appropriate separation distance from marine mammals. Visual observers may be PSO or crew members, but crew members responsible for these duties must be provided sufficient training by Empire Wind to distinguish marine mammals from other types of animals or objects and must be able to identify a marine mammal as a North Atlantic right whale, other whale (defined in this context as sperm whales or baleen whales other than North Atlantic right whales), or other marine mammal. Crew members serving as visual observers must not have duties other than observing for marine mammals while the vessel is operating over 10 knots (kts);

• Year-round and when a vessel is in transit, all vessel operators will continuously monitor U.S. Coast Guard VHF Channel 16 over which North Atlantic right whale sightings are broadcasted;

• At the onset of transiting and at least once every four hours, vessel operators and/or trained crew members will monitor WhaleAlert and the Right Whale Sighting Advisory System (RWSAS) for the presence of North Atlantic right whales. Any notification of a whale in the project area from these systems or observations of any large whale by any Empire Wind staff or contractors, including vessel crew, must be communicated immediately to PSOs, PAM operator, and all vessel captains to increase situational awareness. Conversely, any large whale observation or detection via a sighting network (*e.g.,* Mysticetus) by PSOs or PAM operators will be conveyed to vessel operators and crew.

• All vessels, regardless of size, would operate at 10 knots (18.5 km/hr) or less in any SMA, DMA or visually triggered Slow Zone;

• Between November 1st and April 30th, all vessels, regardless of size, would operate port to port at 10 knots or less, specifically from ports in New Jersey, New York, Maryland, Delaware, and Virginia to the lease area;

• All vessels, regardless of size, would immediately reduce speed to 10 knots or less when a North Atlantic right whale is sighted, at any distance, by an observer or anyone else on the vessel.

• All vessels, regardless of size, would immediately reduce speed to 10 knots or less when any large whale, mother/calf pairs, or large assemblages of non-delphinid cetaceans are observed near (within 500 m) an underway vessel.

• All vessels must maintain a minimum separation distance of 500 m (1,640 ft) from North Atlantic right whales. If a whale is observed but cannot be confirmed as a species other than a North Atlantic right whale, the vessel operator must assume that it is a North Atlantic right whale and take appropriate action. If underway, vessels must steer a course away from any sighted North Atlantic right whale at 10 knots (18.5 km/hr) or less until the 500 m minimum separation distance has been established. If a North Atlantic right whale is sighted in a vessel's path, or within 100 m (330 ft) of an underway vessel, the underway vessel must reduce speed and shift the engine to neutral. Engines will not be engaged until the North Atlantic right whale has moved outside of the vessel's path and beyond 500 m. If stationary, the vessel must not engage engines until the North Atlantic right whale has moved beyond 500 m;

• All vessels must maintain a separation distance of 100 m or greater from any sighted whales. If sighted, the vessel underway must reduce speed and shift the engine to neutral, and must not engage the engines until the whale has moved outside of the vessel's path and beyond 100 m. If a vessel is stationary, the vessel will not engage engines until the whale has moved out of the vessel's path and beyond 100 m;

• All vessels must maintain a separation distance of 50 m (164 ft) or greater from any sighted small cetaceans and pinnipeds. Any vessel underway remain parallel to a sighted small cetacean or pinnipeds 's course whenever possible, and avoid excessive speed or abrupt changes in direction. Vessels may not adjust course and speed until the small cetaceans have moved beyond 50 m and/or the abeam of the underway vessel;

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

• For in-water construction heavy machinery activities other than impact or vibratory pile driving, if a marine mammal is on a path towards or comes within 10 m of equipment, Empire Wind must 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;

• All underway vessels (*e.g.,* transiting, surveying) must have a dedicated visual observer on duty at all times to monitor for marine mammals within a 180 degree direction of the forward path of the vessel (90 degree port to 90 degree starboard). Visual observers must be equipped with alternative monitoring technology for periods of low visibility (*e.g.,* darkness, rain, fog, *etc.*). The dedicated visual observer must receive prior training on protected species detection and identification, vessel strike minimization procedures, how and when to communicate with the vessel captain, and reporting requirements in this proposed action. Visual observers may be third-party observers (*i.e.,* NMFS-approved PSOs) or crew members and must not have any other duties other than observing for marine mammals. Observer training related to these vessel strike avoidance measures must be conducted for all vessel operators and crew prior to the start of in-water construction activities to distinguish marine mammals from other phenomena and broadly to identify a marine mammal as a North Atlantic right whale, other whale (defined in this context as sperm whales or baleen whales other than North Atlantic right whales), or other marine mammal. Confirmation of the observers' training and understanding of the ITA requirements must be documented on a training course log sheet and reported to NMFS.

Monopile Foundation and OSS Foundation Installation

For monopile and OSS foundation installation, NMFS is proposing to include the following mitigation requirements, which are described in detail below: seasonal and daily restrictions; the use of noise abatement systems; the use of PSOs and PAM operators; the implementation of clearance and shutdown zones, and the use of soft-start.

Seasonal and Daily Restrictions

No foundation impact pile driving activities would occur January 1 through April 30. In addition, pile driving will not occur from December 1 through December 31, unless unanticipated delays due to weather or technical issues arise that necessitate extending pile driving into December in which case Empire Wind notify NMFS and BOEM in writing by September 1 that circumstances are expected to necessitate pile driving in December. Based on the best available information (Roberts and Halpin, 2022), the highest densities of North Atlantic right whales in the project area are expected during the months of January through April. NMFS is requiring this seasonal work restriction to minimize the potential for North Atlantic right whales to be exposed to noise incidental to impact pile driving of monopiles, which is expected to greatly reduce the number of takes of North Atlantic right whales.

No more than two monopiles or three pin piles would be installed per day. Monopiles would be no larger than 11-m in diameter and pin piles would be no larger than 2.5-m in diameter. During all pile installation, the minimum amount of hammer energy necessary to effectively and safely install and maintain the integrity of the piles must be used. Hammer energies must not exceed 5,500 kJ for monopile installation and 3,200 kJ for pin pile installation.

Impact pile driving will commence only during daylight hours no earlier than 1 hour after (civil) sunrise. Impact pile driving will not be initiated later than 1.5 hours before (civil) sunset. The exception to this would be if Empire Wind submits, and NMFS approves, an Alternative Monitoring Plan as part of the Pile Driving and Marine Mammal Monitoring Plan that reliably demonstrates the efficacy of their night time devices. Generally, pile driving may continue after dark when the installation of the same pile began during daylight (1.5 hours before (civil) sunset), when clearance zones were fully visible for at least 30 minutes and must proceed for human safety or installation feasibility reasons. Impact pile driving will not be initiated in times of low visibility when the visual clearance zones cannot be visually monitored, as determined by the lead Protected Species Observer (PSO) on duty.

Noise Attenuation Systems

Empire Wind would employ noise attenuation systems (NAS), during all impact pile driving of monopiles and pin piles to reduce the sound pressure levels that are transmitted through the water in an effort to reduce ranges to acoustic thresholds and minimize any acoustic impacts resulting from impact pile driving. Empire Wind would be required to employ a big double bubble curtain or may use a single bubble curtain paired with another noise abatement device. In either case, the NAS used would be required to attenuate pile driving noise such that measured ranges to isopleth distances corresponding to relevant marine mammal harassment thresholds are consistent with those modeled based on 10 dB attenuation, determined via sound field verification.

Noise attenuation 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 and 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 (*e.g.,* Hydro Sound Dampers (HSDs)), can be effective within their targeted frequency ranges (*e.g.,* 100–800 Hz), and when used in conjunction with a bubble curtain appear to create the greatest attenuation. The literature presents a wide array of observed attenuation results for bubble curtains. The variability in attenuation levels is the result of variation in design, as well as differences in site conditions and difficulty in properly installing and operating in-water attenuation devices.

If a bubble curtain is used (single or double), Empire Wind would be required to maintain the following operational parameters: The bubble curtain(s) must distribute air bubbles using a target air flow rate of at least 0.5 $m^3/(min*m)$, and must distribute bubbles around 100 percent of the piling perimeter for the full depth of the water column. The lowest bubble ring must be in contact with the seafloor for the full circumference of the ring, and the weights attached to the bottom ring must ensure 100-percent seafloor contact; no parts of the ring or other objects should prevent full seafloor contact. Empire Wind must require that construction contractors train personnel in the proper balancing of airflow to the bubble ring, and must require that construction contractors submit an inspection/performance report for approval by Empire Wind within 72 hours following the performance test. Corrections to the attenuation device to meet the performance standards must occur prior to impact driving of monopiles. If Empire Wind uses a noise mitigation device in addition to a bubble curtain, similar quality control measures would be required.

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. 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 (~8 m) 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 bubble curtains for noise attenuation. Designed to gather additional data regarding the efficacy of bubble curtains, the Coastal Virginia Offshore Wind (CVOW) pilot project systematically measured noise resulting from the impact driven installation of two 7.8-m monopiles, one installation using a double bubble curtain and the other installation using no noise abatement system (CVOW, unpublished data). Although many factors contributed to variability in received levels throughout the installation of the piles (*e.g.* hammer energy, technical challenges during operation of the double bubble curtain), reduction in broadband SEL using the double bubble curtain (comparing measurements derived from the mitigated and the unmitigated monopiles) ranged from approximately 9–15 dB. Again, NMFS would require Empire Wind to apply a double bubble curtain, or a single bubble curtain coupled with an additional noise mitigation device, to ensure sound generated from the project does not exceed that modeled (assuming 10-dB reduction) at given ranges to harassment isopleths, and to minimize noise levels to the lowest level practicable. Double BBCs are successfully and widely applied across European wind development efforts, and are known to reduce noise levels more than single BBC alone (*e.g.,* Bellman *et al.,* 2020). Empire Wind anticipates, and NMFS agrees, that the use of a noise abatement system would likely produce field measurements of the isopleth distances to the Level A harassment and Level B harassment thresholds that accord with those modeled assuming 10-dB of attenuation for impact pile driving of monopiles (refer back to the Estimated Take, Proposed Mitigation, and Proposed Monitoring and Reporting sections).

Use of PSOs and PAM Operators

As described above, Empire Wind would be required to use PSOs and PAM operators during all foundation installation activities. At minimum, four PSOs would be actively observing marine mammals before, during, and after pile driving. At least two PSOs would be stationed on the pile driving vessel. Concurrently, at least one PAM operator would be actively monitoring for marine mammals before, during, and after pile driving. At least one active PSO on each platform must have a minimum of 90 days at-sea experience working in those roles in offshore environments with no more than eighteen months elapsed since the conclusion of the at-sea experience. Concurrently, at least one acoustic PSO (*i.e.,* passive acoustic monitoring (PAM) operator) must be actively monitoring for marine mammals before, during and after impact pile driving with PAM. More details on PSO and PAM operator requirements can be found in the Proposed Monitoring and Reporting section.

Furthermore, all crew and personnel working on the Empire Wind Project would be required to maintain situational awareness of marine mammal presence (discussed above) and would be required to report any sightings to the PSOs.

Clearance and Shutdown Zones

NMFS is proposing to require the establishment of both clearance and shutdown zones during all impact pile driving of monopile and pin pile, which would be monitored by visual PSOs and PAM operators before, during and after pile driving. PSOs must visually monitor clearance zones for marine mammals for a minimum of 60 minutes prior to commencing pile driving. At least one PAM operator must review data from at least 24 hours prior to pile driving and actively monitor hydrophones for 60 minutes prior to pile driving. Prior to initiating soft-start procedures, all clearance zones must be confirmed to be free of marine mammals for 30 minutes immediately prior to starting a soft-start of pile driving.

The purpose of ''clearance'' of a particular zone is to prevent or minimize potential instances of auditory injury and more severe behavioral disturbances by delaying the commencement of impact pile driving if marine mammals are near the activity. Prior to the start of impact pile driving activities, Empire Wind would ensure the area is clear of marine mammals, per the clearance zones in Table 37, to minimize the potential for and degree of harassment. Once pile driving activity begins, any marine mammal entering the shutdown zone would trigger pile driving to cease (unless shutdown 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).

In addition to the clearance and shutdown zones that would be monitored both visually and acoustically, NMFS is proposing to establish a minimum visibility zone to ensure both visual and acoustic methods are used in tandem to detect marine mammals resulting in maximum detection capability. The minimum visibility zone would extend from the location of the pile being driven out to 1.2 km. This value corresponds to just greater than the modeled maximum $ER_{95\ percent}$ distances to the Level A harassment isopleth for North Atlantic right whales assuming two difficult-to-drive monopiles are driven in a day, rounded up to the nearest hundred. This distance also corresponds to approximately the Level B harassment isopleth for OSS foundation installation. The entire minimum visibility zone must be visible (*i.e.,* not obscured by dark, rain, fog, *etc.*) for a full 30 minutes immediately prior to commencing impact pile driving. For North Atlantic right whales, there is an additional requirement that the clearance zone may only be declared clear if no confirmed North Atlantic right whale acoustic detections (in addition to visual) have occurred during the 60-minute monitoring period. Any large whale sighted by a PSO or acoustically detected by a PAM operator that cannot be identified as a non-North Atlantic right whale must be treated as if it were a North Atlantic right whale.

TABLE 37—WTG AND OSS CLEARANCE AND SHUTDOWN ZONES

[Impact]

Species	Impact pile	
	Clearance zone [1]	Shutdown zone [1]
North Atlantic right whale—PAM	5,000	1,500
North Atlantic right whale—visual detection	Any distance	1,500
All other Mysticetes and sperm whales	2 km	1,500
Harbor porpoise	400	400
Dolphins and Pilot Whales	200	200
Seals	200	200

[1] The minimum visibility zone, an area in which marine mammals must be able to be visually detected, extends 1.2 km.

Proposed clearance and shutdown zones have been developed in consideration of modeled distances to relevant PTS thresholds with respect to minimizing the potential for take by Level A harassment. All proposed clearance and shutdown zones for large whales are larger than the largest modeled exposure range ($ER_{95\ percent}$) distances to thresholds corresponding to Level A harassment (SEL and peak). Recall that Empire Wind is seeking to avoid any pile driving during winter (December 1–December 31) and will only do so in cases of unanticipated delays due to weather or technical problems. 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. If a marine mammal is observed entering or within the respective shutdown zone (Table 37) after impact pile driving has begun, the PSO will request a temporary cessation of impact pile driving. If feasible, Empire Wind will stop pile driving immediately. In situations when shutdown is called for but Empire Wind determines shutdown is not practicable due to imminent risk of injury or loss of life to an individual or pile instability, reduced hammer energy must be implemented when the lead engineer determines it is practicable. Specifically, pile refusal or pile instability could result in not being able 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. 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 shutdown is not feasible because the shutdown 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. In these situations, Empire Wind must reduce hammer energy to the lowest level practicable.

The lead engineer must evaluate the following to determine if a shutdown is safe and practicable:

a. Use of site-specific soil data and real-time hammer log information to judge whether a stoppage would risk causing piling refusal at re-start of piling;

b. Confirmation that pile penetration is deep enough to secure pile stability in the interim situation, taking into account weather statistics for the relevant season and the current weather forecast; and

c. Determination by the lead engineer on duty will be made for each pile as the installation progresses and not for the site as a whole.

If it is determined that shutdown is not feasible, the reason must be documented and reported (see Proposed Monitoring and Reporting section).

Subsequent restart of the equipment can be initiated if the animal has been observed exiting its respective shutdown zone within 30 minutes of the shutdown, or, after an additional time period has elapsed with no further sighting (*i.e.,* 15 minutes for small odontocetes and 30 minutes for all other species).

For impact pile driving, Empire Wind will implement a 60-minute pre-start clearance period of the Clearance zones prior to the initiation of soft-start (described below)) to ensure no marine mammals are in the vicinity of the pile. During this period the Clearance zones will be monitored by both PSOs and passive acoustic monitoring (PAM). Pile driving will not be initiated if any marine mammal is observed within its respective Clearance zone. If a marine mammal is observed within a Clearance zone during the pre-start clearance period, impact pile driving would be delayed and may not begin until the animal(s) has been observed exiting its respective zone, or, until an additional time period has elapsed with no further sightings (*i.e.,* 15 minutes for small odontocetes and pinnipeds and 30 minutes for all other species). In addition, impact pile driving will be delayed upon a confirmed PAM detection of a North Atlantic right whale, if the PAM detection is confirmed to have been located within the 5 km North Atlantic right whale PAM Clearance zone. Any large whale sighted by a PSO within 1,000 m of the pile that cannot be identified to species must be treated as if it were a North Atlantic right whale.

Impact pile driving will not be initiated if the clearance zones cannot be adequately monitored (*i.e.,* if they are obscured by fog, inclement weather, poor lighting conditions) for a 30 minute period prior to the commencement of soft-start, as determined by the Lead PSO. If light is insufficient, the lead PSO will call for a delay until the Clearance zone is visible in all directions. If a soft-start has been initiated before the onset of inclement weather, pile driving activities may continue through these periods if deemed necessary to ensure human safety and/or the integrity of the Project. PAM operators would review data from at least 24 hours prior to pile driving and actively monitor hydrophones for 60 minutes immediately prior to pile driving. odontocetes and 30 minutes for all other marine mammal species).

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. Empire Wind must utilize a soft-start protocol for impact pile driving of monopiles by performing 4–6 strikes per minute at 10 to 20 percent of the maximum hammer energy, 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. For impact hammers, the actual number of strikes at reduced energy will vary because operating the hammer at less than full power results in ''bouncing'' of the hammer as it strikes the pile, resulting in multiple ''strikes''; however, as mentioned previously, Empire Wind will target less than 20 percent of the total hammer energy for the initial hammer strikes during soft-start. Soft-start will be required at the beginning of each day's monopile installation, and at any time following a cessation of impact pile driving of 30 minutes or longer. If a marine mammal is detected within or about to enter the applicable clearance zones prior to the beginning of soft-start procedures, impact pile driving would be delayed until the animal has been visually observed exiting the clearance zone or until a specific time period has elapsed with no further sightings (*i.e.,* 15 minutes for small odontocetes and 30 minutes for all other species).

Cable Landfall and Marina Activities

For sheet pile or casing pipe installation and removal, NMFS is proposing to include the following mitigation requirements, which are described in detail below: daily restrictions; the use of PSOs; the implementation of clearance and shutdown zones; and the use of soft-start if a pneumatic impact hammer is used. Given the short duration of work, relatively small harassment zones if a pneumatic hammer is used, and lower noise levels during vibratory driving, NMFS is not proposing to require PAM or noise abatement system use during these activities.

Seasonal and Daily Restrictions

Empire Wind has proposed to install and remove the sheet piles or casing pipe and goal posts within 2025. NMFS is not requiring any seasonal work restrictions for landfall construction in this proposed rule due to the relatively short duration of work (*i.e.,* low associated impacts). Empire Wind would be required, however, to conduct vibratory pile driving associated with sheet pile installation and pneumatic hammering of casing pipes during daylight hours only.

Use of PSOs

Prior to the start of vibratory pile driving or impact/pneumatic hammering activities, at least two PSOs located at the best vantage points would monitor the clearance zone for 30 minutes, continue monitoring during pile driving or pneumatic hammering, and for 30 minutes following cessation of either activity. The clearance zones must be fully visible for at least 30 minutes and must be confirmed to be clear of marine mammals for at least 30 minutes immediately prior to initiation of either activity.

Clearance and Shutdown Zones

Empire Wind would establish clearance and shutdown zones for vibratory pile driving activities associated with sheet pile installation and impact/pneumatic hammering for casing pipe installation (Table 38). PSOs would monitor the clearance zone for 30 minutes before the start of cable landfall activities, during pile driving associated with cable landfall, and for 30 minutes after pile driving of cable landfall. If a marine mammal is observed entering or is observed within the respective zones, activities will not commence until the animal has exited the zone or a specific amount of time has elapsed since the last sighting (*i.e.,* 30 minutes for large whales and 15 minutes for dolphins, porpoises, and pinnipeds). If a marine mammal is observed entering or within the respective shutdown zone after vibratory pile driving or pneumatic hammering has begun, the PSO will call for a temporary cessation of the activity. Pile driving or hammering must not be restarted until either the marine mammal(s) has voluntarily left the specific clearance zones and has been visually confirmed beyond that clearance zone or when specific time periods have elapsed with no further sightings or acoustic detections have occurred (*i.e.,* 15 minutes for small odontocetes and 30 minutes for all other marine mammal species). Because a vibratory hammer can grip a pile without operating, pile instability should not be a concern and no caveat for re-starting pile driving due to pile instability is proposed.

TABLE 38—CLEARANCE AND SHUTDOWN ZONES FOR SHEET PILE VIBRATORY DRIVING AND IMPACT/PNEUMATIC HAMMERING FOR CASING PIPES (m)

Hearing group (species)	Clearance zone (m)	Shutdown zone (m)
Low-Frequency (North Atlantic right whale, all other mysticetes)	1,600	1,600
High-Frequency (harbor porpoise)	100	100
Mid-Frequency (dolphins and pilot whales)	50	50
Phocid Pinniped (seals)	50	50

HRG Surveys

For HRG surveys, NMFS is proposing to include the following mitigation requirements, which are described in detail below, for all HRG survey activities employing SBPs: the use of PSOs; the implementation of clearance, shutdown, and vessel separation zones; and ramp-up of survey equipment.

There are no mitigation measures prescribed for sound sources operating at frequencies greater than 180 kHz, as these would be expected to fall outside of marine mammal hearing ranges and not result in harassment; however, all HRG survey vessels would be subject to the aforementioned vessel strike avoidance measures described earlier in this section. Furthermore, due to the frequency range and characteristics of some of the sound sources, shutdown, clearance, and ramp-up procedures are not proposed to be conducted during HRG surveys utilizing only non-impulsive sources (*e.g.,* Ultra-Short BaseLine (USBL) and other parametric sub-bottom profilers), with exception to usage of SBPs and other non-parametric sub-bottom profilers. PAM would not be required during HRG surveys. While NMFS agrees that PAM can be an important tool for augmenting detection capabilities in certain circumstances, its utility in further reducing impacts during HRG survey activities is limited. We have provided a thorough description of our reasoning for not requiring PAM during HRG surveys in several **Federal Register** notices (*e.g.,* 87 FR 40796, July 8, 2022; 87 FR 52913, August 3, 2022; 87 FR 51356, August 22, 2022).

Seasonal and Daily Restrictions

Given the potential impacts to marine mammals from exposure to HRG survey noise sources are relatively minor (*e.g.,* limited to Level B harassment) and that the distances to the Level B harassment isopleth is very small (maximum distance is 50.05 m), NMFS is not proposing to implement any seasonal or time-of-day restrictions for HRG surveys.

Although no temporal restrictions are proposed, NMFS would require Empire Wind to deactivate SBPs that result in take during periods where no data are being collected, except as determined necessary for testing. Any unnecessary use of the acoustic source would be avoided.

Use of PSOs

Prior to the start of HRG surveys, all personnel with responsibilities for marine mammal monitoring would participate in joint, onboard briefings that would be led by both the vessel operator and the Lead PSO.These briefings would be repeated whenever new relevant personnel (*e.g.,* new PSOs, acoustic source operators, relevant crew) join the survey operation before work begins.

During all HRG survey activities using SBPs, at least one PSO would be required to monitor during daylight hours and at least two would be required to monitor during nighttime hours, per vessel. PSOs would begin visually monitoring 30 minutes prior to the initiation of the specified acoustic source (*i.e.,* ramp-up, if applicable), during the HRG activities, and through 30 minutes after the use of the specified acoustic source has ceased. PSOs would be required to monitor the appropriate clearance and shutdown zones. These zones would be based around the radial distance from the acoustic source and not from the vessel.

Ramp-Up

At the start or restart of the use of SBPs, a ramp-up procedure would be required unless the equipment operates on a binary on/off switch. A ramp-up procedure, involving a gradual increase in source level output, is required at all times as part of the activation of the acoustic source when technically feasible. Operators would ramp up sources to half power for 5 minutes and then proceed to full power. Prior to a ramp-up procedure starting, the operator would have to notify the Lead PSO of the planned start of the ramp-up. This notification time would not be less than 60 minutes prior to the planned ramp-up activities as all relevant PSOs would need the appropriate 30 minute period to monitor prior to the initiation of ramp-up. The ramp-up procedure will not be initiated during periods of inclement conditions if the clearance zones cannot be adequately monitored by the PSOs using the appropriate visual technology (*e.g.,* reticulated binoculars, night vision equipment) for a 30-minute period. Prior to ramp-up beginning, the operator must receive confirmation from the PSO that the clearance zone is clear of any marine mammals. All ramp-ups would be scheduled to minimize the overall time spent with the source being activated. The ramp-up procedure must be used at the beginning of HRG survey activities or after more than a 30-minute break in survey activities using the specified HRG equipment to provide additional protection to marine mammals in or near the survey area by allowing them to vacate the area prior to operation of survey equipment at full power.

Empire Wind would not initiate ramp-up until the clearance process has been completed (see Clearance and Shutdown Zones section below). Ramp-up activities would be delayed if a marine mammal(s) enters its respective clearance zone. Ramp-up would only be reinitiated if the animal(s) has been observed exiting its respective shutdown zone or until additional time has elapsed with no further sighting (*i.e.,* 15 minutes for small odontocetes and seals, and 30 minutes for all other species).

Clearance and Shutdown Zones

Empire Wind would be required to implement a 30-minute clearance period of the clearance zones (Table 39) immediately prior to the commencing of the survey, or when there is more than a 30-minute break in survey activities and PSOs have not been actively monitoring. The clearance zones would be monitored by PSOs, using the appropriate visual technology. If a marine mammal is observed within a clearance zone during the clearance period, ramp-up (described below) may not begin until the animal(s) has been observed voluntarily exiting its respective clearance zone or until an additional time period has elapsed with no further sighting (*i.e.,* 15 minutes for small odontocetes and seals, and 30 minutes for all other species). In any case when the clearance process has begun in conditions with good visibility, including via the use of night vision equipment (IR/thermal camera), and the Lead PSO has determined that the clearance zones are clear of marine mammals, survey operations would be allowed to commence (*i.e.,* no delay is required) despite periods of inclement weather and/or loss of daylight.

Once the survey has commenced, Empire Wind would be required to shut down SBPs if a marine mammal enters a respective shutdown zone (Table 39). In cases when the shutdown zones become obscured for brief periods due to inclement weather, survey operations would be allowed to continue (*i.e.,* no shutdown is required) so long as no marine mammals have been detected. The use SBPs will not be allowed to commence or resume until the animal(s) has been confirmed to have left the shutdown zone or until a full 15 minutes (for small odontocetes and seals) or 30 minutes (for all other marine mammals) have elapsed with no further sighting. Any large whale sighted by a PSO within 1,000 m of the SBPs that cannot be identified as a non-North Atlantic right whale would be treated as if it were a North Atlantic right whale.

The shutdown requirement would be waived for small delphinids of the following genera: *Delphinus, Stenella, Lagenorhynchus,* and *Tursiops.* Specifically, if a delphinid from the specified genera is visually detected approaching the vessel (*i.e.,* to bow-ride) or towed equipment, shutdown would not be required. Furthermore, if there is uncertainty regarding identification of a marine mammal species (*i.e.,* whether the observed marine mammal(s) belongs to one of the delphinid genera for which shutdown is waived), the PSOs would use their best professional judgment in making the decision to call for a shutdown. Shutdown would be required if a delphinid that belongs to a genus other than those specified is detected in the shutdown zone.

If a SBP is shut down for reasons other than mitigation (*e.g.,* mechanical difficulty) for less than 30 minutes, it would be allowed to be activated again without ramp-up only if (1) PSOs have maintained constant observation, and (2) no additional detections of any marine mammal occurred within the respective shutdown zones. If a SBP was shut down for a period longer than 30 minutes, then all clearance and ramp-up procedures would be required, as previously described.

TABLE 39—HARASSMENT THRESHOLD RANGES AND MITIGATION ZONES DURING HRG SURVEYS

Species	Clearance zone (m)	Shutdown zone (m)
North Atlantic right whale	500	500
All other ESA-listed marine mammals (*e.g.,* fin, sei, sperm whale)	500	100
All other marine mammal species [1]	100	100

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

Fishery Monitoring Surveys

Training

All crew undertaking the fishery monitoring survey activities would be required to receive protected species identification training prior to activities occurring. Marine mammal monitoring must occur prior to, during, and after haul-back and gear must not be deployed if a marine mammal is observed in the area. Trawl operations must only start after 15 minutes of no marine mammal sightings within 1 nm of the sampling station.

Gear-Specific Best Management Practices (BMPs)

Empire Wind would be required to undertake BMPs to reduce risks to marine mammals during trawl surveys. These include:

• All captains and crew conducting trawl surveys will be trained in marine mammal detection and identification;

• Survey vessels will adhere to all vessel mitigation measures (see Proposed Mitigation section);

• Marine mammal monitoring will be conducted by the captain and/or a member of the scientific crew before (15 minutes prior to within 1 nm), during, and after haul back;

• Trawl operations will commence as soon as possible once the vessel arrives on station;

• If a marine mammal (other than dolphins and porpoises) is sighted within 1 nm of the planned location in the 15 minutes before gear deployment, Empire Wind will delay setting the trawl until marine mammals have not been resighted for 15 minutes or Empire Wind may move the vessel away from the marine mammal to a different section of the sampling area. If, after moving on, marine mammals are still visible from the vessel, Empire Wind may decide to move again or to skip the station;

• Gear will not be deployed if marine mammals are observed within the area and if a marine mammal is deemed to be at risk of interaction, all gear will be immediately removed;

• Empire Wind will maintain visual monitoring effort during the entire period of time that trawl gear is in the water (*i.e.,* throughout gear deployment, fishing, and retrieval). If marine mammals are sighted before the gear is fully removed from the water, Empire Wind will take the most appropriate action to avoid marine mammal interaction;

• Limit tow time to 20 minutes and monitoring for marine mammals throughout gear deployment, fishing, and retrieval;

• Empire Wind will open the codend of the net close to the deck/sorting area to avoid damage to animals that may be caught in gear;

• Trawl nets will be fully cleaned and repaired (if damaged) before setting again; and

• Any lost gear associated with the fishery surveys must be reported to the NOAA Greater Atlantic Regional Fisheries Office Protected Resources Division within 48 hours

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

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

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

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

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

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

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

• 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.

During Empire Wind's construction activities, visual monitoring by NMFS-approved PSOs would be conducted before, during, and after impact pile driving, vibratory pile driving, and HRG surveys. PAM would also be conducted during all impact pile driving. Observations and acoustic detections by PSOs would be used to support the activity-specific mitigation measures described above. Also, to increase understanding of the impacts of the activity on marine mammals, observers would record all incidents of marine mammal occurrence at any distance from the piling locations and during active HRG acoustic sources, and monitors would document all behaviors and behavioral changes, in concert with distance from an acoustic source. The required monitoring is described below, beginning with PSO measures that are applicable to all activities or monitoring, followed by activity-specific monitoring requirements.

Protected Species Observer Requirements

Empire Wind would be required to collect marine mammal sighting and behavioral response data during pile driving and HRG surveys using NMFS-approved visual and acoustic PSOs (see Proposed Mitigation section). All observers must be trained in marine mammal identification and behaviors, and are required to have no other construction-related tasks while conducting monitoring. PSOs would monitor all clearance and shutdown zones prior to, during, and following impact pile driving, vibratory pile driving, and during HRG surveys using SBPs (with monitoring durations specified further below). Any PSO would have the authority to call for a delay or shutdown of survey activities. PSOs will also monitor the Level B harassment zones and will document any marine mammals observed within these zones, to the extent practicable (noting that some zones are too large to fully observe). Observers would be located at the best practicable vantage points on the pile driving vessel. Full details regarding all marine mammal monitoring must be included in relevant Plans (*e.g.,* Pile Driving and Marine Mammal Monitoring Plan) that, under this proposed rule, Empire Wind would be required to submit to NMFS for approval at least 180 days in advance of the commencement of any construction activities.

The following measures apply to all visual monitoring efforts:

1. Monitoring must be conducted by NMFS-approved, trained PSOs who would be placed at the primary location relevant to the activity (*i.e.,* pile driving vessel, HRG survey vessel) and located in positions that allow for the best vantage point to monitor for marine mammals and implement the relevant clearance and shutdown procedures, when determined to be applicable;

2. PSO must be independent third-party observers and must have no tasks other than to conduct observational effort, collect data, and communicate with and instruct the relevant vessel crew with regard to the presence of protected species and mitigation requirements;

3. During all observation periods related to pile driving (impact and vibratory), and HRG surveys, PSOs would be located at the best vantage point(s) in order to ensure 360° visual coverage of the entire clearance and shutdown zones around the source and as much of the Level B harassment zone as possible, while still maintaining a safe work environment;

4. PSOs may not exceed 4 consecutive watch hours, must have a minimum 2-hour break between watches, and may not exceed a combined watch schedule of more than 12 hours in a single 24-hour period;

5. PSOs would be required to use appropriate equipment (specified below) to monitor for marine mammals. During periods of low visibility (*e.g.,* darkness, rain, fog, poor weather conditions, etc.), PSOs would be required to use alternative technologies (*i.e.,* infrared or thermal cameras) to monitor the shutdown and clearance zones.

6. PSOs must have the following minimum qualifications:

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

b. Ability to conduct field observations and collect data according to the assigned protocols;

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

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

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

f. PSOs must successfully complete relevant training, including completion of all required coursework and passing a written and/or oral examination developed for the training;

g. PSOs 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 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: Secondary education and/or experience comparable to PSO duties; Previous work experience conducting academic, commercial, or government sponsored marine mammal surveys; or previous work experience as a PSO; the PSO should demonstrate good standing and consistently good performance of PSO duties.

7. One observer on each platform will be designated as lead observer or monitoring coordinator (''Lead PSO''). This Lead PSO would be required to have a minimum of 90 days of at-sea experience working in this role in an offshore environment, and would be required to have no more than eighteen months elapsed since the conclusion of their last at-sea experience;

8. All PSOs must be approved by NMFS. Empire Wind would be required to submit resumes of the initial set of PSOs necessary to commence the project to NMFS OPR for approval at least 60 days prior to the first day of in-water construction activities requiring PSOs. Resumes would need to include the dates of training and any prior NMFS approval, as well as the dates and description of their last PSO experience, and must be accompanied by information documenting their successful completion of an acceptable training course. NMFS would allow three weeks to approve PSOs from the time that the necessary information is received by NMFS, after which any PSOs that meet the minimum requirements would automatically be considered approved.

Some activities planned to be undertaken by Empire Wind may require the use of Passive Acoustic Monitoring (PAM) systems, which would necessitate the employment of at least one acoustic PSO (aka PAM operator) on duty at any given time. PAM operators would be required to meet several of the specified requirements described above for PSOs. Furthermore, PAM operators would be required to complete a specialized training for operating PAM systems and must demonstrate familiarity with the PAM system on which they would be working.

PSOs would be able to act as both acoustic and visual observers for the project if the individual(s) demonstrates that they have had the required level and appropriate training and experience to perform each task. However, a single individual would not be allowed to concurrently act in both roles or exceed work hours specified in #4 above.

Empire Wind's personnel and PSOs would also be required to use available sources of information on North Atlantic right whale presence to aid in monitoring efforts. This includes:

1. Daily monitoring of the Right Whale Sightings Advisory System;

2. Consulting of the WhaleAlert app; and,

3. Monitoring of the Coast Guard's VHF Channel 16 throughout the day to receive notifications of any sightings and information associated with any Dynamic Management Areas, to plan construction activities and vessel routes, if practicable, to minimize the potential for co-occurrence with North Atlantic right whales.

Additionally, whenever multiple project-associated vessels (of any size; *e.g.,* construction survey, crew transfer) are operating concurrently, any visual observations of ESA-listed marine mammals must be communicated to PSOs and vessel captains associated with other vessels to increase situational awareness.

The following are proposed monitoring and reporting measures that NMFS would require specific to each construction activity:

Monopile and OSS Foundation Installation

Empire Wind would be required to implement the following monitoring procedures during all impact pile driving of monopile and OSS foundations.

During all observations associated with impact pile driving, PSOs would use high magnification (25x) binoculars, standard handheld (7x) binoculars, and the naked eye to search continuously for marine mammals. At least one PSO on the foundation pile driving vessel and secondary dedicated-PSO vessel must be equipped with Big Eye binoculars (*e.g.,* 25 x 150; 2.7 view angle; individual ocular focus; height control) of appropriate quality. These would be pedestal-mounted on the deck at the best vantage point that provides optimal sea surface observation and PSO safety.

Empire Wind would be required to have a minimum of four PSOs actively observing marine mammals before, during, and after (specific times described below) the installation of foundation piles (monopiles). At least two PSOs must be actively observing on the pile driving vessel. Concurrently, at least one acoustic PSO (*i.e.,* passive acoustic monitoring (PAM) operator) must be actively monitoring for marine mammals before, during and after impact pile driving.

As described in the Proposed Mitigation section, if the minimum visibility zone cannot be visually monitored at all times, pile driving operations may not commence or, if active, must shutdown, unless Empire Wind determines shutdown 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.

To supplement visual observation efforts, Empire Wind would utilize at least one PAM operator before, during, and after pile installation. PAM monitoring must occur for at least 24 hours immediately prior to foundation installation pile driving. The PAM operator would assist the PSOs in ensuring full coverage of the clearance and shutdown zones. All on-duty visual PSOs would remain in contact with the on-duty PAM operator, who would monitor the PAM systems for acoustic detections of marine mammals in the area. In some cases, the PAM operator and workstation may be located onshore or they may be located on a vessel. In either situation, PAM operators would maintain constant and clear communication with visual PSOs on duty regarding detections of marine mammals that are approaching or within the applicable zones related to impact pile driving. Empire Wind would utilize PAM to acoustically monitor the clearance and shutdown zones (and beyond for situational awareness), and would record all detections of marine mammals and estimated distance, when possible, to the activity (noting whether they are in the Level A harassment or Level B harassment zones). To effectively utilize PAM, Empire Wind would implement the following protocols:

- PAM operators would be stationed on at least one of the dedicated monitoring vessels in addition to the PSOs, or located remotely/onshore.
- PAM operators would have completed specialized training for operating PAM systems prior to the start of monitoring activities, including identification of species-specific mysticete vocalizations (*e.g.,* North Atlantic right whales).
- The PAM operator(s) on-duty would monitor the PAM systems for acoustic detections of marine mammals that are vocalizing in the area.
- Any detections would be conveyed to the PSO team and any PSO sightings would be conveyed to the PAM operator for awareness purposes, and to identify if mitigation is to be triggered.
- For real-time PAM systems, at least one PAM operator would be designated to monitor each system by viewing data or data products that are streamed in real-time or near real-time to a computer workstation and monitor located on a project vessel or onshore.
- The PAM operator would inform the Lead PSO on duty of marine mammal detections approaching or within applicable ranges of interest to the pile driving activity via the data collection software system (*i.e.,* Mysticetus or similar system), who would be responsible for requesting that the designated crewmember implement the necessary mitigation procedures (*i.e.,* delay or shutdown).
- Acoustic monitoring during nighttime and low visibility conditions during the day would complement visual monitoring (*e.g.,* PSOs and thermal cameras) and would cover an area of at least the Level B harassment zone around each foundation.

All PSOs and PAM operators would be required to begin monitoring 60 minutes prior to any impact pile driving, during, and after for 30 minutes. However, PAM operators must review acoustic data from the previous 24 hours as well. As described in the Proposed Mitigation section, impact pile driving of monopiles would only commence when the 1.2 km minimum visibility zone can be visually monitored and the clearance zones are clear of marine mammals for at least 30 minutes, as determined by the Lead PSO, immediately prior to the initiation of impact pile driving.

For North Atlantic right whales, any visual (regardless of distance) or acoustic detection would trigger a delay to the commencement of pile driving. In the event that a large whale is sighted or acoustically detected that cannot be confirmed as a non-North Atlantic right whale species, it must be treated as if it were a North Atlantic right whale. Following a shutdown, monopile installation may not recommence until the minimum visibility zone is fully visible and the clearance zone is clear of marine mammals for 30 minutes and no marine mammals have been detected acoustically within the PAM clearance zone for 30 minutes.

Empire Wind must prepare and submit a Pile Driving and Marine Mammal Monitoring Plan to NMFS for review and approval at least 180 days before the start of any pile driving. The plans must include final pile driving project design (*e.g.,* number and type of piles, hammer type, noise attenuation systems, anticipated start date, etc.) and all information related to PAM PSO monitoring protocols for pile-driving and visual PSO protocols for all activities.

When pile driving is not occurring, Empire Wind would ensure that visual PSOs conduct, as rotation schedules allow, observations for comparison of sighting rates and behavior during and in absence of pile driving. As described above, PAM data must be collected for 24-hours immediately prior to commencement of daily pile driving. Non-pile driving PSO monitoring data must be reflected in the monthly, annual, and final PSO monitoring reports.

As described previously, Empire Wind would be required to utilize a PAM system to supplement visual monitoring for all monopile installations. PAM operators may be on watch for a maximum of four consecutive hours followed by a break of at least two hours between watches. Again, PSOs can act as PAM operators or visual PSOs (but not simultaneously) as long as they demonstrate that their training and experience are sufficient to perform each task.

The PAM system must be monitored by a minimum of one PAM operator beginning at least 60 minutes prior to soft-start of impact pile driving of monopiles, at all times during monopile installation, and 30 minutes post-completion of both activities. PAM operators must immediately communicate all detections of marine mammals at any distance (*i.e.,* not limited to the Level B harassment zones) to visual PSOs, including any determination regarding species identification, distance, and bearing and the degree of confidence in the determination.

PAM systems may be used for real-time mitigation monitoring. The requirement for real-time detection and localization limits the types of PAM technologies that can be used to those systems that are either cabled, satellite, or radio-linked. It is most likely that Empire Wind would deploy autonomous or moored-remote PAM devices, including sonobuoy arrays or similar retrievable buoy systems. The system chosen will dictate the design and protocols of the PAM operations. Empire Wind is not considering seafloor cabled PAM systems, in part due to high installation and maintenance costs, environmental issues related to cable laying, and the associated permitting complexities. For a review of the PAM systems Empire Wind is considering, please see Appendix 4 of the Protected Species Mitigation and Monitoring Plan included in Empire Wind's ITA application.

Empire Wind plans to deploy PAM arrays specific to mitigation and monitoring of marine mammals outside of the shutdown zone to optimize the PAM system's capabilities to monitor for the presence of animals potentially entering these zones. The exact configuration and number of PAM devices would depend 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; however, this approach would add additional costs and greater levels of complexity to the project. Mysticetes, which would produce relatively loud and lower-frequency vocalizations, may be able to be heard with fewer hydrophones spaced at greater distances. However, detecting smaller cetaceans (such as mid-frequency delphinids; odontocetes) may necessitate that more hydrophones be spaced closer together given the shorter propagation range of the shorter, mid-frequency acoustic signals (*e.g.,* whistles and echolocation clicks). As there are no ''perfect fit'' single optimal array configurations, these set-ups would need to be considered on a case-by-case basis.

A Passive Acoustic Monitoring (PAM) Plan must be submitted to NMFS for review and approval at least 180 days prior to the planned start of monopile installations. PAM should follow standardized measurement, processing methods, reporting metrics, and metadata standards for offshore wind (Van Parijs *et al.,* 2021). The plan must describe all proposed PAM equipment, procedures, and protocols.

Cable Landfall and Onshore Substation C Marina Activities

Empire Wind would be required to implement the following procedures during all impact and vibratory pile driving activities associated with cable landfall construction and marina activities.

Empire Wind would be required to have a minimum of two PSOs on active duty during all pile driving associated with installation and removal. These PSOs would always be located at the best vantage point(s) on the pile driving platform or secondary platform in the immediate vicinity of the primary platform, in order to ensure that appropriate visual coverage is available of the entire clearance and shutdown zones and as much of the Level B harassment zone as possible. NMFS would not require the use of PAM for these activities.

PSOs would monitor for marine mammals 30 minutes before pile driving begins, throughout pile driving, and for 30 minutes after all pile driving activities have ceased. Pile driving may only commence when the clearance zones are determined to be clear of marine mammals, as determined by the Lead PSO, for at least 30 minutes immediately prior to initiation of impact or vibratory pile driving.

If a marine mammal is observed entering or within the respective shutdown zone after pile driving has begun, the PSO must call for a temporary shutdown of pile driving. Empire Wind must immediately cease pile driving if a PSO calls for shutdown, unless shutdown is not practicable due to imminent risk of injury or loss of life to an individual or pile refusal or instability. In this situation, Empire Wind must reduce hammer energy to the lowest level practicable and the reason(s) for not shutting down must be documented and reported to NMFS. Pile driving must not restart until either the marine mammal(s) has voluntarily left the specific clearance zones and has been visually or acoustically confirmed beyond that clearance zone, or, when specific time periods have elapsed with no further sightings or acoustic detections have occurred. The specific time periods are 15 minutes for small odontocetes and pinnipeds and 30 minutes for all other marine mammal species. In cases where these criteria are not met, pile driving may restart only if necessary to maintain pile stability at which time Empire Wind must use the lowest hammer energy practicable to maintain stability.

HRG Surveys

Per vessel, Empire Wind would be required to have at least one PSO on active duty during HRG surveys that are conducted during daylight hours (*i.e.,* from 30 minutes prior to sunrise through 30 minutes following sunset) and at least two PSOs during HRG surveys that are conducted during nighttime hours.

All PSOs would begin monitoring 30 minutes prior to the activation of SBPs; throughout use of these acoustic sources, and for 30 minutes after the use of the acoustic sources has ceased.

Given that multiple HRG vessels may be operating concurrently, any observations of marine mammals would be required to be communicated to PSOs on all nearby survey vessels.

SBPs would only commence when visual clearance zones are fully visible (*e.g.,* not obscured by darkness, rain, fog, etc.) and clear of marine mammals, as determined by the Lead PSO, for at least 30 minutes immediately prior to initiation of survey activities utilizing the specified acoustic sources. In any case when the clearance process has begun in conditions with good visibility, including via the use of night vision equipment (IR/thermal camera), and the Lead PSO has determined that the clearance zones are clear of marine mammals, survey operations would be allowed to commence (*i.e.,* no delay is required) despite periods of inclement weather and/or loss of daylight.

During daylight hours when survey equipment is not operating, Empire Wind would ensure that visual PSOs conduct, as rotation schedules allow, observations for comparison of sighting rates and behavior with and without use of the specified acoustic sources. Off-effort PSO monitoring must be reflected in the monthly PSO monitoring reports.

Once the survey has commenced, Empire Wind must shut down SBPs if a marine mammal enters a respective shutdown zone, except in cases when the shutdown zones become obscured for brief periods due to inclement weather, survey operations would be allowed to continue (*i.e.,* no shutdown is required) so long as no marine mammals have been detected. The shutdown requirement does not apply to small delphinids of the following genera: *Delphinus, Stenella, Lagenorhynchus,* and *Tursiops.* If there is uncertainty regarding the identification of a marine mammal species (*i.e.,* whether the observed marine mammal belongs to one of the delphinid genera for which shutdown is waived), the PSOs must use their best professional judgment in making the decision to call for a shutdown. Shutdown is required if a delphinid that belongs to a genus other than those specified here is detected in the shutdown zone.

If a SBP is shut down for reasons other than mitigation (*e.g.,* mechanical difficulty) for less than 30 minutes, it would be allowed to be activated again without ramp-up only if PSOs have maintained constant observation and no additional detections of any marine mammal occurred within the respective shutdown zones.

Sound Field Verification (SFV)

During the installation of the first three monopile foundations and all piles associated with installation of the first OSS foundation, Empire Wind must empirically determine source levels, the ranges to the isopleths corresponding to the Level A harassment and Level B harassment thresholds and transmission loss coefficient(s). Empire Wind may also estimate ranges to the Level A harassment and Level B harassment isopleths by extrapolating from in situ measurements conducted at several distances from the piles monitored. Empire Wind must perform sound field measurements at four distances from the pile being driven, including, but not limited to, 750 m and the modeled Level B harassment zones to verify the accuracy of those modeled zones. The recordings will be continuous throughout the duration of all impact hammering of each pile monitored. The measurement systems will have a sensitivity appropriate for the expected sound levels from pile driving received at the nominal ranges throughout the installation of the pile. The frequency range of the system will cover the range of at least 20 Hz to 20 kHz. The system will be designed to have omnidirectional sensitivity and will be designed so that the predicted broadband received level of all impact pile-driving strikes exceed the system noise floor by at least 10 dB. The dynamic range of the system will be sufficient such that at each location, pile driving signals are not clipped and are not masked by noise floor.

If acoustic field measurements collected during installation of foundation piles indicate ranges to the isopleths corresponding to Level A harassment and Level B harassment thresholds are greater than the ranges predicted by modeling (assuming 10 dB attenuation), Empire Wind must implement additional noise mitigation measures prior to installing the next monopile. Initial additional measures may include improving the efficacy of the implemented noise mitigation technology (*e.g.,* BBC, DBBC) and/or modifying the piling schedule to reduce the sound source. Each sequential modification would be evaluated empirically by acoustic field measurements.

In the event that field measurements indicate ranges to isopleths corresponding to Level A harassment and Level B harassment thresholds are greater than the ranges predicted by modeling (assuming 10 dB attenuation), NMFS may expand the relevant harassment, clearance, and shutdown zones and associated monitoring protocols. If harassment zones are expanded beyond an additional 1,500 m, additional PSOs would be deployed on additional platforms with each observer responsible for maintaining watch in no more than 180 degrees and of an area with a radius no greater than 1,500 m.

If acoustic measurements indicate that ranges to isopleths corresponding to the Level A harassment and Level B harassment thresholds are less than the ranges predicted by modeling (assuming 10 dB attenuation), Empire Wind may request a modification of the clearance and shutdown zones for impact pile driving of monopiles and jacket foundation piles. For NMFS to consider a modification request, Empire Wind would have had to conduct SFV on three or more monopiles to verify that zone sizes are consistently smaller than those predicted by modeling (assuming 10 dB attenuation) and subsequent piles would be installed within and under similar conditions (*e.g.,* monitoring data collected during installation of a typical pile can not be used to adjust difficult-to-drive pile ranges). In addition, if a subsequent monopile installation location is selected that was not represented by previous three locations (*i.e.,* substrate composition, water depth), SFV would be required. Upon receipt of an interim SFV report, NMFS may adjust zones (*i.e.,* Level A harassment, Level B harassment, clearance, shutdown, and/or minimum visibility zone) to reflect SFV measurements.

Empire Wind will submit a SFV Plan to NOAA Fisheries for review and approval at least 180 days prior to planned start of pile driving. In addition to identify how foundation installation noise levels will be monitored, the SFV plan must also include how operational noise would be monitored. Empire Wind would be required to estimate source levels based on measurements in the near and far-field at a minimum of three locations from each foundation monitored. These data must be used to also identify estimated transmission loss rates. Operational parameters (*e.g.,* direct drive/gearbox information, turbine rotation rate) as well as sea state conditions and information on nearby anthropogenic activities (*e.g.,* vessels transiting or operating in the area) must be reported.

Reporting

Prior to initiation of project activities, Empire Wind would provide a report to NMFS (at *robert.pauline@noaa.gov* and *pr.itp.monitoringreports@noaa.gov*) documenting that all required training for Empire Wind personnel (*i.e.,* vessel crews, vessel captains, PSOs, and PAM operators) has been completed and provide the date that each in-water construction activity considered in this proposed rule (*i.e.,* foundation installation, cable landfall construction, marina activities, and HRG surveys) would occur.

NMFS would require standardized and frequent reporting from Empire Wind during the life of the proposed regulations and LOA. All data collected relating to the Empire Wind project would be recorded using industry-standard software installed on field laptops and/or tablets. Empire Wind would be required to submit weekly, monthly and annual reports as described below. For all monitoring efforts and marine mammal sightings, the following information would be collected and reported related to the activity being conducted:

- Date and time that monitored activity begins or ends;
- Construction activities occurring during each observation period;
- Watch status (*i.e.,* sighting made by PSO on/off effort, opportunistic, crew, alternate vessel/platform);
- PSO who sighted the animal;
- Time of sighting;
- Weather parameters (*e.g.,* wind speed, percent cloud cover, visibility);
- Water conditions (*e.g.,* sea state, tide state, water depth);
- All marine mammal sightings, regardless of distance from the construction activity;
- Species (or lowest possible taxonomic level possible);
- Pace of the animal(s);
- Estimated number of animals (minimum/maximum/high/low/best);
- Estimated number of animals by cohort (*e.g.,* adults, yearlings, juveniles, calves, group composition, etc.);
- 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);

• 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;

• Animal's closest distance and bearing from the pile being driven or specified HRG equipment and estimated time entered and spent within the Level A harassment and/or Level B harassment zones;

• Construction activity at time of sighting (*e.g.,* vibratory installation/removal, impact pile driving,, HRG survey), use of any noise attenuation device(s), and specific phase of activity (*e.g.,* ramp-up of HRG equipment, HRG acoustic source on/off, soft-start for pile driving, active pile driving, etc.);

• Marine mammal occurrence in Level A harassment or Level B harassment zones;

• 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.

For all real-time acoustic detections of marine mammals, the following must be recorded and included in weekly, monthly, annual, and final reports:

1. Location of hydrophone (latitude & longitude; in Decimal Degrees) and site name;

2. Bottom depth and depth of recording unit (in meters);

3. Recorder (model & manufacturer) and platform type (*i.e.,* bottom-mounted, electric glider, etc.), and instrument ID of the hydrophone and recording platform (if applicable);

4. Time zone for sound files and recorded date/times in data and metadata (in relation to UTC. *i.e.,* EST time zone is UTC–5);

5. Duration of recordings (start/end dates and times; in ISO 8601 format, yyyy-mm-ddTHH:MM:SS.sssZ);

6. Deployment/retrieval dates and times (in ISO 8601 format);

7. Recording schedule (must be continuous);

8. Hydrophone and recorder sensitivity (in dB *re. 1*µ*Pa*);

9. Calibration curve for each recorder;

10. Bandwidth/sampling rate (in Hz);

11. Sample bit-rate of recordings; and

12. Detection range of equipment for relevant frequency bands (in meters).

For each detection the following information must be noted:

13. Species identification (if possible);

14. Call type and number of calls (if known);

15. Temporal aspects of vocalization (date, time, duration, etc., date times in ISO 8601 format);

16. Confidence of detection (detected, or possibly detected);

17. Comparison with any concurrent visual sightings;

18. Location and/or directionality of call (if determined) relative to acoustic;

19. Location of recorder and construction activities at time of call;

20. Name and version of detection or sound analysis software used, with protocol reference;

21. Minimum and maximum frequencies viewed/monitored/used in detection (in Hz); and

22. Name of PAM operator(s) on duty.

Weekly Report—During foundation installation activities, Empire Wind would be required to compile and submit weekly marine mammals and pile driving activity reports to NMFS (*robert.pauline@noaa.gov and PR.ITP.monitoringreports@noaa.gov*) 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.,* bubble rate). Weekly reports would be due on Wednesday for the previous week (Sunday–Saturday). The weekly report would also identify which turbines become operational and when (a map must be provided). Once all foundation pile installation is complete, weekly reports would no longer be required.

Monthly Report—Empire Wind would be required to compile and submit monthly reports to NMFS (*robert.pauline@noaa.gov and PR.ITP.monitoringreports@noaa.gov*) 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). Once foundation pile installation is complete, monthly reports would no longer be required.

Annual Report—Empire Wind would be required to submit an annual PSO PAM report to NMFS (at *robert.pauline@noaa.gov* and *PR.ITP.monitoringreports@noaa.gov*) no later than 90 days following the end of a given calendar year describing, in detail, all of the information required in the monitoring section above. A final annual report would be prepared and submitted within 30 calendar days following receipt of any NMFS comments on the draft report. If no comments were received from NMFS within 60 calendar days of NMFS' receipt of the draft report, the report would be considered final.

Final Report—Empire Wind must submit its draft final report(s) to NMFS (*robert.pauline@noaa.gov* and *PR.ITP.monitoringreports@noaa.gov*) on all visual and acoustic monitoring conducted under the LOA within 90 calendar days of the completion of activities occurring under the LOA. A final report must be prepared and submitted within 30 calendar days following receipt of any NMFS comments on the draft report. If no comments are received from NMFS within 60 calendar days of NMFS' receipt of the draft report, the report shall be considered final. Information contained within this report is described at the beginning of this section.

Situational Reporting—Specific situations encountered during the development of the Empire Wind project would require immediate reporting. These situations and the relevant procedures include:

• If a North Atlantic right whale is detected via Empire Wind's PAM, the date, time, and location (*i.e.,* latitude and longitude of recorder) of the detection, as well as the recording platform that had the detection, must be reported to *nmfs.pacmdata@noaa.gov* as soon as feasible, no longer than 24 hours after the detection. Full detection data and metadata must be submitted monthly on the 15th of every month for the previous month via the web form on the NMFS North Atlantic right whale Passive Acoustic Reporting System website (*https://www.fisheries.noaa.gov/resource/document/passive-acoustic-reporting-system-templates*).

• If a North Atlantic right whale is observed at any time by PSOs or Empire Wind personnel, Empire Wind must immediately report sighting information to the NMFS North Atlantic Right Whale Sighting Advisory System (866–755–6622), to the U.S. Coast Guard via channel 16, and through the WhaleAlert app (*http://www.whalealert/org/*) as soon as feasible but no longer than 24 hours after the sighting. Information reported must include, at a minimum: time of sighting, location, and number of North Atlantic right whales observed.

• If a large whale is detected during vessel transit, the following information must be recorded and reported:

a. Time, date, and location;

b. The vessel's activity, heading, and speed;

c. Sea state, water depth, and visibility;

d. Marine mammal identification to the best of the observer's ability (*e.g.,* North Atlantic right whale, whale, dolphin, seal);

e. Initial distance and bearing to marine mammal from vessel and closest point of approach; and

f. Any avoidance measures taken in response to the marine mammal sighting.

• If a sighting of a stranded, entangled, injured, or dead marine mammal occurs, the sighting would be reported to NMFS OPR, the NMFS Greater Atlantic Stranding Coordinator for the New England/Mid-Atlantic area (866–755–6622 or the Dolphin and Whale 911 app) and the U.S. Coast Guard within 24 hours. If the injury or death was caused by a project activity, Empire Wind must 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 LOA. NMFS may impose additional measures to minimize the likelihood of further prohibited take and ensure MMPA compliance. Empire Wind may not resume their activities until notified by NMFS. The report must include the following information:

a. Time, date, and location (latitude/longitude) of the first discovery (and updated location information if known and applicable);

b. Species identification (if known) or description of the animal(s) involved;

c. Condition of the animal(s) (including carcass condition if the animal is dead);

d. Observed behaviors of the animal(s), if alive;

e. If available, photographs or video footage of the animal(s); and

f. General circumstances under which the animal was discovered.

• In the event of a vessel strike of a marine mammal by any vessel associated with the Empire Wind project, Empire Wind shall immediately report the strike incident to the NMFS OPR and the GARFO within and no later than 24 hours. Empire Wind must immediately cease all on-water 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 LOA. NMFS may impose additional measures to minimize the likelihood of further prohibited take and ensure MMPA compliance. Empire Wind may not resume their activities until notified by NMFS. The report must include the following information:

a. Time, date, and location (latitude/longitude) of the incident;

b. Species identification (if known) or description of the animal(s) involved;

c. Vessel's speed leading up to and during the incident;

d. Vessel's course/heading and what operations were being conducted (if applicable);

e. Status of all sound sources in use;

f. 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;

g. Environmental conditions (*e.g.,* wind speed and direction, Beaufort sea state, cloud cover, visibility) immediately preceding the strike;

h. Estimated size and length of animal that was struck;

i. Description of the behavior of the marine mammal immediately preceding and following the strike;

j. If available, description of the presence and behavior of any other marine mammals immediately preceding the strike;

k. Estimated fate of the animal (*e.g.,* dead, injured but alive, injured and moving, blood or tissue observed in the water, status unknown, disappeared); and

l. To the extent practicable, photographs or video footage of the animal(s).

Adaptive Management

The regulations governing the take of marine mammals incidental to Empire Wind's Wind's construction activities would contain an adaptive management component. The monitoring and reporting requirements in this rule are designed to provide NMFS with information that helps us better understand the impacts of the activities on marine mammals and informs our consideration of whether any changes to mitigation or monitoring are appropriate. The use of adaptive management allows NMFS to consider new information from different sources to determine (with input from Empire Wind regarding practicability) on an annual or biennial basis if mitigation or monitoring measures should be modified (including additions or deletions). Mitigation measures could be modified if new data suggests that such modifications would have a reasonable likelihood of reducing adverse effects to marine mammals and if the measures are practicable.

The following are some of the possible sources of applicable data to be considered through the adaptive management process: (1) Results from monitoring reports, as required by MMPA authorizations; (2) results from general marine mammal and sound research; and (3) any information which reveals that marine mammals may have been taken in a manner, extent, or number not authorized by these regulations or subsequent LOA. During the course of the rule, Empire Wind (and other LOA-holders conducting offshore wind development activities) would be required to participate in one or more adaptive management meetings convened by NMFS and/or BOEM, in which the above information would be summarized and discussed in the context of potential changes to the mitigation or monitoring measures.

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'' by mortality, serious injury, and Level A harassment or Level B harassment, we consider other factors, such as the likely nature of any behavioral responses (*e.g.,* intensity, duration), the context of any such responses (*e.g.,* critical reproductive time or location, migration), as well as effects on habitat, and the likely effectiveness of 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 environmental baseline (*e.g.,* as reflected in the regulatory status of the species, population size and growth rate where known, ongoing sources of human-caused mortality, or ambient noise levels).

In the Estimated Take of Marine Mammals section, we identified the subset of potential effects that would be expected to qualify as takes under the MMPA, and then identified the maximum number of takes by Level A harassment and Level B harassment that we estimate are likely to occur 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 proposed rule, we evaluate the likely impacts of the enumerated harassment takes that are proposed for authorization 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 for authorization for any species or stock.

The Description of the Specified Activities section describes the specified activities proposed by Empire Wind that may result in take of marine mammals and an estimated schedule for conducting those activities. Empire Wind has provided a realistic construction schedule although we recognize schedules may shift for a variety of reasons (*e.g.,* weather or supply delays). However, the total amount of take would not exceed the 5 year totals and maximum annual total in any given year indicated in Tables 34 and 35, respectively.

We base our analysis and negligible impact determination (NID) on the maximum number of takes that have the potential to occur and are proposed to be authorized annually and across the 5-year LOA, if issued, 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. As stated before, the number of takes, both maximum annual and 5-year total, alone are only a part of the analysis.

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 24 given that some of the anticipated effects of Empire Wind's construction activities on marine mammals are expected to be relatively similar in nature. Then, we subdivide into more detailed discussions for mysticetes, odontocetes, and pinnipeds which have broad life history traits that support an overarching discussion of some factors considered within the analysis for those groups (*e.g.,* habitat-use patterns, high-level differences in feeding strategies).

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 North Atlantic right whales given their population status. Organizing our analysis by grouping species or stocks that share common traits or that would respond similarly to effects of Empire Wind's proposed 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. It is important to note that in the group or species sections, we base our negligible impact analysis on the maximum annual take that is predicted under the 5-year rule; however, the majority of the impacts are associated with monopile foundation and OSS foundation installation, which would occur largely within the first two years. The estimated take in the other years is expected to be notably less, which is reflected in the total take that would be allowable under the rule (see Tables 34, 35, and 36).

As described previously, no serious injury or mortality is anticipated or proposed for authorization in this rule. The amount of harassment Empire Wind has requested, and NMFS is proposing to authorize, is based on exposure models that consider the outputs of acoustic source and propagation models. Several conservative parameters and assumptions are ingrained into these models, such as assuming forcing functions that consider direct contact with piles (*i.e.,* no cushion allowances) and application of the highest monthly sound speed profile to all months within a given season. The exposure model results do not reflect any mitigation measures or avoidance response. The amount of take requested and proposed to be authorized also reflects careful consideration of other data (*e.g.,* PSO and group size data) and, for Level A harassment potential of some large whales, the consideration of mitigation measures. 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 likely 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 (*e.g.,* DeRuiter, 2012; Falcone *et al.,* 2017). As described in the Potential Effects to Marine Mammals and their Habitat section, the intensity and duration of any impact resulting from exposure to Empire 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. 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. Harassment of marine mammals may result in behavioral modifications (*e.g.,* avoidance, temporary cessation of foraging or communicating, changes in respiration or group dynamics, masking) or may result in auditory impacts such as hearing loss. In addition, some of the lower level physiological stress responses (*e.g.,* orientation or startle response, 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. Takes by Level B harassment, then, may have a stress-related physiological component as well; however, we would not expect Empire Wind's 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 by behavioral disturbance (which by nature of the way it is modeled/counted, occurs within one 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 one 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 Empire Wind project area is shallow (5 to 44 m) and 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 Empire 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. These instances may represent either brief exposures or seconds to minutes for HRG surveys) or, in some cases, longer durations of exposure within a day (*e.g.,* pile driving). 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.

For the Empire Wind project, impact pile driving of foundation piles is most likely to result in a higher magnitude and severity of behavioral disturbance than other activities (*i.e.,* impact driving of casing pipe, vibratory pile driving, and HRG surveys). Foundation installation impact pile driving has higher source levels and longer duration than any nearshore pile driving activities. HRG survey equipment also produces much higher frequencies than pile driving, resulting in minimal sound propagation. While foundation installation impact pile driving is anticipated to be most impactful for these reasons, impacts are minimized through implementation of mitigation measures, including soft-start, use of a sound attenuation system, and the implementation of clearance that would facilitate a delay of pile driving if marine mammals were observed approaching or within areas that could be ensonified above sound levels that could result in Level B harassment. Given sufficient notice through the use of soft-start, marine mammals are expected to move away from a sound source that is annoying prior to becoming exposed to very loud noise levels. The requirement to couple visual monitoring and PAM during all clearance periods would increase the overall capability to detect marine mammals than 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 are 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. 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; NAS 2017; New *et al.,* 2014; Southall *et al.,* 2007; Villegas-Amtmann *et al.,* 2015).

Temporary Threshold Shift (TTS)

TTS is one form of Level B harassment that marine mammals may incur through exposure to Empire Wind's activities and, as described earlier, the proposed takes by Level B harassment may represent takes in the form of behavioral disturbance, TTS, or both. As discussed in the Potential Effects to 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 and vibratory pile driving generate 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 the frequencies produced by pile driving 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 Empire 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. However, the mitigation measures proposed by Empire Wind and proposed by NMFS, 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 (refer back to Table 4). However, source level alone is not a predictor of TTS. 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 difficult 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 the Potential Effects to Marine Mammals and their Habitat section), 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 small number of times that any individual might incur TTS, the low degree of TTS and the short anticipated duration, and the unlikely scenario that any TTS overlapped the entirety of a critical hearing range, it is unlikely that TTS of the nature expected to result from Empire Wind'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 (PTS)

Empire Wind has requested, and NMFS proposed to authorize, a very small amount of take by PTS to some marine mammal individuals. The numbers of proposed annual takes by Level A harassment are relatively low for all marine mammal stocks and species: fin whale (2 takes), and minke whale (6). The only activities incidental to which we anticipate PTS may occur is from exposure to impact pile driving, which produce 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 an 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; NMFS 2018; Southall *et al.,* 2019)) 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 either 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. However, 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 annoying prior to it resulting in severe PTS.

Auditory Masking or Communication Impairment

The ultimate 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 time 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 which might individually cause TTS. Fundamentally, masking is referred to as a chronic effect because one of the key potential harmful components of masking is its duration—the fact that an animal would have reduced ability to hear or interpret critical cues becomes much more likely to cause a problem the longer it is occurring. Also 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, for this project we expect that impact pile driving foundations have the greatest potential to mask marine mammal signals, and this pile driving may occur for several, albeit intermittent, hours per day, for multiple days per year. 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. However, the area in which masking would occur for all marine mammal species and stocks (*e.g.,* predominantly in the vicinity of the foundation pile being driven) is small relative to the extent of habitat used by each species and stock. In summary, the nature of Empire Wind's activities, paired with habitat use patterns by marine mammals, does not support the likelihood that the level of masking that could occur would have the potential to affect reproductive success or survival.

Impacts on Habitat and Prey

Construction activities may result in fish and invertebrate mortality or injury very close to the source, and all activities (including HRG surveys) 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), the impacts to marine mammal habitat are not expected to cause significant or long-term negative consequences.

Cable presence and operation are 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.

The presence and operation 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. The presence and operation of an extensive number of structures such as wind turbines are, in general, likely to result in local and broader oceanographic effects in the marine environment, and may disrupt dense aggregations and distribution of marine mammal zooplankton prey through altering 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). However, the scale of impacts is difficult to predict and may vary from hundreds of meters for local individual turbine impacts (Schultze *et al.,* 2020) to large-scale dipoles of surface elevation changes stretching hundreds of kilometers (Christiansen *et al.,* 2022).

As discussed in the Potential Effects to Marine Mammals and Their Habitat section, the Empire Wind offshore project would consist of no more than 147 wind turbine generators in New York coastal waters. While there are likely to be local oceanographic impacts from the presence and operation of the Empire Wind offshore project, meaningful oceanographic impacts relative to stratification and mixing that would significantly affect marine mammal habitat and prey over large areas in key foraging habitats are not anticipated. Although this area supports aggregations of zooplankton (baleen whale prey) that could be impacted if long-term oceanographic changes occurred, prey densities are typically significantly less in the Empire Wind project area than in known baleen whale foraging habitats to the east and north (*e.g.,* south of Nantucket and Martha's Vineyard, Great South Channel). For these reasons, if oceanographic features are affected by wind farm operation during the course of the proposed rule (approximately end of Year 1 through Year 5), the impact on marine mammal habitat and their prey is likely to be comparatively minor.

Mitigation To Reduce Impacts on All Species

This proposed rulemaking includes a variety of mitigation measures designed to minimize impacts on all marine mammals, with a focus on North Atlantic right whales (the latter is described in more detail below). For impact pile driving of foundation piles, eight 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 designated zones triggering 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 Empire Wind project personnel must be reported to PSOs; and (9) sound field verification monitoring

When monopile foundation installation does occur, Empire Wind is committed to reducing the noise levels generated by impact pile driving to the lowest levels practicable and ensuring that they do not exceed a noise footprint above that which was modeled, assuming a 10-dB attenuation. Use of a soft-start would allow animals to move away from (*i.e.,* avoid) the sound source prior to applying higher hammer energy levels needed to install the pile (Empire Wind would not use a hammer energy greater than necessary to install piles). Clearance zone and shutdown zone implementation, required when marine mammals are within given distances associated with certain impact thresholds, would reduce the magnitude and severity of marine mammal take.

Empire Wind proposed, and NMFS would require, use a noise attenuation device (likely a double bubble curtain) during all foundation pile driving to ensure sound generated from the project does not exceed that modeled (assuming 10-dB reduction) distances to harassment isopleths and to minimize noise levels to the lowest level practicable. Double bubble curtains are successfully and widely applied across European wind development efforts, and are known to reduce noise levels more than a single bubble curtain alone (*e.g.,* see Bellman *et al.,* 2020).

Mysticetes

Five mysticete species (comprising five stocks) of cetaceans (North Atlantic right whale, humpback whale, fin whale, sei whale, and minke whale) are proposed to be taken by harassment. These species, to varying extents, utilize coastal New York, including the project area, for the purposes of migration and foraging.

Behavioral data on mysticete reactions to pile driving noise is 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 Empire Wind project area are expected to be migrating through and/or foraging within the project area; the extent to which an animal engages in these behaviors in the area is species-specific and varies seasonally. Given that extensive feeding BIAs for the North Atlantic right whale, humpback whale, fin whale, sei whale, and minke whale exist to the east and north of the project area (LaBrecque *et al.,* 2015; Van Parijs *et al,* 2015), many mysticetes are expected to predominantly be migrating through the project area towards or from these feeding habitats. While we have acknowledged above that mortality, hearing impairment, or displacement of mysticete prey species may result locally from impact pile driving or, 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 would be expected to be minor. Whales temporarily displaced from the proposed project area would be expected to have sufficient remaining feeding habitat available to them, and would not be prevented from feeding in other areas within the biologically important feeding habitats. In addition, any displacement of whales or interruption of foraging bouts would be expected to be temporary in nature.

The potential for repeated exposures is dependent upon the residency time of whales, with migratory animals unlikely to be exposed on repeated occasions and animals remaining in the area to be more likely exposed repeatedly. Where relatively low amounts of species-specific proposed Level B harassment are predicted (compared to the abundance of each mysticete species or stock, such as is indicated in Table 36) 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; the behavioral impacts would, therefore, be expected to occur within a single day within a year—an amount that would not be expected to impact reproduction or survival. Alternatively, species with longer residence time in the project area may be subject to repeated exposures across multiple days. In general, for this project, the duration of exposures would not be continuous throughout any given day and pile driving would not occur on all consecutive days within a given year, due to weather delays or any number of logistical constraints Empire Wind has identified. Species-specific analysis regarding potential for repeated exposures and impacts is provided below. Overall, we do not expect impacts to whales within project area habitat, including fin whales foraging in the fin whale feeding BIA north of the project area, to affect the fitness of any large whales.

Fin and minke whales are the only mysticete species for which PTS is anticipated and proposed to be authorized. As described previously, PTS for mysticetes from impact pile driving 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 reproductive success or survival.

North Atlantic Right whales

North Atlantic right whales are listed as endangered under the ESA and, as described in the Effects to Marine Mammals and Their Habitat section, 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; Stewart *et al.,* 2022). Given this, the status of the North Atlantic right whale population is of heightened concern and, therefore, merits additional analysis and consideration. NMFS proposes to authorize a maximum of 13 takes of North Atlantic right whales, by Level B harassment only, in any given year, with no more than 29 takes incidental to all construction activities over the 5-year period of effectiveness of this proposed rule.

As described above, the project area represents part of an important migratory area for right whales. Quintana-Rizzo *et al.* (2021) noted that southern New England, northeast of the project area, may be a stopover site for migrating right whales moving to or from southeastern calving grounds. The right whales observed during the study period were primarily concentrated in the northeastern and southeastern sections of the MA WEA during the summer (June–August) and winter (December–February). Right whale distribution did shift to the west into the RI/MA WEA in the spring (March–May). Overall, the Empire Wind project area contains habitat less frequently utilized by North Atlantic right whales than the more northerly Southern New England region.

In general, North Atlantic right whales in the project area are expected to be engaging in migratory behavior. Given the species' migratory behavior in the project area, we anticipate individual whales would be typically migrating through the area during most months when foundation installation would occur (given the seasonal restrictions on foundation installation from January through April, rather than lingering for extended periods of time). Other work that involves either much smaller harassment zones (*e.g.*, HRG surveys) or is limited in amount (cable landfall construction) may also occur during periods when North Atlantic right whales are using the habitat for migration. Therefore, it is likely that many of the takes would occur to separate individual whales, each exposed on no more than one day. It is important to note the activities occurring from December through May that may impact North Atlantic right whale would be primarily HRG surveys and cable landfall construction, neither of which would result in very high received levels. Across all years, while it is possible an animal could have been exposed during a previous year, the low amount of take proposed to be authorized during the 5-year period of the proposed rule makes this scenario possible but unlikely. However, if an individual were to be exposed during a subsequent year, the impact of that exposure is likely independent of the previous exposure given the duration between exposures.

North Atlantic right whales 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 North Atlantic right whales. Given the current status of the North Atlantic right whale, the loss of even one individual could significantly impact the population. No mortality, serious injury, or injury of North Atlantic right whales as a result of the project is expected or proposed to be authorized. Any disturbance to North Atlantic right whales due to Empire Wind's activities is expected to result in temporary avoidance of the immediate area of construction. As no injury, serious injury, or mortality is expected or authorized, and Level B harassment of North Atlantic right whales will be reduced to the level of least practicable adverse impact through use of mitigation measures, the authorized number of takes of North Atlantic right whales would not exacerbate or compound the effects of the ongoing UME in any way.

As described in the general Mysticete section above, impact pile driving of foundation piles is likely to result in the highest amount of annual take and is of greatest concern given loud source levels. This activity would likely be limited to two years, during times when North Atlantic right whales are not present in high numbers and are likely to be primarily migrating to more northern foraging grounds. The potential types, severity, and magnitude of impacts are also anticipated to mirror that described in the general mysticete 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 proposed by Empire Wind are expected to be sufficiently low-level and localized to specific areas as to not meaningfully impact important behaviors such as migratory behavior of North Atlantic right whales. As described above, no more than 13 takes would occur in any given year with no more than 29 takes occurring across the 5 years the proposed rule would be effective. If this number of exposures results in temporary behavioral reactions, such as slight displacement (but not abandonment) of migratory habitat or temporary cessation of feeding, it is unlikely to result in energetic consequences that could affect reproduction or survival of any individuals. Overall, NMFS expects that any harassment of North Atlantic right whales incidental to the specified activities would not result in changes to their migration patterns or foraging behavior as only temporary avoidance of an area during construction is expected to occur. As described previously, right whales migrating through and/or foraging in these areas are not expected to remain in this habitat for extensive durations, relative to habitats to the north such as Nantucket and Martha's Vineyard or the Great South Channel (known core foraging habitats) (Quintana-Rizzo *et al.,* 2021), and that any temporarily displaced animals would be able to return to or continue to travel through and forage in these areas once activities have ceased.

Although acoustic masking may occur, based on the acoustic characteristics of noise associated with pile driving (*e.g.,* frequency spectra, short duration of exposure) and construction surveys (*e.g.,* intermittent signals), NMFS expects masking effects to be minimal (*e.g.,* impact or vibratory pile driving) to none (*e.g.,* HRG surveys). In addition, masking would likely only occur during the period of time that a North Atlantic right whale 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 North Atlantic right whales are at lower densities and primarily moving through the area, anticipated mitigation effectiveness, and likely avoidance behaviors. TTS is another potential form of Level B harassment that could result in brief periods of slightly reduced hearing sensitivity affecting behavioral patterns by making it more difficult 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, be 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, the distance of the receiver to the source influences the severity of response with greater distances typically eliciting less severe responses. Additionally, NMFS recognizes North Atlantic right whales 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, as described in the Potential Effects to Marine Mammals and Their Habitat section, 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 right whales would be similar to that of gray whales (Tyack and Clark, 1983), on the order of hundreds of meters up to 1 to 2 km. This diversion from a migratory path otherwise uninterrupted by Empire Wind activities is not expected to result in meaningful energetic costs that would impact annual rates of recruitment of survival. NMFS expects that North Atlantic right whales would be able to avoid areas during periods of active noise production while not being forced out of this portion of their habitat.

North Atlantic right whale presence in the Empire Wind project area 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). 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, Empire Wind has proposed and NMFS is proposing to require a suite of mitigation measures designed to reduce impacts to North Atlantic right whales to the maximum extent practicable. These mitigation measures (*e.g.,* seasonal/daily work restrictions, vessel separation distances, reduced vessel speed) would not only avoid the likelihood of ship strikes but also would minimize the severity of behavioral disruptions by minimizing impacts (*e.g.,* through sound reduction using attenuation systems and reduced temporal overlap of project activities and North Atlantic right whales). This would further ensure that the number of takes by Level B harassment that are estimated to occur are not expected to affect reproductive success or survivorship via detrimental impacts to energy intake or cow/calf interactions during migratory transit. However, even in consideration of recent habitat-use and distribution shifts, Empire Wind would still be installing monopiles when the presence of North Atlantic right whales is expected to be lower.

As described in the Description of Marine Mammals in the Area of Specified Activities section, Empire Wind would be constructed within the North Atlantic right whale migratory corridor BIA, which represent areas and months within which a substantial portion of a species or population is known to migrate. The Empire Wind lease area is relatively small compared with the migratory BIA area (approximately 321 km^2 versus the size of the full North Atlantic right whale migratory BIA, 269,448 km^2). Because of this, overall North Atlantic right whale migration is not expected to be impacted by the proposed activities. There are no known North Atlantic right whale mating or calving areas within the project area. Prey species are mobile (*e.g.,* calanoid copepods can initiate rapid and directed escape responses) and are broadly distributed throughout the project area (noting again that North Atlantic right whale prey is not particularly concentrated in the project area relative to nearby habitats). Therefore, any impacts to prey that may occur are also unlikely to impact marine mammals.

The most significant measure to minimize impacts to individual North Atlantic right whales during monopile installations is the seasonal moratorium on impact pile driving of monopiles from January 1 through April 30 when North Atlantic right whale abundance in the project area 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 the project area from calving grounds to primary foraging grounds (*e.g.,* Cape Cod Bay). Further, NMFS expects that exposures to North Atlantic right whales would be reduced due to the additional proposed mitigation measures that would ensure that any exposures above the Level B harassment threshold would result in only short-term effects to individuals exposed. Impact pile driving may only begin in the absence of North Atlantic right whales (based on visual and passive acoustic monitoring). If impact pile driving has commenced, NMFS anticipates North Atlantic right whales would avoid the area, utilizing nearby waters to carry on pre-exposure behaviors. However, impact pile driving must be shut down if a North Atlantic right whale is sighted at any distance unless a shutdown is not feasible due to risk of injury or loss of life. Shutdown may occur anywhere if right whales are seen within or beyond the Level B harassment zone, further minimizing the duration and intensity of exposure. NMFS anticipates that if North Atlantic right whales go undetected and they are exposed to impact pile driving noise, it is unlikely a North Atlantic right whale would approach the impact pile driving locations to the degree that they would purposely expose themselves to very high noise levels. 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 proposed 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.

The proposed 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, Empire Wind proposed, and NMFS is proposing to require, the combination of PAM and visual observers (as well as communication protocols with other Empire Wind vessels, and other heightened awareness efforts such as daily monitoring of North Atlantic right whale sighting databases) such that as a North Atlantic right whale 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 pile driving or shutdown (if feasible) would occur. In addition, the implementation of a soft-start would provide an opportunity for whales to move away from the source if they are undetected, reducing received levels. Further, Empire Wind will not install two monopile foundations or OSS foundations simultaneously. North Atlantic right whales would, therefore, not be exposed to concurrent impact pile driving on any given day and the area ensonified at any given time would be limited.

The temporary cofferdam Level B harassment zones are relatively small (1,985 m for EW 1 and 1,535 m for EW 2), the cofferdams would be installed within Narragansett Bay over a short timeframe (56 hours total; 28 hours for installation and 28 hours for removal). Therefore, it is unlikely that any North Atlantic right whales would be exposed to vibratory installation noises. Finally, for HRG surveys, the maximum distance to the Level B harassment isopleth is 50.05 m. The estimated take, by Level B harassment only, associated with HRG surveys is to account for any North Atlantic right whale sightings PSOs may miss when HRG acoustic sources are active. However, because of the short maximum distance to the Level B harassment isopleth (50.05 m), the requirement that vessels maintain a distance of 500 m from any North Atlantic right whales, the fact whales are unlikely to remain in close proximity to an HRG survey vessel for any length of time, and that the acoustic source would be shutdown if a North Atlantic right whale is observed within 500 m of the source, any exposure to noise levels above the harassment threshold (if any) would be very brief. To further minimize exposures, ramp-up of sub-bottom profilers must be delayed during the clearance period if PSOs detect a North Atlantic right whale (or any other ESA-listed species) within 500 m of the acoustic source. With implementation of the proposed mitigation requirements, take by Level A harassment is unlikely and, therefore, not proposed for authorization. Potential impacts associated with Level B harassment would include low-level, temporary behavioral modifications, most likely in the form of avoidance behavior. Given the high level of precautions taken to minimize both the amount and intensity of Level B harassment on North Atlantic right whales, it is unlikely that the anticipated low-level exposures would lead to reduced reproductive success or survival.

North Atlantic right whales are listed as endangered under the ESA with a declining population primarily due to vessel strike and entanglement. Again, NMFS is proposing to authorize no more than 13 instances of take, by Level B harassment only, within a given year with no more than 29 instances of take could occur over the 5-year effective period of the proposed rule, with the likely scenario that each instance of exposure occurs to a different individual (a small portion of the stock), and any individual North Atlantic right whale is likely to be disturbed at a low level. The magnitude and severity of harassment are not expected to result in impacts on the reproduction or survival of any individuals, let alone have impacts on annual rates of recruitment or survival of this stock. No mortality, serious injury, or Level A harassment is anticipated or proposed to be authorized. For these reasons, we have preliminarily determined, in consideration of all of the effects of the Empire Wind's activities combined, that the proposed authorized take would have a negligible impact on the North Atlantic stock of North Atlantic right whales.

Humpback Whales

Humpback whales potentially impacted by Empire Wind's activities do not belong to a DPS that is listed as threatened or endangered under the ESA. However, 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 half had evidence of human interaction (ship strike or entanglement). The UME does not yet provide cause for concern regarding population-level impacts, and take from ship strike and entanglement is not proposed to be authorized. 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.

Empire Wind has requested, and NMFS has proposed to authorize, a limited amount of humpback whale harassment by Level B harassment. No mortality or serious injury is anticipated or proposed for authorization. Among the activities analyzed, impact pile driving is likely to result in the highest amount of annual take of humpback whales (0 takes by Level A harassment and 63 takes by Level B harassment) and is of greatest concern, given the associated loud source levels. A recent study examining humpback whale occurrence in the New York Bight area has shown that humpback whales exhibit extended occupancy (mean 37.6 days) in the Bight area and were likely to return from one year to the next (mean 31.3 percent). Whales were also seen at a variety of other sites in the New York Bight within the same year, suggesting that they may occupy this broader area throughout the feeding season. The majority of whales were seen during summer (July–September, 62.5 percent), followed by autumn (October–December, 23.5 percent) and spring (April–June, 13.9 percent) (Brown *et al.* 2022). These data suggest that the 0 and 63 maximum annual instances of predicted take by Level A harassment and Level B harassment, respectively, could consist of individuals exposed to noise levels above the harassment thresholds once during migration through the project area and/or individuals exposed on multiple days if they are utilizing the area as foraging habitat. Since the Lease Area (321 km^2) comprises only a minor portion of the New York Bight area (43,388 km^2), repeated takes of the same individuals would be unlikely given the availability of favorable foraging habitat across the Bight.

For all the reasons described in the Mysticete section above, we anticipate any potential 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 baleen whales. If TTS is incurred, hearing sensitivity would likely return to pre-exposure levels shortly after exposure ends. Any masking or physiological responses would also be of low magnitude and severity for reasons described above.

Altogether, the low magnitude and severity of harassment effects is not expected to result in impacts on the reproduction or survival of any individuals, let alone have impacts on annual rates of recruitment or survival of this stock. No mortality or serious injury is anticipated or proposed to be authorized. For these reasons, we have preliminarily determined, in consideration of all of the effects of Empire Wind's activities combined, that the proposed authorized take would have a negligible impact on the Gulf of Maine stock of humpback whales.

Fin Whales

The western North Atlantic stock of fin whales is listed as endangered under the ESA. The 5-year total amount of take, by Level A harassment and Level B harassment, of fin whales (n=2 and n=200, respectively) that NMFS proposes to authorize is low relative to the stock abundance. Any Level B harassment is expected to be in the form of behavioral disturbance, primarily resulting in avoidance of the project area where pile driving is occurring, and some low-level TTS and masking that may limit the detection of acoustic cues for relatively brief periods of time. Any potential PTS would be minor (limited to a few dB) and any 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 fin whales. No serious injury or mortality is anticipated or proposed for authorization. As described previously, the project area is located 140 km southwest of a fin whale feeding BIA that is active from March to October. Impacts from any of the proposed activities to feeding activities, if any, would be minor. In addition, monopile installations have seasonal work restrictions, such that the temporal overlap between these project activities and the active BIA timeframe would exclude the months of March or April. There is no spatial overlap of the project area and the feeding BIA.

Because of the relatively low magnitude and severity of take proposed for authorization, the fact that no serious injury or mortality is anticipated, the temporary nature of the disturbance, and the availability of similar habitat and resources in the surrounding area, NMFS has preliminarily determined that the impacts of Empire Wind's activities on fin whales and the food sources that they utilize are not expected to cause significant impacts on the reproduction or survival of any individuals, let alone have impacts on annual rates of recruitment or survival of this stock.

Sei Whales

The Nova Scotia stock of sei whales is listed under the ESA. There are no known areas of specific biological importance in or around the project area, nor are there any UMEs. The actual abundance of this stock is likely significantly greater than what is reflected in each SAR because, as noted in the SARs, the most recent population estimate is primarily based on surveys conducted in U.S. waters and the stock's range extends well beyond the U.S. Exclusive Economic Zone (EEZ).

The 5-year total amount of take, by Level B harassment, proposed for authorization proposed for sei whales (8) is low. NMFS is not proposing to authorize take by Level A harassment. Similar to other mysticetes, we would anticipate the number of takes to represent individuals taken only once or, in rare cases two or three times, as most whales in the project area would be migrating. To a small degree, sei whales may forage in the project area, although the currently identified foraging habitats (BIAs) are 280 km northeast of the area in which Empire Wind's activities would occur (LaBrecque *et al.,* 2015). With respect to the severity of those individual takes by behavioral Level B harassment, we would anticipate impacts to be limited to low-level, temporary behavioral responses with avoidance and potential masking impacts in the vicinity of the turbine installation to be the most likely type of response. Any potential 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 sei whales. Any avoidance of the project area due to Empire Wind's activities would be expected to be temporary.

Overall, the take by harassment proposed for authorization is of a low magnitude and severity and is not expected to result in impacts on the reproduction or survival of any individuals, let alone have impacts on annual rates of recruitment or survival of this stock. No mortality or serious injury is anticipated or proposed to be authorized. For these reasons, we have preliminarily determined, in consideration of all of the effects of the Empire Wind's activities combined, that the proposed authorized take would have a negligible impact on the Nova Scotia sei whale stock.

Minke Whales

The Canadian East Coast stock of minke whales is not listed under the ESA. There are no known areas of specific biological importance in or around the project area. Beginning in January 2017, elevated minke whale strandings have occurred along the Atlantic coast from Maine through South Carolina, with highest numbers in Massachusetts, Maine, and New York. This event does not provide cause for concern regarding population level impacts, as the likely population abundance is greater than 21,000 whales. No mortality or serious injury of this stock is anticipated or proposed for authorization.

The 5-year total amount of take, by Level A harassment and Level B harassment proposed for authorization for minke whales (n=6 and n=161, respectively) is relatively low. We anticipate the impacts of this harassment to follow those described in the general Mysticete section above. In summary, Level B harassment would be temporary, with primary impacts being temporary displacement of the project area but not abandonment of any migratory or foraging behavior. Overall, the low magnitude and severity of harassment effects is not expected to result in impacts on the reproduction or survival of any individuals, let alone have impacts on annual rates of recruitment or survival of this stock. No mortality or serious injury is anticipated or proposed to be authorized. Any potential PTS would be minor (limited to a few dB) and any 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. For these reasons, we have preliminarily determined, in consideration of all of the effects of the Empire Wind's activities combined, that the proposed authorized take would have a negligible impact on the Canadian East Coast stock of minke whales.

Odontocetes

In this section, we include information here that applies to all of the odontocete species and stocks addressed below, which are further divided 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.

All of the takes of odontocetes proposed for authorization incidental to Empire Wind's specified activities are by Level B harassment incidental to pile driving and HRG surveys. No Level A harassment, or serious injury or mortality, are anticipated or proposed. 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), these takes are more likely to represent multiple exposures of a smaller number of individuals than is the case for mysticetes, though some takes may also represent one-time exposures to an individual.

Pile driving, particularly impact pile driving foundation piles, is likely to disturb odontocetes to the greatest extent, compared to HRG surveys and cable landfall and marina activities. While we do expect animals to avoid the area during pile driving, their habitat range is extensive compared to the area ensonified during pile driving.

As described earlier, Level B harassment may include direct disruptions in behavioral patterns (*e.g.,* avoidance, changes in vocalizations (from masking) or foraging), as well as those associated with stress responses or TTS. Odontocetes are highly mobile species and, similar to mysticetes, NMFS expects any avoidance behavior to be limited to the area near the pile being driven. While masking could occur during pile driving, it would only occur in the vicinity of and during the duration of the pile driving, and would not generally occur in a frequency range that overlaps most odontocete communication or echolocation signals. The mitigation measures (*e.g.,* use of sound attenuation systems, implementation of clearance and shutdown zones) would also minimize received levels such that the severity of any behavioral response would be expected to be less than exposure to unmitigated noise exposure.

Any masking or TTS effects are anticipated to be of low-severity. First, the frequency range of pile driving, the most impactful activity conducted by Empire Wind in terms of response severity, falls within a portion of the frequency range of most odontocete vocalizations. However, odontocete vocalizations span a much wider range than the low frequency construction activities proposed by Empire Wind. Further, as described above, recent studies suggest odontocetes have a mechanism to self-mitigate (*i.e.,* reduce hearing sensitivity) the impacts of noise exposure, 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. For HRG surveys, the sources operate at higher frequencies than pile driving. However, sounds from these sources attenuate very quickly in the water column, as described above; therefore, any potential for TTS and masking is very limited. Further, odontocetes (*e.g.,* common dolphins, spotted dolphins, bottlenose dolphins) have demonstrated an affinity to bow-ride actively surveying HRG surveys; therefore, the severity of any harassment, if it does occur, is anticipated to be minimal based on the lack of avoidance previously demonstrated by these species.

The waters off the coast of New York 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 York, including the project area, do not contain any particularly unique odontocete habitat features.

Sperm Whales

The Western North Atlantic stock of sperm whales 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 (*i.e.,* commercial whaling) has been eliminated and, further, sperm whales in the western North Atlantic were little affected by modern whaling (Taylor *et al.,* 2008). 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 specific issues 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 project area.

No mortality, serious injury or Level A harassment is anticipated or proposed to be authorized for this species. Impacts would be limited to Level B harassment and would occur to only a very small number of individuals (maximum of 3 in any given year and 6 across all 5 years) incidental to pile driving and HRG surveys. Sperm whales are not common within the project area due to the shallow waters, and it is not expected that any noise levels would reach habitat in which sperm whales are common, including deep-water foraging habitat. If sperm whales do happen to be present in the project area during any activities related to the Empire Wind project, they would likely be only transient visitors and not engaging in any significant behaviors. This very low magnitude and severity of effects is not expected to result in impacts on the reproduction or survival of individuals, much less impact annual rates of recruitment or survival. For these reasons, we have determined, in consideration of all of the effects of the Empire Wind's activities combined, that the take proposed to be authorized would have a negligible impact on sperm whales.

Dolphins and Small Whales (Including Delphinids, Pilot Whales, and Harbor Porpoises)

There are no specific issues with the status of odontocete stocks that cause particular concern (*e.g.,* no recent UMEs). No mortality or serious injury is expected or proposed to be authorized for these stocks. Only Level B harassment is anticipated or proposed for authorization for any dolphin, small whale or harbor porpoise.

The maximum amount of take, by Level B harassment, proposed for authorization within any one year for all odontocetes cetacean stocks ranges from 1 to 9,870 instances. As described above for odontocetes broadly, we anticipate that a fair number 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 is likely given the duration of activity proposed by Empire Wind, the number of takes, and the likely movement patterns of the affected species, 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 dolphins and small whale species and stocks for which we propose to authorize take are stable (no declining population trends), not facing existing UMEs, and the relatively low magnitude and severity of effects is 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, in consideration of all of the effects of the Empire Wind's activities combined, that the take proposed to be authorized would have a negligible impact on all dolphin and small whale species and stocks considered in this analysis.

Harbor Porpoises

The Gulf of Maine/Bay of Fundy stock of harbor porpoises is found predominantly in northern U.S. coastal waters (less than 150 m depth) and up into Canada's Bay of Fundy. 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 authorized for this stock. NMFS proposes to authorize a maximum of 243 takes by Level B harassment only for any given year; no takes by Level A harassment are anticipated for this species.

Regarding the severity of takes by behavioral 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 pile driving. In response to pile driving, 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, pile driving is scheduled to occur off the coast of New York and, given alternative foraging areas, any avoidance of the area by individuals is not likely to impact the reproduction or survival of any individuals.

PTS is not anticipated or proposed for authorization. With respect to 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.

In summary, the amount of take proposed to be authorized across all 5 years is 565 by Level B harassment. While harbor porpoises are likely to avoid the area during any construction activity discussed herein, as demonstrated during European wind farm construction, the time of year in which work would occur is when harbor porpoises are not in high abundance, and any work that does occur would not result in the species' abandonment of the waters off of New York. The low-moderate magnitude and severity of harassment effects is not expected to result in impacts on the reproduction or survival of any individuals, let alone have impacts on annual rates of recruitment or survival of this stock. No mortality or serious injury is anticipated or proposed to be authorized. For these reasons, we have preliminarily determined, in consideration of all of the effects of Empire Wind's activities combined, that the proposed authorized take would have a negligible impact on the Gulf of Maine/Bay of Fundy stock of harbor porpoises.

Phocids (Harbor Seals, Gray Seals, and Harp Seals)

The harbor seal, gray seal, and harp seal are not listed under the ESA. Empire Wind requested, and NMFS proposes to authorize that no more than 678 harbor seals, 484 gray seals, and 4 harp seals by Level B harassment within any one year. Level A harassment is neither anticipated nor proposed for authorization. Harbor and gray seals occur in New York waters most often in winter, when impact pile driving would not occur. Harp seals are anticipated to be rare but could still occur in the project area. Seals are also more likely to be close to shore (*e.g.,* closer to the edge of the area ensonified above NMFS' harassment threshold), such that exposure to impact pile driving would be expected to be at comparatively lower levels. The majority of takes of these species is from monopile installations, vibratory pile driving associated with temporary cofferdam installation and removal, and HRG surveys. 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.,* 2010). Effects on pinnipeds that are taken by Level B harassment in the project area would likely be limited to 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 (see 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.

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. Currently, the only active UME is occurring in Maine with some harbor and gray seals testing positive for highly pathogenic avian influenza (HPAI) H5N1. Although elevated strandings continue, neither UME (alone or in combination) provide cause for concern regarding population-level impacts to any of these stocks. For harbor seals, the population abundance is over 61,000 and annual M/SI (339) is well below PBR (1,729) (Hayes *et al.,* 2020). 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 450,000. In addition, the abundance of gray seals is likely increasing in the U.S. Atlantic, as well as in Canada (Hayes *et al.,* 2020). For harp seals (no recent UME), the total U.S. fishery-related mortality and serious injury for this stock is very low relative to the stock size and can be considered insignificant and approaching zero mortality and serious injury rate (Hayes *et al.,* 2022). The harp seal stock abundance appears to have stabilized (Hayes *et al.,* 2022).

Overall, impacts from the Level B harassment take proposed for authorization incidental to Empire Wind's specified activities would be of relatively low magnitude and a low severity. These effects are not expected to result in impacts on the reproduction or survival of any individuals, let alone have impacts on annual rates of recruitment or survival of this stock. In consideration of all of the effects of Empire Wind's activities combined, we have preliminarily determined that the authorized take will have a negligible impact on harbor seals and gray seals.

Preliminary Negligible Impact Determination

No mortality or serious injury is anticipated to occur or proposed to be authorized. As described in the preliminary analysis above, the impacts resulting from Empire Wind's activities cannot be reasonably expected to, and are not reasonably likely to, adversely affect any of the species or stocks for which take is proposed for authorization 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 all of Empire Wind's specified activities combined will have a negligible impact on all affected marine mammal species or stocks.

Small Numbers

As noted above, only small numbers of incidental take may be authorized under sections 101(a)(5)(A) and (D) of the MMPA for specified activities other than military readiness activities. The MMPA does not define small numbers and so, in practice, where estimated numbers are available, NMFS compares the number of individuals taken to the most appropriate estimation of abundance of the relevant species or stock in our determination of whether an authorization is limited to small numbers of marine mammals. When the predicted number of individuals to be taken is less 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 proposes to authorize incidental take (by Level A harassment and Level B harassment) of 17 species of marine mammal (with 18 managed stocks). The maximum number of takes possible within any one year and proposed for authorization relative to the best available population abundance is less than one-third for all species and stocks potentially impacted (*i.e.,* less than 1 percent for 11 stocks and less than 5 percent for the remaining except for the common dolphin (5.71 percent) and the bottlenose dolphin northern migratory coastal (17.84 percent) as shown in Table 36.

Based on the analysis contained herein of the proposed activities (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 (ESA)

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

NMFS is proposing to authorize the take of four marine mammal species which are listed under the ESA: the North Atlantic right, sei, fin, and sperm whale. The Permit and Conservation Division will request initiation of Section 7 consultation with GARFO for the issuance of this proposed rulemaking. NMFS will conclude the Endangered Species Act consultation prior to reaching a determination regarding the proposed issuance of the authorization. The proposed regulations and any subsequent LOA(s) would be conditioned such that, in addition to measures included in those documents, Empire Wind would also be required to abide by the reasonable and prudent measures and terms and conditions of a Biological Opinion and Incidental Take Statement, issued by NMFS, pursuant to Section 7 of the Endangered Species Act.

Proposed Promulgation

As a result of these preliminary determinations, NMFS proposes to promulgate a LOA to Empire Wind authorizing take, by Level A and B harassment, incidental to construction activities associated with the Empire Wind project offshore of New York for a 5-year period from January 22, 2024 through January 21, 2029, provided the previously mentioned mitigation, monitoring, and reporting requirements are incorporated.

Request for Additional Information and Public Comments

NMFS requests interested persons to submit comments, information, and suggestions concerning Empire Wind's request and the proposed regulations (see **ADDRESSES**). All comments will be reviewed and evaluated as we prepare the final rule and make final determinations on whether to issue the requested authorization. This proposed rule and referenced documents provide all environmental information relating to our proposed action for public review.

Recognizing, as a general matter, that this action is one of many current and future wind energy actions, we invite comment on the relative merits of the IHA, single-action rule/LOA, and programmatic multi-action rule/LOA approaches, including potential marine mammal take impacts resulting from this and other related wind energy actions and possible benefits resulting from regulatory certainty and efficiency.

Classification

Pursuant to the procedures established to implement Executive Order 12866, the Office of Management and Budget has determined that this proposed rule is not significant.

Pursuant to section 605(b) of the Regulatory Flexibility Act (RFA), the Chief Counsel for Regulation of the Department of Commerce has certified to the Chief Counsel for Advocacy of the Small Business Administration that this proposed rule, if adopted, would not have a significant economic impact on a substantial number of small entities. Empire Wind is the sole entity that would be subject to the requirements in these proposed regulations, and Empire Wind is not a small governmental jurisdiction, small organization, or small business, as defined by the RFA. Under the RFA, governmental jurisdictions are considered to be small if they are governments of cities, counties, towns, townships, villages, school districts, or special districts, with a population of less than 50,000. Because of this certification, a regulatory flexibility analysis is not required and none has been prepared.

Notwithstanding any other provision of law, no person is required to respond to nor shall a person be subject to a penalty for failure to comply with a collection of information subject to the requirements of the Paperwork Reduction Act (PRA) unless that collection of information displays a currently valid OMB control number. These requirements have been approved by OMB under control number 0648–0151 and include applications for regulations, subsequent LOA, and reports. Send comments regarding any aspect of this data collection, including suggestions for reducing the burden, to NMFS.

The Coastal Zone Management Act (CZMA) requires Federal actions within and outside the coastal zone that have reasonably foreseeable effects on any coastal use or natural resource of the coastal zone be consistent with the enforceable policies of a state's federally approved coastal management program. 16 U.S.C. 1456(c). Additionally, regulations implementing the CZMA require non-Federal applicants for Federal licenses or permits to submit a consistency certification to the state that declares that the proposed activity complies with the enforceable policies of the state's approved management program and will be conducted in a manner consistent with such program. As required, on June 24, 2021, Empire Wind submitted a Federal consistency certification to New York and voluntarily submitted a Federal consistency certification to New Jersey for approval of the Construction and Operations Plan (COP) by BOEM and the issuance of an Individual Permit by United States Army Corps of Engineers, under section 10 and 14 of the Rivers and Harbors Act and Section 404 of the Clean Water Act (15 CFR part 930, subpart E). New York began its review of the proposed activity pursuant to 15 CFR part 930, subpart D on November 18, 2022. NMFS has determined that Empire Wind's application for an authorization to allow the incidental, but not intentional, take of small numbers of marine mammals on the outer continental shelf is an unlisted activity and, thus, is not, at this time, subject to Federal consistency requirements in the absence of the receipt and prior approval of an unlisted activity review request from the state by the Director of NOAA's Office for Coastal Management.

List of Subjects in 50 CFR Part 217

Administrative practice and procedure, Endangered and threatened species, Fish, Fisheries, Marine mammals, Penalties, Reporting and recordkeeping requirements, Wildlife.

Dated: April 4, 2023.

Kelly Denit,

Acting Deputy Assistant Administrator for Regulatory Programs, National Marine Fisheries Service.

For reasons set forth in the preamble, NMFS proposes to amend 50 CFR part 217 as follows:

PART 217—REGULATIONS GOVERNING THE TAKING AND IMPORTING OF MARINE MAMMALS

■ 1. The authority citation for part 217 continues to read as follows:

Authority: 16 U.S.C. 1361 *et seq.*

■ 2. Add subpart CC, consisting of §§ 217.280 through 217.289, to read as follows:

Subpart CC—Taking Marine Mammals Incidental to the Empire Wind Project, Offshore New York

Subpart CC—Taking Marine Mammals Incidental to the Empire Wind Project, Offshore New York

§ 217.280 Specified activity and specified geographical region.

(a) Regulations in this subpart apply only to the taking of marine mammals that occurs incidental to activities associated with construction of the Empire Wind Project by Empire Offshore Wind, LLC (Empire Wind) and those persons it authorizes or funds to conduct activities on its behalf in the area outlined in paragraph (b) of this section.

(b) The taking of marine mammals by Empire Wind may be authorized in a Letter of Authorization (LOA) only if it occurs in the Bureau of Ocean Energy Management (BOEM) lease area Outer Continental Shelf (OCS)–A–0512 Commercial Lease of Submerged Lands for Renewable Energy Development, along export cable routes, and at sea-to-shore transition points at South Brooklyn Marine Terminal, in Brooklyn, New York (EW1) and Long Island, NY (EW2) and at the Village of Island Park, NY (EW2).

(c) The taking of marine mammals by Empire Wind is only authorized if it occurs incidental to the following activities associated with the Empire Wind Project: installation of up to 147 wind turbine generators (WTG) and 2 offshore substation (OSS) foundations by impact pile driving; impact and vibratory pile driving associated with cable landfall construction and marina activities; and high-resolution geophysical (HRG) site characterization surveys.

§ 217.281 Effective dates.

Regulations in this subpart are effective from January 22, 2024, through January 21, 2029.

§ 217.282 Permissible methods of taking.

Under an LOA issued pursuant to §§ 216.106 and 217.286, Empire Wind, and those persons it authorizes or funds to conduct activities on its behalf, may incidentally, but not intentionally, take marine mammals within the area described in § 217.280(b) in the following ways, provided Empire Wind is in complete compliance with all terms, conditions, and requirements of the regulations in this subpart and the appropriate LOA:

(a) By Level B harassment associated with the acoustic disturbance of marine mammals by impact pile driving (WTG and OSS foundation installation), impact and vibratory pile driving during cable landfall construction and marina activities, and HRG site characterization surveys;

(b) By Level A harassment associated with the acoustic disturbance of marine mammals by impact pile driving WTG and OSS foundations;

(c) Take by mortality (death) or serious injury of any marine mammal species is not authorized; and

(d) The incidental take of marine mammals by the activities listed in paragraphs (a) and (b) of this section is limited to the following species:

TABLE 1 TO PARAGRAPH (d)

Marine mammal species	Scientific name	Stock
Fin whale	*Balaenoptera physalus*	Western North Atlantic.
Sei whale	*Balaenoptera borealis*	Nova Scotia.
Minke whale	*Balaenoptera acutorostrata*	Canadian East Stock.
North Atlantic right whale	*Eubalaena glacialis*	Western North Atlantic.

TABLE 1 TO PARAGRAPH (d)—Continued

Marine mammal species	Scientific name	Stock
Humpback whale	*Megaptera novaeangliae*	Gulf of Maine.
Sperm whale	*Physeter macrocephalus*	North Atlantic.
Atlantic spotted dolphin	*Stenella frontalis*	Western North Atlantic.
Atlantic white-sided dolphin	*Lagenorhynchus acutus*	Western North Atlantic.
Bottlenose dolphin	*Tursiops truncatus*	Western North Atlantic Offshore.
Common dolphin	*Delphinus delphis*	Western North Atlantic.
Harbor porpoise	*Phocoena phocoena*	Gulf of Maine/Bay of Fundy.
Long-finned pilot whale	*Globicephala melas*	Western North Atlantic.
Short-finned pilot whale	*Globicephala macrorhynchus*	Western North Atlantic.
Risso's dolphin	*Grampus griseus*	Western North Atlantic.
Gray seal	*Halichoerus grypus*	Western North Atlantic.
Harbor seal	*Phoca vitulina*	Western North Atlantic.
Harp seal	*Pagophilus groenlandicus*	Western North Atlantic.

§ 217.283 Prohibitions.

Except for the takings described in § 217.282 and authorized by an LOA issued under § 217.286 or § 217.287, it is unlawful for any person to do any of the following in connection with the activities described in this subpart:

(a) Violate, or fail to comply with, the terms, conditions, and requirements of this subpart or an LOA issued under §§ 217.286 and 217.287 of this subpart;

(b) Take any marine mammal not specified in § 217.282(c);

(c) Take any marine mammal specified in the LOA in any manner other than as specified in the LOA; or

(d) Take any marine mammal, as specified in § 217.282(c), after NMFS determines such taking results in more than a negligible impact on the species or stocks of such marine mammals.

§ 217.284 Mitigation requirements.

When conducting the activities identified in §§ 217.280(a) and 217.282, Empire Wind must implement the mitigation measures contained in this section and any LOA issued under § 217.286 or § 217.287. These mitigation measures include, but are not limited to:

(a) *General conditions.* The following measures apply to the Empire Wind Project:

(1) A copy of any issued LOA must be in the possession of Empire Wind and its designees, all vessel operators, visual protected species observers (PSOs), passive acoustic monitoring (PAM) operators, pile driver operators, and any other relevant designees operating under the authority of the issued LOA;

(2) Empire Wind must conduct briefings between construction supervisors, construction crews, and the PSO and PAM team prior to the start of all construction activities, and when new personnel join the work, in order to explain responsibilities, communication procedures, marine mammal monitoring and reporting protocols, and operational procedures. An informal guide must be included with the Marine Mammal Monitoring Plan to aid personnel in identifying species if they are observed in the vicinity of the project area;

(3) Empire Wind must instruct all vessel personnel regarding the authority of the PSO(s). Any disagreement between the Lead PSO and the vessel operator would only be discussed after shutdown has occurred;

(4) Empire Wind must ensure that any visual observations of an ESA-listed marine mammal are communicated to PSOs and vessel captains during the concurrent use of multiple project-associated vessels (of any size; *e.g.,* construction surveys, crew/supply transfers, *etc.*);

(5) If an individual from a species for which authorization has not been granted, or a species for which authorization has been granted but the authorized take number has been met, is observed entering or within the relevant Level B harassment zone for each specified activity, pile driving and HRG acoustic sources must be shut down immediately, unless shutdown would result in 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 be delayed if the activity has not commenced. Impact and vibratory pile driving and initiation of HRG acoustic sources must not commence or resume until the animal(s) has been confirmed to have left the relevant clearance zone or the observation time has elapsed with no further sightings.

(6) Prior to and when conducting any in-water construction activities and vessel operations, Empire Wind personnel (*e.g.,* vessel operators, PSOs) must use available sources of information on North Atlantic right whale presence in or near the project area including daily monitoring of the Right Whale Sightings Advisory System, and monitoring of Coast Guard VHF Channel 16 throughout the day to receive notification of any sightings and/or information associated with any Slow Zones (*i.e.,* Dynamic Management Areas (DMAs) and/or acoustically-triggered slow zones) to provide situational awareness for both vessel operators and PSOs; and

(7) Any marine mammals observed within a clearance or shutdown zone must be allowed to remain in the area (*i.e.,* must leave of their own volition) prior to commencing pile driving activities or HRG surveys;

(8) Empire Wind must treat any large whale sighted by a PSO or acoustically detected by a PAM operator as if it were a North Atlantic right whale, unless a PSO or a PAM operator confirms it is another type of whale; and

(9) For in-water construction heavy machinery activities other than impact or vibratory pile driving, if a marine mammal is on a path towards or comes within 10 m of equipment, Empire Wind must 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.

(b) *Vessel strike avoidance measures.* The following measures apply to all vessels associated with the Empire Wind Project:

(1) Prior to the start of construction activities, all vessel operators and crew must receive a protected species identification training that covers, at a minimum:

(i) Identification of marine mammals and other protected species known to occur or which have the potential to occur in the Empire Wind project area;

(ii) Training on making observations in both good weather conditions (*i.e.,* clear visibility, low winds, low sea states) and bad weather conditions (*i.e.,* fog, high winds, high sea states, with glare);

(iii) Training on information and resources available to the project personnel regarding the applicability of Federal laws and regulations for protected species;

(iv) Observer training related to these vessel strike avoidance measures must be conducted for all vessel operators and crew prior to the start of in-water construction activities; and

(v) Confirmation of marine mammal observer training must be documented on a training course log sheet and reported to NMFS.

(2) All vessel operators and crews, regardless of their vessel's size, 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;

(3) All vessels must have a visual observer on board who is responsible for monitoring the vessel strike avoidance zone for marine mammals. Visual observers may be PSO or crew members, but crew members responsible for these duties must be provided sufficient training by Empire Wind to distinguish marine mammals from other types of animals or objects and must be able to identify a marine mammal as a North Atlantic right whale, other whale (defined in this context as sperm whales or baleen whales other than North Atlantic right whales), or other marine mammal. Crew members serving as visual observers must not have duties other than observing for marine mammals while the vessel is operating over 10 knots (kts);

(4) Year-round and when a vessel is in transit, all vessel operators must continuously monitor U.S. Coast Guard VHF Channel 16, over which North Atlantic right whale sightings are broadcasted. At the onset of transiting and at least once every four hours, vessel operators and/or trained crew members must monitor the project's Situational Awareness System, WhaleAlert, and the Right Whale Sighting Advisory System (RWSAS) for the presence of North Atlantic right whales Any observations of any large whale by any Empire Wind staff or contractors, including vessel crew, must be communicated immediately to PSOs, PAM operator, and all vessel captains to increase situational awareness. Conversely, any large whale observation or detection via a sighting network (*e.g.,* Mysticetus) by PSOs or PAM operators must be conveyed to vessel operators and crew;

(5) Any observations of any large whale by any Empire Wind staff or contractor, including vessel crew, must be communicated immediately to PSOs and all vessel captains to increase situational awareness. Any large whale observation or detections via a sighting network (*e.g.,* Mysticetus) by PSOs or PAM operators will be conveyed to vessel operators and crew;

(6) All vessels must comply with existing NMFS vessel speed regulations in 50 CFR 224.105, as applicable, for North Atlantic right whales;

(7) All vessels must transit active Slow Zones, Dynamic Management Areas (DMAs), and Seasonal Management Areas (SMAs) at 10 kts or less;

(8) Between November 1st and April 30th, all vessels traveling to and from ports in New Jersey, New York, Maryland, Delaware, and Virginia must transit at 10 kts or less;

(9) All vessels, regardless of size, must immediately reduce speed to 10 kts or less when any large whale, mother/calf pairs, or large assemblages of non-delphinid cetaceans are observed (within 500 m) of an underway vessel;

(10) All vessels, regardless of size, must immediately reduce speed to 10 kts or less when a North Atlantic right whale is sighted, at any distance, by anyone on the vessel;

(11) All underway vessels (*e.g.,* transiting, surveying) operating at any speed must have a dedicated visual observer on duty at all times to monitor for marine mammals within a 180° direction of the forward path of the vessel (90° port to 90° starboard) located at the best vantage point for ensuring vessels are maintaining appropriate separation distances from marine mammals. Visual observers must be equipped with alternative monitoring technology for periods of low visibility (*e.g.,* darkness, rain, fog, etc.). The dedicated visual observer must receive prior training on protected species detection and identification, vessel strike minimization procedures, how and when to communicate with the vessel captain, and reporting requirements. Visual observers may be third-party observers (*i.e.,* NMFS-approved PSOs) or crew members. Observer training related to these vessel strike avoidance measures must be conducted for all vessel operators and crew prior to the start of vessel use;

(12) All vessels must maintain a minimum separation distance of 500 m from North Atlantic right whales. If underway, all vessels must steer a course away from any sighted North Atlantic right whale at 10 kts or less such that the 500-m minimum separation distance requirement is not violated. If a North Atlantic right whale is sighted within 500 m of an underway vessel, that vessel must shift the engine to neutral. Engines must not be engaged until the whale has moved outside of the vessel's path and beyond 500 m. If a whale is observed but cannot be confirmed as a species other than a North Atlantic right whale, the vessel operator must assume that it is a North Atlantic right whale.

(13) All vessels must maintain a minimum separation distance of 100 m from sperm whales and baleen whales other than North Atlantic right whales. If one of these species is sighted within 100 m of an underway vessel, that vessel must shift the engine to neutral. Engines must not be engaged until the whale has moved outside of the vessel's path and beyond 100 m;

(14) All vessels must maintain a minimum separation distance of 50 m from all delphinoid cetaceans and pinnipeds, with an exception made for those that approach the vessel (*e.g.,* bow-riding dolphins). If a delphinid cetacean or pinniped is sighted within 50 m of an underway vessel, that vessel must shift the engine to neutral, with an exception made for those that approach the vessel (*e.g.,* bow-riding dolphins). Engines must not be engaged until the animal(s) has moved outside of the vessel's path and beyond 50 m;

(15) When a marine mammal(s) is sighted while a vessel is underway, the vessel must take action as necessary to avoid violating the relevant separation distances (*e.g.,* attempt to remain parallel to the animal's course, avoid excessive speed or abrupt changes in direction until the animal has left the area). If a marine mammal(s) is sighted within the relevant separation distance, the vessel must shift the engine to neutral and not engage the engine(s) until the animal(s) outside and on a path away from the separation area. This does not apply to any vessel towing gear or any situation where respecting the relevant separation distance would be unsafe (*i.e.,* any situation where the vessel is navigationally constrained);

(16) All vessels underway must not divert or alter course to approach any marine mammal. Any vessel underway must avoid speed over 10 kts or abrupt changes in course direction until the animal is out of an on a path away from the separation distances; and

(17) If a vessel is traveling at greater than 10 kts, in addition to the required dedicated visual observer, Empire Wind must monitor the transit corridor in real-time with PAM prior to and during transits. If a North Atlantic right whale is detected via visual observation or PAM within or approaching the transit corridor, all crew transfer vessels must travel at 10 kts or less for 12 hours following the detection. Each subsequent detection triggers an additional 12-hour period at 10 kts or

less. A slowdown in the transit corridor expires when there has been no further visual or acoustic detection of North Atlantic right whales in the transit corridor for 12 hours;

(18) Empire Wind must submit a North Atlantic right whale vessel strike avoidance plan 90 days prior to commencement of vessel use. The plan will, at minimum, describe how PAM, in combination with visual observations, will be conducted to ensure the transit corridor is clear of right whales. The plan will also provide details on the vessel-based observer protocols on transiting vessels.

(c) *WTG and OSS foundation installation.* The following requirements apply to pile driving activities associated with the installation of WTG and OSS foundations:

(1) Foundation impact pile driving activities may not occur January 1 through April 30;

(2) Pile driving may not occur from December 1 through December 31, unless unanticipated delays due to weather or technical issues arise that necessitate extending pile driving into December. If impact pile driving must occur in December, Empire Wind must notify NOAA Fisheries in writing by September 1 that circumstances are expected to necessitate pile driving in December;

(3) Monopiles must be no larger than 11 m in diameter. Pin piles must be no larger than 2.5 m in diameter. During all monopile and pin pile installation, the minimum amount of hammer energy necessary to effectively and safely install and maintain the integrity of the piles must be used. Hammer energies must not exceed 5,500 kJ for monopile installation and 3,200 kJ for pin pile installation. No more than two monopile foundations or three pin piles for jacket foundations may be installed per day;

(4) Empire Wind must not initiate pile driving earlier than 1 hour after civil sunrise or later than 1.5 hours prior to civil sunset, unless Empire Wind submits, and NMFS approves, an Alternative Monitoring Plan as part of the Pile Driving and Marine Mammal Monitoring Plan that reliably demonstrates the efficacy of their night vision devices;

(5) Empire Wind must deploy dual noise attenuation systems that are capable of achieving, at a minimum, 10-dB of sound attenuation, during all impact pile driving of monopile and pin piles:

(i) A single bubble curtain must not be used unless paired with another noise attenuation device;

(ii) A big double bubble curtain may be used without being paired with another noise attenuation device;

(iii) The bubble curtain(s) must distribute air bubbles using an air flow rate of at least 0.5 $m^3/(min*m)$. The bubble curtain(s) must surround 100 percent of the piling perimeter throughout the full depth of the water column. In the unforeseen event of a single compressor malfunction, the offshore personnel operating the bubble curtain(s) must make appropriate adjustments to the air supply and operating pressure such that the maximum possible sound attenuation performance of the bubble curtain(s) is achieved;

(iv) The lowest bubble ring must be in contact with the seafloor for the full circumference of the ring, and the weights attached to the bottom ring must ensure 100-percent seafloor contact;

(v) No parts of the ring or other objects may prevent full seafloor contact; and

(vi) Construction contractors must train personnel in the proper balancing of airflow to the ring. Construction contractors must submit an inspection/performance report for approval by Empire Wind within 72 hours following the performance test. Empire Wind must then submit that report to NMFS; and

(vii) Corrections to the bubble ring(s) to meet the performance standards in this paragraph (c)(5) must occur prior to impact pile driving of monopiles and pin piles. If Empire Wind uses a noise mitigation device in addition to the bubble curtain, Empire Wind must maintain similar quality control measures as described in this paragraph (c)(2);

(6) Empire Wind must have a minimum of two PSOs actively observing marine mammals before, during, and after the installation of all foundation piles (*i.e.,* pin piles and monopiles). Concurrently, at least one PAM operator must be actively monitoring for marine mammals before, during and after impact pile driving with PAM;

(7) All visual PSOs and PAM operators used for the Empire Wind project must meet the requirements and qualifications described in § 217.285(a) through (e), as applicable to the specified activity;

(8) Empire Wind must establish and implement clearance and shutdown zones (all distances to the perimeter are the radii from the center of the pile being driven) as described in the LOA for all monopile and pin pile installation;

(9) Empire Wind must use visual PSOs and PAM operators to monitor the area around each foundation pile before, during and after pile driving. PSOs must visually monitor clearance zones for marine mammals for a minimum of 60 minutes prior to commencing pile driving. At least one PAM operator must review data from at least 24 hours prior to pile driving and actively monitor hydrophones for 60 minutes prior to pile driving. Prior to initiating soft-start procedures, all clearance zones must be confirmed to be free of marine mammals for 30 minutes immediately prior to starting a soft-start of pile driving;

(10) PSOs must be able to visually clear (*i.e.,* confirm no marine mammals are present) an area that extends around the pile being driven. The entire minimum visibility zone must be visible (*i.e.,* not obscured by dark, rain, fog, etc.) for a full 60 minutes immediately prior to commencing impact pile driving (minimum visibility zone size dependent on season);

(11) If a marine mammal is observed acoustically detected within the relevant clearance zone prior to the initiation of impact pile driving activities, pile driving must be delayed and must not begin until either the marine mammal(s) has voluntarily left the specific clearance zones and have been visually or acoustically confirmed beyond that clearance zone, or, when specific time periods have elapsed with no further sightings or acoustic detections. The specific time periods are 15 minutes for small odontocetes and pinnipeds and 30 minutes for all other marine mammal species;

(12) The clearance zone may only be declared clear if no confirmed North Atlantic right whale acoustic detections (in addition to visual) have occurred within the PAM clearance zone during the 60-minute monitoring period. Any large whale sighting by a PSO or detected by a PAM operator that cannot be identified as a non-North Atlantic right whale must be treated as if it were a North Atlantic right whale;

(13) If a marine mammal is observed entering or within the respective shutdown zone, as defined in the LOA, after impact pile driving has begun, the PSO must call for a temporary shutdown of impact pile driving;

(14) Empire Wind must immediately cease pile driving if a PSO calls for shutdown, unless shutdown is not practicable due to imminent risk of injury or loss of life to an individual or pile refusal or instability. In this situation, Empire Wind must reduce hammer energy to the lowest level practicable and the reason(s) for not

shutting down must be documented and reported to NMFS;

(15) Pile driving must not restart until either the marine mammal(s) has voluntarily left the specific clearance zones and has been visually or acoustically confirmed beyond that clearance zone, or, when specific time periods have elapsed with no further sightings or acoustic detections have occurred. The specific time periods are 15 minutes for small odontocetes and pinnipeds and 30 minutes for all other marine mammal species. In cases where these criteria are not met, pile driving may restart only if necessary to maintain pile stability at which time Empire Wind must use the lowest hammer energy practicable to maintain stability;

(16) If impact pile driving has been shut down due to the presence of a North Atlantic right whale, pile driving may not restart until the North Atlantic right whale is no longer observed or 30 minutes has elapsed since the last detection;

(17) Empire Wind must utilize a soft-start protocol for impact pile driving of monopiles by performing 4–6 strikes per minute at 10 to 20 percent of the maximum hammer energy, for a minimum of 20 minutes;

(18) Soft-start must occur at the beginning of monopile installation and at any time following a cessation of impact pile driving of 30 minutes or longer;

(19) If a marine mammal is detected within or about to enter the applicable clearance zones, prior to the beginning of soft-start procedures, impact pile driving must be delayed until the animal has been visually observed exiting the clearance zone or until a specific time period has elapsed with no further sightings. The specific time periods are 15 minutes for small odontocetes and pinnipeds and 30 minutes for all other species;

(20) PAM operators must assist the visual PSOs in monitoring by conducting PAM activities 60 minutes prior to any impact pile driving, at all times during pile driving, and for 30 minutes after pile driving completion for the appropriate size PAM clearance zone (dependent on season). The entire minimum visibility zone must be clear for at least 30 minutes, with no marine mammal detections within the visual or PAM clearance zones prior to the start of impact pile driving. PAM operators must immediately communicate all detections of marine mammals at any distance (*i.e.,* not limited to the Level B harassment zones) to the Lead PSO, including any determination regarding species identification, distance, and bearing and the degree of confidence in the determination;

(21) Any acoustic monitoring must complement visual monitoring efforts and must cover an area of at least the Level B harassment zone around each monopile foundation;

(22) Empire Wind must submit a Pile Driving and Marine Mammal Monitoring Plan to NMFS for review and approval at least 180 days before the start of any pile driving. The plan must include final project design related to pile driving (*e.g.,* number and type of piles, hammer type, noise attenuation systems, anticipated start date, etc.) and all information related to PSO and PAM monitoring protocols;

(23) Empire Wind must submit a Passive Acoustic Monitoring Plan to NMFS for review and approval at least 180 days prior to the planned start of monopile installation. The plan must describe all proposed PAM equipment, procedures, and protocols. The authorization to take marine mammals is contingent upon NMFS' approval of the PAM Plan;

(24) Empire Wind must conduct sound field verification (SFV) on the first three monopiles installed and all piles associated with the first OSS foundation installed. Subsequent SFV is required should additional piles be driven that are anticipated to produce louder sound fields than those previously measured;

(25) Empire Wind must conduct SFV after construction is complete to estimate turbine operational source levels based on measurements in the near and far-field at a minimum of three locations from each foundation monitored. These data must be used to also identify estimated transmission loss rates;

(26) Empire Wind must submit a sound field verification (SFV) plan to NOAA Fisheries for review and approval at least 180 days prior to planned start of pile driving that identifies how Empire Wind will comply with the following requirements:

(i) Empire Wind must empirically determine source levels, the ranges to the isopleths corresponding to the Level A harassment and Level B harassment thresholds in meters, and the transmission loss coefficient(s). Empire Wind may also estimate ranges to the Level A harassment and Level B harassment isopleths by extrapolating from *in situ* measurements conducted at several distances from the piles monitored;

(ii) Empire Wind must perform sound field measurements at four distances from the pile being driven, including, but not limited to, 750 m and the modeled Level B harassment zones to verify the accuracy of those modeled zones;

(iii) The recordings must be continuous throughout the duration of all impact hammering of each pile monitored;

(iv) The measurement systems must have a sensitivity appropriate for the expected sound levels from pile driving received at the nominal ranges throughout the installation of the pile;

(v) The frequency range of the system must cover the range of at least 20 Hz to 20 kHz;

(vi) The system will be designed to have omnidirectional sensitivity and will be designed so that the predicted broadband received level of all impact pile-driving strikes exceed the system noise floor by at least 10 dB. The dynamic range of the system must be sufficient such that at each location, pile driving signals are not clipped and are not masked by noise floor; and

(vii) Identify operational noise levels and transmission loss rates.

(27) If acoustic field measurements collected during installation of foundation piles indicate ranges to the isopleths, corresponding to Level A harassment and Level B harassment thresholds, are greater than the ranges predicted by modeling (assuming 10 dB attenuation), Empire Wind must implement additional noise mitigation measures prior to installing the next monopile. Each modification must be evaluated empirically by acoustic field measurements;

(28) In the event that field measurements indicate ranges to isopleths, corresponding to Level A harassment and Level B harassment thresholds, are greater than the ranges predicted by modeling (assuming 10 dB attenuation), NMFS may expand the relevant harassment, clearance, and shutdown zones and associated monitoring protocols;

(29) If harassment zones are expanded beyond an additional 1,500 m, additional PSOs would be deployed on additional platforms with each observer responsible for maintaining watch in no more than 180 degrees and of an area with a radius no greater than 1,500 m;

(30) If acoustic measurements indicate that ranges to isopleths corresponding to the Level A harassment and Level B harassment thresholds are less than the ranges predicted by modeling (assuming 10 dB attenuation), Empire Wind may request to NMFS a modification of the clearance and shutdown zones for impact pile driving of monopiles and jacket foundation piles;

(31) For NMFS to consider a modification request for reduced zone sizes, Empire Wind must have had to conduct SFV on three or more monopiles to verify that zone sizes are consistently smaller than those predicted by modeling (assuming 10 dB attenuation) and subsequent piles would be installed within and under similar conditions (*e.g.,* monitoring data collected during installation of a typical pile can not be used to adjust difficult-to-drive pile ranges); and

(32) If a subsequent monopile installation location is selected that was not represented by the previous three locations (*i.e.,* substrate composition, water depth), SFV would be required.

(d) *Cable landfall construction and marina activities.* The following requirements apply to cable landfall and marina pile driving activities:

(1) Empire Wind must conduct impact and vibratory pile driving during daylight hours only;

(2) Empire Wind must have a minimum of two PSOs on active duty during any installation and removal of the temporary cofferdams and goal posts. These PSOs must be located at the best vantage point(s) on the vibratory pile driving platform or secondary platform in the immediate vicinity of the vibratory pile driving platform, in order to ensure that appropriate visual coverage is available for the entire visual clearance zone and as much of the Level B harassment zone, as possible;

(3) If a marine mammal is observed entering or within the respective shutdown zone, as defined in the LOA, after pile driving has begun, the PSO must call for a temporary shutdown of pile driving;

(4) Empire Wind must immediately cease pile driving if a PSO calls for shutdown, unless shutdown is not practicable due to imminent risk of injury or loss of life to an individual or pile refusal or instability. In this situation, Empire Wind must reduce hammer energy to the lowest level practicable and the reason(s) for not shutting down must be documented and reported to NMFS; and

(5) Pile driving must not restart until either the marine mammal(s) has voluntarily left the specific clearance zones and has been visually or acoustically confirmed beyond that clearance zone, or, when specific time periods have elapsed with no further sightings or acoustic detections have occurred. The specific time periods are 15 minutes for small odontocetes and pinnipeds and 30 minutes for all other marine mammal species. In cases where these criteria are not met, pile driving may restart only if necessary to maintain pile stability at which time Empire Wind must use the lowest hammer energy practicable to maintain stability.

(e) *HRG surveys.* The following requirements apply to HRG surveys operating sub bottom profilers (SBPs):

(1) Per vessel, Empire Wind would be required to have at least one PSO on active duty during HRG surveys that are conducted during daylight hours (*i.e.,* from 30 minutes prior to sunrise through 30 minutes following sunset) and at least two PSOs during HRG surveys that are conducted during nighttime hours;

(2) Empire Wind must deactivate acoustic sources during periods where no data are being collected, except as determined to be necessary for testing. Unnecessary use of the acoustic source(s) is prohibited;

(3) All personnel with responsibilities for marine mammal monitoring must participate in joint, onboard briefings that would be led by the vessel operator and the Lead PSO, prior to the beginning of survey activities. The briefing must be repeated whenever new relevant personnel (*e.g.,* new PSOs, acoustic source operators, relevant crew) join the survey operation before work commences;

(4) PSOs must begin visually monitoring clearance and shutdown zones 30 minutes prior to the initiation of the specified acoustic source (*i.e.,* ramp-up, if applicable), during the HRG activities, and for 30 minutes after the use of the specified acoustic source has ceased;

(5) Empire Wind is required to ramp-up sub-bottom profilers (SBPs) prior to commencing full power (unless the equipment operates on a binary on/off switch) and only when visual clearance zones are fully visible (*e.g.,* not obscured by darkness, rain, fog, etc.) and clear of marine mammals, as determined by the Lead PSO, for at least 30 minutes immediately prior to the initiation of survey activities using a specified acoustic source;

(6) Prior to a ramp-up procedure starting, the operator must notify the Lead PSO of the planned start of the ramp-up. This notification time must not be less than 60 minutes prior to the planned ramp-up activities as all relevant PSOs must monitor the clearance zone for 30 minutes prior to the initiation of ramp-up;

(7) Prior to starting the survey and after receiving confirmation from the PSOs that the clearance zone is clear of any marine mammals, Empire Wind must ramp-up sources to half power for 5 minutes and then proceed to full power, unless the source operates on a binary on/off switch in which case ramp-up is not required. Ramp-up activities must be delayed if a marine mammal(s) enters its respective shutdown zone. Ramp-up may only be reinitiated if the animal(s) has been observed exiting its respective shutdown zone or until 15 minutes for small odontocetes and pinnipeds, and 30 minutes for all other species;

(8) Empire Wind must implement a 30-minute clearance period of the clearance zones immediately prior to the commencing of the survey or when there is more than a 30-minute break in survey activities or PSO monitoring;

(9) If a marine mammal is observed within a clearance zone during the clearance period, ramp-up or acoustic surveys may not begin until the animal(s) has been observed voluntarily exiting its respective clearance zone or until a specific time period has elapsed with no further sighting. The specific time period is 15 minutes for small odontocetes and seals, and 30 minutes for all other species;

(10) In any case when the clearance process has begun in conditions with good visibility, including via the use of night vision equipment (IR/thermal camera), and the Lead PSO has determined that the clearance zones are clear of marine mammals, survey operations would be allowed to commence (*i.e.,* no delay is required) despite periods of inclement weather and/or loss of daylight;

(11) Once the survey has commenced, Empire Wind must shut down SBPs if a marine mammal enters a respective shutdown zone, except in cases when the shutdown zones become obscured for brief periods due to inclement weather, survey operations would be allowed to continue (*i.e.,* no shutdown is required) so long as no marine mammals have been detected. The shutdown requirement does not apply to small delphinids of the following genera: *Delphinus, Stenella, Lagenorhynchus,* and *Tursiops.* If there is uncertainty regarding the identification of a marine mammal species (*i.e.,* whether the observed marine mammal belongs to one of the delphinid genera for which shutdown is waived), the PSOs must use their best professional judgment in making the decision to call for a shutdown. Shutdown is required if a delphinid that belongs to a genus other than those specified here is detected in the shutdown zone;

(12) If SBPs have been shutdown due to the presence of a marine mammal, the use of SBPs not commence or resume until the animal(s) has been confirmed to have left the Level B harassment zone

or until a full 15 minutes (for small odontocetes and seals) or 30 minutes (for all other marine mammals) have elapsed with no further sighting;

(13) Empire Wind must immediately shutdown any SBP acoustic source if a marine mammal is sighted entering or within its respective shutdown zones;

(14) If a SBP is shut down for reasons other than mitigation (*e.g.,* mechanical difficulty) for less than 30 minutes, it would be allowed to be activated again without ramp-up only if:

(i) PSOs have maintained constant observation; and

(ii) No additional detections of any marine mammal occurred within the respective shutdown zones;

(17) If a SBP was shut down for a period longer than 30 minutes, then all clearance and ramp-up procedures must be initiated; and

(18) If multiple HRG vessels are operating concurrently, any observations of marine mammals must be communicated to PSOs on all nearby survey vessels.

(f) *Trawl Surveys.* The following measures apply to all trawl surveys:

(1) All captains and crew conducting fishery surveys will be trained in marine mammal detection and identification. Marine mammal monitoring will be conducted by the captain and/or a member of the scientific crew before (within 1 nautical mile (nm) and 15 minutes prior to deploying gear), during, and after haul back;

(2) Survey gear will be deployed as soon as possible once the vessel arrives on station;

(3) Empire Wind and/or its cooperating institutions, contracted vessels, or commercially-hired captains must implement the following ''move-on'' rule: If marine mammals are sighted within 1 nm of the planned location and 15 minutes before gear deployment, Empire Wind and/or its cooperating institutions, contracted vessels, or commercially-hired captains, as appropriate, may decide to move the vessel away from the marine mammal to a different section of the sampling area if the animal appears to be at risk of interaction with the gear, based on best professional judgment. If, after moving on, marine mammals are still visible from the vessel, Empire Wind and/or its cooperating institutions, contracted vessels, or commercially-hired captains may decide to move again or to skip the station;

(4) If a marine mammal is deemed to be at risk of interaction after the gear is set, all gear will be immediately removed from the water;

(5) Empire Wind will maintain visual monitoring effort during the entire period of time that gear is in the water (*i.e.,* throughout gear deployment, fishing, and retrieval). If marine mammals are sighted before the gear is fully removed from the water, Empire Wind will take the most appropriate action to avoid marine mammal interaction;

(6) Trawls must have a limited tow time of 20 minutes (and depth);

(7) Empire Wind must open the codend of the trawl net close to the deck/sorting area to avoid damage to animals that may be caught in gear; and

(8) Trawl nets must be fully cleaned and repaired (if damaged) before setting again; and

(9) Any lost gear associated with the fishery surveys must be reported to the NOAA Greater Atlantic Regional Fisheries Office Protected Resources Division within 48 hours.

§ 217.285 Requirements for monitoring and reporting.

(a) *Protected Species Observer (PSO) and PAM operator qualifications.* The following measures apply to PSOs and PAM operators:

(1) Empire Wind must use independent, dedicated, qualified PSOs, meaning that the PSOs must be employed by a third-party observer provider, must have no tasks other than to conduct observational effort, collect data, and communicate with and instruct relevant vessel crew with regard to the presence of protected species and mitigation requirements;

(2) PSOs must successfully complete relevant training, including completion of all required coursework and passing a written and/or oral examination developed for the training;

(3) PSOs 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 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: Secondary education and/or experience comparable to PSO duties; previous work experience conducting academic, commercial, or government sponsored marine mammal surveys; or previous work experience as a PSO; the PSO should demonstrate good standing and consistently good performance of PSO duties;

(4) 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; Sufficient training, orientation, or experience with the construction operation to provide for personal safety during observations; writing skills sufficient to document observations, including but not limited to, the number and species of marine mammals observed, the dates and times of when in-water construction activities were conducted, the dates and time when in-water construction activities were suspended to avoid potential incidental injury of marine mammals from construction noise within a defined shutdown zone, and marine mammal behavior; and 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, as necessary;

(5) All PSOs must be approved by NMFS. Empire Wind must submit PSO resumes for NMFS' review and approval at least 60 days prior to commencement of in-water construction activities requiring PSOs. Resumes must include dates of training and any prior NMFS approval, as well as dates and description of last experience, and must be accompanied by information documenting successful completion of an acceptable training course. NMFS shall be allowed three weeks to approve PSOs from the time that the necessary information is received by NMFS, after which PSOs meeting the minimum requirements will automatically be considered approved;

(6) 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);

(7) All PSOs must be trained in 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;

(8) At least one PSO on active duty for each activity (*i.e.,* foundation installation, cable landfall and marina activities, and HRG surveys) must be designated as the ''Lead PSO''. The Lead PSO must have a minimum of 90 days

of at-sea experience working in an offshore environment and is required to have no more than eighteen months elapsed since the conclusion of their last at-sea experience; and

(9) PAM operators must complete specialized training for operating PAM systems and must demonstrate familiarity with the PAM system on which they must be working. PSOs may act as both acoustic operators and visual observers (but not simultaneously), so long as they demonstrate that their training and experience are sufficient to perform each task.

(b) *General PSO requirements.* The following measures apply to PSOs during all project activities:

(1) All PSOs must be located at the best vantage point(s) on the primary vessel in order to obtain 360° visual coverage of the entire clearance and shutdown zones around the vessels, and as much of the Level B harassment zone as possible;

(2) During all visual observation periods, PSOs must use high magnification (25x) binoculars, standard handheld (7x) binoculars, and the naked eye to search continuously for marine mammals. During impact pile driving, at least one PSO on the primary pile driving must be equipped with Big Eye binoculars (*e.g.,* 25 x 150; 2.7 view angle; individual ocular focus; height control) of appropriate quality. These must be pedestal mounted on the deck at the best vantage point that provides for optimal sea surface observation and PSO safety;

(3) During periods of low visibility (*e.g.,* darkness, rain, fog, poor weather conditions, etc.), PSOs must use alternative technologies (*i.e.,* infrared or thermal cameras) to monitor the shutdown and clearance zones;

(4) PSOs must not exceed four consecutive watch hours on duty at any time, must have a two-hour (minimum) break between watches, and must not exceed a combined watch schedule of more than 12 hours in a 24-hour period;

(5) Any PSO has the authority to call for a delay or shutdown of project activities.

(6) Any visual observations of ESA-listed marine mammals must be communicated immediately to PSOs and vessel captains associated with other vessels to increase situational awareness; and

(7) Empire Wind's personnel and PSOs are required to use available sources of information on North Atlantic right whale presence to aid in monitoring efforts. These include daily monitoring of the Right Whale Sightings Advisory System, consulting of the WhaleAlert app, and monitoring of the Coast Guard's VHF Channel 16 throughout the day to receive notifications of any sightings and information associated with any Dynamic Management Areas, to plan construction activities and vessel routes, if practicable, to minimize the potential for co-occurrence with North Atlantic right whales.

(c) *PSO and PAM operator requirements during WTG and OSS foundation installation.* The following measures apply to PSOs and PAM operators during monopile and OSS foundation installation:

(1) At least two PSOs must be actively observing marine mammals before, during, and after installation of foundation piles (monopiles). At least two PSOs must be stationed and observing on the pile driving vessel. Concurrently, at least one acoustic monitoring PSO (*i.e.,* passive acoustic monitoring (PAM) operator) must be actively monitoring for marine mammals with PAM before, during and after impact pile driving;

(2) All on-duty visual PSOs must remain in contact with the on-duty PAM operator, who would monitor the PAM systems for acoustic detections of marine mammals in the area.

(3) If PSOs cannot visually monitor the minimum visibility zone at all times using the equipment described in paragraph (b)(1)(ii) of this section, impact pile driving operations must not commence or must shutdown if they are currently active;

(4) All PSOs must begin monitoring 60 minutes prior to pile driving, during, and for 30 minutes after an activity. The impact pile driving of monopiles must only commence when the minimum visibility zone is fully visible (*e.g.,* not obscured by darkness, rain, fog, etc.) and the clearance zones are clear of marine mammals for at least 30 minutes, as determined by the Lead PSO, immediately prior to the initiation of impact pile driving;

(5) For North Atlantic right whales, any visual or acoustic detection must trigger a delay to the commencement of pile driving. In the event that a large whale is sighted or acoustically detected that cannot be confirmed by species, it must be treated as if it were a North Atlantic right whale;

(6) Empire Wind must prepare and submit a Pile Driving and Marine Mammal Monitoring Plan to NMFS for review and approval at least 180 days before the start of any pile driving. The plans must include final pile driving project design (*e.g.,* number and type of piles, hammer type, noise attenuation systems, anticipated start date, *etc.*) and all information related to PAM PSO monitoring protocols for pile-driving and visual PSO protocols for all activities;

(8) Empire Wind must conduct PAM for at least 24 hours immediately prior to foundation installation pile driving activities;

(9) During use of any real-time PAM system, at least one PAM operator must be designated to monitor each system by viewing data or data products that would be streamed in real-time or in near real-time to a computer workstation and monitor;

(10) PAM operators may be located on a vessel or remotely on-shore but must have the appropriate equipment (*i.e.,* computer station equipped with a data collection software system (*i.e.,* Mysticetus or similar system and acoustic data analysis software) available wherever they are stationed;

(11) Visual PSOs must remain in contact with the PAM operator currently on duty regarding any animal detection that might be approaching or found within the applicable zones no matter where the PAM operator is stationed (*i.e.,* onshore or on a vessel); and

(12) PAM operators must be on watch for a maximum of four consecutive hours, followed by a break of at least two hours between watches, and may not exceed a combined watch schedule of more than 12 hours in a single 24-hour period.

(d) *PSO requirements during cable landfall construction and marina activities.* The following measures apply to PSOs during pile driving associated with cable landfall construction and marina activities:

(1) At least two PSOs must be on active duty during all activities related to the installation and removal of cofferdams, goal posts, and casing pipes;

(2) These PSOs must be located at the best vantage points on the pile driving platform or secondary platform in the immediate vicinity of the pile driving;

(3) PSOs must ensure that there is appropriate visual coverage for the entire clearance and shutdown zones and as much of the Level B harassment zone as possible; and

(4) PSOs must monitor the clearance zone for the presence of marine mammals for 30 minutes before, throughout pile driving, and for 30 minutes after all pile driving activities have ceased. Pile driving must only commence when visual clearance zones are fully visible (*e.g.,* not obscured by darkness, rain, fog, *etc.*) and clear of marine mammals, as determined by the Lead PSO, for at least 30 minutes immediately prior to initiation of impact or vibratory pile driving.

(e) *PSO requirements during HRG surveys.* The following measures apply to PSOs during HRG surveys using SBPs:

(1) At least one PSO must be on active duty monitoring during HRG surveys conducted during daylight (*i.e.,* from 30 minutes prior to sunrise through 30 minutes following sunset) and at least two PSOs must be on activity duty monitoring during HRG surveys conducted at night;

(2) During periods of low visibility (*e.g.,* darkness, rain, fog, *etc.*), PSOs must use alternative technology (*i.e.,* infrared/thermal camera) to monitor the clearance and shutdown zones;

(3) PSOs on HRG vessels must begin monitoring 30 minutes prior to activating SBPs during the use of these acoustic sources, and for 30 minutes after use of these acoustic sources has ceased;

(4) Any observations of marine mammals must be communicated to PSOs on all nearby survey vessels during concurrent HRG surveys; and

(5) During daylight hours when survey equipment is not operating, Empire Wind must ensure that visual PSOs conduct, as rotation schedules allow, observations for comparison of sighting rates and behavior with and without use of the specified acoustic sources. Off-effort PSO monitoring must be reflected in the monthly PSO monitoring reports.

(f) *Reporting.* Empire Wind must comply with the following reporting measures:

(1) Prior to initiation of project activities, Empire Wind must demonstrate in a report submitted to NMFS (at *robert.pauline@noaa.gov* and*pr.itp.monitoringreports@noaa.gov*) that all required training for Empire Wind personnel (including the vessel crews, vessel captains, PSOs, and PAM operators) has been completed;

(2) Empire Wind must use a standardized reporting system during the effective period of this subpart and LOA. All data collected related to the Empire Wind Project must be recorded using industry-standard softwares (*e.g.,* Mysticetus or a similar software) that is installed on field laptops and/or tablets. Empire Wind must submit weekly (during foundation installation only), monthly and annual reports as described below. For all monitoring efforts and marine mammal sightings, Empire Wind must collect the following information:

(i) Date and time that monitored activity begins or ends;

(ii) Construction activities occurring during each observation period;

(iii) Watch status (*i.e.,* sighting made by PSO on/off effort, opportunistic, crew, alternate vessel/platform);

(iv) PSO who sighted the animal;

(v) Time of sighting;

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

(vii) Water conditions (*e.g.,* sea state, tide state, water depth);

(viii) All marine mammal sightings, regardless of distance from the construction activity;

(ix) Species (or lowest possible taxonomic level possible);

(x) Pace of the animal(s);

(xi) Estimated number of animals (minimum/maximum/high/low/best);

(xii) Estimated number of animals by cohort (*e.g.,* adults, yearlings, juveniles, calves, group composition, etc.);

(xiii) 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);

(xiv) 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;

(xv) Animal's closest distance and bearing from the pile being driven or specified HRG equipment and estimated time entered or spent within the Level A harassment and/or Level B harassment zones;

(xvi) Activity at time of sighting (*e.g.,* vibratory installation/removal, impact pile driving, construction survey), use of any noise attenuation device(s), and specific phase of activity (*e.g.,* ramp-up of HRG equipment, HRG acoustic source on/off, soft-start for pile driving, active pile driving, *etc.*);

(xvii) Marine mammal occurrence in Level A harassment or Level B harassment zones;

(xviii) 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

(xix) Other human activity in the area.

(3) If a marine mammal is acoustically detected during PAM monitoring, the following information must be recorded and reported to NMFS:

(i) Location of hydrophone (latitude & longitude; in Decimal Degrees) and site name;

(ii) Bottom depth and depth of recording unit (in meters);

(iii) Recorder (model & manufacturer) and platform type (*i.e.,* bottom-mounted, electric glider, etc.), and instrument ID of the hydrophone and recording platform (if applicable);

(iv) Time zone for sound files and recorded date/times in data and metadata (in relation to UTC. *i.e.,* EST time zone is UTC–5);

(v) Duration of recordings (start/end dates and times; in ISO 8601 format, yyyy-mm-ddTHH:MM:SS.sssZ);

(vi) Deployment/retrieval dates and times (in ISO 8601 format);

(vii) Recording schedule (must be continuous);

(viii) Hydrophone and recorder sensitivity (in dB *re. 1*μ*Pa*);

(ix) Calibration curve for each recorder;

(x) Bandwidth/sampling rate (in Hz);

(xi) Sample bit-rate of recordings; and,

(xii) Detection range of equipment for relevant frequency bands (in meters);

(4) Information required for each detection, the following information must be noted:

(i) Species identification (if possible);

(ii) Call type and number of calls (if known);

(iii) Temporal aspects of vocalization (date, time, duration, etc.; date times in ISO 8601 format);

(iv) Confidence of detection (detected, or possibly detected);

(v) Comparison with any concurrent visual sightings;

(vi) Location and/or directionality of call (if determined) relative to acoustic recorder or construction activities;

(vii) Location of recorder and construction activities at time of call;

(viii) Name and version of detection or sound analysis software used, with protocol reference;

(ix) Minimum and maximum frequencies viewed/monitored/used in detection (in Hz); and

(x) Name of PAM operator(s) on duty.

(5) Empire Wind must compile and submit weekly reports to NMFS (at *robert.pauline@noaa.gov* and *PR.ITP.monitoringreports@noaa.gov*) that document the daily start and stop of all pile driving and HRG survey, 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 attenuation system(s) used and its performance. Weekly reports are due on Wednesday for the previous week (Sunday–Saturday) and must include the information required under this section. The weekly report must also identify which turbines become operational and when (a map must be provided). Once all foundation pile installation is completed, weekly reports are no longer required;

(6) Empire Wind must compile and submit monthly reports to NMFS (at *robert.pauline@noaa.gov* and *PR.ITP.monitoringreports@noaa.gov*) 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 action taken. Monthly reports are due on the 15th of the month for the previous month. The monthly report must also identify which turbines become operational and when (a map must be provided). Once foundation installation is complete, monthly reports are no longer required;

(7) Empire Wind must submit an annual report to NMFS (at *robert.pauline@noaa.gov* and *PR.ITP.monitoringreports@noaa.gov*) no later than 90 days following the end of a given calendar year. Empire Wind must provide a final report within 30 days following resolution of comments on the draft report. The report must detail the following information:

(i) The total number of marine mammals of each species/stock detected and how many were within the designated Level A harassment and Level B harassment zones with comparison to authorized take of marine mammals for the associated activity type;

(ii) Marine mammal detections and behavioral observations before, during, and after each activity;

(iii) What mitigation measures were implemented (*i.e.,* number of shutdowns or clearance zone delays, etc.) or, if no mitigative actions was taken, why not;

(iv) Operational details (*i.e.,* days of impact and vibratory pile driving, days/amount of HRG survey effort etc.);

(v) Any PAM systems used;

(vi) The results, effectiveness, and which noise attenuation systems were used during relevant activities (*i.e.,* impact pile driving);

(vii) Summarized information related to Situational Reporting; and

(viii) Any other important information relevant to the Empire Wind Project, including additional information that may be identified through the adaptive management process.

(ix) The final annual report must be prepared and submitted within 30 calendar days following the receipt of any comments from NMFS on the draft report. If no comments are received from NMFS within 60 calendar days of NMFS' receipt of the draft report, the report must be considered final.

(8) Empire Wind must submit its draft final report to NMFS (at *robert.pauline@noaa.gov* and *PR.ITP.monitoringreports@noaa.gov*) on all visual and acoustic monitoring conducted under the LOA within 90 calendar days of the completion of activities occurring under the LOA. A final report must be prepared and submitted within 30 calendar days following receipt of any NMFS comments on the draft report. If no comments are received from NMFS within 30 calendar days of NMFS' receipt of the draft report, the report shall be considered final.

(9) Empire Wind must submit situational reports if the following circumstances occur:

(i) If a North Atlantic right whale is observed at any time by PSOs or personnel on or in the vicinity of any project vessel, or during vessel transit, Empire Wind must immediately report sighting information to the NMFS North Atlantic Right Whale Sighting Advisory System (866) 755–6622, through the WhaleAlert app (*http://www.whalealert/org/*), and to the U.S. Coast Guard via channel 16, as soon as feasible but no longer than 24 hours after the sighting. Information reported must include, at a minimum: time of sighting, location, and number of North Atlantic right whales observed.

(ii) When an observation of a large whale occurs during vessel transit, the following information must be recorded and reported to NMFS:

(A) Time, date, and location (latitude/longitude; in Decimal Degrees);

(B) The vessel's activity, heading, and speed;

(C) Sea state, water depth, and visibility;

(D) Marine mammal identification to the best of the observer's ability (*e.g.,* North Atlantic right whale, whale, dolphin, seal);

(E) Initial distance and bearing to marine mammal from vessel and closest point of approach; and

(F) Any avoidance measures taken in response to the marine mammal sighting.

(iii) If a North Atlantic right whale is detected via PAM, the date, time, location (*i.e.,* latitude and longitude of recorder) of the detection as well as the recording platform that had the detection must be reported to *nmfs.pacmdata@noaa.gov* as soon as feasible, but no longer than 24 hours after the detection. Full detection data and metadata must be submitted monthly on the 15th of every month for the previous month via the webform on the NMFS North Atlantic right whale Passive Acoustic Reporting System website (*https://www.fisheries.noaa.gov/resource/document/passive-acoustic-reporting-system-templates*);

(iv) In the event that the personnel involved in the activities defined in § 217.280(a) discover a stranded, entangled, injured, or dead marine mammal, Empire Wind must immediately report the observation to the NMFS Office of Protected Resources (OPR), the NMFS Greater Atlantic Stranding Coordinator for the New England/Mid-Atlantic area (866–755–6622), and the U.S. Coast Guard within 24 hours. If the injury or death was caused by a project activity, Empire Wind must 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 LOA. NMFS may impose additional measures to minimize the likelihood of further prohibited take and ensure MMPA compliance. Empire Wind may not resume their activities until notified by NMFS. The report must include the following information:

(A) Time, date, and location (latitude/longitude; in Decimal Degrees) of the first discovery (and updated location information if known and applicable);

(B) Species identification (if known) or description of the animal(s) involved;

(C) Condition of the animal(s) (including carcass condition if the animal is dead);

(D) Observed behaviors of the animal(s), if alive;

(E) If available, photographs or video footage of the animal(s); and

(F) General circumstances under which the animal was discovered.

(v) In the event of a vessel strike of a marine mammal by any vessel associated with the Empire Wind Project, Empire Wind must immediately report the strike incident to the NMFS OPR and the NMFS Greater Atlantic Regional Fisheries Office (GARFO) within and no later than 24 hours. Empire Wind must immediately cease all on-water 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 LOA. NMFS may impose additional measures to minimize the likelihood of further prohibited take and ensure MMPA compliance. Empire Wind may not resume their activities until notified by NMFS. The report must include the following information:

(A) Time, date, and location (latitude/longitude; in Decimal Degrees) of the incident;

(B) Species identification (if known) or description of the animal(s) involved;

(C) Vessel's speed leading up to and during the incident;

(D) Vessel's course/heading and what operations were being conducted (if applicable);

(E) Status of all sound sources in use;

(F) 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;

(G) Environmental conditions (*e.g.,* wind speed and direction, Beaufort sea state, cloud cover, visibility) immediately preceding the strike;

(H) Estimated size and length of animal that was struck;

(I) Description of the behavior of the marine mammal immediately preceding and following the strike;

(J) If available, description of the presence and behavior of any other marine mammals immediately preceding the strike;

(K) Estimated fate of the animal (*e.g.,* dead, injured but alive, injured and moving, blood or tissue observed in the water, status unknown, disappeared); and

(L) To the extent practicable, photographs or video footage of the animal(s).

§ 217.286 Letter of Authorization.

(a) To incidentally take marine mammals pursuant to this subpart, Empire Wind must apply for and obtain an LOA.

(b) An LOA, unless suspended or revoked, may be effective for a period of time not to exceed the January 21, 2029, the expiration date of this subpart.

(c) In the event of projected changes to the activity or to mitigation and monitoring measures required by an LOA, Empire Wind must apply for and obtain a modification of the LOA as described in § 217.287.

(d) The LOA must set forth:

(1) Permissible methods of incidental taking;

(2) Means of effecting the least practicable adverse impact (*i.e.,* mitigation) on the species, its habitat, and on the availability of the species for subsistence uses; and

(3) Requirements for monitoring and reporting.

(e) Issuance of the LOA must be based on a determination that the level of taking must be consistent with the findings made for the total taking allowable under this subpart.

(f) Notice of issuance or denial of an LOA must be published in the **Federal Register** within 30 days of a determination.

§ 217.287 Modifications of Letter of Authorization.

(a) An LOA issued under §§ 217.282 and 217.286 or § 217.287 for the activity identified in § 217.280(a) shall be modified upon request by the applicant, provided that:

(1) The proposed specified activity and mitigation, monitoring, and reporting measures, as well as the anticipated impacts, are the same as those described and analyzed for this subpart (excluding changes made pursuant to the adaptive management provision in paragraph (c)(1) of this section), and

(2) NMFS determines that the mitigation, monitoring, and reporting measures required by the previous LOA under this subpart regulations were implemented.

(b) For a LOA modification request by the applicant that include changes to the activity or the mitigation, monitoring, or reporting (excluding changes made pursuant to the adaptive management provision in paragraph (c)(1) of this section) that do not change the findings made for this subpart or result in no more than a minor change in the total estimated number of takes (or distribution by species or years), NMFS may publish a notice of proposed LOA in the **Federal Register**, including the associated analysis of the change, and solicit public comment before issuing the LOA.

(c) An LOA issued under §§ 217.282 and 217.286 or § 217.287 for the activities identified in § 217.280(a) may be modified by NMFS under the following circumstances:

(1) Through adaptive management, NMFS may modify (including augment) the existing mitigation, monitoring, or reporting measures (after consulting with Empire Wind regarding the practicability of the modifications, if doing so creates a reasonable likelihood of more effectively accomplishing the goals of the mitigation and monitoring set forth in the preamble for these regulations;

(i) Possible sources of data that could contribute to the decision to modify the mitigation, monitoring, or reporting measures in an LOA:

(A) Results from Empire Wind's monitoring from the previous year(s);

(B) Results from other marine mammals and/or sound research or studies;

(C) Any information that reveals marine mammals may have been taken in a manner, extent or number not authorized by this subpart or subsequent LOA; and

(ii) If, through adaptive management, the modifications to the mitigation, monitoring, or reporting measures are substantial, NMFS shall publish a notice of proposed LOA in the **Federal Register** and solicit public comment;

(2) If NMFS determines that an emergency exists that poses a significant risk to the well-being of the species or stocks of marine mammals specified in the LOA issued pursuant to §§ 217.282 and 217.286 or § 217.287, an LOA may be modified without prior notice or opportunity for public comment. Notice would be published in the **Federal Register** within thirty days of the action.

§§ 217.288–217.289 [Reserved]

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