Petition for Incidental Take Regulations for the Construction and Operation of the Sunrise Wind Offshore Wind Farm

Submitted To:

National Marine Fisheries Service
Office of Protected Resources
Silver Spring, MD

Submitted By: **Sunrise Wind, LLC**

Sunrise Wind | Powered by Ørsted & Eversource

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1 Description of Specified Activity

Sunrise Wind LLC (Sunrise Wind), a 50/50 joint venture between Orsted North America Inc. (Orsted NA) and Eversource Investment LLC (Eversource), proposes to construct and operate the Sunrise Wind Farm Project (hereinafter referred to as the Project). The purpose of the Project is to provide clean, reliable offshore wind energy that will increase the amount and availability of renewable energy to New York consumers while creating the opportunity to displace electricity generated by fossil fuel-powered plants and offering substantial economic and environmental benefits. New York has adopted substantial renewable portfolio standards and clean energy targets to address issues associated with climate change, highlighting the current and future demand for this Project. As such, the Project will help the state achieve the clean energy goals set forth in the Clean Energy Standards (CES) and more recently, the Climate Leadership Community Protection Act (CLCPA), which was signed in July 2019 and adopts the most ambitious and comprehensive climate and clean energy legislation in the country. The CLCPA sets forth an ambitious plan that sets the New York State (NYS) goal of achieving 100 percent carbon-free electricity by 2040 and 70 percent of electricity from renewable sources by 2030, including a target of reaching 9,000 MW of offshore wind by 2035. In response to the expressed need and demand, Sunrise Wind executed a contract with New York State Energy Research and Development Authority (NYSERDA) for a 25-year Offshore Wind Renewable Energy Certificate (OREC) Agreement in October 2019. Under the OREC Agreement, NYSERDA will purchase ORECs generated by the operational Project and make them available for purchase by New York load-serving entities. The Project is being developed to fulfill its obligations to New York in accordance with this Agreement. As specified in the OREC Agreement, the Project will generate electricity from an offshore wind farm located in the Sunrise Wind Farm for transmission and delivery to the existing Long Island Power Authority (LIPA) Holbrook Substation.

The Project is defined within the Sunrise Wind Construction and Operations Plan (COP) (Sunrise-Wind 2021) using a Project Design Envelope (PDE) approach. The PDE defines “a reasonable range of project designs” associated with various components of a project (e.g., foundation and WTG options) (Sunrise-Wind 2021). The PDE for the Project is based on a generating capacity ranging between 924 megawatts (MW) and 1,034 MW with power transmitted to shore through direct current (DC) submarine cables. The project includes the following primary offshore components: up to 94 wind turbine generators (WTG) at 102 potential locations; one Offshore Converter Station (OCS-DC), up to 95 foundations (for WTGs and the OCS-DC); up to 180 miles (mi) (290 kilometers [km]) of Inter-Array Cables (IACs); and one DC Sunrise Wind Export Cable (SRWEC) located within an up to 104.7-mi (168.5-km)-long corridor. Onshore components will include an Onshore Transmission Cable, transition join bay (TJB) and concrete and/or direction buried joint bays and associated components; onshore interconnection cable; fiber optic cable co-located with the Onshore Transmission and Onshore Interconnection Cables; and one Onshore Converter Station (OnCS-DC). Sunrise Wind is committed to a Project layout with WTGs and the OCS-DC sited in a uniform east-west/ north-south grid with 1.15 mi (1 nm, 1.8 km) by 1.15 mi (1 nm, 1.8 km) spacing that aligns layouts proposed for other projects in the Rhode Island/Massachusetts Wind Energy Area (RI-MA WEA) and Massachusetts Wind Energy Area (MA WEA).

The wind farm portion of the Project (i.e., the SRWF) will be located on the Outer Continental Shelf (OCS) in the designated BOEM Renewable Energy Lease Area OCS-A 0487 (Lease Area)[1]. The Lease Area is approximately 18.9 statute mi (16.4 nautical miles [nm], 30.4 km) south of Martha's Vineyard, Massachusetts (MA), approximately 30.5 mi (26.5 nm, 48.1 km) east of Montauk, New York (NY), and 16.7 mi (14.5 nm, 26.8 km) from Block Island, Rhode Island (RI) (Figure 1). The Lease Area contains portions of areas that were originally awarded through the BOEM competitive renewable energy lease auctions of the WEA off the shores of RI and MA. Other components of the Project will be located in federal waters on the OCS, in state waters of New York, and onshore components in the Town of Brookhaven, Long Island, New York. Figure 2 depicts the conceptual arrangement of offshore and onshore Project components. The SRWEC is planned to make landfall at Smith Point Country Park (in the Town of Brookhaven) using a combination of cable installation methods from shore and in nearshore waters. The proposed interconnection location for the Project is the Holbrook Substation, which is owned and operated by the LIPA.

For the purposes of analyzing potential take of marine mammals as a result of construction and operations activities, the Project has been split into eight (8) primary elements including: WTG monopile foundation installation, OCS-DC piled jacket foundation installation, cable landfall construction, OCS-DC seawater cooling system, high resolution geophysical (HRG) surveys, potential munitions, explosives of concern (MEC)/unexploded ordnance (UXO) detonations, construction vessel activity, and fisheries and benthic monitoring. Locations of both the Sunrise Wind Farm (SRWF) and the Sunrise Wind Export Cable (SRWEC) are shown on Figure 1; the onshore portions of the Project are shown on Figure 2.

[1] A portion of Lease Area OCS-A 0500 (Bay State Wind LLC) and the entirety of Lease Area OCS-A 0487 (formerly Deepwater Wind New England LLC) were assigned to Sunrise Wind LLC on September 3, 2020, and the two areas were merged, and a revised Lease OCS-A 0487 was issued on March 15, 2021. Thus, when using the term "Lease Area" within this document, Sunrise Wind is referring to the new merged Lease Area OCS-A 0487.

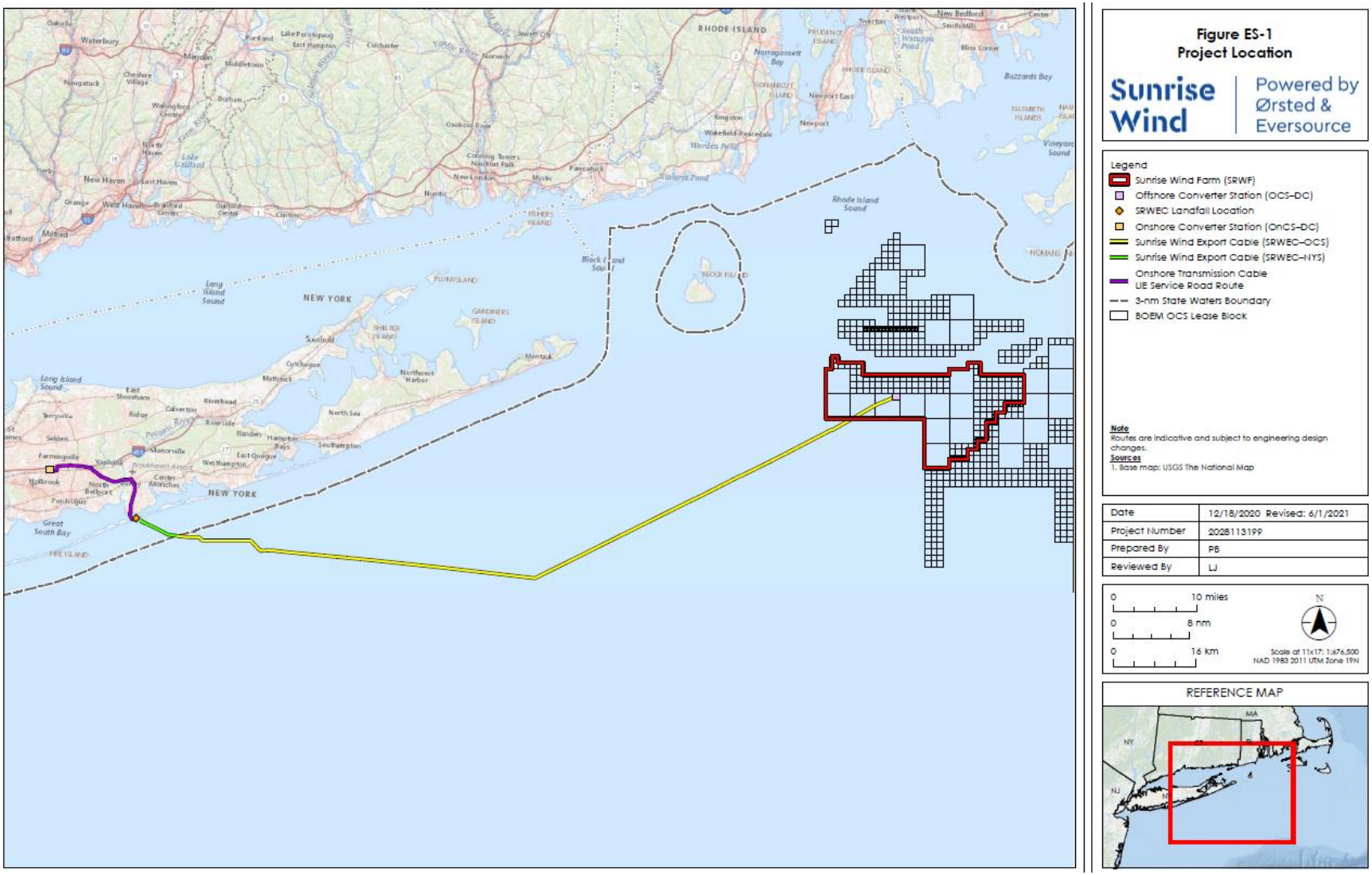


Figure 1. Location of the SRWF within Lease Area OCS-A 0487 and the SRWEC (Sunrise-Wind 2021).

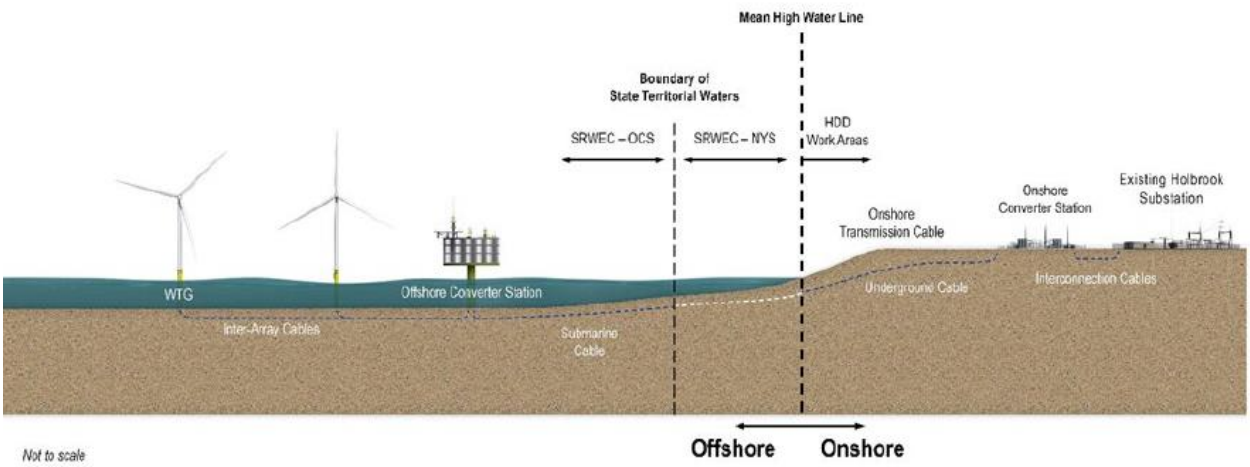


Figure 2. Onshore and offshore project components (reproduced from COP Figure 1.1-3) (Sunrise-Wind 2021).

1.1 Offshore Project Components and Construction Activities

The Project's key offshore components are described in detail in Section 3.3.3 - 3.3.5 of Volume I of the COP (Sunrise-Wind 2021). These include components within the SRWF (WTG and OCS-DC Foundations) and the SRWEC. Sunrise Wind has evaluated all Project activities for potential harassment as required under 50 CFR §216.104. Construction of the Project will include WTG foundation installation using monopiles, OCS-DC foundation installation using a piled jacket, cable landfall construction, OCS-DC seawater cooling system, HRG surveys, potential in-situ UXO/MEC disposal, and construction vessel activity including during inter-array cable (IAC) and SRWEC installation. Of these activities, only the OCS-DC seawater cooling system and HRG surveys are anticipated to occur during subsequent years of operation. It is anticipated that separate installation vessels will complete installation of the WTG monopile foundations and the OCS-DC piled jacket foundation. Thus, piling of monopile foundations and piled jacket foundations may occur simultaneously. If one monopile vessel and one piled jacket vessel are working simultaneously, installation of up to 6 piles may be installed (2 monopiles and 6 pin piles). Additionally, it is possible that 2 separate vessels may work simultaneously to install up to 4 total monopiles per day (assuming 2 monopiles per day, per vessel). At a maximum, the Project expects up to two vessels working simultaneously (e.g., two monopile vessels, or one monopile foundation vessel and one piled jacket foundation vessel). This approach assumes 24/7 piling in addition to simultaneous piling operations among the up to 2 pile installation vessels.

1.1.1 WTG Monopile Foundation Installation

Figure 3 provides a conceptual example of the WTG support structures (i.e., towers and foundations) which will be designed to withstand 500-year hurricane wind and wave conditions, and the external platform level will be designed above the 1,000-year wave scenario. A WTG monopile foundation typically consists of a single steel tubular section, with several sections of rolled steel plate welded together. A transition piece (TP) may be fitted over the top of the monopile and secured via a bolted connection. Secondary structures on each WTG monopile foundation will include a boat landing or alternative means of safe access (e.g., Get Up Safe – a motion compensated hoist system allowing vessel

to foundation personnel transfers without a boat landing), ladders, a crane, and other ancillary components. The TP may either be installed separately following the monopile installation or the monopile and TP may be fabricated and installed as an integrated single component. If the monopile and TP are fabricated and installed as an integrated component, the secondary structures will be installed on the TP subsequently and in separate smaller operations. The TP will be painted yellow and marked according to U.S. Coast Guard (USCG) requirements.

Up to 94 WTG monopile foundations (located at 102 potential positions) with a maximum diameter tapering from 7 m above the waterline to 12 m (39 ft) below the waterline (7/12 m monopile) will be installed in the Sunrise Wind Farm. Although up to 94 WTGs are expected to be installed, Sunrise Wind has accounted for up to 8 potential locations where WTG installation is begun but unable to be completed due to environmental or engineering constraints (i.e., only 94 WTGs will be installed, but the PDE includes seafloor preparation and foundation installation activities at 102 potential locations).

Monopiles will be installed using an impact pile driver with a maximum hammer energy of 4,000 kJ to a maximum penetration depth of 50 m (164 ft). Installation of each monopile will include a 20-minute soft start where lower hammer energy is used at the beginning of each pile installation during pile driving activity to provide additional protection to mobile species (e.g., whales, dolphins, porpoises) in the vicinity by allowing them to vacate the area prior to the commencement of pile driving activities. Under normal conditions, after completion of the 20-minute soft start period, installation of a single monopile foundation is estimated to require 1-4 hours (12 hours maximum for a single monopile). It is anticipated that a maximum of 3 monopile foundations can be driven into the seabed per day using one installation vessel, assuming 24-hour pile driving operation[2]. Additionally, it is possible that 2 separate vessels may work simultaneously which would result in installation of up to 4 total monopiles per day (maximum 2 per day on each of the two vessels), assuming 24-hour pile driving operations.

To be able to install WTG and OCS-DC foundations, impact pile driving 24-hours per day is deemed necessary by taking into account the amount of time required to install the foundations in comparison to the time available for installation when factoring in various limitations. Under ideal conditions and consistent with the assumption that up to 3 monopile foundations could be installed in a single day (24-hour period including nighttime), installation of a single monopile at a minimum would involve a 1-hour pre-clearance period, 4 hours of piling, and 4 hours to move to the next piling location where the process would begin again. This results in an estimated 9 hours of installation time per pile, or 918 total hours for 102 WTG monopile foundations under ideal conditions for all installations. Installation of the OCS-DC jacket foundation pin piles (see details below) would require a 1-hr pre-clearance period, up to 6 hours of piling, and approximately 2 hours between piles for a per-pile installation time of 9 hours and a total of time of 72 hours for all 8 OCS-DC jacket foundation pin piles. Adding this to the WTG monopile foundation installation time brings the total to 990 hours of installation time under ideal conditions.

If pile driving were only allowed from sunrise to sunset, and no pile driving was conducted from January 1 through April 30, then approximately 2,940 hours would initially be available for pile driving (this assumes an average of 12 hours of daylight per day for 245 days). Based on prior experience, it is reasonable to assume that approximately 30% of the time would be unavailable due to weather conditions,

[2] In support of the request for nighttime piling, Ørsted is assessing the opportunity to conduct a marine mammal monitoring field demonstration project in the spring of 2022. Additional details on the project and further engagement will follow.

bringing the available time down to 2,058 hours and leaving a buffer of approximately 1,100 hours between the minimum time required to install the foundations and the time available. However, many other factors are anticipated to further reduce the time available for installations. For example, delays are likely due to the presence of protected species, equipment downtime and/or supply chain issues in receiving materials, commercial fishing, and other marine activity in the area. Other Project operations that must occur during good weather conditions such as vessel-to-vessel transfers of crew, equipment, and materials are all likely to prohibit piling during otherwise available daylight hours. COVID-19 has introduced new challenges, increases the potential for in-season Project delays, and highlights the schedule risks associated with heath concerns. Although not quantifiable at this time, the combined effect of these unforeseeable factors will further reduce the available time for piling to a point where there is an insufficient buffer between the time required for installations and the time available for installations within a single operational season should piling only be allowed during daylight hours.

To complete installation within a single season and should pile driving be limited to daylight hours, operations would need to be conducted in the currently excluded January-April timeframe to create a sufficient buffer between required installation time and available installation time. Since the January to April timeframe is when North Atlantic right whales (NARW) are present in the region in higher numbers, the potential impacts to this species would increase. Alternatively, if the installations were to occur within the same May–December period during daylight only but extend across multiple seasons, there would be an overall increase in vessel traffic, which could also increase potential impacts to NARW and other marine mammals. For these reasons, the ability to conduct nighttime impact pile driving of WTG and OCS-DC foundations during time periods when the fewest number of NARW are likely to be present in the region is expected to result in the lowest overall impact of the project on marine mammals, including NARW.

Should nighttime pile driving occur, the best currently available technology will be used to mitigate the potential impacts and result in the least practicable adverse impacts. These monitoring methods will include the use of night vision equipment and infrared/thermal imaging. Night vision equipment and infrared/thermal imaging have been shown to allow for the detection of marine mammals at night at a similar probability of detecting marine mammals during daylight visual monitoring (Verfuss et al. 2018; Guazzo et al. 2019).

One or more noise abatement systems (NAS), such as a bubble curtain, evacuated sleeve system, encapsulated bubble system (HydroSound Dampers), or Helmholtz resonators (AdBm) will be used during WTG and OCS-DC foundation installations to reduce sounds propagated into the marine environment. Several recent studies summarizing the effectiveness of NAS have shown that broadband sound levels are likely to be reduced by anywhere from 7 to 17 dB, depending on the environment, pile size, and the size, configuration and number of systems used (Buehler et al. 2015; Bellmann et al. 2020a). The type and number of NAS to be used during construction have not yet been determined, but at a minimum, will consist of a double big bubble curtain or a single bubble curtain paired with an additional sound attenuation device. Based on prior measurements, this combination of NAS is reasonably expected to achieve at least 10 dB broadband attenuation of impact pile driving sounds (described further in Section 0).

A typical monopile installation sequence begins with the monopiles transported directly to the Sunrise Wind Farm for installation or to the construction staging port by an installation vessel or a feeding barge. At the foundation location, the main installation vessel upends the monopile in a vertical

position in the pile gripper mounted on the side of the vessel. The hammer is then lifted on top of the pile and pile driving commences with a soft start and proceeds to completion using up to 4,000-kJ of hammer energy. Piles are driven until the target embedment depth is met (up to 50 m), then the pile hammer is removed and the monopile is released from the pile gripper. Once the monopile is installed to the target depth, the TP or separate secondary structures will be lifted over the pile by the installation vessel. If used, the TP will be bolted to the monopile. Once installation of the monopile and TP is complete, the vessel moves to the next installation location.

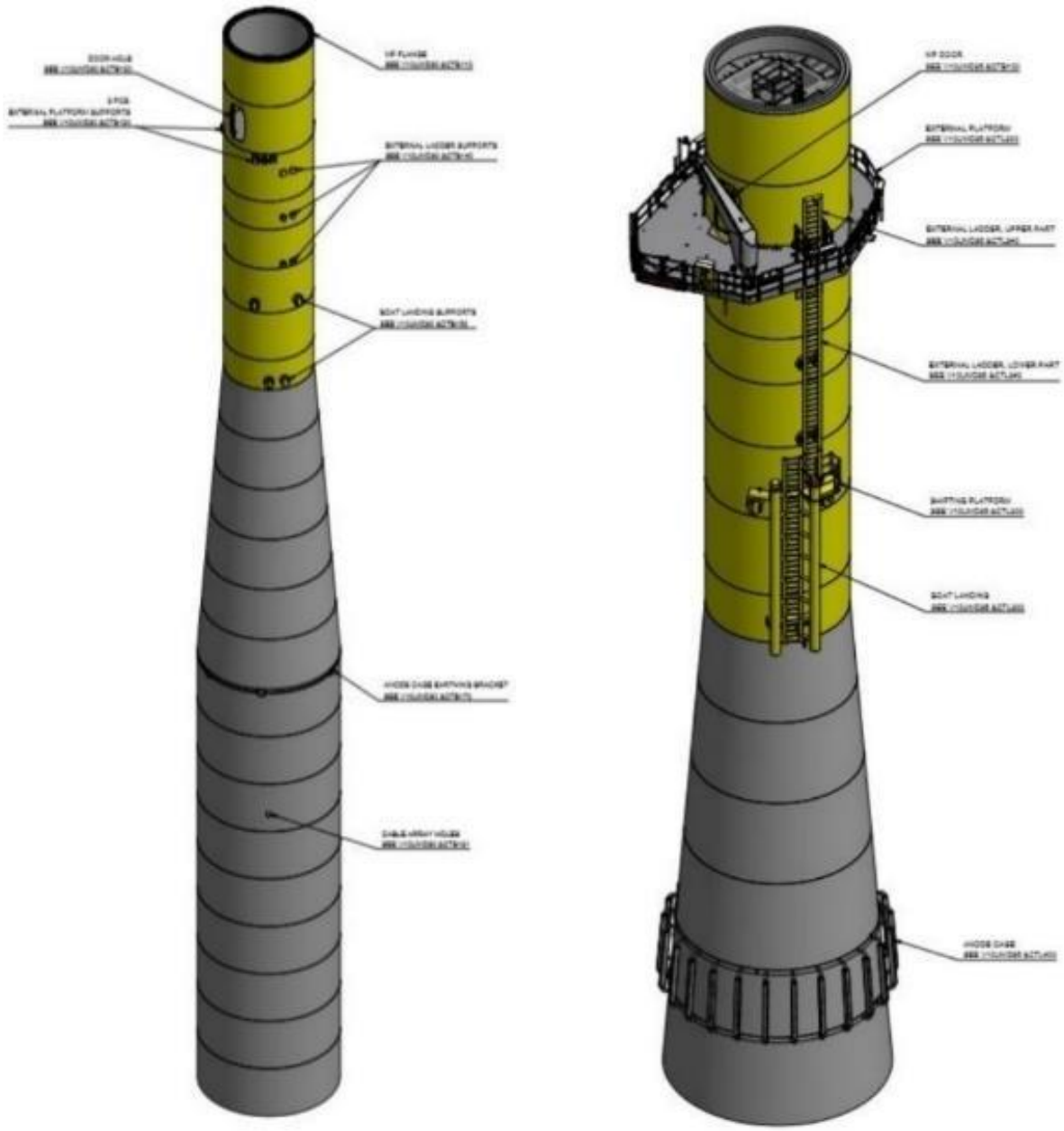


Figure 3. Conceptual monopile foundation with Secondary Structure after Installation (reproduced from COP Figure 3.3.5-1) (Sunrise-Wind 2021).

1.1.2 OCS-DC Piled Jacket Foundation Installation

One OCS-DC piled jacket foundation will be constructed to support the OCS-DC. A piled jacket foundation is formed of a steel lattice construction (comprising tubular steel members and welded joints) secured to the seabed by means of hollow steel pin piles attached to the jacket. Unlike monopiles, there is no separate TP; the TP and ancillary components are fabricated as an integrated part of the jacket. Rock may be used to provide a level seafloor around the base of the structure. Figure 4 represents the four-legged piled jacket foundation being considered for the OCS-DC, which will be designed to withstand the 1,000-year hurricane wind and wave conditions in accordance with the American Petroleum Institute (API) standards.

The piled jacket foundation will have four legs with 2 pin piles per leg. The platform height will be up to 26.8 m (88 ft) with a leg diameter of up to 4.6 m (15 ft) and a pile diameter of up to 4 m (13 ft). Installation of OCS-DC jacket foundation pin piles (2 per leg, 8 total) will be performed using an impact pile driver with a maximum hammer energy of 4,000-kJ to a maximum penetration depth of 90 m (295 ft). Installation of a single piled jacket foundation is estimated to require approximately 48 hours of pile driving per jacket (which includes up to 6 hours of pile driving per pile). It is assumed that the pile driving would occur within a 72-hour window (~ 3 days) including wait time in between pile installation. Pile driving activity will include a 20-minute soft start at the beginning of each pile installation.

Delivery of pin piles and the associated jacket foundations will be the same as delivery of WTG monopiles described above using installation vessels and feeder barges. The jacket is installed first and is lifted vertically and lowered onto the jacket's foundation and the pin piles lifted into place through the jacket feet for driving. Each pin pile is then driven in turn until the target embedment depth is met for each pin, then the pile hammer is removed. If a pin pile does not reach target depth due to the presence of rock or hard soil in some lower part of the substrate, the drive and drill method will be used. When the pin pile meets refusal, impact piling will be stopped and the substrate below the pile will be drilled out. Then the piling will be re-established again and piled to its final position. If refusal occurs again, the drilling and driving will alternate until the pin pile has reached its final position.

1.1.3 OCS-DC Seawater Cooling System

The OCS-DC requires the withdrawal of raw seawater through a cooling water intake structure (CWIS) to dissipate heat produced through the AC to DC conversion and then discharge this water as thermal effluent to the marine receiving waters. Sunrise Wind has submitted an NPDES Permit application to the US Environmental Protection Agency (EPA), as the EPA will be responsible for implementing the NPDES permit program for the Project. The OCS-DC discharge is subject to the requirements of Section 403 of the Clean Water Act (CWA), commonly referred to as the Ocean Discharge Criteria. Section 316(b) of the CWA also requires NPDES permits for facilities with a CWIS ensure that the location, design, construction, and capacity reflect the best technology available (BTA) to minimize harmful impacts on the environment.

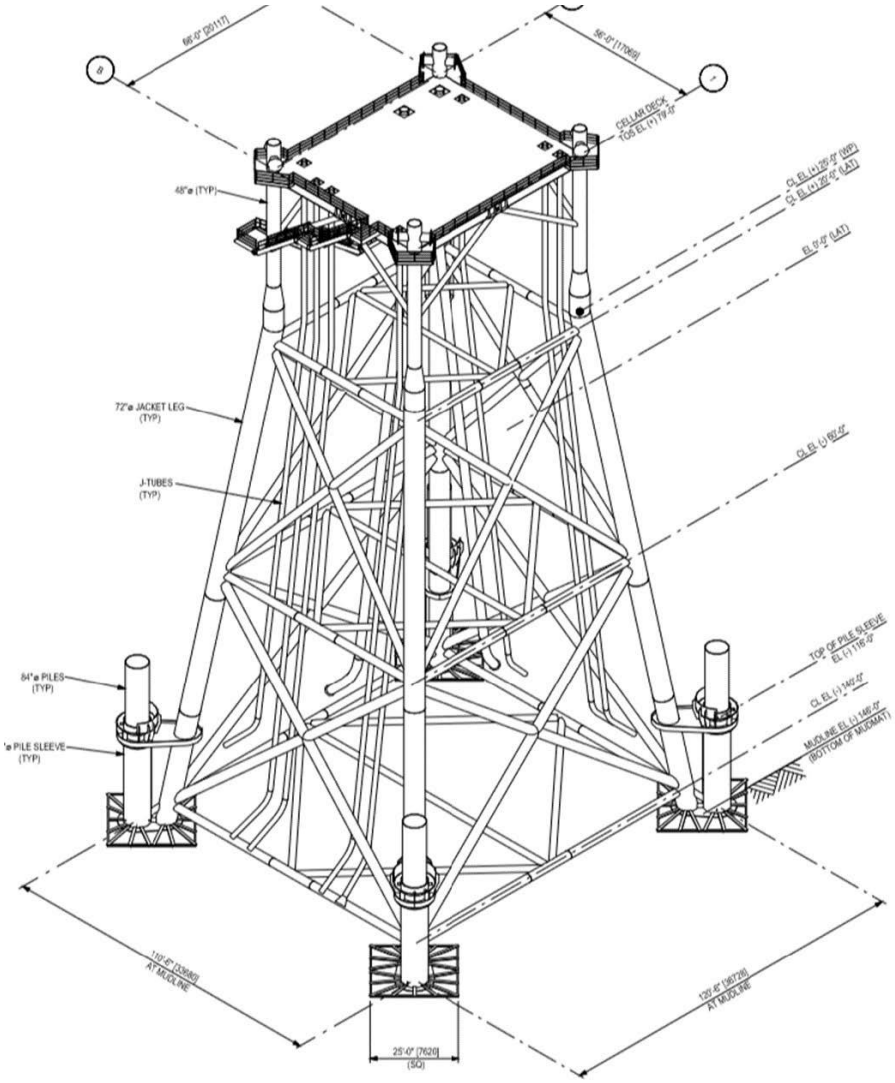


Figure 4. Example OCS-DC piled jacket foundation concept (reproduced from COP Figure 3.3.5-2) (Sunrise-Wind 2021).

The CWIS includes intake pipes and sweater lift pumps (SWLP), course filters, electrochlorination system, heat exchange system, and a dump caisson. The OCS-DC is proposing to discharge non-contact cooling water (NCCW) and non-contact stormwater to the marine receiving water. NCCW is defined as a wastewater that does not come into contact with process operations (raw materials, intermediate product, waste product, finished product) of a facility and will only be used to covey heat from the facility.

The CWIS is comprised of three individual vertical pipes in a single parallel cluster attached to the steel foundation jacket. Each intake pipe will be separate, with no cross-over connections between intake pipes (i.e., each SWLP/intake pipe assembly will operate independent). The SWLPs will be located within the vertical intake pipe, approximately 12 m (39 ft) below the ocean surface. The design intake flow (DIF) for the OCS-DC is 8.1 million gallons per day (MGD); however, the Average Flow Intake (AFI) will generally range from 4.0 MGD to 5.3 MGD. The cooling water withdrawn by the SWLPs will be directed to the coarse filters, after which a small portion (approximately 1 percent) will be diverted to

the Electrochlorination System and the remainder (approximately 99 percent) will be directed to the Heat Exchange System and then discharged through the Dump Caisson. Although the intake of raw seawater is substantial (up to 8.1 MGD), this water would cool quite quickly when it mixes with the surrounding waters. In addition, the amount of heated seawater that would be discharged is very small relative to the waters surrounding the Project Area. The rate at which seawater would be taken (e.g. maximum through-screen velocity [TSV], 0.1525 m/s [0.5 ft/s]) is below the threshold required for new facilities defined at §125.84(c) and is therefore protective against the impingement of juvenile and adult life stages of finfish and other mobile organisms. However, egg or larval life stages of fish as well as invertebrates present in the vicinity of the intake would be susceptible to entrainment. Further description on potential entrainment to marine mammal prey is described in Section 9.2.

The Dump Caisson consists of a single outlet vertical pipe oriented downward in the water column. The Dump Caisson is the primary discharge point for the OCS-DC. Pollutants discharged at the Dump Caisson will include NCCW and residual chlorine. The heated effluent from the Heat Exchange System will be directed to the Dump Caisson, as will the backwash from the Coarse Filters. Water will discharge through the 0.5 m^2 (5.4 ft^2) Dump Caisson opening (at the bottom of the Dump Caisson), which is located approximately 12 m (40 ft) below local mean seal level (LMSL). In the Dump Caisson, it is expected that chlorine levels in the NCCW will be negligible/zero during normal operations. Although very unlikely, hypochlorite could occasional be up to the maximum 2 ppm shock dosing in the Dump Caisson. The temperature of the water exiting the Heat Exchange System will depend on the ambient air temperature, ambient water temperature, power output, and other factors. The maximum temperature under all operating scenarios and conditions will not exceed 32° C (90° F). The behavior of the thermal plume at the Dump Caisson, including a modelling assessment, is provided in the NPDES Permit application and summarized below in Section 9.2.

1.1.4 Cable Landfall Construction

Installation of the SRWEC landfall will be accomplished using a horizontal directional drilling (HDD) methodology. HDD will be used to connect the SRWEC offshore cable to the Onshore Transmission Cable at the Landfall and to cross the Intercoastal Waterway (ICW) from Fire Island to mainland Long Island. The drilling equipment will be located onshore and used to create a borehole, one for each cable, from shore to an exit point on the seafloor approximately 0.5 mi (800 m) offshore. At the seaward exit site for each borehole, construction activities may include the temporary installation of a casing pipe, supported by sheet pile “goal posts”, to collect drilling mud from the borehole exit point. Additionally, 10 sheet piles may be used to support the casing pipe and help to anchor/stabilize the vessel which will be collecting drilling fluid. Installation of up to two casing pipes (one at each HDD exit pit location) would be completed using pneumatic pipe ramming equipment while installation of sheet pile for goal posts would be completed using a vibratory pile driving hammer. These activities would not occur simultaneously as some of the same equipment on the barge is necessary to conduct both types of installations. All installation activities would occur during daylight periods.

There will be up to 2 casing pipes which would be installed at an 11–12-degree angle with the seabed so that the casing pipe creates a straight alignment between the point of penetration at the seabed and the construction barge. Casing pipe installation will occur from the construction barge and be accomplished using a pneumatic pipe ramming tool (e.g., Grundoram Taurus or similar) with a hammer energy of up to 18 kJ. If necessary, additional sections of casing pipe may be welded together on the barge to extend the length of the casing pipe from the barge to the penetration depth in the seabed.

Installation of a single casing pipe may take up to 3 hours of pneumatic hammering on each of 2 days for installation. Installation time will be dependent on the number of pauses required to weld additional sections onto the casing pipe. For both casing pipes, this would mean a total of 4 days of installation. Removal of the casing pipes is anticipated to require approximately the same amount of pneumatic hammering and overall time, or less, meaning the pneumatic pipe ramming tool may be used for up to 3 hours per day on up to 8 days.

Up to 6 goal posts may be installed to support the casing pipe between the barge and the penetration point on the seabed. Each goal post would be composed of 2 vertical sheet piles installed using a vibratory hammer such as an American Piledriving Equipment (APE) model 300 (or similar). A horizontal cross beam connecting the two sheet piles would then be installed to provide support to the casing pipe. Up to 10 additional sheet piles may be installed per borehole to help anchor the barge and support the construction activities. This results in a total of up to 22 sheet piles per borehole and two boreholes bringing the overall total to 44 sheet piles. Sheet piles used for the goal posts and supports would be up to 30 m (100 ft) long, 0.6 m (2 ft) wide, and 1 inch thick. Installation of the goal posts would require up to 6 days per borehole, or up to 12 days total for both boreholes. Sheet pile may require up to 2 hours of vibratory piling and up to 4 sheet piles may be installed per day (total of 8 hours of vibratory pile driving per day). Removal of the goal posts may also involve the use of a vibratory hammer and likely require approximately the same amount of time as installation (12 days total for both boreholes). Thus, use of a vibratory pile driver to install and remove sheet piles may occur on up to 24 days at the landfall location. Installation of the SRWEC Landfall will be subject to New York State time of year restrictions. All landfall activities will be conducted within this allocated timeframe. All of the sheet pile goal posts would be installed first, followed by installation of the casing pipe.

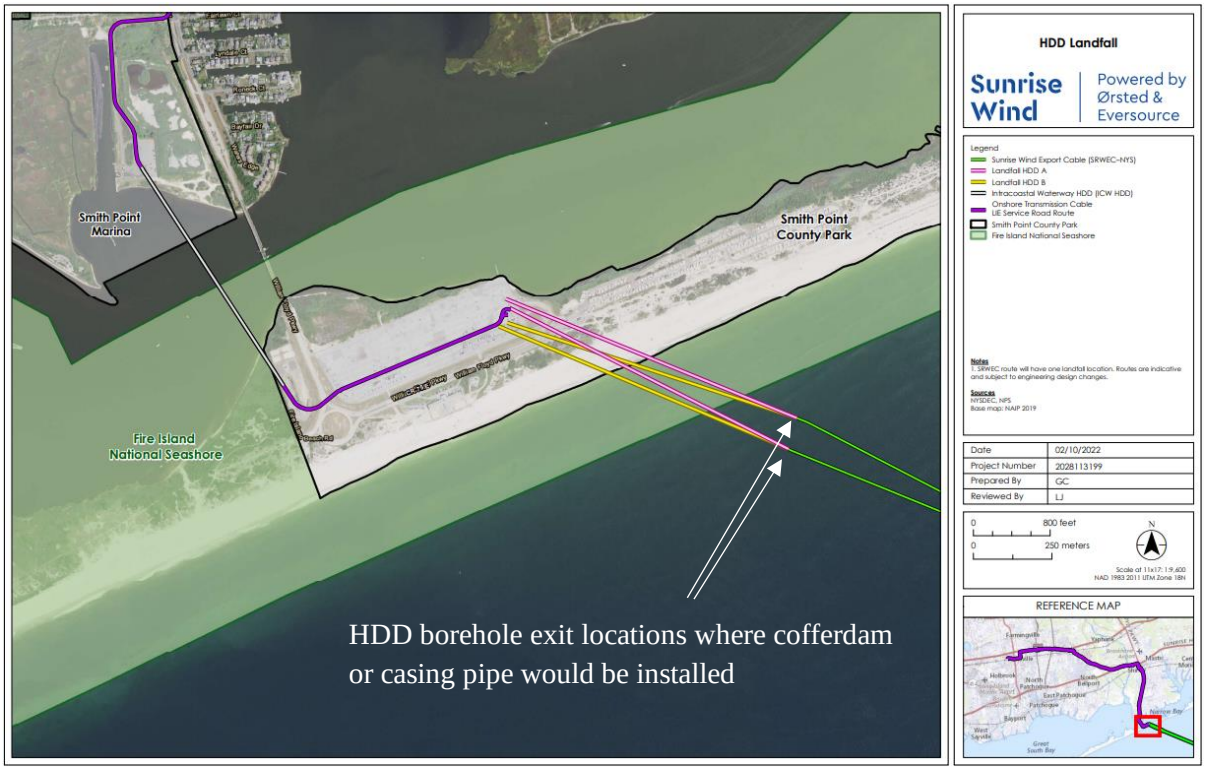


Figure 5: HDD Cable Landfall Design (Sunrise-Wind 2021).

1.1.5 High Resolution Geophysical (HRG) Surveys

HRG surveys will be conducted intermittently during the construction period to identify seabed debris and inspect cable installations. These surveys may utilize equipment such as multi-beam echosounders, sidescan sonars, shallow penetration sub-bottom profilers (SBPs) (e.g., "Chirp", parametric, and non-parametric SBPs), medium penetration sub-bottom profilers (e.g., sparkers and boomers), ultra-short baseline positioning equipment, and marine magnetometers. See Table 36 within section 6.5.2 for more information on the equipment listed above. An estimated 30,861 line km may be surveyed during the construction and operations phases of the Project over the 5-year duration of the ITRs; further breakdown of this total is described in the following paragraphs.

During the construction phase, an estimated 24,550 survey line km, plus in-fill and re-surveys may be necessary to survey the inter-array cables and the Sunrise Wind Export Cable in water depths ranging from 2 m (6.5 ft) to 55 m (180 ft). A maximum of 4 total vessels may be used for surveying. While the final survey plans will not be completed until construction contracting commences, on average, 70 km will be surveyed each day at 7.4 km/hour (4 knots) on a 24-hour basis, although some vessels may only operate during daylight hours (~12-hour survey vessels). While the final survey plans will not be completed until construction contracting commences, HRG surveys are anticipated to operate at any time of year for a maximum of 351 active sound source days over the 2-years of construction.

During the operations phase (a period of approximately 3 years following up to 2 years of construction anticipated to be covered by the requested incidental take regulations) an estimated 6,311 km per year may be surveyed in the Sunrise Wind Farm and along the Sunrise Wind Export Cable. Using the same estimate of 70 km of survey completed each day per vessel, approximately 90 days of survey would occur each year for a total of up to 270 active sound source days over the 3-year operations period.

1.1.6 Unexploded Ordnance/ Munitions, Explosives of Concern (UXO/MEC)

Within the SRWF there is potential for construction activities to encounter unexploded ordnances/ munitions and explosives of concern and/or (UXO/MEC) on the seabed. These include explosive munitions such as bombs, shells, mines, torpedoes, etc. that did not explode when they were originally deployed or were intentionally discarded in offshore munitions dump sites to avoid land-based detonations. The risk of incidental detonation associated with conducting seabed-altering activities such as cable laying and foundation installation in proximity to UXO/MECs jeopardizes the health and safety of project participants. Sunrise Wind follows an industry standard As Low as Reasonably Practical (ALARP) process that minimizes the number of potential detonations (COP Appendix G2, (Sunrise-Wind 2021)).

For UXO/MECs that are positively identified in proximity to planned activities on the seabed, several alternative strategies will be considered prior to in-situ UXO/MEC in place. These may include relocating the activity away from the (avoidance), moving the UXO/MEC away from the activity (lift and shift), cutting the UXO/MEC open to apportion large ammunition or deactivate fused munitions, using shaped charges to reduce the net explosive yield of a UXO/MEC (low-order detonation), or using shaped charges to ignite the explosive materials and allow them to burn at a slow rate rather than detonate instantaneously (deflagration). Only after these alternatives are considered would a decision to utilize in-situ UXO/MEC disposal. To detonate a UXO/MEC, a small charge would be placed on the UXO/MEC and detonated causing the UXO/MEC to then detonate.

While many of the munitions dump sites are mapped and can be avoided, some UXO/MECs may have migrated from those sites or are unrecorded elsewhere in the region. To better assess the potential UXO/MEC encounter risk, geophysical surveys have been and continue to be conducted to identify potential UXO/MECs that have not been previously mapped. The current estimate of the number of UXO/MECs that may need to be detonated is based on preliminary findings of historical information on UXO/MECs in the region and HRG survey data. However, potential UXO/MECs identified by HRG surveys have not yet been investigated to determine if they truly are UXO/MECs. Some that are determined to be UXO/MECs may be able to be avoided without the need for detonation, but other UXO/MECs may be encountered that have not yet been identified by the HRG surveys. As these surveys and analysis of data from them are still underway, the exact number and type of UXO/MECs in the Project Area are not yet known. Based on prior experience in other regions, the total number of potential UXO/MECs that have thus far been identified was reduced to the existing estimates using conservative assumptions of how many may actually be UXO/MECs, and how many of those may not be possible to avoid, and thus will have to be detonated. It is currently assumed that up to 3 UXO/MECs in the SRWF may have to be detonated in place and none along the SRWEC route. If all potential UXO/MECs (up to 3) require detonation, these detonations would occur on 3 different days (1 detonation per day).

1.1.7 Construction Vessel Activity

Project installation is scheduled to take place over a two-year period as seen in

Figure 6 (COP Section 3.2.2) (Sunrise-Wind 2021). The largest vessels are expected to be used during the WTG installation phase, with floating/jackup crane barges, cable-laying vessels, supply/crew vessels, and associated tugs and barges transporting construction equipment and materials. Sunrise Wind is evaluating the potential use of several existing port facilities located in New York, Connecticut, Maryland, Massachusetts, New Jersey, Rhode Island, and Virginia to support offshore construction, assembly and fabrication, crew transfer and logistics. The primary construction ports that are expected to be used during construction include: Albany and/or Coeymans, New York; Port of New London, Connecticut; and Port of Dainsville-Quonset Point, Rhode Island. Potential ports expected to be utilized by construction of the SRWF are summarized in COP Table 3.3.10-3.

Large work vessels (e.g., jack-up installation vessels and DP cable-laying vessels) for foundation and WTG installation will generally transit to the work location and remain in the area until installation time is complete. These large vessels will move slowly over a short distance between work locations. Transport vessels will travel between several ports and the SRWF over the course of the construction period following mandatory vessel speed restrictions (see Appendix C). These vessels will range in size from smaller crew transport boats to tug and barge vessels. However, construction crews responsible for assembling the WTGs will hotel onboard installation vessels at sea, thus limiting the number of crew vessel transits expected during the installation of the SRWF. Not all vessels supporting SRWF construction activities will be deployed at one time. Construction is also anticipated to take place within specified work windows, which will limit the number of vessels added to the local traffic level at once. Given the Project location relative to major commercial shipping lanes, no significant disruption to the normal traffic pattern from construction of the SRWF is expected. Overall, the projected number of vessels operating during construction of the SRWF and SRWEC is expected to result in only a small and temporary increase in vessel traffic within the region, with underwater noise expected to be similar to existing vessel-related underwater noise levels in the area. The types of vessels anticipated to be used during construction activities, as well as the anticipated number of vessels and vessel trips[3], are summarized in Table 1.

Table 1. Type and number of vessels and number of vessel trips anticipated during construction activities over the effective period of the requested ITRs.

Vessel Type	Maximum Number of Simultaneous Vessels	Maximum Number of Return Trips
Monopile Installation		
Heavy Lift Installation Vessel	2	5
Transport Barges	4	102
Transport Barge Tugs	4	102
In-Field Support tug	1	102
Vessel for Bubble Curtain	1	102
Crew Transport Vessel	1	200

[3] The anticipated number of vessels and vessel trips are considered within the Vessel Strike Avoidance Plan (Section 11.1.4). The number of vessels and trips would increase with vessel speed constraints.

Vessel Type	Maximum Number of Simultaneous Vessels	Maximum Number of Return Trips
PSO Noise Monitoring Vessel	4	102
Completions Vessel	1	102
Sound Field Verification Vessel	1	102
Fall Pipe Vessel	1	6
Turbine Installation		
Installation Vessel	1	26
Support Vessels	1	9
Array Cable Installation		
Pre-Lay Grapnel Run	1	5
Boulder Clearance Vessel	1	5
Sandwave Clearance Vessel	1	3
Cable Laying Vessel	3	3
Cable Burial Vessel	2	3
Walk to Work Vessel (SOV)	1	6
Crew Transfer Vessel (CTV)	3	18
Survey Vessel	4	8
Construction Vessel	2	4
Fall Pipe Vessel	2	10
Offshore Converter Station Installation		
Primary Installation Vessel	3	0
Transport Vessel	2	0
Support vessels	11	5
Fall Pipe Vessel	1	2
Offshore Export Cable Installation		
Pre-Lay Grapnel Run	1	1
Boulder Clearance Vessel	1	1
Sandwave Clearance Vessel	1	1
Cable Laying Vessel	3	6
Cable Burial Vessel	2	4
Tug	4	8

Vessel Type	Maximum Number of Simultaneous Vessels	Maximum Number of Return Trips
Crew Transport Vessel	3	18
Guard Vessel/Scout Vessel	5	9
Survey Vessel	2	6
Fall Pipe Vessel	1	2
Construction Vessel	2	2
All Construction Activities		
Safety Vessel	2	40
Crew Transport Vessel	3	300
Jack Up / Lift Boat	1	0
Supply Vessel	1	10
Service Operation Vessel	1	6
Helicopter	2	350

1.1.8 Helicopter Activity

Helicopters may be used during Sunrise Wind Farm construction and operation phases for crew transfer activities to provide a reduction in the overall transfer time, as well as to reduce the number of vessels on the water. Two of the closest ports to the Sunrise Wind Lease Area are the Port of Davisville-Quonset Point, Rhode Island, and the Port of New London, Connecticut. The ports are located approximately 60–70 km (32 – 38 nautical miles) from the nearest portion of the Lease Area and 90–110 km (49–59 nautical miles) from the most distant parts of the Lease Area, respectively. Assuming a vessel speed of 10 knots, a one-way trip from one of these ports by vessel would require between 3.25 and 6 hours. Typical crew transfer helicopters are capable of maximum cruising speeds of approximately 140 knots. Assuming a somewhat slower speed of 120 knots, a one-way trip by helicopter would require 16–30 minutes, thus reducing transit time by 92%.

Without the use of helicopters, all crew transfers to/from offshore locations would be conducted by vessel (either a dedicated crew transfer vessel or other project vessel transiting between a port and the offshore location). Crew transfers conducted by helicopters will reduce the number of vessel transits required for this purpose. Any reduction in the number of vessel transits during the Project will help to reduce the overall risk of ship strike with marine mammals.

Use of helicopters may be limited by many factors, such as logistical constraints (e.g., ability to land on the vessels) and weather conditions that effect flight operations. Helicopter use also adds significant health, safety and environment (HSE) risk to personnel and therefore requires substantially more crew training and additional safety procedures. These factors can result in significant limitations to helicopter usage. To maintain construction schedules and reliable wind farm operations, the necessity for crew transfer vessels and necessary over ocean transits will remain a core component of offshore wind farm construction and operations.

However, helicopters do produce sounds that could be audible to marine mammals. Sound generated by aircraft, both fixed wing and helicopters, is produced within the air, but can transmit through the water surface and propagated underwater. In general, underwater sound levels produced by fixed wing aircraft and helicopters are typically low-frequency (16-500 Hz) and range between 84-159 dB re 1 µPa (Richardson et al. 1995; Patenaude et al. 2002; Erbe et al. 2018). Most sound energy from aircraft reflects off the air-water interface; only sound radiated downward within a 26-degree cone penetrates below the surface water (Urick 1972). Aircraft noise is typically in the low- to mid-frequency ranges used by marine mammals and has therefore has the potential to cause temporary change in behavior and localized displacement of marine mammals to the extent it transmits from air through the water surface (Richardson et al. 1985a; Richardson and Würsig 1997; Nowacek et al. 2007).

Consistent with how sound from aircraft may enter the water, marine mammals tend to react to aircraft noise more often when the aircraft is lower in altitude, closer in lateral distance, and flying over shallow water (Richardson et al. 1985b; Patenaude et al. 2002). Temporary reactions by marine mammals include short surfacing, hasty dives, aversion from the aircraft or dispersal from the incoming aircraft (Bel'kovich 1960; Kleĭnenberg et al. 1964; Richardson et al. 1985a; Richardson et al. 1985b; Luksenburg and Parsons 2009). The response of cetaceans to aircraft noise largely depends on the species as well as the animal's behavioral state at the time of exposure (e.g., migrating, resting, foraging, socializing) (Würsig et al. 1998). A study conducted in the Beaufort Sea in northern Alaska observed a general lack of reaction in bowhead and beluga whales to passing helicopters (Patenaude et al. 2002). Patenaude et al. (2002) reported behavioral response by only 17% of the observed bowhead whales to passing helicopters at altitudes below 150 m and within a lateral distance of 250 m. Similarly, most observed beluga whales did not show any visible reaction to helicopters passing when flight altitudes were over 150 m (Patenaude et al. 2002). Although the sound emitted by aircraft has the potential to result in temporary behavioral responses in marine mammals, Project-related aircraft would only occur at low altitudes over water during takeoff and landing at an offshore location where one or more vessels are located. Due to the intermittent nature and the small area potentially ensonified by this sound source, the potential for disturbance of marine mammals is expected to be negligible. Thus, the use of helicopters to conduct crew transfers is likely to provide an overall benefit to marine mammals in the form reduced vessel activity and associated ship strike risk.

1.1.9 Fisheries and Benthic Monitoring

Fisheries and benthic monitoring surveys 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), which state that a fishery survey plan should aim to:

- Identify and confirm which dominant benthic, demersal, and pelagic species are using the project site, and when these species may be present where development is proposed;
- Establish a pre-construction baseline which may be used to assess whether detectable changes associated with proposed operations occurred in post-construction abundance and distribution of fisheries;
- Collect additional information aimed at reducing uncertainty associated with baseline estimates and/or to inform the interpretation of research results; and

- Develop an approach to quantify any substantial changes in the distribution and abundance of fisheries associated with proposed operations.

The Rhode Island Coastal Resources Management Council (RI CRMC) also set out monitoring guidelines as part of the Rhode Island Ocean Special Area Management Plan (Ocean SAMP; RICRMC 2010) which stipulate that RI CRMC shall work in conjunction with the Joint Agency Working Group to "determine requirements for monitoring prior to, during, and post construction." The Project's Fisheries and Benthic Monitoring Plan was developed through an iterative process, and the survey protocols and methodologies were refined and updated based on feedback received from stakeholder groups. Sunrise Wind met with numerous regulatory agencies and stakeholders during the development of this plan including NOAA/NMFS, BOEM, Rhode Island Department of Environmental Management Division of Marine Fisheries, Massachusetts Division of Marine Fisheries, Massachusetts Office of Coastal Zone Management, New York Department of Environmental Conservation, New York State Department of State, and the NYSERDA Environmental and Technical Working Groups (E-TWG and F-TWG). An additional meeting with RI CRMC and their Habitat and Fisheries Advisory Boards (HAB and FAB) will be held in Q1 2022 prior to initiation of surveys. Table 2 summarizes the survey types to be implemented per the Project's Fisheries and Benthic Monitoring Plan.

Table 2: Summary of Fisheries Monitoring Plan Survey Types and Marine Mammal Harassment Potentials

Activity/Type	Description	Potential Take Requested	Risk Assessment and Mitigation Measures
Trawl Survey	Northeast Area Monitoring and Assessment Program (NEAMAP) style trawl survey to sample fish and invertebrate community.	None	Minimal risk. Marine mammal monitoring prior to, during, and after haul-back; gear won't be deployed if marine mammals (other than dolphins and porpoises) observed in the area (see gear-specific mitigation measures below).
Acoustic Telemetry-Highly Migratory Species	Highly Migratory Species (bluefin tuna, shortfin mako sharks, and blue sharks) will be caught with rod and reel using traditional methods and will be tagged with acoustic transmitters. An existing acoustic receiver array will be expanded, and 150 acoustic transmitters will be deployed on HMS. This study will use acoustic telemetry to assess the movements of these species. Sunrise Wind will also deploy up to 100 additional acoustic tags opportunistically for cod caught as part of trawl survey.	None	Minimal risk associated with telemetry is anticipated due to this activity. Rod and reel acoustic transmitters will operate at a frequency of 69 kHz. The tag transmissions last <5 seconds and are 90-180 seconds apart. Ropeless technology (acoustic release receivers) will be utilized on the receivers to minimize risks to marine mammals. The receivers do not have a surface buoy, nor do they have a vertical line to the surface. Vessel mitigation measures within this section will be employed while collecting samples and while deploying/retrieving receivers.
Acoustic Telemetry-Sunrise Wind Export Cable	The species selected for telemetry monitoring are; American lobsters, horseshoe crabs, winter skates, sandbar sharks, sand tiger sharks, dusky sharks, and smooth dogfish. Capture and tagging of animals will occur from a variety of vessels and projects (e.g., rod and reel). Lobsters will be tagged during ride-along trips with local fishermen during their normal fishing operations (while they are operating within the fishery). Horseshoe crabs will either be tagged from the beach during the spawning season or tagged opportunistically during other planned research activities being carried out by Cornell University Cooperative Extension. A nearshore and offshore acoustic receiver array will be established and 225 acoustic transmitters per year will be deployed. This study will use acoustic telemetry to assess the movements of these species in proximity to the SRWEC.	None	Minimal risk associated with telemetry is anticipated due to this activity. Ropeless technology (acoustic release receivers) will be utilized on the receivers to minimize risks to marine mammals. Vessel mitigation measures within this section will be employed while collecting samples and while deploying/retrieving receivers.

Activity/Type	Description	Potential Take Requested	Risk Assessment and Mitigation Measures
Benthic Habitat Monitoring	Hard bottom habitat monitoring using a remotely operated vehicle (ROV) and video surveying approach to characterize changes from pre-construction conditions. Soft bottom habitat monitoring using Sediment Profile and Plan View Imaging (SPI/PV) to document physical (and biological changes. Grab samples will also be collected in NYS waters.	None	Minimal risk is anticipated due to this activity. Vessel mitigation measures described in this section will be employed while retrieving and deploying the ROV and SPI/PV and grab sampler.

Survey activities for the offshore Project Area are bound by several key mitigation measures, in addition to additional mitigations for specific gear types. All vessels will comply with the vessel speed plan outlined in the Protected Species Monitoring and Mitigation Plan (PSMMP).

In addition to speed restrictions (See Section 1.1.9.1 and PSMMP vessel strike avoidance plan), vessel operators and crews shall receive protected species identification training and maintain a vigilant watch for marine mammals and other protected species and respond with the appropriate action (e.g., change course, slow down, steer away from the animal) to avoid striking marine mammals. Vessels will maintain separation distances of 500 m for North Atlantic right whales, 100 m for other whales, and 50 m for dolphins, porpoises, seals, and sea turtles.

All attempts shall be made to remain parallel to the animal's course when a travelling marine mammal is sighted in proximity to the vessel in transit. If an animal or group of animals is sighted in the vessel's path, attempts shall be made to divert away from the animals or reduce speed and shift gears into neutral until the animal(s) have moved beyond the associated separation distance (with the exception of voluntary bow riding dolphin species). Vessels with gear in the water (e.g., trawling vessels) will scan the surrounding waters with the naked eye and range-finding binoculars and will continue visual monitoring while gear is deployed.

Effective monitoring is a key step in implementing mitigation measures and is achieved through regular marine mammal watches. Marine mammal watches and monitoring occur during daylight hours prior to deployment of gear (e.g., trawls) and will continue until gear is brought back on board. If marine mammals are sighted in the area within 15 minutes prior to deployment of gear and are considered to be at risk of interaction with the research gear, then the sampling station is either moved or canceled or the activity is suspended until there are no sightings for 15 minutes within 1 nm of sampling location. Trawl surveying will occur during daylight hours only. Although the majority of rod and reel sampling will occur during the daylight hours, it is possible for some sampling to occur during nighttime. Further monitoring and mitigations measures are described in Section 1.1.9.1.

1.1.9.1 Gear Specific Mitigation

In addition to the general measures that apply to all vessels outlined above, gear-specific measures will also be implemented to avoid the potential for interactions with MMPA species. Sunrise Wind has

reviewed the recently issued NEFSC fisheries surveys Incidental Take Rule and is implementing similar gear specific measures as applicable.

Research Trawl Survey

The following mitigation measures will be used to minimize the potential for marine mammal capture during the research trawling:

- All gear restrictions, closures, and other regulations set forth by take reduction plans (e.g., Harbor Porpoise Take Reduction Plan, Atlantic Large Take Whale Reduction Plan, etc.) will be adhered to as with typical scientific fishing operations to reduce the potential for interaction or injury. The trawl net that will be used is configured very similarly to the trawl used by the commercial fishery, with the exception of the smaller mesh that will be used throughout the net to effectively sample juvenile fish and invertebrate species;
- Marine mammal monitoring will be conducted by the captain and/or a member of the scientific crew before, during, and after haul back. Training will occur as outlined in section 3.9.1 of the PSMMP. The person carrying out the marine mammal monitoring would not have other responsibilities while they are performing the monitoring;
- Vessel strike avoidance measures as described in the PSMMP will be implemented. In particular, vessel operators and crews will receive protected species trainings (3.9.1), vessel operators and crews will maintain a vigilant watch for marine mammals (3.9.2), compliance with NARW regulations and speed restrictions (3.9.4), compliance with speed restrictions in NARW SMAs (3.9.5), and safe vessel operation practices to minimize risks to marine mammals (3.9.7, 3.9.8, and 3.9.9.);
- Trawl operations will commence as soon as possible once the vessel arrives on station; the target tow time will be limited to 20 minutes. The start of the tow will be recorded when the net is fully deployed, and the winches are locked. The end of the tow will be recorded when the winches are engaged to retrieve the net back to the vessel. Therefore, the net will be present in the water for longer than 20 minutes, but will only be actively fishing for the 20-minute tow duration;
- Sunrise Wind will initiate marine mammal watches (visual observation) 15 minutes prior to sampling within 1 nautical mile (nm) of the site;
- 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 Sunrise Wind will delay setting the trawl until marine mammals have not been resighted for 15 minutes, or Sunrise 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, Sunrise 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;
- Sunrise 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, Sunrise Wind will take the most appropriate action to avoid marine mammal interaction;
- Sunrise 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; and
- Gear will be emptied as close to the deck/sorting area and as quickly as possible after retrieval;
- Trawl nets will be fully cleaned and repaired (if damaged) before setting again.

Sunrise Wind does not anticipate and is not requesting take of marine mammals incidental to research trawl surveys but, in the case of a marine mammal interaction, the Marine Mammal Stranding Network will be contacted immediately. Any lines or trawls that go missing will be reported to the NOAA Greater Atlantic Regional Fisheries Office Protected Resources Division as soon as possible.

Vessel speed will remain below 10 knots at all phases of the Project. If a NARW is observed at any time by any scientists or vessel crew involved in the Project, during any project-related activity or during vessel transit, the scientists contracted to execute the trawl survey will immediately report sighting information to NMFS (866-755- 6622), the U.S. Coast Guard via phone or and through the WhaleAlert app (http://www.whalealert.org/).

1.2 Activities Resulting in Potential Take of Marine Mammals

Based on the planned construction activities summarized above, pile driving during WTG monopile foundation installation, OCS-DC piled jacket foundation installation, cable landfall construction, HRG surveys and potential in-situ UXO/MEC disposal may cause incidental take of marine mammals.

Impact pile driving during the Project could result in incidental take of marine mammals through the introduction of sound into the water column. When piles are driven with impact hammers, they deform, sending a bulge travelling down the pile that radiates sound into the surrounding air, water, and seabed. Thus, noise generated by impact pile driving consists of regular, pulsed sounds of short duration. This sound may be received as a direct transmission from the source to biological receivers such as marine mammals, sea turtles, and fish; through the water, as the result of reflected paths from the surface, or re-radiated into the water from the seabed. Sound transmission depends on many environmental parameters, such as the sound speeds in water and substrates, and sound production parameters of the pile and how it is driven, including the pile material, size (length, diameter, and thickness), and the type and energy of the hammer.

Studies of underwater sound from impact pile driving have found that most of the acoustic energy is below one to two kHz, with broadband sound energy near the source (40 Hz to >40 kHz) and only low-frequency energy (<400 Hz) at longer ranges (Illinworth & Rodkin 2007; Erbe 2009; Bailey et al. 2010). There is typically a decrease in sound pressure and an increase in pulse duration the greater the distance from the noise source (Bailey et al. 2010). Maximum noise levels from impact pile driving usually occur during the last stage of driving each pile where the highest hammer energy levels are used (Betke 2008).

During cable landfall construction, a pneumatic pipe rammer and/or impact hammer may be used to install and remove casing pipe while a vibratory hammer may be used to install and remove sheet piles for the goal posts. Vibratory hammering is accomplished by applying rapidly alternating (~250 Hz) forces to the pile that create non-impulsive sounds while the pneumatic pipe rammer and/or impact hammer produce pulsed sounds like an impact pile driver. Vibratory pile driving produces non-impulsive and continuous sounds with lower peak sound pressure levels (SPL_{pk}) (Guan and Miner 2020) of around 180 dB re 1 μPa or greater, generally 10 to 20 dB lower than those generated during impact pile driving (Buehler et al. 2015). Although the overall sound levels associated with vibratory hammering are typically less than impact hammering, the lower disturbance threshold (120 dB re 1 μPa SPL_{rms}) for continuous sounds means that vibratory pile driving activity will often result in a larger area ensonified above that threshold and therefore a larger number of potential takes.

Some of the sounds produced by HRG survey equipment have the potential to be audible to marine mammals (MacGillivray et al. 2014) including those with operating frequencies below 180 kHz. As noted in the previous section (Section 1.2), HRG equipment with operation frequencies below 180 kHz may cause take. HRG survey sources with operating frequencies >180 kHz are outside the hearing range of marine mammals and will not cause take (NMFS 2021m). The operating frequencies of representative HRG sound sources are shown in (Table 3). Despite generating sounds in frequencies below 180 kHz, certain characteristics of the signals produced by some HRG survey equipment mean that they are unlikely to cause takes of marine mammals (see Section 1.3). However, the frequency range and signal characteristics of sparkers, boomers, and non-parametric SBPs may cause take and are therefore assessed further in Section 6.

Table 3. Representative HRG survey equipment and operating frequencies.

Equipment Type	Representative Model	Operating Frequency
Sub-bottom Profiler	EdgeTech 216	2 – 16 kHz
	EdgeTech 424	4 – 24 kHz
	EdgeTech 512	0.7 – 12 kHz
	GeoPulse 5430A	2 – 17 kHz
	Teledyne Benthos Chirp III – TTV 170	2 – 7 kHz
Sparker	Applied Acoustics Dura-spark UHD (400 tips, 500 J)	0.3 – 1.2 kHz
Boomer	Applied Acoustics triple plate S-Boom (700-1,000 J)	0.1 – 5 kHz

Underwater detonations create broadband impulsive sounds with a high peak pressures and rapid rise times (Richardson et al. 1995). UXO/MECs with more net explosive weight will produce higher peak pressures. For example, UXO/MECs with 2.3 kg (5 lb) may produce peak pressures of ~255 dB at 10 m, while UXO/MECs of 454 kg (1,000 lb) may produce peak pressures of over 270 dB at 10 m. At close ranges, these sounds have the potential to cause non-auditory injury to marine mammals and at longer ranges, auditory injury and behavioral disturbance are possible. The unique nature of sounds and pressure into the water column from underwater detonations, including the high peak pressure levels and the fact that they are typically just a single impulsive event, means threshold criteria for UXO/MEC detonations are different than for other anthropogenic sounds. Further descriptions of those criteria are provided in Section 6.2.

To estimate the potential take of marine mammals from these activities and sound sources, acoustic propagation modeling was conducted to determine distances to relevant acoustic and non-acoustic thresholds. These threshold distances were used to calculate the area potentially ensonified above the threshold levels and then potential takes were calculated by multiplying the areas by the densities of marine mammals expected in those areas. For WTG and OCS-DC foundation installations, animal movement modeling was also performed to better understand the potential for incidental take of marine mammals. These methods are described in detail in Section 6 along with the resulting estimates of potential take. Appendix A contains a detailed description of the acoustic propagation and animal movement modeling, including modeling procedures and assumptions.

1.3 Activities Not Resulting in Potential Incidental Take of Marine Mammals

During operations, the OCS-DC will discharge NCCW and non-contact stormwater. The NCCW does not come into contact with process operations and will only be used to covey heat from the facility. Although chlorine will be used to limit biofouling during operation of the OCS-DC, the dosage will be adjusted so that it is completely consumed within the system. Raw seawater will be withdrawn through a CWIS to dissipate heat produced through the AC to DC conversion; this heated water will be discharged via a dump caisson (single outlet vertical pipe) as thermal effluent to the marine receiving waters. A very small percentage of the fish and invertebrate populations that occur in the North Atlantic are likely to be adversely affected by increased temperatures from the thermal plume. Any adverse effects would be very localized around the dump caisson, as the thermal plume is not expected to extend beyond 30 m of the dump caisson, which is well within the regulatory mixing zone of 100 m distance from the point of discharge in the receiving water. Due to the slow rate at which seawater is taken (0.1525 m/s [0.5 ft/s]), there is no risk of entrapment or entrainment to marine mammals in the Project Area. However, the seawater cooling system has potential to impact marine mammal prey through possible entrainment. Further impacts to marine mammal habitat and prey are described below in Section 9.

Routine vessel activities such as transits between ports and the SRWF and SRWEC corridor or between worksites within those areas are not anticipated to cause take of marine mammals. As part of various construction related activities, including cable laying and construction material delivery, some vessels may use DP thrusters to hold vessels in position or move slowly. Sound produced through use of DP thrusters is similar to that produced by transiting vessels and DP thrusters are typically operated either in a similarly predictable manner or used for short durations around stationary activities. Sound produced by DP thrusters would be preceded by, and associated with, sound from ongoing vessel noise and would be similar in nature; thus, any marine mammals in the vicinity of the activity would be aware of the vessel's presence, further reducing the potential for startle or flight responses on the part of marine mammals. Monitoring of past projects that entailed use of DP thrusters has shown a lack of observed marine mammal responses as a result of exposure to sound from DP thrusters (NMFS 2018b). As DP thrusters are not expected to result in take of marine mammals, these activities are not analyzed further in this document.

HRG survey sources with operating frequencies above 180 kHz, including most multi-beam echosounders and side scan sonars, are not anticipated to cause take since these frequencies are not audible to marine mammals. As noted in the previous section (Section 1.2), HRG equipment with operating frequencies below 180 kHz may cause take. However, some HRG survey equipment with operating frequencies below 180 kHz are also not anticipated to cause take. Parametric SBPs produce very narrowly focused beams of sound (0.5–3°) at relatively high frequencies that attenuate rapidly in water and are therefore not expected to cause takes of marine mammals (NMFS 2021l). Similarly, USBL systems used for high-accuracy positioning of survey equipment have previously been shown to produce extremely short distances to threshold levels under typical operating conditions so are also not expected to result in take (NMFS 2021l).

Equipment and gear used during fisheries and benthic monitoring surveys, including rod and reel and acoustic transmitters operating above 180 kHz, are not anticipated to cause take of marine mammals. Rod and reel and acoustic transmitters will be used in tagging highly migratory species and species along the SRWEC. Acoustic receiver arrays will be established where the deployment of these acoustic transmitters will be deployed. The acoustic transmitters used for tagging will operate at a frequency of 69

kHz and produce signals once every 60–120 seconds with a source level between 137–162 dB re 1 µPa SPL_{rms}). Additionally, ropeless technology (acoustic release receivers) will be utilized on the receivers to minimize risk to marine mammals. The receivers do not have a surface buoy, nor do they have a vertical line to the surface.

2 Dates, Duration, and Specified Geographic Region

2.1 Dates of Construction Activities

The overall Project construction activities including the SRWF and SRWEC will occur over approximately two to three years from fourth quarter 2023 to fourth quarter 2025. During this time, activities will occur 24 hours a day to minimize the overall duration of activities and the associated period of potential impact on marine mammals. Pile driving during nighttime hours could potentially occur. The total number of construction days will be dependent on a number of factors, including environmental conditions, planning, construction and installation logistics. The general construction schedule is provided in (Table 4). The installation schedule includes all of the major project components including those that may result in harassment takes and those that are not expected to result in any take.

In the SRWF, WTG foundations are expected to be completed within a 4–5-month period from Q3 – Q4 2024 (

Figure 6); however, pile driving to install a single WTG monopile is anticipated to last for 1-4 hours at a time. There will also be time between piling events to mobilize to the next location and prepare for the next installation. An installation date of Q3-Q4 2024 for WTG foundations is scheduled (

Figure 6). The OCS-DC foundation installation is expected to occur anytime within a 2–3-month period within Q4 2024, but the actual impact pile driving would likely occur within a 3-day period (72 hours) for the OCS-DC. It is possible both monopile and piled jacket installation will take place in Q4, including during the month of December. Installation of other project components within the SRWF include the array cable and HRG surveys, as well as potential in-situ UXO/MEC disposal. Array cable installation is expected to occur within a 7-month window, potentially in two different time periods for seafloor preparation from Q2-Q3 2024 and cable installation from Q2-Q3 2025 (

Figure 6). HRG surveys could take place within the SRWF at any time during the overall construction period from fourth quarter 2023 to fourth quarter 2025. In-situ UXO/MEC detonation may occur sometime during Q2 2024.

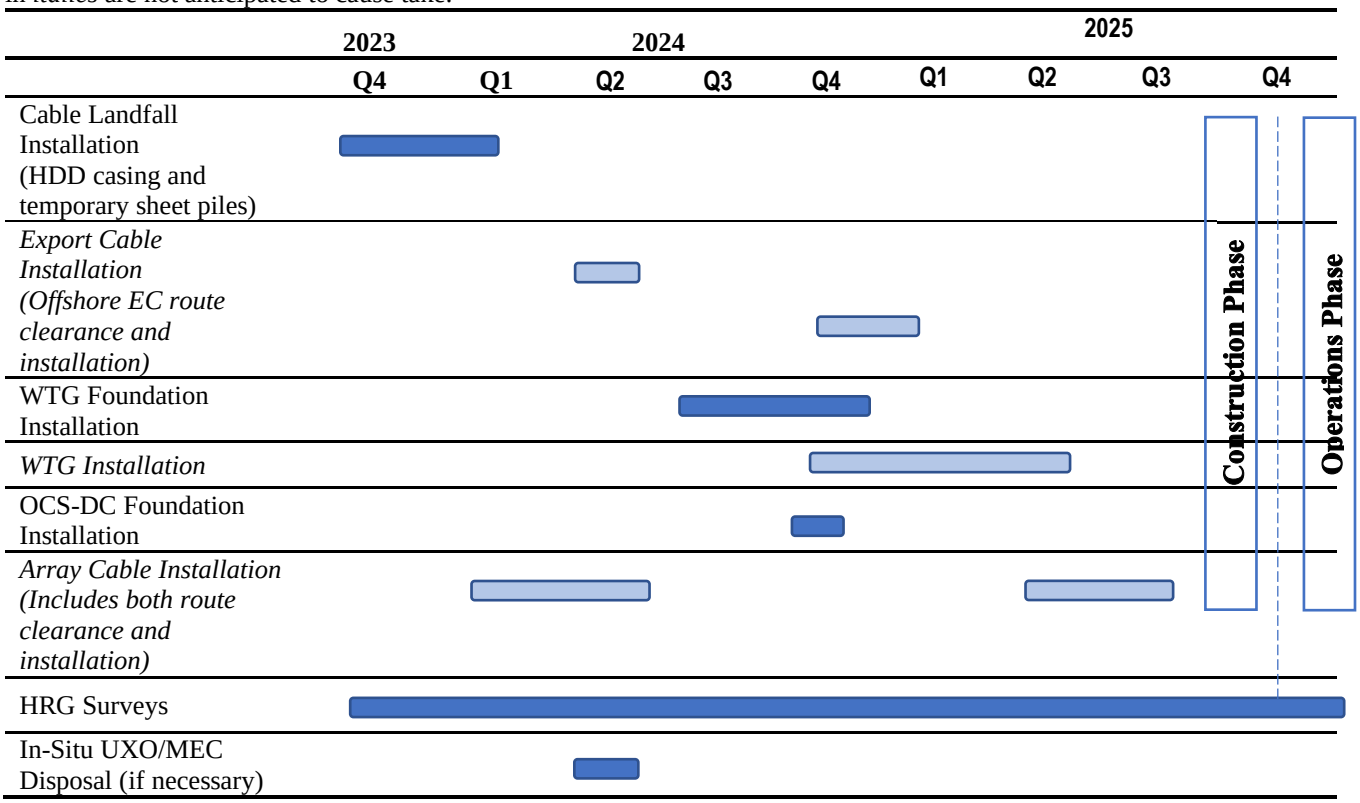
Construction activity within SRWEC area includes cable landfall installation, offshore export cable installation, and HRG surveys. Installation of the cable landfall may involve the use of a casing pipe supported by sheet pile goal posts. Installation and removal of these structures would involve the use of a vibratory pile driver and/or a pneumatic pipe ramming tool from Q4 2023 and Q1 2024; although vibratory pile driving and/or pipe ramming activities for installation and removal are only anticipated to occur on up to 26 days. Offshore export cable installation is expected to occur in two separate periods from Q3 – Q4 2024 and Q4 2024 – Q1 2025. HRG surveys could take place within the SRWEC at any time during the overall construction period from fourth quarter 2023 to fourth quarter 2025.

After construction is completed and through the end of the effective period for the requested regulations in Q3 2028, HRG surveys could take place within the SRWF and SRWEC at any time of year. However, it is anticipated that the annual amount of survey activity will be less than required during the construction phase.

Table 4. Anticipated installation schedule for the major SRWF and SRWEC project components. Project components in *italics* are not anticipated to cause take.

Project Area	Project Component	Expected Duration and Timing
SRWF Construction	OCS-DC Foundation Installation	~ 2-3 days (48-72 hours) Q4 2024
	WTG Foundation Installation	~ 4 – 5 months Q3-Q4 2024
	WTG Installation	~9 months Q4 2024 – Q2 2025
	Array Cable Installation *(Seafloor Preparation)* *(Cable Installation)*	~ 7 months Q1-Q2 2024 Q2-Q3 2025
	HRG Surveys	Any time of year Q4 2023 to Q4 2025
	In-Situ UXO/MEC Disposal	~ Up to 3 days Q2 2024
SRWEC Construction	Cable Landfall Installation (HDD casing pipe and sheet pile installation and removal)	~ Up to 32 days Q4 2023 to Q1 2024
	Offshore Export Cable Installation *(Route Clearance)* *(EC Installation)*	~ 8 months Q2 2024 Q4 2024 to Q1 2025
	HRG Surveys	Any time of year Q4 2023 to Q4 2025
Operations	HRG Surveys	Any time of year Q4 2025 to Q3 2028

Figure 6. Anticipated installation periods for the major SRWF and SRWEC project components. Project components in *italics* are not anticipated to cause take.



Construction phase switches to operations phase at the Commercial Operations Date (in Q4 2025).

2.2 Specified Geographical Region of Activity

The offshore components of the Project, including the WTGs, OCS-DC, and IAC, will be located in federal waters in the SRWF within the Lease Area OCS A-0487. The SRWEC will traverse both federal waters (SRWEC-OCS) and state territorial waters of New York (SRWEC-NYS). Refer to Figure 1 for a depiction of the SRWF and SRWEC location.

During construction, the Project will require support from temporary construction laydown yard(s) and construction port(s). The operational phase of the Project will require support from onshore O&M facilities. Sections 3.3.9.4 and 3.5.5 of the COP (Sunrise-Wind 2021) provide further detail regarding specific ports being considered and their potential usage.

3 Species and Number of Marine Mammals

3.1 Species Present

There are 40 marine mammal species and/or stocks in the Western North Atlantic OCS Region that are protected under the MMPA and whose ranges include the Northeastern U.S. region where the Project will be located (BOEM 2013, 2014b). This includes two different stocks of the common bottlenose dolphin (offshore and migratory coastal) as well as four different species of beaked whale that are often pooled together when estimating abundance. The marine mammal assemblage comprises cetaceans

(whales, dolphins, and porpoises), pinnipeds (seals), and sirenians (manatee). There are 35 cetacean species, including 29 members of the suborder Odontoceti (toothed whales, dolphins, and porpoises) and 6 of the suborder Mysticeti (baleen whales) within the region. There are four phocid species (true seals) that are known to occur in the region, including harbor seals (*Phoca vitulina*), gray seals (*Halichoerus grypus*), harp seals (*Pagophilus groenlandica*), and hooded seals (*Cystophora cristata*) (Hayes et al. 2020). Finally, one species of sirenian, the Florida manatee (*Trichechus manatus latirostris*), is an occasional visitor to the region during the summer months (USFWS 2019).

Six of the species known to occur in the Western North Atlantic are listed under the Endangered Species Act (ESA); these include the fin whale (Endangered), sei whale (Endangered), blue whale (Endangered), North Atlantic right whale (Endangered), sperm whale (Endangered), and Florida manatee (Threatened). Five of these six species, the blue whale, fin whale, sei whale, North Atlantic right whale, and sperm whale are expected to occur in the Project Area and are considered affected species. The Florida manatee is uncommon in the Project Area and is unlikely to be affected. The blue whale is uncommon in the SRWF; however, blue whale vocalizations and sighting data in the region demonstrate the possibility for the species to be present in the Project Area. The following sections provide further information regarding species behavior and expected occurrence in the Project Area.

The protection status, habitat, seasonality in the Project Area, stock identification, and abundance estimates of each marine mammal species with geographic ranges that include the Northeastern U.S. region are provided in Table 5. Abundance information was included in this table from Roberts et al. (2018; 2020) when available; however, abundance estimates were not available for all species. Table 5 evaluates the potential occurrence of marine mammals in the Project Area based on five categories defined as follows:

- **Common** – Occurring consistently in moderate to large numbers;
- **Regular** – Occurring in low to moderate numbers on a regular basis or seasonally;
- **Uncommon** – Occurring in low numbers or on an irregular basis;
- **Rare** – Records for some years but limited; and
- **Not expected** – Range includes the Project Area, but due to habitat preferences and distribution information, species are not expected to occur in the Project Area although records may exist for adjacent waters.

The expected occurrence of each species in the Project Area is based on information provided in a number of different sources including Environmental Assessments (EAs) conducted by BOEM offshore Rhode Island and New York (BOEM 2013, 2014b, 2019; Sunrise-Wind 2021); current public data sources related to marine mammals, sea turtles and ESA-listed fish (Kenney and Vigness-Raposa 2010; NYSERDA 2017; Normandeau and APM 2019a, b, c, d, 2020); regional surveys such as the Northeast Large Pelagic Survey, the Atlantic Marine Assessment Program for Protected Species (AMAPPS) (Palka et al. 2017; NMFS 2020b), the NYSDEC Whale Monitoring Program Final Comprehensive Report for aerial surveys conducted 2017-2020 (Tetra-Tech and LGL 2020), the summary report of the New York Bight Sea Turtle Workshop held in 2018 (Bonacci-Sullivan 2018), available Protected Species Observer (PSO) sighting data derived from different contractor datasets for geophysical and geotechnical surveys undertaken across the Sunrise Wind Project Area (Smultea 2020) and Bay State Wind Project Area (Smultea 2019), or the Cetacean and Turtle Assessment Program (CETAP) (CeTAP 1982; Kraus et al. 2016; Palka et al. 2017); stock information from NMFS and USFWS available for the region (Hayes et al. 2018, 2019; USFWS 2019; Hayes et al. 2020); density and other available information from published

literature (Roberts et al. 2016; Roberts et al. 2017; Roberts et al. 2018; Roberts et al. 2020, 2021). Available information was applicable to both the SRWF and SRWEC corridor.

Of the 40 marine mammal species and/or stocks within geographic ranges that include the western North Atlantic OCS, 25 are not expected to be present or are considered to be "rare" or "not expected" in the Project Area based on sighting and distribution data (Table 5). These are the 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*), short-finned pilot whale (*Globicephalus Macrohynchus*), melon-headed whale (*Peponocephala electra*), Risso's dolphin (*Grampus griseus*), Fraser's dolphin (*Lagenodelphis hosei*), white-beaked dolphin (*Lagenorhynchus albirotris*), pantropical spotted dolphin (*Stenella attenuate*), Clymene dolphin (*Stenella Clymene*), striped dolphin (*Stenella coeruleoalba*), spinner dolphin (*Stenella longirostris*), rough-toothed dolphin (*Steno bredanensis*), common bottlenose dolphin (*Tursiops truncatus*) northern migratory coastal stock, harp seal (*Pagophilus groenlandicus*), hooded seal (*Cystophora cristata*), and the Florida manatee (*Trichechus manatus latirostris*) (Kenney and Vigness-Raposa 2010; Kraus et al. 2016; Roberts et al. 2016; Roberts et al. 2017; Roberts et al. 2018; Hayes et al. 2019, 2020; Roberts et al. 2020, 2021).

Due to their limited occurrence in the Project Area, the likelihood that individuals from one of these species would be taken by harassment during the construction activities is negligible so they are not carried forward in this ITR Application.

Table 5. Marine Mammals Potentially Occurring Within the Regional Waters of the Western North Atlantic OCS and Project Area. NA means not available.

Common name; scientific name; and stock	**MMPA and ESA Status[a]**	**Relative Occurrence in the SRWF[b]**	**Relative Occurrence in the SRWEC[b]**	**Habitat[c]**	**Seasonality in Offshore Project area[b]**	**Abundance[d] (NOAA Fisheries best available)**
Mysticetes						
Blue Whale *Balaenoptera musculus musculus* Western North Atlantic Stock	ESA Endangered MMPA Depleted and Strategic	Rare	Rare offshore; Not expected nearshore	Pelagic and coastal	NA	402
Fin Whale *Balaenoptera physalus physalus* Western North Atlantic Stock	ESA Endangered MMPA Depleted and Strategic	Common	Common	Slope, pelagic	Year-round, but mainly spring and summer	6,802
Humpback Whale *Megaptera novaeangliae* Gulf of Maine Stock	MMPA Non-strategic	Common	Common	Mainly nearshore and banks	Year-round, but mainly spring and early summer (March to July)	1,396
Minke Whale *Balaenoptera acutorostrata acutorostrata* Canadian East Coast Stock	MMPA Non-Strategic	Common	Common	Coastal, shelf	Mainly spring and summer	21,968
North Atlantic Right Whale *Eubalaena glacialis* Western Atlantic Stock	ESA Endangered MMPA Depleted and Strategic	Common	Common	Coastal, shelf, offshore	Year-round, but mainly winter and spring (December-April)	368
Sei Whale *Balaenoptera borealis borealis* Nova Scotia Stock	ESA Endangered MMPA Depleted and Strategic	Regular	Regular offshore; Uncommon nearshore	Mostly pelagic	Spring and summer (March to July)	6,292
Odontocetes						
Atlantic Spotted Dolphin *Stenella frontalis* Western North Atlantic Stock	MMPA Non-strategic	Regular	Uncommon	Continental shelf, slope	Summer and fall	39,921

Table 5. Marine Mammals Potentially Occurring Within the Regional Waters of the Western North Atlantic OCS and Project Area. NA means not available.

Common name; scientific name; and stock	**MMPA and ESA Status[a]**	**Relative Occurrence in the SRWF[b]**	**Relative Occurrence in the SRWEC[b]**	**Habitat[c]**	**Seasonality in Offshore Project area[b]**	**Abundance[d] (NOAA Fisheries best available)**
Atlantic White-Sided Dolphin *Lagenorhynchus acutus* Western North Atlantic Stock	MMPA Non-strategic	Common	Common	Offshore, slope	Year-round, but more abundant in the spring and summer	93,233
Clymene Dolphin *Stenella clymene* Western North Atlantic Stock	MMPA Non-strategic	Not Expected	Not Expected	Off continental shelf	NA	4,237
Common Bottlenose Dolphin *Tursiops truncatus truncatus* Western North Atlantic Offshore Stock	MMPA Non-strategic	Common	Common	Coastal, shelf, deep	Year-round	62,851
Common Bottlenose Dolphin *Tursiops truncatus truncatus* Western North Atlantic, Northern migratory coastal	MMPA Depleted and Strategic	Rare	Rare offshore; Uncommon nearshore	Coastal, shelf, deep	Year-round	6,639
Common Dolphin *Delphinus delphis* Western North Atlantic Stock	MMPA Non-strategic	Common	Common	Shelf, pelagic	Year-round, but more abundant in summer	172,974
Cuvier's Beaked Whale *Ziphius cavirostris* Western North Atlantic Stock	MMPA Non-strategic	Rare	Rare	Pelagic	NA	21,818
Dwarf Sperm Whale *Kogia sima* Western North Atlantic Stock	MMPA Non-strategic	Rare	Rare	Deep, shelf, slope	NA	7,750
False Killer Whale *Pseudorca crassidens* Western North Atlantic Stock	MMPA Depleted and Strategic	Rare	Rare	Pelagic	NA	1,791
Fraser's Dolphin *Lagenodelphis hosei* Western North Atlantic Stock	MMPA Non-strategic	Rare	Rare	Pelagic, shelf	NA	Unknown

Table 5. Marine Mammals Potentially Occurring Within the Regional Waters of the Western North Atlantic OCS and Project Area. NA means not available.

Common name; scientific name; and stock	**MMPA and ESA Status[a]**	**Relative Occurrence in the SRWF[b]**	**Relative Occurrence in the SRWEC[b]**	**Habitat[c]**	**Seasonality in Offshore Project area[b]**	**Abundance[d] (NOAA Fisheries best available)**
Harbor Porpoise *Phocoena phocoena* Gulf of Maine/Bay of Fundy Stock	MMPA Non-strategic	Common	Common	Shelf	Year-round, but less abundant in summer	95,543
Killer Whale *Orcinus orca* Western North Atlantic Stock	MMPA Non-strategic	Rare	Rare	Widely distributed	NA	Unknown
Melon-Headed Whale *Peponocephala electra* Western North Atlantic Stock	MMPA Non-strategic	Not expected	Not expected	Pelagic	NA	Unknown
Mesoplodont Beaked Whales *Mesoplodon densitostris, M. europaeus, M. mirus, and M. bidens* Western North Atlantic Stock	MMPA Depleted and Strategic	Rare	Rare	Slope, offshore	NA	10,107[f]
Northern Bottlenose Whale *Hyperoodon ampullatus* Western North Atlantic Stock	MMPA Non-strategic	Not expected	Not expected	Deep, pelagic	NA	Unknown
Pantropical Spotted Dolphin *Stenella attenuata* Western North Atlantic Stock	MMPA Non-strategic	Rare	Rare	Pelagic, slope	NA	6,593
Pilot Whale, Long-Finned *Globicephalus melas* Western North Atlantic Stock	MMPA Depleted and Strategic	Common	Uncommon	Continental shelf edge, high relief	Year-round, with peak occurrence in the spring	39,215
Pilot Whale, Short-Finned *Globicephalus macrorhynchus* Western North Atlantic Stock	MMPA Depleted and Strategic	Rare	Rare	Pelagic, high relief	Year-round	28,924
Pygmy Killer Whale *Feresa attenuate*	MMPA Non-strategic	Not expected	Not expected	Pelagic	NA	Unknown

Table 5. Marine Mammals Potentially Occurring Within the Regional Waters of the Western North Atlantic OCS and Project Area. NA means not available.

Common name; scientific name; and stock	**MMPA and ESA Status[a]**	**Relative Occurrence in the SRWF[b]**	**Relative Occurrence in the SRWEC[b]**	**Habitat[c]**	**Seasonality in Offshore Project area[b]**	**Abundance[d] (NOAA Fisheries best available)**
Western North Atlantic Stock						
Pygmy Sperm Whale *Kogia breviceps* Western North Atlantic Stock	MMPA Non-strategic	Rare	Rare	Deep, off shelf	NA	7,750
Risso's Dolphin *Grampus griseus* Western North Atlantic Stock	MMPA Non-strategic	Rare	Rare	Shelf, slope	Year-round, but more abundant in summer	35,215
Rough Toothed Dolphin *Steno bredanensis* Western North Atlantic Stock	MMPA Non-strategic	Rare	Rare	Pelagic, nearshore	NA	136
Sperm Whale *Physeter macrocephalus* North Atlantic Stock	ESA Endangered MMPA Depleted and Strategic	Regular	Regular offshore; Uncommon nearshore	Pelagic, steep topography	Year-round, but mainly summer and fall	4,349
Spinner Dolphin *Stenella longirostris* Western North Atlantic Stock	MMPA Non-strategic	Rare	Rare	Pelagic, deep	NA	4,102
Striped Dolphin *Stenella coeruleoalba* Western North Atlantic Stock	MMPA Non-strategic	Rare	Rare	Off continental shelf	NA	67,036
White-Beaked Dolphin *Lagenorhynchus albirotris* Western North Atlantic Stock	MMPA Non-strategic	Rare	Rare	Continental shelf, offshore	NA	536,016
Pinnipeds						
Gray Seal *Halichoerus grypus atlantica* Western North Atlantic Stock	MMPA Non-strategic	Regular	Regular	Nearshore, shelf	Year-round	27,300[g]
Harbor Seal *Phoca vitulina vitulina* Western North Atlantic Stock	MMPA Non-strategic	Regular	Regular	Coastal	Year-round, with peak abundance (April to May)	61,336

Table 5. Marine Mammals Potentially Occurring Within the Regional Waters of the Western North Atlantic OCS and Project Area. NA means not available.

Common name; scientific name; and stock	**MMPA and ESA Status[a]**	**Relative Occurrence in the SRWF[b]**	**Relative Occurrence in the SRWEC[b]**	**Habitat[c]**	**Seasonality in Offshore Project area[b]**	**Abundance[d] (NOAA Fisheries best available)**
Harp Seal *Pagophilus groenlandicus* Western North Atlantic Stock	MMPA Non-strategic	Rare	Rare offshore; Uncommon nearshore	Nearshore	Spring and winter	7.6 M
Hooded Seal *Cystophora cristata* Western North Atlantic Stock	MMPA Non-strategic	Rare	Rare offshore; Uncommon nearshore	Pelagic, offshore	Spring and Winter	Unknown
Sirenian						
Florida Manatee[e] *Trichechus manatus latirostris*	ESA Threatened MMPA Depleted and Strategic	Rare	Rare	Coastal, nearshore	NA	Unknown

Endangered Species Act; MMPA = Marine Mammal Protection Act; Project Area = includes the Sunrise Wind Farm (SRWF), Sunrise Wind Export Cable (SRWEC) – Outer Continental Shelf (OCS) and SRWEC – New York State (NYS) state waters, and Onshore Facilities.

NA= Not Applicable and/or insufficient data available to determine seasonal occurrence in the offshore project area.

a. Special status accorded by the US Endangered Species Act (ESA), NMFS (Hayes et al. 2019, 2020) and Rhode Island Endangered Species Act (ESA) (RI.gov 2021).

b. Occurrence and seasonality were mainly derived from (Kenney and Vigness-Raposa 2010; Kraus et al. 2016).

c. Habitat descriptions from the 2019 Marine Mammal Stock Assessment Report (Hayes et al. 2019).

d. "Best Available" abundance estimate is from the 2019 Marine Mammal Stock Assessment Report, published by NMFS on the Federal Register on 27 November 2019 (84 FR 65353) the Final 2020 Marine Mammal Stock Assessment Report (Hayes et al. 2020); and the Draft 2021 Marine Mammal Stock Assessment Report (Hayes et al. 2021).

e. Under management jurisdiction of United States Fish and Wildlife Service rather than National Marine Fisheries Service and therefore not included in 2019 or the Draft 2020 Stock Assessment Report; currently no reliable abundance estimate is available for this population

f. Mesoplodont beaked whale abundance estimate accounts for all undifferentiated beaked whale species (not including Cuvier's beaked whale) within the Western Atlantic (Hayes et al. 2019).

g. The abundance for the gray seal does not include the Canadian portion of the stock (Hayes et al. 2021).

4 Affected Species Status and Distribution

Of the 40 marine mammal species and/or stocks with geographic ranges that include areas offshore of the Northeastern U.S., 15 species can be reasonably expected to reside, traverse, or routinely visit the Project Area in densities that could result in acoustic exposures from Proposed Activities, and therefore, be considered potentially affected species. Of the species with relative occurrence considered "not expected" or "rare" (Table 5), the likelihood of exposure is deemed low. Therefore, the species are not carried forward in the modelling analysis of this ITR Application as the chances for take are negligible. The 14 affected species, which are carried forward for further analysis include:

- Blue whale
- Fin whale;
- Sei whale;
- North Atlantic right whale;
- Minke whale;
- Humpback whale;
- Sperm whale;
- Long-finned pilot whale
- Atlantic spotted dolphin;
- Atlantic white-sided dolphin;
- Common dolphin;
- Common bottlenose dolphin;
- Harbor porpoise;
- Harbor seal; and
- Grey seal.

The following subsections summarize the information available on the life history, hearing and communication frequencies, habitat preferences, distribution, abundance, and status of marine mammals expected to occur in the Project Area and be potentially affected. The expected occurrence for each species within the SRWF area and SRWEC corridor (including both the SRWEC–OCS and SRWEC–NYS areas) was assessed separately.

4.1 Mysticetes

4.1.1 Blue Whale (Balaenoptera musculus musculus)

The blue whale is the largest cetacean, although its size range overlaps with that of fin and sei whales. Most adults of this subspecies are 23 to 27 m (75 to 90 feet in length (Jefferson et al. 2008). Blue whales feed almost exclusively on krill (Kenney and Vigness-Raposa 2010).

Blue whales are considered low-frequency cetaceans in terms of their classification in the acoustic categories assigned by NMFS for the purposes of assessment of the potential for harassment or injury arising from exposure to anthropogenic noise sources, a group whose hearing is estimated to range from 7 Hz to 35 kHz (NMFS 2018b). Peak frequencies of blue whale vocalizations range from roughly 10 to 120 Hz; an analysis of calls recorded since the 1960s indicates that the tonal frequency of blue whale calls has decreased over the past several decades (McDonald et al. 2009).

4.1.1.1 Distribution

Blue whales are found in all oceans, including at least two distinct populations inhabiting the eastern and western North Atlantic Ocean (Sears et al. 2005). Although blue whales spend most of their time in deep open ocean waters, there are summertime feeding aggregations of western North Atlantic blue whales in the Gulf of St. Lawrence, where animals target krill swarms in accessible shallow waters (McQuinn et al. 2016). Data from animals tagged in the St. Lawrence estuary indicate that blue whales use other summer feeding grounds off of Nova Scotia and Newfoundland and also feed sporadically during the winter in the Mid-Atlantic Bight, occasionally venturing to waters along or shoreward of the continental shelf break (Lesage et al. 2017; Lesage et al. 2018). Tagging studies show blue whale movements from the Gulf of St. Lawrence to North Carolina, including both on- and off-shelf waters, extending into deeper waters around the New England Seamounts (Lesage et al. 2017; Davis et al. 2020). Acoustic detections of blue whales have occurred in deep waters north of the West Indies and east of the U.S. EEZ, indicating that their southern range limit is unknown (Clark 1995; Nieukirk et al. 2004; Davis et al. 2020).

Recent deployment of passive acoustic devices in the New York Bight yielded detections of blue whales about 20 nm southeast of the entrance to New York Harbor during the months of January, February, and March (Muirhead et al. 2018). Blue whale vocalizations have been detected in the area surrounding the SRWF during acoustic surveys (Kraus et al. 2016). However, these detections could have originated at large distances from the receivers, meaning the detections in or near the Project Area do not necessarily mean presence within the Project Area. Three sightings of three individual blue whales were observed in the Project Area during the AMAPPS surveys (Palka et al. 2017). More recently, during three years of monthly area surveys in the New York Bight from 2017–2020, Zoidis et al. (2021) reported 3 sightings of 5 individuals. Additional sightings of blue whales off the coast of Virginia were recorded including a vessel sighting of a juvenile in April 2018 (Engelhaupt et al. 2019), and a sighting of an adult whale off the coast of Virginia made in February 2019 during a systematic aerial survey (Cotter 2019). The aerial sighting was recorded in deep waters beyond the shelf break, but the vessel sighting was over the shelf near the 50-m isobath. Both sightings are considered extremely rare and constitute the southernmost sightings of blue whales off the U.S. east coast in the U.S. EEZ.

4.1.1.2 Abundance

The current minimum estimate of the western North Atlantic population, based on photo-identification efforts in the St. Lawrence estuary and the northwestern Gulf of St. Lawrence, is 402 animals (Sears and Calambokidis 2002; Ramp and Sears 2013; Hayes et al. 2020). This work led to a suggestion that between 400–600 individuals may be found in the western North Atlantic (Hayes et al. 2020).

4.1.1.3 Status

The blue whale is listed as Endangered under the ESA and the western North Atlantic stock of blue whales is considered Strategic and Depleted under the MMPA. Human induced threats to blue whales include entanglement in fishing gear, ship-strikes, pollution, and disruptions of pelagic food webs in response to changes in ocean temperatures and circulation processes (Hayes et al. 2020). There is no designated critical habitat for this species within the proposed survey area (Hayes et al. 2020).

4.1.2 Fin Whale (Balaenoptera physalus)

Fin Whales are the second largest species of baleen whale in the Northern Hemisphere (NMFS 2021c), with a maximum length of about 22.8 m (75 ft). These whales have a sleek, streamlined body with a V-shaped head that makes them fast swimmers. This species has a distinctive coloration pattern: the dorsal and lateral sides of the body are black or dark brownish-gray, and the ventral surface is white. The lower jaw is dark on the left side and white on the right side. Fin whales feed on krill (*Euphausiacea*), small schooling fish (e.g., Herring [*Clupea harengus*], Capelin [*Mallotus villosus*], Sand Lance [*Ammodytidae spp*.]), and squid (*Teuthida spp*.) by lunging into schools of prey with their mouths open (Kenney and Vigness-Raposa 2010).

Fin whales produce characteristic vocalizations that can be distinguished during passive acoustic monitoring (PAM) surveys (BOEM 2013; Erbe et al. 2017). The most commonly observed calls are the "20-Hz signals," a short down sweep falling from 30 to 15 Hz over a 1-sec period. Fin whales can also produce higher frequency sounds up to 310 Hz, and SLs as high as 195 dB re 1 μPa @ 1 m SPL_{rms} have been reported, making it one of the most powerful biological sounds in the ocean (Erbe et al. 2017). Anatomical modeling based on fin whale ear morphology suggests their greatest hearing sensitivity is between 20 Hz and 20 kHz (Cranford and Krysl 2015; Southall et al. 2019)

4.1.2.1 Distribution

Fin whales have a wide distribution and can be found in the Atlantic and Pacific Oceans in both the Northern and Southern Hemisphere (Hayes et al. 2020). The population is divided by ocean basins; however, these boundaries are arbitrary as they are based on historical whaling patterns rather than biological evidence (Hayes et al. 2020). Fin Whales off the eastern US, Nova Scotia, and the southeastern coast of Newfoundland are believed to constitute a single stock under the present International Whaling Commission (IWC) management scheme (Donovan 1991), which has been called the Western North Atlantic stock.

Fin whales transit between summer feeding grounds in the high latitudes and the wintering, calving, or mating habitats in low latitudes or offshore. However, acoustic records indicate that fin whale populations may be less migratory than other mysticetes whose populations make distinct annual migrations (Watkins et al. 2000). Fin whales typically feed in New England waters on fishes (e.g., sea lance, capelin, herring), krill, copepods, and squid in deeper waters near the edge of the continental shelf (90 to 180 m [295 to 591 ft]) but will migrate towards coastal areas following prey distribution. However, fin whales' habitat use has shifted in the southern Gulf of Maine, most likely due to changes in the abundance of sand lance and herring, both of which are prey for the fin whale (Vigness-Raposa et al. 2010). While fin whales typically feed in the Gulf of Maine and the waters surrounding New England, mating and calving (and general wintering) areas remain largely unknown (Hayes et al. 2020). Between October 2018 and February 2021, there were 24 sightings of 26 individual fin whales recorded during HRG and geotechnical (GT) surveys conducted within the area surrounding the Sunrise Wind Farm and Sunrise Wind Export Cable (AIS-Inc. 2019; Bennett 2021; Stevens et al. 2021; Stevens and Mills 2021).

SRWF and SRWEC

Fin whales have a documented presence within the New York Offshore Planning Area (OPA), per the NYSERDA Digital Aerial Baseline Surveys conducted from Summer 2016 through Winter 2019 (Normandeau and APM 2019a, b, c, d, 2020). Fin whales sighted within the New York Offshore Planning Area (OPA) occurred relatively uniformly during all four seasons with the highest number documented in

Summer 2016 (137 individuals). Similarly, during the NYSDEC Whale Monitoring Program aerial surveys conducted from 2017-2020, 207 estimated individual fin whales were sighted within the New York Bight (Tetra-Tech and LGL 2020). These sightings occurred year-round with a higher prevalence in spring and summer months, within a wide geographical area ranging from nearshore to the continental shelf edge and beyond.

Two well-known feeding grounds for fin whales are present near the SRWF. These include the Great South Channel and Jeffrey's Ledge and waters directly east of Montauk, NY (Kenney and Vigness-Raposa 2010; NMFS 2019). The highest occurrences of fin whales in this region are identified south of Montauk Point, NY to south of Nantucket, MA (Kenney and Vigness-Raposa 2010). Surveys conducted in the RI-MA and MA WEAs indicate that fin whale sightings are highest during spring and summer. During Project-specific geotechnical surveys from November 2019 to March 2020 (Smultea 2020), three estimated individuals were detected inside the SRWF, and one estimated individual was detected outside the SRWF area.

Although fin whale sightings are greatest in spring and summer, they are known to occur in all four seasons in inner shelf waters (Kenney and Winn 1986; Kenney and Vigness-Raposa 2010). Fin whales are typically centered along the 100-m (328-ft) isobath off the US East Coast, but sightings have occurred in both shallower and deeper waters. Fin whales are common in New York state waters and adjacent OCS waters in this area, and aggregations of fin whales are often reported between Block Island, RI and Montauk Point, NY (Sadove and Cardinale 1993; Kenney and Vigness-Raposa 2010). Therefore, it is highly likely that fin whales will be present within the SRWEC corridor.

4.1.2.2 *Abundance*

The best abundance estimate available for the Western North Atlantic stock is 6,802 based on data from NOAA shipboard and aerial surveys and the 2016 NEFSC and Department of Fisheries and Oceans Canada (DFO) surveys (Hayes et al. 2020) A population trend analysis does not currently exist for this species because of insufficient data; however, based on photographic identification, the gross annual reproduction rate is 8% with a mean calving interval of 2.7 years (Agler et al. 1993; Hayes et al. 2020).

4.1.2.3 *Status*

Fin whales are listed as Endangered under the ESA and are listed as Vulnerable by the International Union for Conservation of Nature (IUCN) Red List (Hayes et al. 2020; IUCN 2020). This stock is listed as strategic and depleted under the MMPA due to its Endangered status (Hayes et al. 2020). Potential Biological Removal (PBR) for the western North Atlantic fin whale is 11 (Hayes et al. 2020). PBR being the product of minimum population size, one-half the maximum net productivity rate and recovery factor for endangered, depleted, threatened, or stocks of unknown status relative to the optimal sustainable population (OSP) (Hayes et al. 2020). Annual human-caused mortality and serious injury for the period between 2015 and 2019 was estimated to be 1.8 per year (Hayes et al. 2021). This estimate includes incidental fishery interactions (i.e., bycatch/entanglement) and vessel collisions, but other threats to fin whales include contaminants in their habitat and potential climate-related shifts in distribution of prey species (Hayes et al. 2020). There is no designated critical habitat for this species in or near the Project Area.

4.1.3 Sei Whale (Balaenoptera borealis)

Sei Whales are a baleen whale that can reach lengths of about 12–18 m (40–60 ft) (NMFS 2021j). This species has a long, sleek body that is dark bluish gray to black in color and pale underneath (NMFS 2021j). Their diet is comprised primarily of plankton, schooling fish, and cephalopods. Sei whales generally travel in small groups (two to five individuals), but larger groups are observed on feeding grounds (NMFS 2021j).

Although uncertainties still exist with distinguishing sei whale vocalizations during PAM surveys, they are known to produce short duration (0.7 to 2.2 sec) upsweeps and downsweeps between 20 and 600 Hz. SLs for these calls can range from 147 to 183 dB re 1 µPa @ 1 m SPL_{rms} (Erbe et al. 2017). No auditory sensitivity data are available for this species (Southall et al. 2019) but they are categorized as in the low-frequency cetacean hearing group.

4.1.3.1 Distribution

Sei whales occur in all the world's oceans and migrate between feeding grounds in temperate and sub-polar regions to wintering grounds in lower latitudes (Kenney and Vigness-Raposa 2010; Hayes et al. 2020). In the Western North Atlantic, most of the population is concentrated in northerly waters along the Scotian Shelf (Davis et al. 2020). Sei whales are observed in the spring and summer, utilizing the northern portions of the U.S. Atlantic Exclusive Economic Zone (EEZ) as feeding grounds, including the Gulf of Maine and Georges Bank. The highest concentration is observed during the spring along the eastern margin of Georges Bank and in the Northeast Channel area along the southwestern edge of Georges Bank.

Passive acoustic monitoring (PAM) conducted along the Atlantic Continental Shelf and Slope in 2004-2014 detected sei whales calls from south of Cape Hatteras to the Davis Strait with evidence of distinct seasonal and geographic patterns. Davis et al. (2020) detected peak call occurrence in northern latitudes during summer indicating feeding grounds ranging from Southern New England (SNE) through the Scotian Shelf. Sei whales were recorded in the southeast on Blake's Plateau in the winter months, but only on the offshore recorders indicating a more pelagic distribution in this region. Persistent year-round detections in Southern New England and the New York Bight highlight this as an important region for the species (Hayes et al. 2021). In general, sei whales are observed offshore with periodic incursions into more shallow waters for foraging (Hayes et al. 2020). Between October 2018 and February 2021, there was 1 sighting of 1 individual sei whales recorded during HRG and GT surveys conducted within the area surrounding the Sunrise Wind Farm and Sunrise Wind Export Cable all recorded in May 2020 (AIS-Inc. 2019; Stevens et al. 2021; Stevens and Mills 2021).

SRWF and SRWEC

Sei whales have a documented presence within the New York OPA, per the NYSERDA Digital Aerial Baseline Surveys conducted from Summer 2016 through Winter 2019 (Normandeau and APM 2019a, b, c, d, 2020). Sei whales sighted within the New York OPA occurred most often during spring and summer months with the highest number documented in Spring 2018 (84 individuals). Similarly, during the NYSDEC Whale Monitoring Program aerial surveys conducted from 2017-2020, seven estimated individual sei whales were sighted within the New York Bight (Tetra-Tech and LGL 2020). These sightings occurred exclusively during the spring within deeper waters along the continental shelf edge.

CETAP surveys observed sei whales along the OCS edge only during spring (237 sightings) and summer (101 sightings) (CeTAP 1982). Similarly, the Kraus et al. (2016) study reported sei whales only within the RI-MA and MA WEAs during spring (8 individuals) and summer (13 individuals). No sightings were reported during fall and winter (Kraus et al. 2016).

A small cluster of five individual sei whales were reported south of Montauk Point, NY and Block Island, RI in July 1981, August 1982, and May 2003 (Kenney and Vigness-Raposa 2010). Additionally, sei whales are associated with the deeper waters along the continental shelf edge and are observed in shallower waters when foraging (Hayes et al. 2019). In spring and summer, sei whales are seen in feeding habitats in Nova Scotia and Cape Cod north of the SRWEC corridor (Hayes et al. 2019). Therefore, sei whales are expected to be present seasonally in the SRWF, primarily in the spring and summer. Sei whales have occasionally been reported feeding in association with fin whales along Long Island in July and August (Sadove and Cardinale 1993). Sei whales are therefore unlikely to be encountered in shallower waters along the SRWEC corridor.

4.1.3.2 Abundance

Prior to 1999, sei whales in the Western North Atlantic were considered a single stock. Following the suggestion of the Scientific Committee of the International Whaling Commission (IWC), two separate stocks were identified for this species: a Nova Scotia stock and a Labrador Sea stock. Only the Nova Scotia stock can be found in U.S. waters, and the current abundance estimate for this population is 6,292 derived from recent surveys conducted between Halifax, Nova Scotia and Florida (Hayes et al. 2020). Population trends are not available for this stock because of insufficient data (Hayes et al. 2020).

4.1.3.3 Status

Sei whales are listed as Endangered under the ESA and by the IUCN Red List (Hayes et al. 2020; IUCN 2020). This stock is listed as strategic and depleted under the MMPA due to its Endangered status (Hayes et al. 2020). Annual human-caused mortality and serious injury from 2015 to 2019 was estimated to be 0.8 per year (Hayes et al. 2021). The PBR for this stock is 6.2 (Hayes et al. 2020). Like fin whales, major threats to sei whales include fishery interactions, vessel collisions, contaminants, and climate-related shifts in prey species (Hayes et al. 2020). There is no designated critical habitat for this species in or near the Project Area.

4.1.4 North Atlantic Right Whale (Eubalaena glacialis)

NARWs are among the rarest of all marine mammal species in the Atlantic Ocean. They average approximately 15 m (50 ft) in length (NMFS 2021i). They have stocky, black bodies with no dorsal fin, and bumpy, coarse patches of skin on their heads called callosities. NARWs feed mostly on zooplankton and copepods belonging to the *Calanus* and *Pseudocalanus* genera (Hayes et al. 2020). NARWs are slow-moving grazers that feed on dense concentrations of prey at or below the water's surface, as well as at depth (NMFS 2021i). Research suggests that NARWs must locate and exploit extremely dense patches of zooplankton to feed efficiently (Mayo and Marx 1990). These dense zooplankton patches are a primary characteristic of the spring, summer, and fall NARW habitats (Kenney et al. 1995). NARWs are usually observed in groups of less than 12 individuals, and most often as single individuals or pairs. Larger groups may be observed in feeding or breeding areas (Jefferson et al. 2008).

NARW vocalizations most frequently observed during PAM studies include upsweeps rising from 30 to 450 Hz, often referred to as "upcalls," and broadband (30 to 8,400 Hz) pulses, or "gunshots," with

SLs between 172 and 187 dB re 1 µPa @ 1 m SPL_{rms} (Erbe et al. 2017). However, recent studies have shown that mother-calf pairs reduce the amplitude of their calls in the calving grounds, possibly to avoid detection by predators (Parks et al. 2019). Modeling conducted using right whale ear morphology suggest that the best hearing sensitivity for this species is between 16 Hz and 25 kHz (Ketten et al. 2014; Southall et al. 2019).

4.1.4.1 Distribution

The NARW is a migratory species that travels from high-latitude feeding waters to low-latitude calving and breeding grounds, though this species has been observed feeding in winter in the mid-Atlantic region and has been recorded off the coast of New Jersey in all months of the year (Whitt et al. 2013). These whales undertake a seasonal migration from their northeast feeding grounds (generally spring, summer, and fall habitats) south along the US east coast to their calving grounds in the waters of the southeastern US (Kenney and Vigness-Raposa 2010).

NARWs are considered to be comprised of two separate stocks: Eastern and Western Atlantic stocks. The Eastern North Atlantic stock was largely extirpated by historical whaling (Aguilar 1986). NARWs in US waters belong to the Western Atlantic stock. This stock ranges primarily from calving grounds in coastal waters of the southeastern US to feeding grounds in New England waters and the Canadian Bay of Fundy, Scotian Shelf, and Gulf of St. Lawrence (Hayes et al. 2018). Since 2010, NARWs have been declining in and around once key habitats in the Gulf of Maine and the Bay of Fundy (Davies et al. 2015; Davis et al. 2017), while sightings have increased in other areas including Cape Cod Bay, Massachusetts Bay, the Mid-Atlantic Bight, and the Gulf of St. Lawrence (Whitt et al. 2013; Davis et al. 2017; Mayo et al. 2018; Davies and Brillant 2019; Ganley et al. 2019; Charif et al. 2020). An 8-year analysis of NARW sightings within SNE show that the NARW distribution has been shifting (Quintana-Rizzo et al. 2021). The study area of SNE (shores of Martha's Vineyard and Nantucket to and covering all the offshore wind lease sites of Massachusetts and Rhode Island) recorded sightings of NARWs in almost all months of the year with the highest sighting rates occurring during winter months into early spring (Quintana-Rizzo et al. 2021).

With the exception of some known hot spots such as the calving grounds in the SE Atlantic and Cape Cod Bay, the winter distribution of NARWs is not well understood; however, between October 2018 and February 2021, during recent HRG and GT surveys within the area surrounding the Sunrise Wind Farm and Sunrise Wind Export Cable, 4 sightings of 4 individual NARWs were recorded in November 2020 and January 2021 (AIS-Inc. 2019; Bennett 2021; Stevens et al. 2021; Stevens and Mills 2021). Some evidence provided through acoustic monitoring suggests that not all individuals of the population participate in annual migrations, with a continuous presence of NARWs occupying their entire habitat rage throughout the year, particularly north of Cape Hatteras (Davis et al. 2017). These data also recognize changes in population distribution throughout the NARW habitat range that could be due to environmental or anthropogenic effects, a response to short-term changes in the environment, or a longer-term shift in the NARW distribution cycle (Davis et al. 2017). A climate-driven shift in the Gulf of Maine/western Scotian Shelf region occurred in 2010 and impacted the foraging environment, habitat use, and demography of the NARW population (Meyer-Gutbrod et al. 2021). In 2010, the number of NARWs returning to the traditional summertime foraging grounds in the eastern Gulf of Maine/Bay of Fundy region began to decline rapidly (Davies et al. 2019; Davies and Brillant 2019; Record et al. 2019). Despite considerable survey effort, the location of most of the population during the 2010-2014 foraging seasons are largely unknown; however, sporadic sightings and acoustic detections in Canadian waters suggest a

dispersed distribution (Davies et al. 2019) and a significant increase in the presence of whales in the southern Gulf of St. Lawrence beginning in 2015 (Simard et al. 2019).

Surveys demonstrate the existence of seven areas where NARWs congregate seasonally: the coastal waters of the southeastern US, the Great South Channel, Jordan Basin, Georges Basin along the northeastern edge of Georges Bank, Cape Cod and Massachusetts Bays, the Bay of Fundy, and the Roseway Basin on the Scotian Shelf (Hayes et al. 2018). National Oceanic and Atmospheric Administration (NOAA) Fisheries has designated two critical habitat areas for the NARW under the ESA: the Gulf of Maine/Georges Bank region, and the southeast calving grounds from North Carolina to Florida (DoC 2016). Two additional critical habitat areas in Canadian waters, Grand Manan Basin and Roseway Basin, were identified in Canada's final recovery strategy for the NARW (Brown et al. 2009).

SRWF and SRWEC

North Atlantic right whales are known to occur within both New York and Rhode Island state and adjacent OCS waters year-round, although primarily in the winter and spring. During the NYSDEC Whale Monitoring Program aerial surveys conducted from 2017-2020, 24 estimated individual North Atlantic right whales were sighted within the New York Bight (Tetra-Tech and LGL 2020). These sightings occurred in the fall, winter, and spring seasons just outside New York state waters in federal, offshore waters extending out to the continental shelf edge. The North Atlantic right whale has a documented presence within the New York OPA as well, per the NYSERDA Digital Aerial Baseline Surveys conducted from Summer 2016 through Winter 2019 (Normandeau and APM 2019a, b, c, d, 2020). North Atlantic right whales sighted within the New York OPA occurred most often in the spring and winter months, with the highest number documented in Winter 2016 and 2017 (44 individuals). Kraus et al. (2016) observed North Atlantic right whales in the RI-MA and MA WEAs during winter and spring. However, the North Atlantic right whale has the potential to occur within the waters off Rhode Island and Massachusetts any time of the year. Typically, right whale sightings begin in December and continue through April. A total of 77 individuals was sighted in the WEAs from October 2011 to June 2015. The greatest numbers are seen in March. The Muskeget Channel and south of Nantucket, both located within the RI-MA and MA WEAs, were also identified as right whale hotspots during spring (Kraus et al. 2016).

The Gulf of Maine has been designated as a critical habitat area; therefore, they may migrate through the SRWEC corridor and SRWF as they travel to this feeding habitat. Kraus et al. (2016) reported a seasonal cluster of right whales south of Martha's Vineyard, MA and east of Nantucket, MA during winter. Right whales have been observed along Long Island, primarily by whale-watching vessels originating from Montauk.

During Project-specific HRG surveys from 2019 to 2020 (Smultea 2020), no individuals were detected inside the SRWF, but two estimated individuals were detected outside the SRWF. The SRWF will also overlap with the designated Block Island SMA as previously mentioned. Therefore, right whales are likely to occur within the SRWF and SRWEC corridor.

4.1.4.2 Abundance

The Western North Atlantic population size was estimated to be 368 individuals in the most recent Draft 2021 SAR, which used data from the photo-identification database maintained by the New England Aquarium that were available in October 2019 (Hayes et al. 2020, 2021). The Right Whale Consortium 2020 Report Card estimates the NARW population to be 368 individuals as well (Pettis et al. 2021). A population trend analysis conducted on the abundance estimates from 1990 to 2011 suggest an increase at

about 2.8% per year from an initial abundance estimate of 270 individuals in 1998 (Hayes et al. 2020). However, modeling conducted by Pace et al. (2021) showed a decline in annual abundance after 2011, which has likely continued as evidenced by the decrease in the abundance estimate from 451 in 2018 (Hayes et al. 2019) to 412 in 2020 (Hayes et al. 2020). Highly variable data exists regarding the productivity of this stock. Over time, there have been periodic swings of per capita birth rates (Hayes et al. 2020). Net productivity rates do not exist as the Western North Atlantic stock lacks any definitive population trend (Hayes et al. 2020).

4.1.4.3 Status

The NARW is listed as Endangered under the ESA and are listed as Critically Endangered by the IUCN Red List (Hayes et al. 2020; IUCN 2020; RI-DEM 2020). NARWs are considered to be the most critically Endangered large whales in the world (Hayes et al. 2019). The average annual human-related mortality/injury rate exceeds that of the calculated PBR of 0.7, classifying this population as strategic and depleted under the MMPA (Hayes et al. 2021). Estimated human-caused mortality and serious injury between 2015 and 2019 was 7.7 whales per year (Hayes et al. 2021). Using refined methods of Pettis et al. (2021), the estimated annual rate of total mortality for the period of 2014-2018 was 27.4, which is 3.4 times larger than the 8.15 total derived from reported mortality and serious injury for the same period (Hayes et al. 2021).

The predominant threats to NARWs are entanglement and vessel collisions. Available data from 2000 to 2017 suggest an increase in the percent of injuries and mortalities (per capita) caused by entanglement (Hayes et al. 2020). There have been elevated numbers of mortalities reported since 2017 and continuing to through 2022 totaling 34 dead NARWs which prompted NMFS to designate an Unusual Mortality Event (UME) for NARWs (NMFS 2022c). This includes 21 dead stranded whales in Canada and 13 in the United States (NMFS 2022c). The leading category for the cause of death for this UME is “human interaction”, specifically from entanglements or vessel strikes (NMFS 2022c). Additionally, since 2017, 16 live free-swimming non-stranded whales have been documented with serious injuries from entanglements or vessel strikes. In addition to the documented mortalities, since 2017, seventeen individuals have been documented with serious injury resulting from entanglement and two have been reported with serious injury resulting from a vessel strike (NMFS 2022c).

To protect this species from ship strikes, NOAA Fisheries designated SMAs in US waters in 2008 (73 FR 60173 2008). The SRWF and SRWEC will cross the Block Island SMA (NMFS 2020d). All vessels greater than 19.8 m (65 ft) in overall length must operate at speeds of 10 knots (5.1 meters per second [m/s]) or less within these areas from November 1 through April 30 when NARWs are most likely to pass through these waters (NMFS 2020e). In addition, the rule provides for the establishment of Dynamic Management Areas (DMAs) when and where NARWs are sighted outside SMAs. DMAs are generally in effect for two weeks and the 10 knots (5.1 m/s) or less speed restriction is voluntary (NMFS 2020e).

4.1.5 Minke Whale (Balaenoptera acutorostrata)

Minke whales are a baleen whale species reaching 10 m (35 ft) in length. The minke whale is common and widely distributed within the US Atlantic EEZ and is the third most abundant great whale (any of the larger marine mammals of the order Cetacea) in the EEZ (CeTAP 1982). A prominent morphological feature of the minke whale is the large, pointed median ridge on top of the rostrum. The body is dark gray to black with a pale belly, and frequently shows pale areas on the sides that may extend

up onto the back. The flippers are smooth and taper to a point, and the middle third of each flipper has a conspicuous bright white band that can be distinguished during visual surveys (Kenney and Vigness-Raposa 2010). Its diet is comprised primarily of crustaceans, schooling fish, and copepods. Minke Whales generally travel in small groups (one to three individuals), but larger groups have been observed on feeding grounds (NMFS 2021h).

In the North Atlantic, minke whales commonly produce pulse trains lasting 10 to 70 sec with a frequency range between 10 and 800 Hz. SLs for this call type have been reported between 159 and 176 dB re 1 μPa @ 1 ^{m} SPL_{rms} (Erbe et al. 2017). Some minke whales also produce a unique "boing" sound which is a train of rapid pulses often described as an initial pulse followed by an undulating tonal (Rankin and Barlow 2005; Erbe et al. 2017). The "boing" ranges from 1 to 5 kHz with an SLs of approximately 150 dB re 1 μPa @ 1 m SPL_{rms} (Rankin and Barlow 2005; Erbe et al. 2017). Auditory sensitivity for this species based on anatomical modeling of minke whale ear morphology is best between 10 Hz and 34 kHz (Ketten et al. 2014; Southall et al. 2019).

4.1.5.1 *Distribution*

Minke whales prefer the colder waters in northern and southern latitudes, but they can be found in every ocean in the world. Available data suggest that minke whales are distributed in shallower waters along the continental shelf between the spring and fall and are located in deeper oceanic waters between the winter and spring (Hayes et al. 2020). They are most abundant in New England waters in the spring, summer, and early fall (Hayes et al. 2020). Acoustic detections show that minke whales migrate sound in mid-October to early November and return from wintering grounds starting in March through early April (Risch et al. 2014b). Between October 2018 and February 2021, there were 13 sightings of 16 individual minke whales recorded during Recent HRG and GT surveys within the area surrounding the SWRF and SRWEC (AIS-Inc. 2019; Bennett 2021; Stevens and Mills 2021).

SRWF and SRWEC

Minke whales have a documented presence within the New York OPA, per the NYSERDA Digital Aerial Baseline Surveys conducted from Summer 2016 through Winter 2019 (Normandeau and APM 2019a, b, c, d, 2020). Minke whales sighted within the New York OPA occurred most often in the spring and winter months, but they were sighted relatively uniformly during all four seasons with the highest number documented Spring 2018 (112 individuals). During previous studies conducted in the RI-MA and MA WEAs, 103 minke whales were sighted within the area (Kraus et al. 2016). Minke whales are almost absent from OCS waters off the western Atlantic in winter; however, they were common in the fall and abundant in spring and summer (CeTAP 1982; Kenney and Vigness-Raposa 2010). Spring observations included the most individuals (76 sightings) followed by summer (26 sightings) and fall (1 sighting) (Kraus et al. 2016).

Minke whales have been sighted offshore New York in both state and OCS waters in all four seasons (Kenney and Vigness-Raposa 2010). Based on sighting data, the minke whale is the second most abundant mysticete in the New York Bight. It is found regularly near the coast and occasionally in the Peconic Estuary, the Long Island Sound, and the Great South Bay (Sadove and Cardinale 1993). A large proportion of these sightings were reported from whale-watching boats. A dense concentration was seen between Block Island, RI and Montauk Point, NY in spring and summer (Kenney and Vigness-Raposa 2010). Therefore, minke whales expected to be common in spring and summer within the SRWF and SRWEC corridor.

4.1.5.2 Abundance

The best available current global abundance estimates for the common minke whale, compiled by the IUCN Red List, is around 200,000 (Graham and Cooke 2008). The most recent population estimate for the Canadian East Coast stock which occurs in the Project Area is 21,968 minke whales, derived from surveys conducted by NOAA and the Department of Fisheries and Oceans Canada between Labrador and central Virginia (Hayes et al. 2020). There are no current population trends or net productivity rates for this species due to insufficient data.

4.1.5.3 Status

Minke whales are not listed under the ESA or classified as strategic under the MMPA. They are list as Least Concern on the IUCN Red List (Hayes et al. 2020; IUCN 2020). The estimated annual human-caused mortality and serious injury from 2014 to 2018 was 10.55 per year attributed to fishery interactions, vessel strikes, and non-fishery entanglement in both the U.S. and Canada (Hayes et al. 2020), and a UME was declared for this species in January 2017, which is ongoing (NMFS 2022b). As of October 2021, a total of 118 strandings have been reported, with 9 occurring in Rhode Island and 18 occurring in New York (NMFS, 2021). The PBR for this stock is estimated to be 170 (Hayes et al. 2020). Minke whales may also be vulnerable to climate-related changes in prey distribution, although the extent of this effect on minke whales remains uncertain (Hayes et al. 2020). No designated critical habitat for this stock currently exists in the Project Area.

4.1.6 Humpback Whale (Megaptera novaengilae)

Humpback whale females are larger than males and can reach lengths of up to 18 m (60 ft) (NMFS 2021f). Humpback Whale body coloration is primarily dark gray, but individuals have a variable amount of white on their pectoral fins, belly, and flukes. These distinct coloration patterns are used by scientists to identify individuals. These baleen whales feed on small prey often found in large concentrations, including krill and fish such as Herring and Sand Lance (Kenney and Vigness-Raposa 2010). Humpback whales use unique behaviors, including bubble nets, bubble clouds, and flicking of their flukes and fins, to herd and capture prey (NMFS 1991).

During migration and breeding seasons, male humpback whales are often recorded producing vocalizations arranged into repetitive sequences termed “songs” that can last for hours or even days. These songs have been well studied in the literature to document changes over time and geographic differences. Generally, the frequencies produced during these songs range from 20 Hz to over 24 kHz. Most of the energy is focused between 50 and 1,000 Hz and reported SLs range from 151 to 189 dB re 1 µPa @ 1 m SPL_{rms} (Erbe et al. 2017). Other calls produced by humpbacks, both male and female, include pulses, moans, and grunts used for foraging and communication. These calls are lower frequency (under 2 kHz) with SLs ranging from 162 to 190 dB re 1 µPa @ 1 m SPL_{rms} (Thompson et al. 1986; Erbe et al. 2017). Anatomical modeling based on humpback whale ear morphology indicate that their best hearing sensitivity is between 18 Hz and 15 kHz (Ketten et al. 2014; Southall et al. 2019).

4.1.6.1 Distribution

The humpback whale can be found worldwide in all major oceans from the equator to sub-polar latitudes. Humpback whales exhibit consistent fidelity to feeding areas within the northern hemisphere (Stevick et al. 2006) where there are six subpopulations of humpback whales that feed in six different areas during spring, summer, and fall. These feeding populations can be found in the Gulf of Maine, the

Gulf of St. Lawrence, Newfoundland/Labrador, western Greenland, Iceland, and Norway (Waring et al. 2015). During the winter months, humpbacks migrate to calving grounds in subtropical or tropical waters, such as the Dominican Republic in the Atlantic and Hawaiian Islands in the Pacific (Hayes et al. 2020). Humpback whales from the North Atlantic feeding areas mate and calve in the West Indies (Hayes et al. 2020). Since 1989, observations of juvenile humpbacks in the Mid-Atlantic have been increasing during the winter months, peaking January through March (Swingle et al. 1993). Biologists theorize that non-reproductive animals may be establishing a winter-feeding range in the Mid-Atlantic since they are not participating in reproductive behavior in the Caribbean. Acoustic survey data collected from 2004 to 2014 on 281 bottom-mounted recorders (for a total of 35,033 days) concluded that humpback whales (as well as fin, sei, and blue whales) were present from the US Southeast to Greenland in the winter seasons, suggesting baleen whales are widely distributed during these months (Davis et al. 2020). Between October 2018 and February 2021, 53 sightings of 78 individual humpback whales were recorded during recent HRG and GT surveys within the area surrounding the SRWF and SRWEC (AIS-Inc. 2019; Bennett 2021; Stevens et al. 2021; Stevens and Mills 2021).

SRWF and SRWEC

The humpback whale has a documented presence within the New York OPA, per the NYSERDA Digital Aerial Baseline Surveys conducted from Summer 2016 through Winter 2019 (Normandeau and APM 2019a, b, c, d, 2020). Humpback whales sighted within the New York OPA occurred most often during the spring and fall months however they were recorded in all four seasons with the highest number documented in Spring 2018 (70 individuals). Similarly, during the NYSDEC Whale Monitoring Program aerial surveys conducted from 2017-2020, 279 estimated individual humpback whales were sighted within the New York Bight (Tetra-Tech and LGL 2020). These sightings occurred during all seasons with a higher prevalence in the summer, within a wide geographical area ranging from nearshore to the continental shelf edge and beyond.

Kraus et al. (2016) reported humpback whale sightings in the RI-MA and MA WEAs during all seasons, with peak abundance during spring and summer, but their presence within the region varies between years. Increased stocks of sand lance (*Ammodytes spp.*) appear to correlate with the years in which most whales were observed, suggesting that humpback whale distribution and occurrences could largely be influenced by prey availability (Kenney and Vigness-Raposa 2010). The greatest number of sightings of humpbacks in the RI-MA and MA WEAs occurred during April (33 sightings); their presence increased starting in March and continued through July. Seasonal abundance estimates of humpback whales in the RI-MA and MA WEAs range from 0 to 41, with higher estimates observed during spring and summer (Kraus et al. 2016). Acoustic detections within the RI-MA and MA WEAs were primarily during the summer months (Kraus et al. 2016).

In the 1980s, numerous sightings of humpbacks were reported between Long Island, NY and Martha's Vineyard, MA. Humpback whales were regularly found in shallow water for extended periods of time (greater than one week) within Long Island Sound, Block Island Sound, and Gardiner's Bay. They were also observed moving in and out of some of the inlets along the south shore of Long Island (i.e., Shinnecock, Fire Island, New York Harbor) (Sadove and Cardinale 1993).

Montauk boats reported two sightings in 1986 and 63 sightings in 1987 (Sadove and Cardinale 1993; Kenney and Vigness-Raposa 2010). Recently, multiple humpbacks were reported feeding off Long Island, NY during Jul 2016 and near New York City during November and December 2016 (Waring et al.

2016; Hayes et al. 2019). Humpback strandings were also reported along the southern shore of eastern Long Island, NY in February 1992, November 1992, October 1993, August 1997, and April 2004.

Furthermore, during Project-specific PSO surveys from 2019 to 2020 (Smultea 2020), one estimated individual was detected inside the SRWF, and six estimated individuals were detected outside the SRWF. Based on these data, humpback whales are likely to be common within the SRWF and SRWEC corridor, predominantly during spring and summer.

4.1.6.2 Abundance

The best available abundance estimate of the Gulf of Maine stock is 1,396, derived from modeled sighting histories constructed using photo-identification data collected through October 2016 (Hayes et al. 2020). Available data indicate that this stock is characterized by a positive population trend, with an estimated increase in abundance of 2.8% per year (Hayes et al. 2020).

4.1.6.3 Status

NMFS revised the listing status for humpback whales under the ESA in 2016 (81 FR 62260 2016). Globally, there are 14 distinct population segments (DPSs) recognized for humpback whales, four of which are listed as Endangered. The Gulf of Maine stock (formerly known as the Western North Atlantic stock) which occurs in the Project Area is considered non-strategic under the MMPA and does not coincide with any ESA-list DPS (Hayes et al. 2020). This stock is considered non-strategic because the detected level of U.S. fishery-caused mortality and serious injury derived from the available records do not exceed the calculated PBR of 22, with a set recovery factor at 0.5 (Hayes et al. 2019). Because the observed mortality is estimated to be only 20% of all mortality, total annual mortality may be 60-70 animals in this stock (Hayes et al. 2019). If anthropogenic causes are responsible for as little as 31% of potential total mortality, this stock could be over PBR. While detected mortalities yield an estimated minimum fraction anthropogenic mortality at 0.85, additional research is being done before apportioning mortality to anthropogenic versus natural causes for undetected mortalities and making a potential change to the MMPA status of this stock. A UME was declared for this species in January 2016, which as of June 2021 has resulted in 151 stranded humpback whales, with 6 occurring in Rhode Island and 31 occurring in New York (Hayes et al. 2020; NMFS 2022a). Major threats to humpback whales include vessel strikes, entanglement, and climate-related shifts in prey distribution (Hayes et al. 2020). There is no designated critical habitat for this stock in the Project Area.

4.2 Odontocetes

4.2.1 Sperm Whale (Physeter macrocephalus)

The sperm whale is the largest of all toothed whales; males can reach 16 m (52 ft) in length and weigh over 40,823 kilograms ("kg" [45 US tons]), and females can attain lengths of up to 11 m (36 ft) and weigh over 13,607 kg (15 tons) (Whitehead 2009). Sperm whales have extremely large heads, which account for 25–35% of the total length of the animal. This species tends to be uniformly dark gray in color, though lighter spots may be present on the ventral surface. Sperm whales frequently dive to depths of 400 m (1,300 ft) in search of their prey, which includes large squid, fishes, octopus, sharks, and skates (Whitehead 2009). This species can remain submerged for over an hour and reach depths as great as 1,000 m (3,280 ft). Sperm whales form stable social groups and exhibit a geographic social structure; females and juveniles form mixed groups and primarily reside in tropical and subtropical waters, whereas

males are more solitary and wide-ranging and occur at higher latitudes (Whitehead 2002; Whitehead 2003).

Unlike mysticete whales that produce various types of calls used solely for communication, sperm whales produce clicks that are used for echolocation and foraging as well as communication (Erbe et al. 2017). Sperm whale clicks have been grouped into five classes based on the click rate, or number of clicks per second; these include "squeals," "creaks," "usual clicks," "slow clicks," and "codas." In general, these clicks are broadband sounds ranging from 100 Hz to 30 kHz with peak energy centered around 15 kHz. Depending on the class, SLs for sperm whale calls range between approximately 166 and 236 dB re 1 μPa @ 1 m SPL_{rms} (Erbe et al. 2017). Hearing sensitivity data for this species are currently unavailable (Southall et al. 2019).

4.2.1.1 Distribution

Sperm whales can be found throughout the world's oceans. They can be found near the edge of the ice pack in both hemispheres and are also common along the equator. The North Atlantic stock is distributed mainly along the continental shelf-edge, over the continental slope, and mid-ocean regions, where they prefer water depths of 600 m or more and are less common in waters <300 m deep (Waring et al. 2015; Hayes et al. 2020). In the winter, sperm whales are observed east and northeast of Cape Hatteras. In the spring, sperm whales are more widely distributed throughout the Mid-Atlantic Bight and southern portions of George's Bank (Hayes et al. 2020). In the summer, sperm whale distribution is similar to the spring, but they are more widespread in Georges Bank and the Northeast Channel region and are also observed inshore of the 100-m isobath south of New England (Hayes et al. 2020). Sperm whale occurrence on the continental shelf in areas south of New England is at its highest in the fall (Hayes et al. 2020).

SRWF and SRWEC

Sperm whales have a documented presence within the New York OPA, per the NYSERDA Digital Aerial Baseline Surveys conducted from Summer 2016 through Winter 2019 (Normandeau and APM 2019a, b, c, d, 2020). Sperm whales sighted within the New York OPA occurred the most often in summer and fall months with the highest number documented in Summer 2017 (42 individuals). Similarly, during the NYSDEC Whale Monitoring Program aerial surveys conducted from 2017 to 2020, a total of 32 sperm whale sightings (an estimated 72 individuals) were recorded (Tetra-Tech and LGL 2020). These sightings occurred year-round within deeper waters along the continental shelf edge, however sightings were more prevalent in the summer seasons. All sperm whale sightings occurred near the shelf edge in water greater than 656 ft (200 m) (Tetra-Tech and LGL 2020).

Sperm whales were the fifth most commonly sighted large whale in the CETAP study area and were observed in all four seasons (CeTAP 1982). The study sighted 341 individuals, which accounted for only 8 percent of the total large whale sightings during their survey period (CeTAP 1982). Kraus et al. (2016) similarly reported sightings of sperm whales in the RI-MA and MA WEAs during the summer and fall months: five individuals in August 2012, one in September 2012, and three in June 2015. There have also been occasional strandings in Massachusetts and Long Island (Kenney and Vigness-Raposa 2010). As accounts of sperm whales in the area are low, their occurrence within the SRWF and offshore SRWEC is expected to be regular.

CETAP reported that the distribution of sperm whales primarily centers at about the 1,000-m (3,280-ft) depth contour. However, their distribution can also extend shoreward, inshore of the 328-ft

(100-m) contour, particularly in summer and fall (CeTAP 1982; Hayes et al. 2019). Although relatively infrequent, sightings have been reported in waters as shallow as 197 ft (60 m). Southern New England is one of the few locations in the world in which sperm whales frequent inshore areas (Kenney and Vigness-Raposa 2010). Many reported sightings take place from May through November in a narrow band just south of Block Island, RI Martha's Vineyard, MA and Nantucket, MA. This high occurrence of sperm whales is believed to be related to the presence of spawning squid (CeTAP 1982). Sadove and Cardinale (1993) also reported sperm whale presence south of Montauk Point in less than 18 m depths from late May through early June and again in October (Sadove and Cardinale 1993). Given the species' preference for deeper waters, sperm whales are only likely to occur in offshore areas of the SRWEC corridor but may also occur in shallower waters seasonally in the summer and fall.

4.2.1.2 Abundance

The IWC recognizes only one stock of sperm whales for the North Atlantic, and Reeves and Whitehead (1997) and Dufault et al. (1999) suggest that sperm whale populations lack clear geographic structure. The best and most recent abundance estimate based on 2016 surveys conducted between the lower Bay of Fundy and Florida is 4,349 (Hayes et al. 2020). No population trend analysis is available for this stock.

4.2.1.3 Status

The Western North Atlantic stock is considered strategic under the MMPA due to its listing as Endangered under the ESA, and the global population is listed as Vulnerable on the IUCN Red List (Hayes et al. 2020; IUCN 2020). Between 2013 and 2017, 12 sperm whale strandings were documented along the U.S. East Coast, but none of the strandings showed evidence of human interactions (Hayes et al. 2020). A moratorium on sperm whale hunting was adopted in 1986 and currently no hunting is allowed for any purposes in the North Atlantic. Occasionally, sperm whales will become entangled in fishing gear or be struck by ships off the east coast of the U.S. However, this rate of mortality is not believed to have biologically significant impacts. The current PBR for this stock is 6.9, and because the total estimated human-caused mortality and serious injury is <10% of this calculated PBR, it is considered insignificant (Hayes et al. 2020). Other threats to sperm whales include contaminants, climate-related changes in prey distribution, and anthropogenic noise, although the severity of these threats on sperm whales is currently unknown (Hayes et al. 2020). There is no designated critical habitat for this population in the Project Area.

4.2.2 Long-Finned Pilot Whale (Globicephala melas)

Two species of pilot whale occur within the Western North Atlantic: the long-finned pilot whale and the short-finned pilot whale. These species are difficult to differentiate at sea and cannot be reliably distinguished during most surveys (Rone et al. 2012; Hayes et al. 2017). Both short-finned and long-finned pilot whales are similar in coloration and body shape. Pilot Whales have bulbous heads, are dark gray, brown, or black in color, and can reach approximately 7.3 m (25 ft) in length (NMFS 2021g). However, long-finned pilot whales can be distinguished by their long flippers, which are 18 to 27% of the body length with a pointed tip and angled leading edge (Jefferson et al. 1993). These whales form large, relatively stable aggregations that appear to be maternally determined (ACS 2018). Pilot whales feed primarily on squid, although they also eat small to medium-sized fish and octopus when available (NMFS 2021g).

Like dolphin species, long-finned pilot whales can produce whistles and burst-pulses used for foraging and communication. Whistles typically range in frequency from 1 to 11 kHz while burst-pulses cover a broader frequency range from 100 Hz to 22 kHz (Erbe et al. 2017). Auditory evoked potential (AEP) measurements conducted by Pacini et al. (2010) indicate that the hearing sensitivity for this species ranges from <4 kHz to 89 kHz.

4.2.2.1 Distribution

Because it is difficult to differentiate between the two pilot whale species in the field, sightings are usually reported to genus level only (CeTAP 1982; Hayes et al. 2020). However, short-finned pilot whales are a southern or tropical species and pilot whale sightings above approximately 42° N are most likely long-finned pilot whales. Short-finned pilot whale occurrence in the Project Area is considered rare (CeTAP 1982; Hayes et al. 2020). Long-finned pilot whales are distributed along the continental shelf waters off the Northeastern U.S. in the winter and early spring. By late spring, pilot whales migrate into more northern waters including Georges Bank and the Gulf of Maine and will remain there until fall (Hayes et al. 2020). The two species' ranges overlap spatially along the shelf break between the southern flank of Georges Bank and New Jersey (Rone et al. 2012; Hayes et al. 2019).

SRWF and SRWEC

Pilot whales have a documented presence within the New York OPA, per the NYSERDA Digital Aerial Baseline Surveys conducted from Summer 2016 through Winter 2019 (Normandeau and APM 2019a, b, c, d, 2020). Pilot whales sighted within the New York OPA occurred most often during the summer months but also had high occurrences in fall and spring with the highest recorded occurrence in Summer 2016 (1,393 individuals). CETAP surveys reported long-finned pilot whales as the third most commonly sighted small whale in their study area with 12,438 individuals (CeTAP 1982). Long-finned pilot whales have been observed in OCS waters off Rhode Island in all four seasons, with peak occurrences in spring (CeTAP 1982; Sadove and Cardinale 1993). There are 43 records of long-finned pilot whales and 226 records of non-specific pilot whales in this area. Nine sightings during summer and three sightings in spring were reported from whale-watching data for pilot whales (Kenney and Vigness-Raposa 2010).

Within the RI-MA and MA WEAs, no sightings of pilot whales were observed during summer, fall, or winter (Kraus et al. 2016). Long-finned pilot whales are expected to be common within the SRWF during spring.

Long-finned pilot whales have been observed inshore along the 30- to 40-fathom contours between the area south of Shinnecock Inlet east to south of Block Island primarily during spring (Sadove and Cardinale 1993). However, they prefer deep pelagic temperate to subpolar oceanic waters and are expected to be uncommon within the SRWEC.

4.2.2.2 Abundance

The best available estimate of long-finned pilot whales in the Western North Atlantic is 39,215 based on recent surveys covering waters between Labrador and Central Virginia (Hayes et al. 2020). A trend analysis has not been conducted for this stock due to the relatively imprecise abundance estimates (Hayes et al. 2020).

4.2.2.3 Status

Long-finned pilot whales are not listed under the ESA and are classified as Least Concern by the IUCN Red List (Hayes et al. 2020; IUCN 2020). Long-finned pilot whales have a propensity to mass strand in U.S. waters, although the role of human activity in these strandings remains unknown (Hayes et al. 2020). The PBR for this stock is 306, and the annual human-caused mortality and serious injury was estimated to be 9 whales between 2015 and 2019 (Hayes et al. 2021). Threats to this population include entanglement in fishing gear, contaminants, climate-related shifts in prey distribution, and anthropogenic noise (Hayes et al. 2020). There is no designated critical habitat for this stock in the Project Area.

4.2.3 Atlantic Spotted Dolphin (Stenella frontalis)

Atlantic spotted dolphins can reach 2.3 m (7.5 ft) in length and their body shape resembles that of a common bottlenose dolphin (Jefferson et al. 2008). They start out with no spotting and resemble slender bottlenose dolphins. Large spotting develops as the animals age making it easier to distinguish them in visual surveys (Jefferson et al. 2008; Cipriano 2018).

Atlantic spotted dolphins have an estimated auditory bandwidth of 150 Hz to 160 kHz and vocalizations typically range from 100 Hz to 130 kHz (Navy 2007; Southall et al. 2007a). No auditory sensitivity data are available for this species (Southall et al. 2019).

4.2.3.1 Distribution

Atlantic spotted dolphins are found in tropical and warm temperate waters. In the Western North Atlantic, their distribution ranges from the Northeastern U.S. to the Gulf of Mexico and the Caribbean to Venezuela (Hayes et al. 2020). They are regularly seen in continental shelf and slope waters. There are two Atlantic spotted dolphin ecotypes which may be distinct sub-species. The larger heavily spotted ecotype inhabits shelf waters inside or near the 200-m isobath south of Cape Hatteras. The smaller form is less spotted and is found further offshore and only occurs in the Atlantic. Recent genetic data also suggests that they may be genetically distinct populations (Hayes et al. 2020). Both ecotypes can occur in the Northeastern U.S.; however, they are difficult to differentiate at sea and are therefore not distinguished in this assessment.

SRWF and SRWEC

The Atlantic spotted dolphin has a documented presence within the New York OPA, per the NYSERDA Digital Aerial Baseline Surveys conducted from Summer 2016 through Winter 2019 (Normandeau and APM 2019a, b, c, d, 2020). Atlantic spotted dolphins sighted within the New York OPA occurred most often during the spring and fall months with the highest occurrence in Fall 2016 (607 individuals). There are a few reported occurrences of spotted dolphins (*Stenella* spp.) in the Project Area. CETAP described spotted dolphins as the seventh most commonly sighted cetaceans in the study area, with 126 sightings over the course of a three-year study. The 1982 CETAP data observed 40 individuals south of Block Island, RI (CeTAP 1982). NOAA Fisheries shipboard surveys conducted during June to August between central Virginia and the Lower Bay of Fundy reported 542 to 860 individual sightings from two separate visual teams (Palka et al. 2017). Surveys conducted by the New York State Marine Mammal and Sea Turtle Stranding Program indicated that sightings were in offshore waters more than 164 ft (50 m) in depth along the continental shelf south of Montauk Point and at the shelf valley of Hudson Canyon (Sadove and Cardinale 1993).

During Project-specific PSO surveys from 2019 to 2020 (Smultea 2020), four estimated individuals were detected inside the SRWF, with no individuals detected outside the SRWF. Therefore, Atlantic spotted dolphins are expected to have a regular occurrence within the SRWF.

Atlantic spotted dolphins north of Cape Hatteras tend to be observed over and beyond the continental slope; however, per single sightings outlined above, their presence in the SRWEC is expected to be unlikely.

4.2.3.2 Abundance

The best population estimate available for this species is 39,921 based on surveys conducted in summer 2016 between the lower Bay of Fundy and Florida (Hayes et al. 2020). A population trend analysis of available abundance estimates from 2004, 2011, and 2016 indicate a linear decrease in abundance, however interannual variability in abundance is a key uncertainty in this trend analysis (Hayes et al. 2020).

4.2.3.3 Status

Atlantic spotted dolphins are not listed under the ESA and are classified as Least Concern by the IUCN Red List (Hayes et al. 2020; IUCN 2020). The PBR for this stock is 320, and the estimated annual human-caused mortality and serious injury from 2013 to 2017 was presumed to be zero (Hayes et al. 2020). Twenty-one Atlantic spotted dolphins were reported stranded between North Carolina and Florida during this period; however, no definitive evidence of human interaction was found (Hayes et al. 2020). Major threats to this population include anthropogenic noise; offshore development, particularly south of Cape Hatteras where this species inhabits inshore shelf waters; contaminants; and climate-related shifts in prey distribution (Hayes et al. 2020). There is no designated critical habitat for this stock in the Project Area.

4.2.4 Atlantic White-Sided Dolphin (Lagenorhynchus acutus)

The Atlantic white-sided dolphin is robust and attains a body length of approximately 2.8 m (9 ft) (Jefferson et al. 2008). It is characterized by a strongly “keeled” tail stock and distinctive, white-sided color pattern (BOEM 2014a). Atlantic white-sided dolphins form groups of varying sizes, ranging from a few individuals to over 500 (NMFS 2021a). They feed mostly on small schooling fishes, shrimps, and squids, and are often observed feeding in mixed-species groups with pilot whales and other dolphin species (Jefferson et al. 2008; Cipriano 2018).

Like most dolphin species, Atlantic white-sided dolphins produce clicks, buzzes, calls, and whistles. Their clicks are broadband sounds ranging from 30 to 40 kHz that can contain frequencies over 100 kHz and are often produced during foraging and for orientation within the water column. Buzzes and calls are not as well studied, and they may be used for socialization as well as foraging. Whistles are primarily for social communication and group cohesion and are characterized by a down sweep followed by an upsweep with an approximate starting frequency of 20 kHz and ending frequency of 17 kHz (Hamran 2014). No hearing sensitivity data are currently available for this species (Southall et al. 2019).

4.2.4.1 Distribution

Atlantic white-sided dolphins migrate between the temperate and polar waters of the North Atlantic Ocean, but usually maintain migration routes over outer shelf or slope waters. This is the most abundant dolphin in the Gulf of Maine and the Gulf of St. Lawrence; they are rarely seen off the coast of Nova Scotia (Kenney and Vigness-Raposa 2010). The species occurs year-round between central West

Greenland to North Carolina primarily in continental shelf waters to the 100-m depth contour (Hayes et al. 2020). There are seasonal shifts in the distribution of the Atlantic white-sided dolphins off the northeastern US coast, with low abundance in winter between Georges Basin and Jeffrey's Ledge and very high abundance in the Gulf of Maine during spring. During summer, Atlantic white-sided dolphins are most abundant between Cape Cod and the lower Bay of Funday. And during fall, the distribution of the species is similar to that in summer, with less overall abundance (DoN (U.S. Department of the Navy) 2005). Behaviorally, this species is highly social, but not as demonstrative as some other common dolphins. They typically form pods of around 30 to 150 individuals but have also been seen in very large pods of 500 to 2,000 individuals (Hayes et al. 2020). It is common to find these pods associated with the presence of other white-beaked dolphins, pilot whales, fin whales, and humpback whales. Between October 2018 and February 2021, one sighting of 18 individual Atlantic white-sided dolphins was recorded in May 2020 during recent HRG and GT surveys conducted within the area surrounding the SRWF and SRWEC (AIS-Inc. 2019; Bennett 2021; Stevens et al. 2021; Stevens and Mills 2021).

SRWF and SRWEC

The Atlantic white-sided dolphin has a documented presence within the New York OPA, per the NYSERDA Digital Aerial Baseline Surveys conducted from Summer 2016 through Winter 2019 (Normandeau and APM 2019a, b, c, d, 2020). Atlantic white-sided dolphin sighted within the New York OPA occurred most often during the fall and winter months with the highest documented occurrence in Fall 2016 (180 individuals). Over the course of BOEM's study in the RI-MA and MA WEAs, 185 individual Atlantic white-sided dolphins were sighted within the SRWF; most were observed during summer (112 sightings) followed by fall (70 sightings) (Kraus et al. 2016).

Atlantic white-sided dolphins are one of the three odontocetes primarily inhabiting OCS waters shoreward of the 100-m (328-ft) depth contour (CeTAP 1982; Sadove and Cardinale 1993; Hayes et al. 2019). Most of the sightings (90 percent) were seen within an estimated depth range of 125 to 889 ft (38 to 2,710 m). Sightings are concentrated in coastal waters near Cape May, NJ, and in shallow waters within the Gulf of Maine (CeTAP 1982; Sadove and Cardinale 1993). The Gulf of Maine population is commonly seen from the Hudson Canyon to Georges Bank. Sightings south of Georges Bank and Hudson Canyon occur year-round although at lower densities (Hayes et al. 2019).

Atlantic white-sided dolphins are common in OCS waters, with a slight tendency to occur in shallower New York state waters in spring (Kenney and Vigness-Raposa 2010). Records indicate that there is an aggregation of sightings southeast of Montauk Point, NY, during spring and summer. Strandings of white-sided dolphins within the SRWEC are relatively rare; from 2001 to 2011, there was an average of 1.2 strandings per year (Kenney and Vigness-Raposa 2010). Atlantic white-sided dolphins occur in seasonably high numbers in nearshore areas during spring and summer. Therefore, Atlantic white-sided dolphins are one of the most likely delphinids to occur year-round within the SRWF and SRWEC waters.

4.2.4.2 Abundance

The best abundance estimate currently available for the Western North Atlantic stock is 93,233 based on surveys conducted between Labrador to Florida (Hayes et al. 2020). A trend analysis is not currently available for this stock due to insufficient data (Hayes et al. 2020).

4.2.4.3 *Status*

Atlantic white-sided dolphins are not listed under the ESA or considered a strategic stock under the MMPA. They are classified as Least Concern on the IUCN Red List (Hayes et al. 2020; IUCN 2020). The PBR for this stock is 544 and the annual rate of human-caused mortality and serious injury from 2015 to 2019 was estimated to be 27 dolphins (Hayes et al. 2021). This estimate is based on observed fishery interactions, but Atlantic white-sided dolphins are also threatened by contaminants in their habitat, and climate-related shifts in prey distribution (Hayes et al. 2020). There is no designated critical habitat for this stock in the Project Area.

4.2.5 Short-Beaked Common Dolphin (Delphinus delphis delphis)

Two common dolphin species were previously recognized: the long-beaked common dolphin (*Delphinus capensis*) and the short-beaked common dolphin (*Delphinus delphis)*; however, Cunha et al. (2015) summarized the relevant data and analyses along with additional molecular data and analysis, and recommended that the long-beaked common dolphin not be further recognized in the Atlantic Ocean. Short-beaked common dolphins can reach 2.7 m (9 ft) in length and have a distinct color pattern with a white ventral patch, yellow or tan flank, and dark gray dorsal "cape" (NMFS 2021k). This species feeds on schooling fish and squid found near the surface at night (NMFS 2021k). They have been known to feed on fish escaping from fishermen's nets or fish that are discarded from boats (NMFS 1993). This highly social and energetic species usually travels in large pods consisting of 50 to >1,000 individuals (Cañadas and Hammond 2008). The common dolphin can frequently be seen performing acrobatics and interacting with large vessels and other marine mammals.

Common dolphin clicks are broadband sounds between 17 and 45 kHz with peak energy between 23 and 67 kHz. Burst-pulse sounds are typically between 2 and 14 kHz while the key frequencies of common dolphin whistles are between 3 and 24 kHz (Erbe et al. 2017). No hearing sensitivity data are available for this species (Southall et al. 2019).

4.2.5.1 *Distribution*

Short-beaked common dolphins in the US Atlantic EEZ belong to the Western North Atlantic stock, generally occurring from Cape Hatteras, North Carolina to the Scotian Shelf (Hayes et al. 2018). Short-beaked common dolphins are a highly seasonal, migratory species. In the US Atlantic EEZ this species is distributed along the continental shelf between the 200–2,000 m (650–6,561.6 ft) isobaths and is associated with Gulf Stream features (CeTAP 1982; Payne and Selzer 1989; Hamazaki 2002; Hayes et al. 2018). Short-beaked common dolphins occur from Cape Hatteras northeast to Georges Bank (35° to 42°N) during mid-January to May and move as far north as the Scotian Shelf from mid-summer to fall (Payne and Selzer 1989; Hayes et al. 2020). Migration onto the Scotian Shelf and continental shelf off Newfoundland occurs when water temperatures exceed 11°C (51.8°F) (Sergeant et al. 1970; Gowans and Whitehead 1995). Breeding usually takes place between the months of June and September and females have an estimated calving interval of two to three years Between October 2018 and February 2021, 560 sightings of 5,634 individual short-beaked common dolphins were recorded during recent HRG and GT surveys within the area surrounding the SRWF and SRWEC (AIS-Inc. 2019; Bennett 2021; Stevens et al. 2021; Stevens and Mills 2021).

SRWF and SRWEC

The short-beaked common dolphin has a documented presence within the New York OPA, per the NYSERDA Digital Aerial Baseline Surveys conducted from Summer 2016 through Winter 2019 (Normandeau and APM 2019a, b, c, d, 2020). Short-beaked common dolphins sighted within the New York OPA occurred relatively uniformly across all four seasons with the highest number documented in Summer 2017 (11,908 individuals).

Kraus et al. (2016) observed 3,896 short-beaked common dolphins within the RI-MA and MA WEAs. Most were observed during summer surveys (1,964 sightings), followed by fall (725), winter (132), then spring (75). This was the highest number of individual sightings of all the small cetaceans. Similarly, during Project-specific PSO surveys from 2019 to 2020 (Smultea 2020), the short-beaked common dolphin was the most commonly recorded species and also the marine mammal with the largest average group size. A total of 86 estimated individuals was detected inside the SRWF, and 566 estimated individuals were detected outside the SRWF.

The majority of sightings of this species are found in water depths greater than 33 ft (10 m) along the south shore of Long Island (Sadove and Cardinale 1993). They are also found frequently around significant submarine features such as Hudson and Block Canyons with aggregations up to 10,000 individuals (Sadove and Cardinale 1993). Strandings have been recorded in Long Island Sound, the eastern end of Long Island near Montauk, and inland waters of Rhode Island.

Since the short-beaked common dolphin has a wide distribution, it can be found in both nearshore and offshore waters of the Pacific and Atlantic Oceans and has a documented presence within the SRWF per PSO data (Smultea 2020), they are expected to have a year-round common occurrence within the SRWF and SRWEC corridor.

4.2.5.2 *Abundance*

The best population estimate in the US Atlantic EEZ for the Western North Atlantic short-beaked common dolphin is 70,184 (Hayes et al. 2018) while Roberts et al. (2016) habitat-based density models provide an abundance estimate of 86,098 short-beaked common dolphins in the US Atlantic EEZ. The current best abundance estimate for the entire Western North Atlantic stock is 172,974 based on recent surveys conducted between Newfoundland and Florida (Hayes et al. 2020). A trend analysis was not conducted for this stock because of the imprecise abundance estimate and long survey intervals (Hayes et al. 2020).

4.2.5.3 *Status*

The common dolphin is not listed under the ESA and is classified as Least Concern by the IUCN Red List (Hayes et al. 2020; IUCN 2020). Historically, this species was hunted in large numbers for food and oil. Currently, they continue to suffer incidental mortality from vessel collisions and Eastern North American fishing activities within the Atlantic, most prominently yellowfin tuna (*Thunnus albacares*) nets, driftnets, and bottom-set gillnets (Kraus et al. 2016; Hayes et al. 2020). The common dolphin faces anthropogenic threats because of its utilization of nearshore habitat and highly social nature, but it is not considered a strategic stock under the MMPA because the average annual human-caused mortality and serious injury does not exceed the calculated PBR of 1,452 for this stock (Hayes et al. 2020). The annual estimated human-caused mortality and serious injury for 2015 to 2019 was 390.4, which included fishery-interactions and research takes (Hayes et al. 2021). Other threats to this species include contaminants in their habitat and climate-related changes in prey distribution (Hayes et al. 2020). There is no designated critical habitat for this stock in the Project Area.

4.2.6 Common Bottlenose Dolphin (Tursiops truncatus truncatus)

Bottlenose Dolphins are one of the most well-known and widely distributed species of marine mammals. These dolphins reach 2–4 m (6–12.5 ft) in length (NMFS 2021b). The snout is stocky and set off from the head by a crease. They are typically light to dark grey in color with a white underside (Jefferson et al. 1993). Bottlenose dolphins are commonly found in groups of two to 15 individuals, though aggregations in the hundreds are occasionally observed (NMFS 2021b). They are considered generalist feeders and consume a wide variety of organisms, including fish, squid, and shrimp and other crustaceans (Jefferson et al. 2008).

Whistles produced by bottlenose dolphins can vary over geographic regions, and newborns are thought to develop "signature whistles" within the first few months of their lives that are used for intraspecific communication. Whistles generally range in frequency from 300 Hz to 39 kHz with SLs between 114 and 163 dB re 1 μPa @ 1 m SPL_{rms} (Erbe et al. 2017). Bottlenose dolphins also make burst-pulse sounds and echolocation clicks, which can range from a few kHz to over 150 kHz. As these sounds are used for locating and capturing prey, they are directional calls; the recorded frequency and sound level can vary depending on whether the sound was received head-on or at an angle relative to the vocalizing dolphin. SLs for burst-pulses and clicks range between 193 and 228 dB re 1 μPa @ 1 m SPL_{rms} (Erbe et al. 2017). There are sufficient available data for bottlenose dolphin hearing sensitivity using both behavioral and AEP methods as well as anatomical modeling studies, which show hearing for the species is most sensitive between approximately 400 Hz and 169 kHz (Southall et al. 2019).

4.2.6.1 Distribution

In the Western North Atlantic, there are two morphologically and genetically distinct common bottlenose morphotypes, the Western North Atlantic Northern Migratory Coastal stock and the Western North Atlantic Offshore stock (Rosel et al. 2009). The offshore stock is a year-round resident primarily distributed along the outer shelf and slope from Georges Bank to Florida during spring and summer and has been observed in the Gulf of Maine during late summer and fall (Hayes et al. 2020) and in the Gulf of Maine is largely concentrated around significant submarine features such as Hudson and Block Canyons (Sadove and Cardinale 1993; Hayes et al. 2020) and has been observed in the Project Area in recent years (AMCS 2020). The northern migratory coastal stock is distributed along the coast between southern Long Island, New York, and Florida (Hayes et al. 2018). Given their distribution, only the offshore stock is likely to occur in the Project Area and is the only stock included in this application. The western North Atlantic offshore stock is distributed primarily along the OCS and continental slope, from Georges Bank to Cape Hatteras during spring and summer (CeTAP 1982). Between October 2018 and February 2021, 9 sightings of 200 individual common bottlenose dolphins were recorded during the months of May and July of 2020 during recent HRG and GT surveys within the area surrounding the SRWF and SRWEC (AIS-Inc. 2019; Bennett 2021; Stevens et al. 2021; Stevens and Mills 2021).

SRWF and SRWEC

The common bottlenose dolphin has a documented presence within the New York OPA, per the NYSERDA Digital Aerial Baseline Surveys conducted from Summer 2016 through Winter 2019 (Normandeau and APM 2019a, b, c, d, 2020). Common bottlenose dolphins sighted within the New York OPA occurred most often during the spring and summer months; however, they were recorded in all four seasons with the highest number documented in Summer 2017 (2,443 individuals).

Common bottlenose dolphins were reported in the RI-MA and MA WEAs in all seasons; highest seasonal abundance estimates were during fall, summer, and spring. Kraus et al. (2016) report the offshore stock as only being sighted in the RI-MA and MA WEAs during the summer months. The greatest concentrations of common bottlenose dolphins were observed in the southernmost portion of the RI-MA WEA study area in the fall (Kraus et al. 2016).

Common bottlenose dolphins that occur within the nearshore areas of the Project Area can come from either the migratory or the offshore stock. Seasonal stranding records have historically matched the temporal patterns of the offshore stock rather than the coastal stock (Kenney and Vigness-Raposa 2010), but recent observations of the migratory stock in New York waters suggests the distribution may be shifting northward (AMCS 2020). Therefore, common bottlenose dolphins are expected to be a common species within the SRWF and SRWEC corridor.

4.2.6.2 Abundance

The best abundance estimate for the Western North Atlantic offshore stock is 62,851 based on recent surveys between the lower Bay of Fundy and Florida (Hayes et al. 2020). A population trend analysis for this stock was conducted using abundance estimates from 2004, 2011, and 2016, which show no statistically significant trend (Hayes et al. 2020).

4.2.6.3 Status

Common bottlenose dolphins are not listed under the ESA and are classified as Least Concern on the IUCN Red List (Hayes et al. 2020; IUCN 2020). The PBR for this stock is 519, and the average annual human-cause mortality and serious injury from 2013 to 2017 was estimated to be 28, attributed to fishery interactions (Hayes et al. 2020). Because annual mortality does not exceed PBR, this stock is not classified as strategic under the MMPA. In addition to fisheries, threats to common bottlenose dolphins include non-fishery related human interaction; anthropogenic noise; offshore development; contaminants in their habitat; and climate-related changes in prey distribution (Hayes et al. 2020). There is no designated critical habitat for either stock in the Project Area.

4.2.7 Harbor Porpoise (Phocoena phocoena)

This species is among the smallest of the toothed whales and is the only porpoise species found in Northeastern U.S. waters. A distinguishing physical characteristic is the dark stripe that extends from the flipper to the eye. The rest of its body has common porpoise features; a dark gray back, light gray sides, and small, rounded flippers (Jefferson et al. 1993). It reaches a maximum length of 1.8 m (6 ft) and feeds on a wide variety of small fish and cephalopods (Reeves and Read 2003; Kenney and Vigness-Raposa 2010). Most harbor porpoise groups are small, usually between five and six individuals, although they aggregate into large groups for feeding or migration (Jefferson et al. 2008).

Harbor porpoises produce high frequency clicks with a peak frequency between 129 and 145 kHz and an estimated SLs that ranges from 166 to 194 dB re 1 µPa @ 1 m SPL_{rms} (Villadsgaard et al. 2007). Available data estimating auditory sensitivity for this species suggest that they are most receptive to noise between 300 Hz and 160 kHz (Southall et al. 2019).

4.2.7.1 Distribution

The harbor porpoise is mainly a temperate, inshore species that prefers to inhabit shallow, coastal waters of the North Atlantic, North Pacific, and Black Sea. Harbor porpoises mostly occur in shallow shelf and coastal waters. In the summer, they tend to congregate in the Northern Gulf of Maine, Southern

Bay of Fundy, and around the southern tip of Nova Scotia (Hayes et al. 2020). In the fall and spring, harbor porpoises are widely distributed from New Jersey to Maine (Hayes et al. 2020). In the winter, intermediate densities can be found from New Jersey to North Carolina, with lower densities from New York to New Brunswick, Canada (Kenney and Vigness-Raposa 2010). In cooler months, harbor porpoises have been observed from the coastline to deeper waters (>1,800 m), although the majority of sightings are over the continental shelf (Hayes et al. 2020). Between October 2018 and February 2021, one sighting of 5 individual harbor porpoises was recorded in May 2020 during recent HRG and GT surveys conducted within the area surrounding the SRWF and SRWEC (AIS-Inc. 2019; Bennett 2021; Stevens et al. 2021; Stevens and Mills 2021).

SRWF and SRWEC

The harbor porpoise has a documented presence within the New York OPA, per the NYSERDA Digital Aerial Baseline Surveys conducted from Summer 2016 through Winter 2019 (Normandeau and APM 2019a, b, c, d, 2020). Harbor porpoises sighted within the New York OPA occurred most often during spring and winter with the highest number documented in Winter 2016-2017 (2,125 individuals).

Over the course of another study, Kraus et al. (2016) observed 121 individual harbor porpoises within the RI-MA and MA WEAs. Fall observations included the most individuals (49 sightings), followed by winter (35), spring (36), and summer (1). Vertical camera detections of all small cetaceans showed that the most commonly detected species over time was the harbor porpoise (Kraus et al. 2016). The preferred habitat of the harbor porpoise further increases the likelihood of encountering them seasonally in fall, winter, and spring (BOEM 2013; Hayes et al. 2019).

Strandings are reported all along the southern shore of Long Island, NY and along both sides of Long Island Sound (Smith 2014). There are occasional sightings in the bays, estuaries, and rivers of New York state. In spring, they tend to congregate in the southwestern Gulf of Maine around Nantucket Shoals, western Georges Bank, and the southern New England shelf (Sadove and Cardinale 1993). In fall and spring, harbor porpoises are widely distributed from New Jersey to Maine, from the coastline to deep waters (more than 1,800 m [5,905 ft]). In winter, intermediate densities can be found from New Jersey to North Carolina, with lower densities from New York to New Brunswick, Canada (Kenney and Vigness-Raposa 2010). Therefore, harbor porpoises are likely to occur within the SRWF and SRWEC corridor.

4.2.7.2 Abundance

The best available abundance estimate for the Gulf of Maine/Bay of Fundy stock occurring in the Project Area is 95,543 based on combined survey data from NOAA and the Department of Fisheries and Oceans Canada between the Gulf of St. Lawrence/Bay of Fundy/Scotian Shelf and Central Virginia (Hayes et al. 2020). A population trend analysis is not available because data are insufficient for this species (Hayes et al. 2019).

4.2.7.3 Status

This species is not listed under the ESA and is considered non-strategic under the MMPA (Hayes et al. 2020). Harbor porpoise is listed as Least Concern by the IUCN Red List (IUCN 2020). The PBR for this stock is 851, and the estimated human-caused annual mortality and serious injury from 2015 to 2019 was 164 harbor porpoises per year (Hayes et al. 2021). This species faces major anthropogenic impacts because of its nearshore habitat. Historically, Greenland populations were hunted in large numbers for food and oil. Currently, they continue to suffer incidental mortality from Western North Atlantic fishing activities such as gillnets and bottom trawls (Hayes et al. 2020). Harbor porpoises also face threats from

contaminants in their habitat, vessel traffic, habitat alteration due to offshore development, and climate-related shifts in prey distribution (Hayes et al. 2020). There is no designated critical habitat for this species near the Project Area.

4.3 Pinnipeds

Two species of pinnipeds occur in the Atlantic Ocean near the Project Area: the harbor seal and the gray seal. Both pinniped species are likely to occur in the region year-round.

The Draft 2021 SAR mentions an increase of sightings and stranding data for harp seals off of the east coast of the United States from Maine to New Jersey (Hayes et al. 2021). However, these appearances usually occur from January–May during their southernmost point of migration (Hayes et al. 2021). With the majority of the SRWF offshore construction occurring between Q2–Q4, it is unlikely for harp seals to be present in the Project area during the construction phase of the Project. Although Sunrise Wind export cable installation and landfall construction push into the start of Q1, minimal sightings data suggests a low potential of overlap within the project area. Additionally, assessment of the Ocean Biodiversity Information System (OBIS 2021) database found only records of stranding for the harp seal. Although the presence of stranded animals indicates some level of occurrence in the regions, it does not necessarily reflect the likely encounter of free-ranging animals in the area of planned activities.

4.3.1 Harbor Seal (Phoca vitulina vitulina)

The harbor seal is one of the smaller pinnipeds, and adults are often light to dark grey or brown with a paler belly and dark spots covering the head and body (Jefferson et al. 1993; Kenney and Vigness-Raposa 2010). This species is approximately 2 m (6 ft) in length (NMFS 2021e). Harbor seals complete both shallow and deep dives during hunting, depending on the availability of prey (Tollit et al. 1997). Harbor seals consumes a variety of prey, including fish, shellfish, and crustaceans (Bigg 1981; Reeves 1992; Burns 2002; Jefferson et al. 2008). They commonly occur in coastal waters and on coastal islands, ledges, and sandbars (Jefferson et al. 2008).

Harbor seals communicate through a variety of vocalizations, particularly during breeding seasons. Male harbor seals have been documented producing an underwater roar call which is used for competition with other males and attracting mates. These are relatively short calls with a duration of about 2 sec and a peak frequency between 1 and 2 kHz (Van Parijs et al. 2003). Matthews et al. (2017) found that vocalizations peaked in June and July, corresponding with the estimated breeding season of harbor seals. The source levels of harbor seal breeding vocalizations ranged from 129 to 149 dB re 1 μPa with an average of 144 dB re 1 μPa at 1 m (Matthews et al. 2017). Furthermore, roar vocalizations were shown to play a role in male-female communication by Matthews et al. (2017) where female harbor seals were shown to approach playback speakers playing dominant vocalizations more often than subordinate vocalizations. Behavioral audiometric studies for this species estimate peak hearing sensitivity between 100 Hz and 79 kHz (Southall et al. 2019).

4.3.1.1 Distribution

The harbor Seal is found throughout coastal waters of the Atlantic Ocean and adjoining seas above 30°N and is the most abundant pinniped in the US Atlantic EEZ (Hayes et al. 2018). Harbor seals, also known as common seals, are one of the most widely distributed seal species in the Northern Hemisphere. They can be found inhabiting coastal and inshore waters from temperate to polar latitudes. Harbor seals occur seasonally along the coast during winter months from southern New England to New Jersey,

typically from September through late May (Kenney and Vigness-Raposa 2010; Hayes et al. 2020). In recent years, this species has been seen regularly as far south as North Carolina, and regular seasonal haul-out sites of up to 40-60 animals have been documented on the eastern shore of Virginia and the Chesapeake Bay (Jones and Rees 2020). During the summer, most harbor seals can be found north of New York, within the coastal waters of central and northern Maine, as well as the Bay of Fundy (DoN (U.S. Department of the Navy) 2005; Hayes et al. 2020). Genetic variability from different geographic populations has led to five subspecies being recognized. Peak breeding and pupping times range from February to early September, and breeding occurs in open water (Temte 1994). Between October 2018 and February 2021, 9 sightings of 9 individual harbor seals were recorded during the months of November and December in 2018 and 2020 during recent HRG and GT surveys within the area surrounding the SRWF and SRWEC (AIS-Inc. 2019; Bennett 2021; Stevens et al. 2021; Stevens and Mills 2021).

SRWF and SRWEC

The harbor seal has a documented presence within the New York OPA, per the NYSERDA Digital Aerial Baseline Surveys conducted from Summer 2016 through Winter 2019 (Normandeau and APM 2019a, b, c, d, 2020). Harbor seals sighted within the New York OPA occurred most often during the winter months with the highest number documented in winter 2017-2018 (28 individuals). Several seal haulout sites are located on Block Island, RI (BOEM 2013). Survey data collected from NOAA Fisheries and the Provincetown Center for Coastal Research reported 151 harbor seal sightings, a large concentration of which were observed near the coast from eastern Long Island, NY to Buzzards Bay and Vineyard Sound (CRESLI 2020). There were also occurrences of harbor seal offshore; however, the level of abundance was lower than what was observed near haulout sites (Kenney and Vigness-Raposa 2010).

There are about 30 known Long Island haulout sites, which are scattered around the eastern end of Long Island and along both sides of the Atlantic and Long Island Sound shores (Kenney and Vigness-Raposa 2010; CRESLI 2020). From 2019 to 2021, the AMCS has documented approximately four harbor and/or gray seal haulout sites along the Atlantic coastline of Long Island, with more scattered within Long Island Sound and off the coast of Rhode Island (AMCS 2020).

Seals are generally present on New York beaches from late fall until early spring (CRESLI 2020) and are most likely to be encountered at low tide. Furthermore, seal watching activities on the northeast US coastline is most prevalent from December through mid-April in New York (DiGiovanni and Sabrosky 2010). Within the last three years, seals have been sited along the Fire Island National Seashore, Cupsogue Beach County Park, Montauk Point State Park, and Smith Point County Park (Long-Island-Pulse 2017; Harrington 2020). In November 2018, an aerial survey of haulout sites around Long Island, Connecticut, and Rhode Island were conducted by the AMCS to support a UME investigation. During this survey, more than 900 harbor and gray seals were observed (AMCS 2020).

Harbor seals are regularly observed in coastal areas and are the most abundant seals found in New York State. Important haulouts in Long Island include Fishers Island, Great Gull Island, Montauk Point, Gardiners Island, and Sag Harbor (Kenney and Vigness-Raposa 2010). Harbor seals utilize Eastern Point and Montauk Point of Long Island as terrestrial habitat, and the nearshore portion of the SRWEC as foraging and potential breeding grounds. These seals can likely be found in the nearshore areas around the proposed SRWEC landfall location at Smith Point adjacent to Fire Island. The most localized estimates of populations residing within the Long Island Sound harbors come from CRESLI, which observed nearly 16,000 harbor seals over 302 seal observation trips from 2007 through 2017 around Cupsogue Beach,

during which CRESLI found the highest monthly concentrations of seals from December through April, with abrupt declines in May.

During Project-specific PSO surveys from 2019 to 2020 (Smultea 2020), three estimated individuals were detected inside the SRWF, and four estimated individuals were detected outside the SRWF. Therefore, harbor seals are expected to have a regular occurrence within the SRWF and SRWEC corridor.

4.3.1.2 Abundance

The best available abundance estimate for harbor seals in the Western North Atlantic is 61,366, with global population estimates reaching 610,000 to 640,000 (Bjørge et al. 2010; Hayes et al. 2020; IUCN 2020; Hayes et al. 2021). Estimates of abundance are based on surveys conducted during the pupping season, when most of the population is assumed to be congregated along the Maine coast. Abundance estimates do not reflect the portion of the stock that might pup in Canadian waters (Hayes et al. 2021). Trend in population from 1993 to 2018 was estimated for non-pups and pups using a Bayesian hierarchical model to account for missing data both within and between survey years. The estimated mean change in non-pup harbor seal abundance per year was a positive from 2001 to 2004, but close to zero or negative between 2005 and 2018 (Hayes et al. 2021). After 2005, mean change in pup abundance was steady or declining until 2018 but these changes were not significant (Hayes et al. 2021).

4.3.1.3 Status

Harbor seals are not listed under the ESA, are listed as Least Concern by the IUCN Red List and are considered non-strategic because anthropogenic mortality does not exceed PBR (Hayes et al. 2020; IUCN 2020). The PBR for this population is 1,729 and the annual human-caused mortality and serious injury from 2015 to 2019 was estimated to be 399 seals per year (Hayes et al. 2021). This mortality and serious injury was attributed to fishery interactions, non-fishery related human interactions, and research activities (Hayes et al. 2020). Until 1972, harbor seals were commercially and recreationally hunted. Currently, only Alaska natives can hunt harbor seals for sustenance and the creation of authentic handicrafts. Other threats to harbor seals include disease and predation (Hayes et al. 2020). A UME was declared for harbor seal and grey seals with mortalities occurring across Maine, New Hampshire, and Massachusetts. A total of 3,152 strandings occurred between July 1, 2018 – March 13, 2020 with 103 in Connecticut/Rhode Island and 172 in New York (NMFS 2020a). The UME is no longer active, but official closure is still pending. There is no designated critical habitat for this species in the Project Area.

4.3.2 Gray Seal (Halichoerus grypus atlantica)

Gray Seals are the second most common pinniped in the US Atlantic EEZ (Jefferson et al. 2008). This species inhabits temperate and sub-arctic waters and lives on remote, exposed islands, shoals, and unstable sandbars (Jefferson et al. 2008). Gray Seals are large, reaching 2–3 m (7.5–10 ft) in length, and have a silver-gray coat with scattered dark spots (NMFS 2021d). These seals are generally gregarious and live in loose colonies while breeding (Jefferson et al. 2008). Though they spend most of their time in coastal waters, Gray Seals can dive to depths of 300 m (984 ft), and frequently forage on the outer shelf (Hammill et al. 2001; Jefferson et al. 2008). These opportunistic feeders primarily consume fish, crustaceans, squid, and octopus (Bonner et al. 1971; Reeves 1992; Jefferson et al. 2008). They often co-occur with Harbor Seals because their habitat and feeding preferences overlap (NMFS 2021d).

Two types of underwater vocalizations have been recorded for male and female gray seals; clicks and hums. Clicks are produced in a rapid series resulting in a buzzing noise with a frequency range between 500 Hz and 12 kHz. Hums, which is described as being similar to that of a dog crying in its sleep, are lower frequency calls, with most of the energy <1 kHz (Schusterman et al. 1970). AEP studies indicate that hearing sensitivity for this species is greatest between 140 Hz and 100 kHz (Southall et al. 2019).

4.3.2.1 Distribution

The eastern Canadian population of gray seals ranges from New Jersey to Labrador and is centered at Sable Island, Nova Scotia (Davies 1957; Mansfield 1966; Richardson and Rough 1993; Hammill et al. 2001). There are three breeding concentrations in eastern Canada: Sable Island, the Gulf of St. Lawrence, and along the east coast of Nova Scotia (Lavigueur and Hammill 1993). In US waters, gray seals currently pup at four established colonies from late December to mid-February: Muskeget and Monomoy Islands in Massachusetts, and Green and Seal Islands in Maine (Center for Coastal Studies 2017; Hayes et al. 2018). Pupping was also observed in the early 1980s on small islands in Nantucket-Vineyard Sound and more recently at Nomans Island (Hayes et al. 2018). Following the breeding season, gray seals may spend several weeks ashore in the late spring and early summer while undergoing a yearly molt. Between October 2018 and February 2021, 11 sightings of 11 individual gray seals were recorded all during the months of September between May 2018 and January 2021 during recent HRG and GT surveys within the area surrounding the SRWF and SRWEC (AIS-Inc. 2019; Bennett 2021; Stevens et al. 2021; Stevens and Mills 2021).

SRWF and SRWEC

Gray seals have a documented presence within the New York OPA, per the NYSERDA Digital Aerial Baseline Surveys conducted from Summer 2016 through Winter 2019 (Normandeau and APM 2019a, b, c, d, 2020). Gray seals sighted within the New York OPA occurred most often during the spring and winter months but were also documented in the fall, with the highest number documented in Winter 2016 to 2017 (33 individuals). As previously described, from 2019 to 2021, the AMCS has documented approximately four harbor and/or gray seal haulout sites along the Atlantic coastline of Long Island, with more scattered within Long Island Sound and off the coast of Rhode Island (AMCS 2020). Furthermore, in November 2018, an aerial survey of haulout sites around Long Island, Connecticut, and Rhode Island were conducted by the AMCS to support a UME investigation. During this survey, more than 900 harbor and gray seals were observed (AMCS 2020).

Young pups have been documented as stranded at Long Island, NY and Rhode Island beaches. The AMAPPS surveys identified 11 individuals during their winter aerial surveys (NMFS 2017; Palka et al. 2017). The overall time spent in US waters remains uncertain (Hayes et al. 2019), but the updated US population estimates make it possible that these seals will be seen around offshore New York waters. Additionally, during Project-specific PSO surveys from 2019 to 2020 (Smultea 2020), 12 estimated individuals were detected inside the SRWF, and three estimated individuals were detected outside the SRWF.

Historically, gray seals were relatively absent from New York, Massachusetts, Rhode Island, and nearby OCS waters. However, with the recent recovery of the Massachusetts and Canadian populations, their occurrence has increased in the US Mid-Atlantic (Kenney and Vigness-Raposa 2010). Records of gray seal strandings are primarily observed in spring and are distributed broadly along ocean-facing

beaches in Long Island, NY and Rhode Island. In New York, gray seals are typically seen alongside harbor seal haulouts. Two frequent sighting locations include Great Gull Island and Fisher's Island, NY as well as Sag Harbor and Gardiners Island (Kenney and Vigness-Raposa 2010). Therefore, the gray seal is expected to have a regular presence within the SRWF and SRWEC corridor.

4.3.2.2 *Abundance*

Estimates of the entire Western North Atlantic gray seal population are not available. Some estimates are available for portions of the stock, although recent genetic evidence suggests that all Western North Atlantic gray seals may actually comprise a single stock (Hayes et al. 2020). The best available current abundance estimate for gray seals of the Canadian gray seal stock is 424,300 and the current U.S. population estimate is 27,300 (Hayes et al. 2021). The population of gray seals is likely increasing in the U.S. Atlantic EEZ; recent data show approximately 28,000 to 40,000 gray seals were observed in Southeastern Massachusetts in 2015 (Hayes et al. 2020). A population trend is not currently available for this stock, although the observed increase in the number of pops born in U.S. pupping colonies between 1991 and 2019 is currently being evaluated (Hayes et al. 2020).

4.3.2.3 *Status*

This species is not listed under the ESA and is non-strategic under the MMPA because anthropogenic mortality does not exceed PBR (Hayes et al. 2020). Gray seal is listed as Least Concern by the IUCN Red List (IUCN 2020). The PBR for this population is 1,458, and the annual human-caused mortality and serious injury between 2015 and 2019 was estimated to be 4,453 in both the U.S. and Canada (Hayes et al. 2021). Like harbor seals, the gray seal was commercially and recreationally hunted until 1972. Mortality is currently attributed to fishery interactions, non-fishery related human interactions and hunting, research activities, Canadian commercial harvest, and removals of nuisance animals in Canada (Hayes et al. 2020). Other threats to this population include disease, predation, and natural phenomena like storms (Hayes et al. 2020). There is no designated critical habitat for this species in the Project Area). A UME was declared for harbor seal and grey seals with mortalities occurring across Maine, New Hampshire, and Massachusetts. A total of 3,152 strandings occurred between July 1, 2018 – March 13, 2020 with 103 in Connecticut/Rhode Island and 172 in New York (NMFS 2020a). The UME is no longer active, but official closure is still pending. There is no designated critical habitat for this species in the Project Area.

5 Type of Incidental Take Authorization Requested

Sunrise Wind is requesting the promulgation of incidental take regulations and issuance of a Letter of Authorization pursuant to section 101(a)(5)(A) of the MMPA for incidental take by Level A and Level B harassment of small numbers of marine mammals during the construction and operations activities described in Sections 1 and 2 in and around OCS-A 0487 and along the Sunrise Wind Export Cable to Smith Point Country Park, Long Island, New York (Figure 1).

The construction and operations activities have the potential to take by "Level B" harassment marine mammals as a result of sound energy introduced to the marine environment. In the absence of mitigation measures, sounds that may "harass" marine mammals include pulsed sounds generated by impact pile driving, HRG survey equipment, and potential in-situ UXO/MEC disposal as well as non-impulsive sounds from vibratory pile driving. The potential effects will depend on the species of marine

mammal, the behavior of the animal at the time of reception of the stimulus, as well as the received level (RL) of the sound. Disturbance reactions are likely to vary among some of the marine mammals in the general vicinity of the sound source. The mitigation and monitoring activities described in Section 11, including noise attenuation systems and advanced monitoring technologies such as passive acoustic recorders, infrared cameras, and night vision devices will be implemented so that the amount of Level B take is reduced to the lowest practicable level.

Certain construction activities, including monopile foundation installation and in-situ UXO/MEC disposal, have a small chance of causing Level A "take" for some marine mammal species. The planned monitoring and mitigation measures will reduce, but cannot eliminate, this possibility. Therefore, Level A takes are also requested as described below.

6 Takes Estimates for Marine Mammals

Nearly all anticipated takes would be "takes by harassment", involving temporary changes in behavior (i.e., Level B harassment). That is, acoustic exposure could result in temporary displacement of marine mammals from within ensonified zones or other temporary changes in behavioral state. The mitigation measures to be applied will reduce the already very low probability of Level A take, but for certain species and activities, some potential Level A takes could occur. The planned construction and operations activities are not expected to "take" more than small numbers of marine mammals and will have a negligible impact on the affected species or stocks. In the sections below, we describe the methods used to estimate "take by harassment" and present the resulting estimates of the numbers of marine mammals that might be affected during the planned activities.

6.1 Basis for Estimating Potential "Take"

The amount of potential "take by harassment" is calculated in two separate ways, depending on the activity. For WTG monopile and OCS-DC piled jacket foundation installation, sound exposure modeling was conducted to more accurately account for the movement and behavior of marine mammals and their exposure to the underwater sound fields produced during pile driving. Sound exposure modeling involves the use of a three-dimensional computer simulation in which simulated animals (animats) move through the modeled marine environment over time in ways that are defined by the known or assumed movement patterns for each species derived from visual observation, animal borne tag, or other similar studies. The sound field produced by the activity, in this case impact pile driving, is then added to the modeling environment at the location and for the duration of time anticipated for one or more pile installations. At each time step in the simulation, each animat records the received sound levels at its location resulting in a sound exposure history for each animat. These exposure histories are then analyzed to determine whether and how many animats were exposed above Level A and Level B thresholds. Finally, the density of animats used in the modeling environment, which is usually much higher than the actual density of marine mammals in the activity area so that the results are more statistically robust, is compared to the actual density of marine mammals anticipated to be in the activity area. The results are then used to scale the animat exposure estimates to the actual density estimates. A more detailed description of this method is available in Appendix A, including results for some species if avoidance of anthropogenic sounds (aversion) is included in the exposure modeling. However, the exposure modeling results including aversion are not used in the estimates of potential take included in this application.

For landfall construction activities, HRG surveys, and potential UXO/MEC detonations, takes are calculated by multiplying the expected densities of marine mammals in the activity area(s) by the area of water likely to be ensonified above the NMFS defined threshold levels in a single day (24-hour period). The result is then multiplied by the number of days on which the activity is expected to occur resulting in a density-based estimated take for each activity.

In both take calculation methods, the densities of marine mammals (individuals per unit area) expected to occur in the activity areas were calculated from habitat-based density modeling results reported by Roberts et al. (2016; 2017; 2018; 2021) (Table 6). Those data provide abundance estimates for species or species guilds within 10 km x 10 km grid cells (100 km^2) ((except NARW which are provided in a 5 km x 5 km grid (Roberts et al. 2021)) on a monthly or annual basis, depending on the species. The average monthly abundance for each species in each activity area was calculated as the mean value of the grid cells within each survey area in each month and then converted to density (individuals / 1 km^2) by dividing by 100 km^2. The grid cells used for the density calculations of each activity area are described separately in the sections below.

Table 6. Marine mammal density model version number, release date, and report citation for densities used in the density-based calculations.

Species	Scientific Name	Density Model Version Used	Model Release Date	Report Citation
Mysticetes				
Blue Whale*	*Balaenopter musculus*	1.3	09-26-2015	Roberts et al. 2016
Fin Whale*	*Balaenoptera physalus*	11	04-22-2018	Roberts et al. 2018
Humpback Whale	*Megaptera novaeangliae*	10	06-01-2017	Roberts et al. 2017
Minke Whale	*Balaenoptera acutorostrata*	9	06-01-2017	Roberts et al. 2017
North Atlantic Right Whale*	*Eubalaena glacialis*	11.1	11-22-2021	Roberts et al. 2021
Sei Whale*	*Balaenoptera borealis*	8	04-22-2018	Roberts et al. 2018
Odontocetes				
Atlantic Spotted Dolphin	*Stenella frontalis*	8	04-14-2018	Roberts et al. 2018
Atlantic White-Sided Dolphin	*Lagenorhynchus acutus*	3	04-14-2018	Roberts et al. 2018
Bottlenose Dolphin	*Tursiops truncatus*	5	04-14-2018	Roberts et al. 2018
Common Dolphin	*Delphinus delphis*	4	04-14-2018	Roberts et al. 2018
Harbor Porpoise	*Phocoena phocoena*	4	06-01-2017	Roberts et al. 2017
Pilot Whales	*Globicephala* spp.	6	08-08-2017	Roberts et al. 2017
Risso's Dolphin	*Grampus griseus*	4	04-14-2018	Roberts et al. 2018
Sperm Whale*	*Physeter macrocephalus*	7	06-01-2017	Roberts et al. 2017
Pinnipeds				
Seals (Harbor and Gray)	*Phocidae* spp.	4	04-14-2018	Roberts et al. 2018

For some species, observational data from Protected Species Observers (PSOs) aboard HRG and GT survey vessels indicate that the density-based take estimates may be insufficient to account for the number of individuals of a species that may be encountered during the planned activities. PSO data from HRG and GT surveys conducted in the area surrounding the Sunrise Wind Farm and Sunrise Wind Export

Cable from October 2018 through February 2021 (AIS-Inc. 2019; Bennett 2021; Stevens et al. 2021; Stevens and Mills 2021) were analyzed to determine the average number of individuals of each species observed per vessel day. To account for individuals not identified to the species level by PSOs (i.e. those recorded as "unidentified whale", "unidentified dolphin", "unidentified seal", etc.), the proportion of identified individuals of each species within each taxonomic group was calculated as shown in the column "Proportion of Total Individuals of Species Within Each Species Group" within Table 7. The proportion of each species was then multiplied by the total number of "unidentified" individuals belonging to that taxonomic group so that the unassigned individuals were re-assigned to the identified species proportional to the identified individuals within each taxonomic as shown in the column "Unidentified Individuals Assigned to Species" column in Table 7. The identified and re-assigned unidentified individuals for each species was then summed as shown in the "Total Individuals Including Proportion of Unidentified" column of Table 7. This value was then divided by the number of vessel days during which observations were conducted in 2018–2021 HRG surveys (470 days) to calculate the number of individuals observed per vessel day as shown in the final column in Table 7.

For other less-common species, the predicted densities from Roberts et al. (2016; 2017; 2018) are very low and the resulting density-based take estimate is less than a single animal or a typical group size for the species. In such cases, the density-based take estimate is increased to the mean group size for the species to account for a chance encounter during an activity. Mean group sizes for each species were calculated from recent aerial and/or vessel-based surveys as shown in Table 6.

The largest of the three take estimates: density based, PSO data based, or mean group size was then identified as the "highest Level B take" and used as the estimated take for each activity.

Table 7. The number of individual marine mammals observed, with and without inclusion of unidentified individuals, and the estimated number of individuals observed per vessel during day HRG surveys in 2018–2021.

Species	Identified Individuals	Proportion of Total Individuals Identified to Species Within Each Species Group	Unidentified Individuals Assigned to Species	Total Individuals Including Proportion of Unidentified	Individuals Observed Per Vessel Day
Mysticetes	**125**				
Blue Whale*	0	-	-	-	-
Fin Whale*	26	0.21	32.9	58.9	0.25
Humpback Whale	78	0.62	98.6	176.6	0.74
Minke Whale	16	0.13	20.2	36.2	0.15
North Atlantic Right Whale*	4	0.03	5.1	9.1	0.04
Sei Whale*	1	0.01	1.3	2.3	0.01
Unidentified Mysticetes	**158**				
Unidentified Mysticete Whale	124				-
Unidentified Whale	34				-
Odontocetes	**5871**				
Atlantic Spotted Dolphin	0	-	-	-	-
Atlantic White-Sided Dolphin	18	0.00	4.8	22.8	0.10
Bottlenose Dolphin	200	0.03	53.6	253.6	1.06
Common Dolphin	5634	0.96	1508.5	7142.5	29.76
Harbor Porpoise	5	0.00	1.3	6.3	0.03
Pilot Whales	0	-	-	-	-
Risso's Dolphin	14	0.00	3.7	17.7	0.07
Sperm Whale*	0	-	-	-	-
Unidentified Odontocetes	**1572**				
Unidentified Dolphin	1562				-
Unidentified Dolphin or Porpoise	10				-
Pinnipeds	**20**				
Harbor Seal	9	0.45	8.1	17.1	0.07
Gray Seal	11	0.55	9.9	20.9	0.09
Unidentified Pinniped	**18**				
Unidentified Pinniped	18				-

* Denotes species listed under the Endangered Species Act

Table 8. Mean group sizes of species for which incidental take is being requested.

Species	Individuals	Sightings	Mean Group Size	Source
Mysticetes				
Blue Whale*	3	3	1.0	Palka et al. (2017)
Fin Whale*	155	86	1.8	Kraus et al. (2016)
Humpback Whale	160	82	2.0	Kraus et al. (2016)
Minke Whale	103	83	1.2	Kraus et al. (2016)
North Atlantic Right Whale*	145	60	2.4	Kraus et al. (2016)
Sei Whale*	41	25	1.6	Kraus et al. (2016)
Odontocetes				
Atlantic Spotted Dolphin	1334	46	29.0	Palka et al. (2017)
Atlantic White-Sided Dolphin	223	8	27.9	Kraus et al. (2016)
Bottlenose Dolphin	259	33	7.8	Kraus et al. (2016)
Common Dolphin	2896	83	34.9	Kraus et al. (2016)
Harbor Porpoise	121	45	2.7	Kraus et al. (2016)
Pilot Whales	117	14	8.4	Kraus et al. (2016)
Risso's Dolphin	1215	224	5.4	Palka et al. (2017)
Sperm Whale*	208	138	1.5	Palka et al. (2017)
Pinnipeds				
Seals (Harbor and Gray)	201	144	1.4	Palka et al. (2017)

* Denotes species listed under the Endangered Species Act

6.2 Acoustic Thresholds

To assess potential auditory injury or permanent threshold shift (PTS), Level A harassment, NMFS has provided technical guidance (NMFS 2018a) that establishes dual criteria for five different marine mammal hearing groups, four of which occur in the Project Area (Table 8). The two criteria are based on different acoustic metrics or ways of measuring sound, the peak sound pressure level (SPL_{pk}) and the cumulative sound exposure level (SEL_{cum}). The SPL_{pk} metric captures the potential for auditory injury caused by very strong, instantaneous sounds while the SEL_{cum} metric captures the potential for injury caused by fatiguing of the auditory system from sounds received over time (in this case, a maximum 24-hr period).

The marine mammal hearing groups are based on the frequencies of sound to which species in that group are most sensitive. The frequency-dependent hearing sensitivities of each group are characterized by frequency weighting functions that are applied to the sounds being modeled and effective filter out sound energy at frequencies of less importance to species. Frequency weighting is applied when calculating distances to the SEL_{cum} threshold and some behavioral thresholds while SPL_{pk} is not frequency weighted, which is commonly referred to as unweighted or flat-weighted (Table 8).

Table 9. Marine mammal functional hearing groups and PTS (Level A harassment) and TTS thresholds as defined by NMFS (2018a) for species present in the survey area.

Marine Mammal Hearing Group	Generalized Hearing Range	PTS onset (Level A) Thresholds (Impulsive Sounds)	TTS onset Thresholds (Impulsive Sounds)
Low-frequency cetaceans (LF)	7 Hz to 35 kHz	$L_{pk,flat}$: 219 dB $L_{E,LF,24h}$: 183 dB	$L_{pk,flat}$: 213 dB $L_{E,LF,24h}$: 168 dB
Mid-frequency cetaceans (MF)	150 Hz to 160 kHz	$L_{pk,flat}$: 230 dB $L_{E,LF,24h}$: 185 dB	$L_{pk,flat}$: 224 dB $L_{E,LF,24h}$: 170 dB
High-frequency cetaceans (HF)	275 Hz to 160 kHz	$L_{pk,flat}$: 202 dB $L_{E,LF,24h}$: 155 dB	$L_{pk,flat}$: 196 dB $L_{E,LF,24h}$: 140 dB
Phocid pinnipeds (underwater) (PW)	50 Hz to 86 kHz	$L_{pk,flat}$: 218 dB $L_{E,LF,24h}$: 185 dB	$L_{pk,flat}$: 212 dB $L_{E,LF,24h}$: 170 dB

Scientific recommendations for revisions to these classifications were recently published by Southall et al. (2019). This publication proposes a new nomenclature and classification for the marine mammal hearing groups, but the proposed thresholds and weighting functions do not differ in effect from those in NMFS (2018a). The hearing groups and nomenclature proposed by Southall et al. (2019) have not yet been incorporated into the NMFS guidelines.

The received level at which marine mammals may behaviorally respond to anthropogenic sounds varies by numerous factors including the frequency content, predictability, and duty cycle of the sound as well as the experience, demography, and behavioral state of the marine mammals (Richardson et al. 1995; Southall et al. 2007b; Ellison et al. 2012). Despite this variability, there is a practical need for a reasonable and specific threshold. NMFS currently defines the threshold for behavioral harassment, Level B take, as 160 dB re 1 µPa SPL_{rms} [unless otherwise noted, all dB values hereafter are referenced to 1 µPa] for impulsive or intermittent sounds such as those produced by impact pile driving and some HRG survey equipment. For non-impulsive sounds, such as vibratory pile driving, NMFS defines the threshold for behavioral harassment at 120 dB re 1 µPa SPL_{rms}.

In the case of potential UXO/MEC detonations, additional thresholds for mortality and non-auditory injury to lung and gastrointestinal organs from the blast shock wave and/or onset of high peak pressures are also relevant (at relatively close ranges). These criteria have been developed by the U.S. Navy (DoN (U.S. Department of the Navy) 2017; Hannay and Zykov 2021)) and are based on the mass of the animal and the depth at which it is present in the water column. This means that specific decibel levels for each hearing group are not provided and instead the criteria are presented as equations that allow for incorporation of specific mass and depth values. Two separate sets of equations are available, the first is less conservative and reflects when individuals have a 50% chance of mortality or non-auditory injury (Table 10), while the second is more conservative and reflect the onset (1% chance) of experiencing the potential effects (Table 11). Only the results from the equations in Table 11 were used in the subsequent analyses.

Table 10. U.S. Navy impulse and peak pressure threshold equations for estimating at what levels marine mammals have a 50% probability of experiencing mortality or injury due to underwater explosions (DoN (U.S. Department of the Navy) 2017; Hannay and Zykov 2021). M is animal mass (in kg) and D is animal depth (m).

Impact Assessment Criterion	Threshold
Mortality- Impulse	$144M^{1/3}(1+\frac{D}{10.1})^{1/6}$ Pa-s
Injury- Impulse	$65.8M^{1/3}(1+\frac{D}{10.1})^{1/6}$ Pa-s
Injury- Peak Pressure	243 dB re 1 µPa peak

Table 11. U.S. Navy impulse and peak pressure threshold equations for estimating at what levels marine mammals have a 1% probability of experiencing mortality or non-auditory injury due to underwater explosions (DoN (U.S. Department of the Navy) 2017; Hannay and Zykov 2021). M is animal mass (in kg) and D is animal depth (m).

Onset Effect for Mitigation Consideration	Threshold
Onset Mortality- Impulse	$103M^{1/3}(1+\frac{D}{10.1})^{1/6}$ Pa-s
Onset Injury- Impulse (Non-auditory)	$47.5M^{1/3}(1+\frac{D}{10.1})^{1/6}$ Pa-s
Onset Injury- Peak Pressure (Non-auditory)	237 dB re 1 µPa peak

A single UXO/MEC detonation per day is not considered to cause behavioral harassment at the 160 dB level noted above. Instead, Level B harassment is considered possible if received sounds from a single UXO/MEC detonation per day rise above temporary threshold shift (TTS) levels or above 5 dB below the TTS thresholds in the event of multiple detonations in one day. Since only a single detonation per day is being considered, sub-TTS threshold behavioral harassment is not expected to occur. As with PTS onset levels used to define Level A take thresholds, TTS criteria use both SPL_{pk} and SEL_{cum} criteria as shown in

Table 9.

6.3 WTG Monopile and OCS-DC Piled Jacket Foundation Installation

Monopile foundations for WTGs will be up to 7/12 m in diameter and installed using an impact pile driver with a maximum hammer energy of up to 4,000 kJ. The pin piles used to secure the OCS-DC piled jacket foundation will be up to 4 m in diameter and installed using an impact pile driver with a maximum hammer energy of up to 4,000 kJ.

As summarized in Section 6.1, the take estimates for foundation installations were calculated using the animal exposure modeling process. Because the exact location and number of piles to be installed each day is uncertain, exposure modeling was conducted for several different scenarios to assess potential differences in the number of takes that could result from different installation timelines. The five modeled scenarios are summarized in the following list. The first two scenarios assumed consecutive (non-simultaneous) pile installation while the third through fifth scenarios assumed concurrent (simultaneous) pile installations:

1. Consecutive installation of 2 WTG monopiles or 4 OCS-DC pin piles consecutively in one day for 51 days.
2. Consecutive installation of 3 WTG monopiles or 4 OCS-DC pin piles consecutively in one day for 34 days.
3. Concurrent installation of 4 WTG monopiles in one day, two each by two different installation vessels operating concurrently in close proximity to each other ("Proximal", i.e. 3 nautical miles apart) for 25.5 days, plus 4 OCS-DC pin piles per day for two days.
4. Concurrent installation of 4 WTG monopiles in one day, two each by two different installation vessels operating concurrently at long distances from each other ("Distal", i.e. opposite ends of the SRWF) for 25.5 days plus 4 OCS-DC pin piles per day for two days.
5. Concurrent installation of 2 WTG monopiles and 4 OCS-DC pin piles in one day by one vessel and two WTG monopiles per day by a second vessel operating concurrently for two days and then 2 WTG monopiles per day by a single vessel for 47 days.

Additional details regarding the scenarios and associated assumptions are available in Appendix A.

6.3.1 Marine Mammal Densities

Monthly mean densities for each species were calculated from Roberts et al. (2016; 2017; 2018; 2020) habitat-based density predictions (Table 12). Density data for the calculations were selected from all grid cells within a 50 km distance from the outer perimeter of the SRWF (Figure 7; Appendix A). The 50 km distance was used since it provides a large sample of grid cells and represents the largest distance at which behavioral responses may occur (Dunlop et al. 2017). Since the precise timing of foundation installation is not currently known but will likely occur over at least two months, the exposure calculations were performed using the mean densities from the two months with the highest density estimates for each species excluding the months of January through April when foundation installations will not occur (Table 13). Due to differences in seasonal migration patterns, the two months selected are different for each species. Densities for the blue whale in this area were considered too low to be relevant for animal exposure modeling.

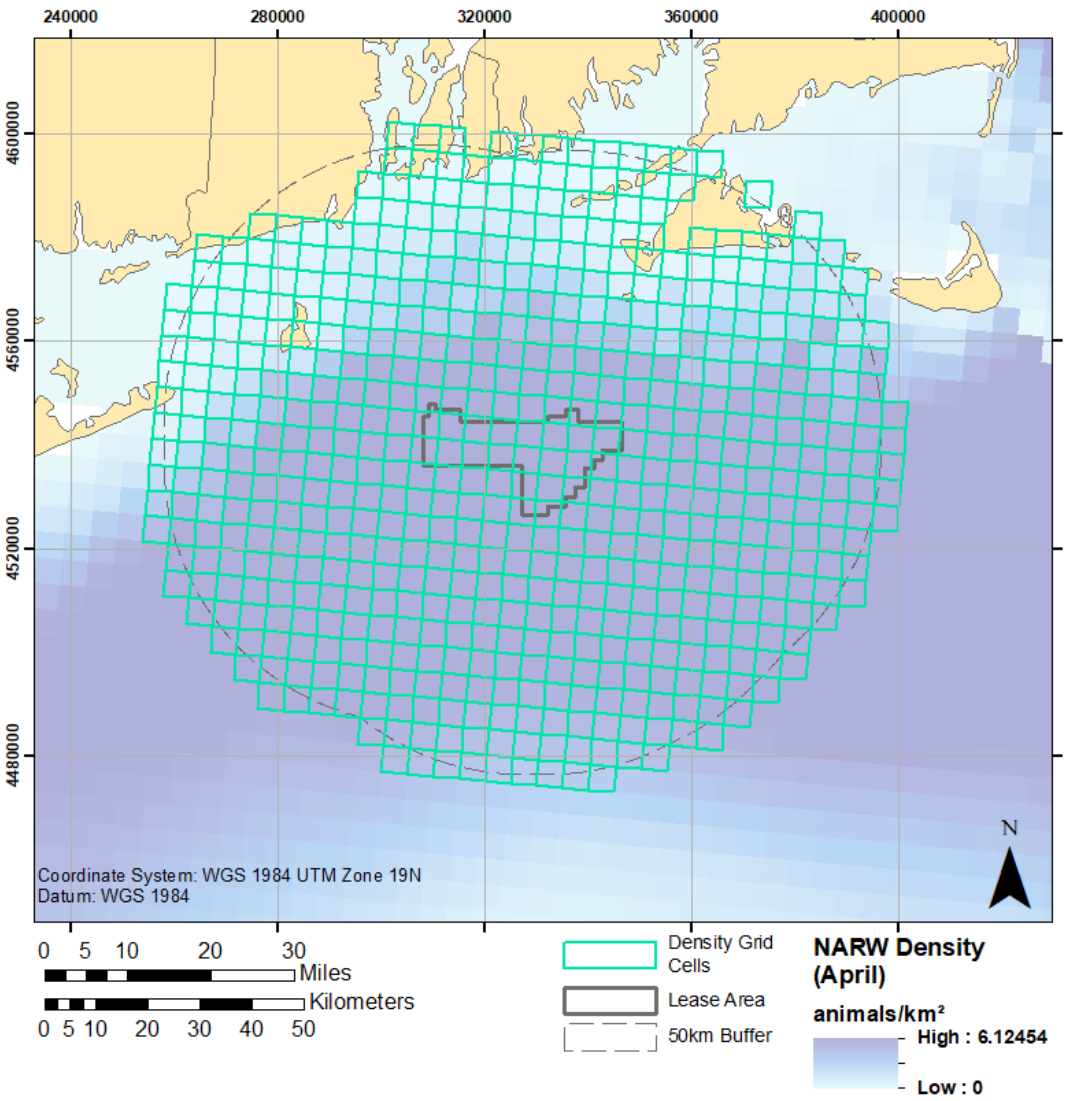


Figure 7. North Atlantic right whale density map showing highlighted grid cells from Roberts et al. (2021) used to calculate mean monthly density estimates within 50 km of OCS-A 0487 (Reproduced from Figure 3.1-1 in Appendix A).

Table 12. Average monthly marine mammal densities within 50 km of the SRWF perimeter.

	Monthly Average Densities (Individuals/1 km^2)											
Species	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Mysticetes												
Blue Whale*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Fin Whale*	0.0014	0.0014	0.0015	0.0028	0.0025	0.0026	0.0030	0.0028	0.0025	0.0015	0.0012	0.0012
Humpback Whale	0.0004	0.0002	0.0003	0.0013	0.0012	0.0013	0.0008	0.0006	0.0019	0.0012	0.0005	0.0006
Minke Whale	0.0005	0.0006	0.0006	0.0014	0.0021	0.0018	0.0006	0.0004	0.0004	0.0006	0.0003	0.0004
North Atlantic Right Whale*	0.0038	0.0049	0.0054	0.0060	0.0020	0.0001	0.0000	0.0000	0.0000	0.0001	0.0003	0.0016
Sei Whale*	0.0000	0.0000	0.0000	0.0003	0.0003	0.0002	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000
Odontocetes												
Atlantic Spotted Dolphin	0.0000	0.0000	0.0000	0.0001	0.0002	0.0004	0.0007	0.0010	0.0010	0.0013	0.0006	0.0001
Atlantic White-Sided Dolphin	0.0272	0.0153	0.0165	0.0358	0.0601	0.0539	0.0314	0.0162	0.0210	0.0303	0.0322	0.0383
Bottlenose Dolphin	0.0063	0.0009	0.0003	0.0068	0.0096	0.0291	0.0633	0.0592	0.0549	0.0321	0.0169	0.0117
Common Dolphin	0.1420	0.0342	0.0129	0.0281	0.0490	0.0578	0.0547	0.0803	0.1187	0.1440	0.1099	0.1983
Harbor Porpoise	0.0402	0.0745	0.1109	0.0668	0.0339	0.0050	0.0036	0.0036	0.0028	0.0043	0.0238	0.0264
Pilot Whales	0.0070	0.0070	0.0070	0.0070	0.0070	0.0070	0.0070	0.0070	0.0070	0.0070	0.0070	0.0070
Risso's Dolphin	0.0002	0.0001	0.0000	0.0001	0.0001	0.0002	0.0005	0.0008	0.0005	0.0002	0.0002	0.0004
Sperm Whale*	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0003	0.0002	0.0001	0.0001	0.0001	0.0000
Pinnipeds												
Seals (Harbor and Gray)	0.1433	0.1339	0.0791	0.0773	0.0935	0.0363	0.0101	0.0044	0.0060	0.0123	0.0195	0.1021

Table 13. Maximum and second highest average monthly marine mammal densities within 50 km of the SRWF perimeter excluding the months of January through April when foundation installations will not occur.

Species	Maximum Monthly Density (Ind./km²)	Maximum Density Month	2nd Highest Monthly Density (Ind./km²)	2nd Highest Density Month
Mysticetes				
Blue Whale*	N/A	Annual	N/A	Annual
Fin Whale*	0.0030	July	0.0028	August
Humpback Whale	0.0019	September	0.0013	June
Minke Whale	0.0021	May	0.0018	June
North Atlantic Right Whale*	0.0020	May	0.0016	December
Sei Whale*	0.0003	May	0.0002	June
Odontocetes				
Atlantic Spotted Dolphin	0.0013	October	0.0010	August
Atlantic White-Sided Dolphin	0.0601	May	0.0539	June
Bottlenose Dolphin	0.0633	July	0.0592	August
Common Dolphin	0.1983	December	0.1440	October
Harbor Porpoise	0.0339	May	0.0264	December
Pilot Whales	0.0070	Annual	0.0070	Annual
Risso's Dolphin	0.0008	August	0.0005	September
Sperm Whale*	0.0003	July	0.0002	August
Pinnipeds				
Seals (Harbor and Gray)	0.1021	December	0.0935	May

6.3.2 Area Potentially Exposed to Sounds Above Threshold Levels from WTG Monopile and OCS-DC Piled Jacket Installation

Sounds produced by installation of the 7/12 m WTG monopiles were modeled at two locations: one in the northwest section of the SRWF area and one in the southeast section (Figure 8). The installation of pin piles to secure the OCS-DC jacket foundation were modeled at one location in the central portion of the SRWF area (Figure 8). All piles were assumed to be vertical and driven to a maximum expected penetration depth of 50 m for the WTG monopiles and 90 m for the OCS-DC jacket foundation pin piles monopiles. For the 7/12 m WTG monopiles, 10,398 total hammer strikes were assumed, with hammer energy varying from 1,000 to 3,200 kJ. A single strike at 4,000 kJ on a 7/12 m WTG monopile was also modeled in case the use of the maximum hammer energy is required during some installations. The smaller 4 m pin piles for the OCS-DC jacket foundation were assumed to require 17,088 total strikes with hammer energy ranging from 300 to 4,000 kJ during the installation.

Forcing functions for impact pile driving were computed for each pile type using GRLWEAP (Pile-Dynamics 2010). The resulting forcing functions were used as inputs to JASCO's impact pile driving source model (PDSM) to characterize the sounds generated by the piles. Acoustic sound fields were estimated using JASCO's Marine Operations Noise model (MONM) and Full Wave Range Dependent Acoustic Model (FWRAM). To account for the likely minimum sound reduction resulting

from noise abatement systems (NAS) such as bubble curtains, the modeling study included hypothetical broadband attenuation levels of 0, 6, 10, and 15 dB for all impact pile driving acoustic modeling results.

Due to seasonal changes in the water column, sound propagation is likely to differ at different times of the year. 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. Additional details on modeling inputs and assumptions are described in Appendix A.

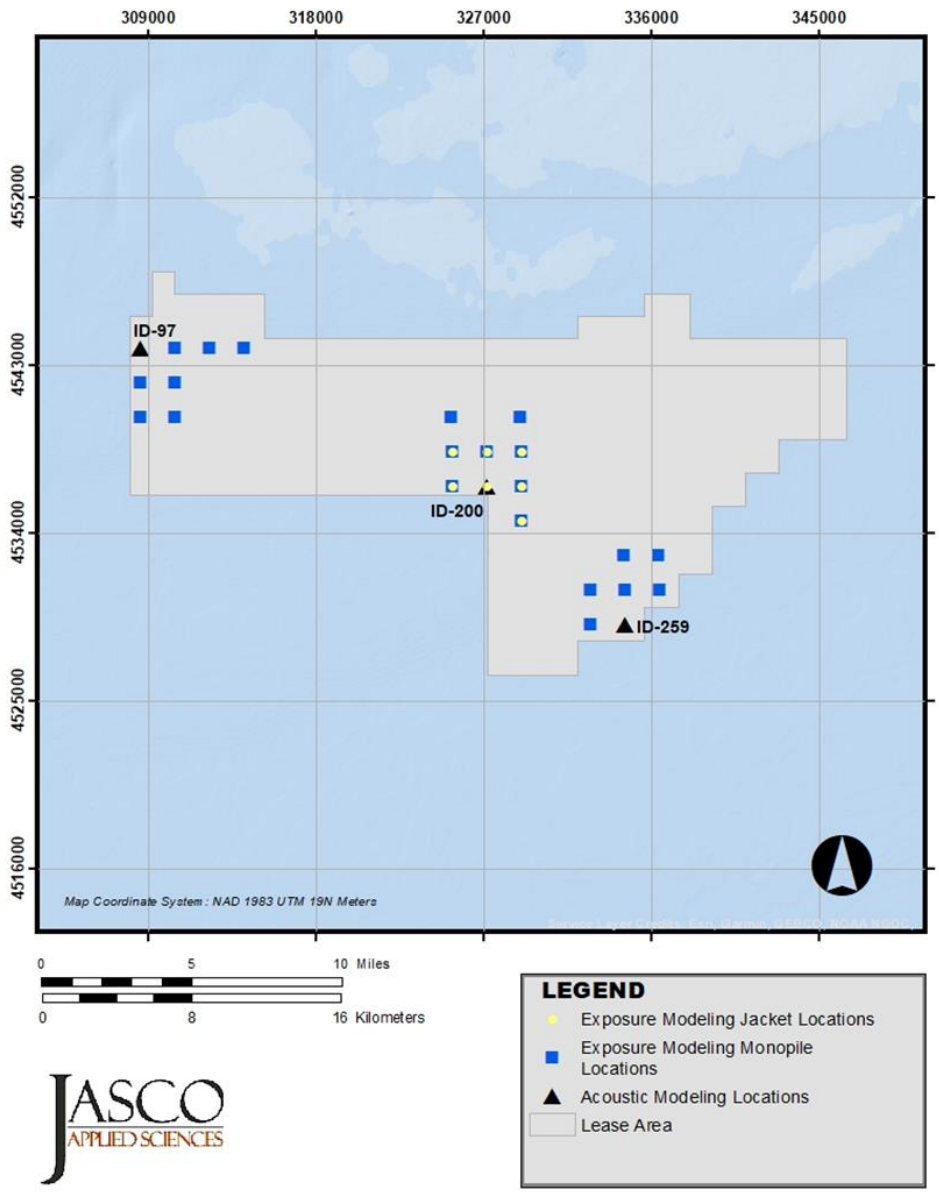


Figure 8. Location of acoustic propagation and animal exposure modeling for WTG monopile and OCS-DC piled jacket foundations (reproduced from Figure 1.2-3 in Appendix A).

The acoustic modeling included assumptions about the potential effectiveness of one or more NAS, such as bubble curtains, evacuated sleeve systems, encapsulated bubble systems (HydroSound Dampers), and Helmholtz resonators (AdBm) in reducing sounds propagated into the surrounding marine environment. Several recent studies summarizing the effectiveness of NAS have shown that broadband sound levels are likely to be reduced by anywhere from 7 to 17 dB, depending on the environment, pile size, and the size, configuration and number of systems used (Buehler et al. 2015; Bellmann et al. 2020a). The single bubble curtain applied in shallow water environments regularly achieves 7-8 dB broadband attenuation (Lucke et al. 2011; Rustemeier et al. 2012; Bellmann 2014, 2019). More recent in situ measurements during installation of large monopiles (~8 m) for WTGs in comparable water depths and conditions indicate that attenuation levels of 10 dB are readily achieved for a single bubble curtain (Bellmann 2019; Bellmann et al. 2020b). Large bubble curtains tend to perform better and more reliably, particularly when deployed with two rings (Koschinski and Ludemann 2013; Bellmann 2014; Nehls et al. 2016; Bellmann et al. 2020a). A California Department of Transportation study tested several small, single, bubble curtain systems and found that the best attenuation systems resulted in 10-15 dB of attenuation (Buehler et al. 2015). Buehler et al. (2015) concluded that attenuation greater than 10 dB could not be reliably predicted from small, single, bubble curtains because sound transmitted through the seabed and re-radiated into the water column is the dominant sound in the water for bubble curtains deployed immediately around the pile. Combinations of systems (e.g., double big bubble curtain, hydrodsound damper plus single big bubble curtain) potentially achieve much higher attenuation. The type and number of NAS to be used during construction have not yet been determined but will consist of at a minimum a single bubble curtain paired with an additional sound attenuation device or a double big bubble curtain. Based on prior measurements this combination of NAS are reasonably expected to achieve far greater than 10 dB broadband attenuation of impact pile driving sounds.

The ranges to threshold levels resulting from the acoustic modeling are reported using two different terminologies to reflect the underlying assumptions of the modeling. The term “acoustic range” is used to refer to acoustic modeling results that are based only on sound propagation modeling and not animal movement modeling. Acoustic ranges assume receivers of the sound energy (marine mammals) are stationary throughout the duration of the exposure. These are most applicable to thresholds where any single instantaneous exposure above the threshold is considered to cause a take, such as the Level A SPL_{pk} thresholds and the Level B SPL_{rms} threshold. For SEL_{cum} based thresholds, acoustic ranges represent the maximum distance at which a receiver would be exposed above the threshold level if it remained present during the entire sound producing event or 24 hours, whichever is less. Because of the instantaneous or single event nature of these thresholds, acoustic ranges will not differ between installation scenarios that assume consecutive piling and concurrent piling.

Since marine mammals are unlikely to remain stationary during the entire installation of a pile, SEL_{cum} acoustic ranges are difficult to interpret and tend to be overly conservative. To address this, results from animal movement modeling are used to estimate an “exposure range”. This involves analyzing the movements and resulting accumulated sound energy during the exposure modeling and identifying the ranges within which most animals (95%) were exposed above the threshold level if they occurred within that range at any point in time. Therefore, the exposure ranges provide a more realistic assessment of the distances within which animals would need to occur in order to accumulate enough sound energy to cross the applicable SEL_{cum} threshold. Because these are calculated using simulated animal movements over time that can also allow for multiple sound fields in different positions to be encountered, exposure ranges allow evaluation of impacts from scenarios that assume consecutive and concurrent pile installations.

The acoustic ranges to the SPL_{pk} and $R_{95\%}$ SEL_{cum} thresholds for WTG and OCS-DC foundations assuming various reductions in sound levels through use of a NAS are shown in Table 14, Table 15, and Table 16. The SPL_{pk} ranges in Table 14 are from modeling performed using a summer season sound speed profile which resulted in slightly longer distances for HF-cetaceans than in the winter season and no difference for the other hearing groups (Appendix A). Also note that the ranges in Table 14 do not include the 10 dB of noise attenuation assumed in most other results. For the 7/12 m WTG monopiles, both the 3,200 kJ hammer energy assumed in the per-pile installation schedule used to calculate potential exposures and the maximum 4,000 kJ hammer energy are shown. If the maximum 4,000 kJ hammer energy were used during an installation it is expected that fewer total strikes would be necessary, thus the total sound energy introduced to the water would not increase and the modeled ranges to SEL_{cum} thresholds, exposures, and exposure ranges would not change.

Results for both summer and winter seasons are shown for acoustic ranges to SEL_{cum} thresholds in Table 15, and Table 16, respectively. The distances to the unweighted and frequency-weighted (Southall et al. 2007b) 160 dB SPL_{rms} Level B harassment threshold in summer and winter seasons and assuming 10 dB of noise attenuation are provided in Table 17. As described in Section 6.2, NMFS currently uses the unweighted threshold for assessing potential Level B harassment of marine mammals, while the frequency-weighted thresholds take into account the hearing abilities of marine mammals relative to the sounds produced by the activity. Thus, the frequency-weighted ranges provide a more realistic indication of the distances at which sounds perceived by marine mammals within each hearing group might reach the established threshold.

Table 14. Acoustic ranges ($R_{95\%}$) in km to Level A peak sound pressure level (SPL_{pk}) thresholds for marine mammals from 7/12 m WTG monopile and 4 m OCS-DC jacket foundation pin pile installation using an IHC-4000 hammer and the summer sound speed profile. The values shown here do not assume 10 dB of broadband noise attenuation.

		Range (km)		
Hearing Group	**SPL_{pk} Threshold (dB re 1 µPa)**	**WTG Monopile Foundation (3,200 kJ)**	**WTG Monopile Foundation (4,000 kJ)**	**OCS-DC Jacket Foundation (4,000 kJ)**
Low-frequency	219	0.11	0.13	0.06
Mid-frequency	230	<0.01	<0.01	<0.01
High-frequency	202	0.9	1.00	0.57
Phocid pinniped	218	0.13	0.14	0.07

Table 15. Acoustic ranges ($R_{95\%}$) in km to Level A cumulative sound exposure level (SEL_{cum}) thresholds for marine mammals from installation of a single 7/12 m WTG monopile (10,398 strikes) and four 4 m OCS-DC jacket foundation pin piles (17,088 strikes each) in the summer (May – November) using an IHC S-4000 hammer and assuming increasing levels of broadband noise attenuation.

		Range (km)							
	SEL_{cum} Threshold	WTG Monopile Foundation				OCS-DC Jacket Foundation			
Hearing Group	(dB re 1 µPa²)	0	6	10	15	0	6	10	15
Low-frequency	183	10.15	7.32	5.7	4	13.52	8.68	6.6	4.77
Mid-frequency	185	-	-	-	-	0.25	0.07	0.04	-
High-frequency	155	0.67	0.19	0.09	0.03	3.53	2.17	1.46	0.88
Phocid pinniped	185	2.63	1.32	0.73	0.34	3.78	2.21	1.42	0.72

Table 16. Acoustic ranges ($R_{95\%}$) in km to Level A cumulative sound exposure level (SEL_{cum}) thresholds for marine mammals from installation of a single 7/12 m WTG monopile (10,398 strikes) and four 4 m OCS-DC jacket foundation pin piles (17,088 strikes each) in the winter (December – April) using an IHC S-4000 hammer and assuming increasing levels of broadband noise attenuation.

		Range (km)							
	SEL_{cum} Threshold	WTG Monopile Foundation				OCS-DC Jacket Foundation			
Hearing Group	(dB re 1 µPa²)	0	6	10	15	0	6	10	15
Low-frequency	183	11.91	8.04	6.14	4.26	18.98	10.44	7.22	4.95
Mid-frequency	185	-	-	-	-	0.13	0.07	0.04	-
High-frequency	155	0.48	0.32	0.09	0.03	3.3	1.98	1.36	0.76
Phocid pinniped	185	2.77	1.37	0.74	0.34	3.91	2.28	1.48	0.75

Table 17. Acoustic ranges ($R_{95\%}$) in km to the Level B, 160 dB re 1 µPa sound pressure level (SPL_{rms}) threshold impact pile driving during 7/12 m WTG monopile and OCS-DC jacket foundation pin pile (4 m) installation using an IHC S-4000 hammer and assuming 10 dB of broadband noise attenuation. Frequency-weighting functions from Southall et al.(2007a).

	Range (km)					
	WTG Monopile Foundation (3,200 kJ)		WTG Monopile Foundation (4,000 kJ)		OCS-DC Jacket Foundation (4,000 kJ)	
Hearing Group	Summer	Winter	Summer	Winter	Summer	Winter
Unweighted	6.07	6.5	6.49	6.97	6.47	6.63
Low-frequency	6.03	6.44	N.A.	N.A.	6.45	6.59
Mid-frequency	2.85	3.01	N.A.	N.A.	2.94	2.77
High-frequency	2.19	2.33	N.A.	N.A.	2.28	2.21
Phocid pinnipeds	4.38	4.64	N.A.	N.A.	4.81	4.62

N.A. – Not Available, frequency-weighted modeling of a 4,000 kJ hammer energy on WTG monopiles was not conducted.

Exposure ranges ($ER_{95\%}$) to Level A SEL_{cum} thresholds resulting from animal exposure modeling assuming various consecutive pile installation scenarios and 10 dB of attenuation by a NAS are summarized in

Table 18. By incorporating animal movement into the calculation of ranges to time-dependent thresholds (SEL metrics), these provide a more realistic assessment of the distances within which acoustic thresholds may be exceeded. This also means that different species within the same hearing group can have different exposure ranges as a result of differences in movement patterns for each species. Meaningful differences (greater than 500 m) between species within the same hearing group occurred for LF-cetaceans, so exposure ranges are shown separately for those species (

Table 18). For mid-frequency cetaceans and pinnipeds, the largest value from any single species was selected (

Table 18). In the event two installation vessels are able to work simultaneously, exposure ranges ($ER_{95\%}$) to Level A SEL_{cum} thresholds from the three concurrent pile installation scenarios summarized in Section 6.3 and 10 dB of attenuation by a NAS are summarized in Table 19. Comparison of the results in

Table 18 and Table 19 show that the scenario assuming consecutive installation of 2 WTG monopiles per day (which assumes the piles are located close to each other) and concurrent installation of 4 WTG monopiles per day at distant locations yield very similar results. This makes logical sense because the close proximity of the two piles installed at each location in the concurrent scenario is very similar to the 2 piles installed in the consecutive installation scenario and animals are unlikely to occur in both locations in the concurrent scenarios when they are far apart. Exposure ranges from the "Proximal" concurrent installation scenario (assuming close distances between concurrent pile installations) are slightly greater than from the "Distal" concurrent installation scenario (assuming long distances between concurrent pile installations) reflecting the fact that animals may be exposed to slightly higher cumulative sound levels when concurrent pile installations occur close to each other. However, the differences are not large which suggests there is relatively little additional risk to marine mammals from concurrent piling occurring in close proximity (~ 3 nautical miles).

Table 18. Exposure ranges[1] ($ER_{95\%}$) to Level A cumulative sound exposure level (SEL_{cum}) thresholds for marine mammals from consecutive installation of two and three 7/12 m WTG monopiles (10,398 strikes each) and four 4-m OCS-DC jacket foundation pin piles (17,088 strikes each) in one day during the summer and winter seasons using a IHC S-4000 hammer and assuming 10 dB of broadband noise attenuation.

		Range (km)					
		WTG Monopile 2-Piles/Day		WTG Monopile 3-Piles/Day		OCS-DC Jacket 4 piles/Day	
Hearing Group	**SEL_{cum} Threshold (dB re 1 μPa² ·s)**	**Summer**	**Winter**	**Summer**	**Winter**	**Summer**	**Winter**
Low-frequency	183						
Fin Whale*		3.91	4.19	3.68	4.24	5.55	6.42
Humpback Whale		3.63	3.8	3.4	3.82	5.13	3.2
Minke Whale		1.98	2.12	1.86	2.02	2.88	6.03
NA Right Whale*		2.66	2.81	2.51	2.9	3.62	4.06
Sei Whale*		2.69	3.09	2.67	3.01	4.22	4.73
Mid-frequency	185	0	0	0	0	0	0
High-frequency	155	0	0	0	0	0.81	0.59
Phocid pinnipeds	185	<0.01	<0.01	0.03	0.03	1.72	1.73

* Denotes species listed under the Endangered Species Act
[1]Exposure ranges are a result of animal movement modelling.

Table 19. Exposure ranges[1] ($ER_{95\%}$) to Level A cumulative sound exposure level (SEL_{cum}) thresholds for marine mammals from concurrent installation scenarios including up to four 7/12 m WTG monopiles (10,398 strikes each) per day in close proximity to each other ("Proximal") and distant from each other ("Distal") or two 7/12 m WTG monopiles and four 4-m OCS-DC jacket foundation pin piles (17,088 strikes each) in one day during the summer and winter seasons using a IHC S-4000 hammer and assuming 10 dB of broadband noise attenuation.

		Range (km)					
		Proximal WTG Monopiles 4-Piles/Day		Distal WTG Monopiles 4-Piles/Day		2 WTG Monopiles and 4 OCS-DC Jacket Pin-piles	
Hearing Group	**SEL_{cum} Threshold (dB re 1 μPa² ·s)**	**Summer**	**Winter**	**Summer**	**Winter**	**Summer**	**Winter**
Low-frequency	183						
Fin Whale*		4.23	4.83	3.8	3.8	5.25	6.21
Humpback Whale		4.02	4.32	3.66	3.66	4.83	5.68
Minke Whale		2.17	2.37	1.96	1.96	2.71	3.07
NA Right Whale*		2.94	3.31	2.61	2.61	3.49	3.85
Sei Whale*		3.18	3.37	2.74	2.74	3.97	4.65
Mid-frequency	185	0	0	0	0	0	0
High-frequency	155	0	0	0	0	0.61	0.57
Phocid pinnipeds	185	0.22	0.16	0.22	0.22	1.62	1.74

* Denotes species listed under the Endangered Species Act
[1]Exposure ranges are a result of animal movement modelling.

Exposure ranges ($ER_{95\%}$) to Level A SEL_{cum} thresholds and Level B SPL_{rms} resulting from animal exposure modeling assuming 3 WTG monopiles installed in one day and various levels of attenuation from 0 to 20 dB in the summer are shown in Table 20 and in the winter are shown in Table 21. Any activities conducted in the winter season (December) will utilize monitoring and mitigation measures based on the exposure ranges ($ER_{95\%}$) calculated using winter sound speed profiles as shown in Table 21. Exposure ranges assuming various levels of attenuation from 0 to 20 dB are available for the other modeled installation scenarios in Appendix A.

Table 20. Exposure ranges[1] ($ER_{95\%}$) to Level A cumulative sound exposure levels (SEL_{cum}) and Level B sound pressure level (SPL_{rms}) thresholds for marine mammals from installation of three 7/12 m WTG monopiles (10,398 strikes each) in one day during the summer season using an IHC S-4000 hammer and assuming various levels of broadband noise attenuation.

	Injury										Behavior				
	SEL_{cum}					SPL_{pk}					SPL_{rms}				
	Attenuation (dB)					Attenuation (dB)					Attenuation (dB)				
Hearing Group	**0**	**6**	**10**	**15**	**20**	**0**	**6**	**10**	**15**	**20**	**0**	**6**	**10**	**15**	**20**
Low-frequency															
Fin Whale*	7.8	5.36	3.68	2.21	1.23	0.05	0.02	<0.01	<0.01	0	11	7.49	5.73	3.89	2.59
Humpback Whale	7.31	4.88	3.4	2.07	1.07	0.06	<0.01	<0.01	<0.01	0	10.8	7.32	5.52	3.86	2.51
Minke Whale	5.04	3.03	1.86	0.91	0.45	0.08	0	0	0	0	10.3	6.93	5.3	3.53	2.18
NA Right Whale*	6	3.79	2.51	1.4	0.52	0.07	0.01	0	0	0	10.4	6.97	5.26	3.65	2.37
Sei Whale*	6.33	4.01	2.67	1.41	0.48	0.09	<0.01	<0.01	<0.01	0	10.8	7.33	5.46	3.76	2.43
Mid-frequency	0	0	0	0	0	<0.01	0	0	0	0	10.6	7.42	5.47	3.76	2.54
High-frequency	0.02	0	0	0	0	0.64	0.32	0.18	0.03	0.01	10.3	6.89	5.22	3.52	2.23
Phocid pinnipeds	1.27	0.45	0.03	0	0	0.04	<0.01	<0.01	<0.01	0	11.2	7.74	5.84	4.06	2.97

* Denotes species listed under the Endangered Species Act
[1]Exposure ranges are a result of animal movement modelling.

Table 21. Exposure ranges[1] ($ER_{95\%}$) to Level A cumulative sound exposure levels (SEL_{cum}) and Level B sound pressure level (SPL_{rms}) thresholds for marine mammals from installation of three 7/12 m WTG monopiles (10,398 strikes each) in one day during the winter season using an IHC S-4000 hammer and assuming various levels of broadband noise attenuation.

	Injury										Behavior				
	SEL_{cum}					SPL_{pk}					SPL_{rms}				
	Attenuation (dB)					Attenuation (dB)					Attenuation (dB)				
Hearing Group	**0**	**6**	**10**	**15**	**20**	**0**	**6**	**10**	**15**	**20**	**0**	**6**	**10**	**15**	**20**
Low-frequency															
Fin Whale*	9.4	5.98	4.24	2.46	1.35	0.05	0.02	<0.01	<0.01	0	13.2	8.44	6.16	4.13	2.55
Humpback Whale	8.96	5.52	3.82	2.29	1.06	0.06	<0.01	<0.01	<0.01	0	13.1	8.28	5.97	4.06	2.57
Minke Whale	5.77	3.39	2.02	0.98	0.47	0.07	0	0	0	0	12.3	7.87	5.66	3.73	2.24
NA Right Whale*	7.01	4.2	2.9	1.43	0.55	0.07	0.01	0	0	0	12.8	7.98	5.78	3.87	2.44
Sei Whale*	7.52	4.55	3.01	1.45	0.5	0.09	<0.01	<0.01	<0.01	0	12.9	8.24	5.93	4.08	2.46
Mid-frequency	0	0	0	0	0	<0.01	0	0	0	0	12.8	8.47	5.98	3.98	2.58
High-frequency	0.02	0	0	0	0	0.57	0.32	0.18	0.03	0.01	12.8	7.96	5.72	3.78	2.36
Phocid pinnipeds	1.34	0.45	0.03	0	0	0.04	<0.01	<0.01	<0.01	0	13.3	8.77	6.46	4.31	2.82

* Denotes species listed under the Endangered Species Act
[1]Exposure ranges are a result of animal movement modelling.

6.3.3 Estimated Takes from WTG Monopile and OCS-DC Piled Jacket Foundation Installation

Exposure modeling of consecutive pile installations was conducted at 2 different WTG monopile sites and 1 OCS-DC jacket foundation site (Figure 8; Appendix A). Results from the site that produced the highest exposure estimates for WTG and OCS-DC were selected and used in the following way to estimate the total potential take from the installations. The density from the highest month for each species was used to calculate exposures from installing 84 WTG monopiles (3 per day for 28 days) and the OCS-DC jacket foundation pin piles (4 per day for 2 days). Then the density from the second highest month for each species was used to calculate the take from installing 18 WTG monopiles (3 per day for 6 days). The results of these calculations were then summed to arrive at the total estimated exposure from WTG and OCS-DC foundation installations. Sound exposure modeling results showing potential Level A and Level B takes from installation of 102 WTG monopiles and 1 OCS-DC piled jacket foundations are shown in Table 22.

The Level A estimates shown are only from the SEL_{cum} threshold as the very short distances to the SPL_{pk} thresholds (Table 14) resulted in no meaningful likelihood of take from exposure to those sound levels. Level B take estimates are shown from sound exposure modeling using the unweighted 160 dB SPL_{rms} criterion, not the frequency weighted Wood et al. (2012) criteria. For comparison, Level B take estimates were also calculated using the unweighted 160 dB distances shown in Table 17 (assuming 4,000 kJ hammer energy for both the WTG Monopile and OCS-DC jacket pin pile installations) to calculate the ensonified area around each foundation. This total area was then multiplied by the densities shown in Table 13 to estimate take without the use of animal movement modeling. For both exposure modeling results and the "static" estimates, when the species density in Table 13 occurred during one of the winter months (December through April), the appropriate winter sound field or threshold distance in Table 17 was used in the calculations and vice versa for summer months.

Table 22. Estimated Level A and Level B take from installation of 102, 7/12 m WTG monopile foundations and 1 OCS-DC piled jacket foundation using an IHC S-4000 hammer assuming 10 dB of noise attenuation. Level B exposure modeling[1] take estimates are based on the unweighted distances to the 160 dB level. "Static" Level B take estimates are from the standard density X area method described in the text, not from exposure modeling.

	Exposure Modeling Take Estimates					
Species	**Level A (SPL_{cum})**	**Level B (SPL_{rms})**	**Static Level B Take Estimates**	**PSO Data Take Estimate**	**Mean Group Size**	**Highest Level B Take**
Mysticetes						
Blue Whale*	N/A	N/A	0.1	-	1.0	1
Fin Whale*	12.3	27.2	40.9	25.5	1.8	41
Humpback Whale	9.9	19.7	24.6	76.5	2.0	77
Minke Whale	13.4	41.6	27.8	15.7	1.2	42
North Atlantic Right Whale*	8.8	23.9	27.7	3.9	2.4	28
Sei Whale*	0.9	2.5	3.2	1.0	1.6	4
Odontocetes						
Atlantic Spotted Dolphin	0.0	4.1	16.6	-	29.0	29
Atlantic White-Sided Dolphin	0.0	1,193.3	812.4	9.9	27.9	1,194
Bottlenose Dolphin	0.0	909.3	861.6	109.9	7.8	910
Common Dolphin	0.0	5,783.2	2,940.4	3,095.1	34.9	5,784
Harbor Porpoise	2.5	402.5	458.5	2.7	2.7	459
Pilot Whales	0.0	127.0	96.2	-	8.4	127
Risso's Dolphin	0.0	11.2	10.5	7.7	5.4	11
Sperm Whale*	0.0	3.5	3.8	-	1.5	4
Pinnipeds						
Gray Seal	4.2	962.8	480.3	7.4	1.4	963
Harbor Seal	6.8	1,183.1	1,079.1	9.1	1.4	1,166

* Denotes species listed under the Endangered Species Act
[1] Exposure estimates are a result of animal movement modelling.

Exposure modeling of concurrent pile installations was conducted in the same general areas as the modeling of consecutive piles, but the pile locations were selected to fit the assumptions of the three concurrent piling scenarios described previously in Section 6.3 (Proximal, Distal and Monopile + OCS-DC pin piles) (Figure 9). Species densities were selected in the same manner as described for the consecutive pile installation modeling such that the highest monthly density for each species was applied to the first 30 days of each concurrent pile driving scenario while the second highest monthly density was applied to the remaining days of pile driving for each scenario. The resulting exposure estimates were similar among the three scenarios (Table 23), with Level A exposures for large whales being slightly higher for all species in the Proximal scenario while Level B exposures for large whales were largest in the Distal scenario. The maximum Level A and Level B exposure estimates among the three concurrent piling scenarios (Table 23) were very similar to the maximum from the consecutive piling scenarios (Table 22). Nonetheless, the highest Level A and Level B exposure estimates from across the five

installation scenarios was selected and summarized in Table 24 along with the static Level B and PSO-based take estimates.

The estimated monthly density of seals provided in Roberts et al. (2018) includes all seal species present in the region as a single guild. To split the resulting "seal" density-based exposure estimate by species, we multiplied the estimate by the proportion of the combined abundance attributable to each species. Specifically, we summed the SAR N_{best} abundance estimates (Hayes et al. 2021) for the two species (gray seal = 27,300, harbor seal = 61,336; total = 88,636) and divided the abundance estimate for each species by the combined total to get the proportion of the total for each species (gray seal = 0.308; harbor seal = 0.692). The total estimated exposure from the "seal" density provide by Roberts et al. (2018) was then multiplied by these proportions to get the species-specific exposure estimates.

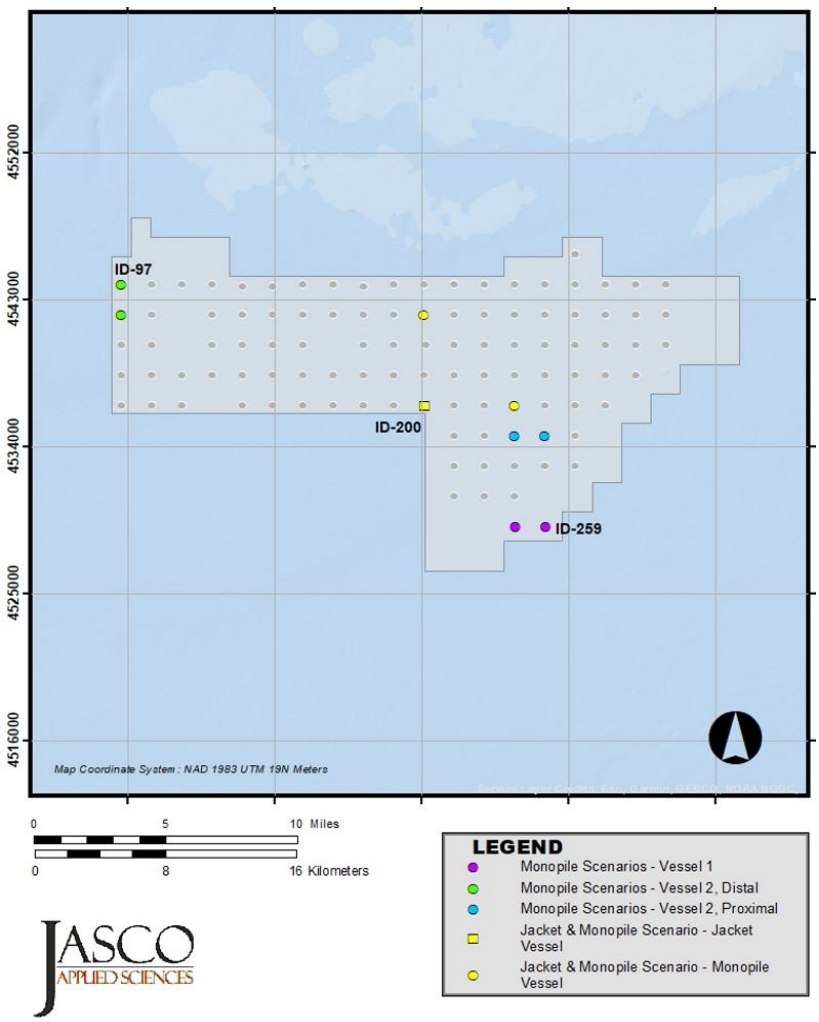


Figure 9. Locations of sound exposure modeling for concurrent WTG monopile and OCS-DC piled jacket foundation scenarios (reproduced from Figure 1.2-4 in Appendix A).

Table 23. Estimated Level A and Level B take from three different concurrent installation scenarios of 102, 7/12 m WTG monopile foundations and 1 OCS-DC piled jacket foundation using an IHC S-4000 hammer assuming 10 dB of noise attenuation. Level B exposure modeling[1] take estimates are based on the unweighted distances to the 160 dB level.

	Proximal WTG Monopiles 4-Piles/Day		Distal WTG Monopiles 4-Piles/Day		2 WTG Monopiles and 4 OCS-DC Jacket pin-piles		Maximum Among 3 Scenarios	
Species	**Level A (SPL_{cum})**	**Level B (SPL_{rms})**	**Level A (SPL_{cum})**	**Level B (SPL_{rms})**	**Level A (SPL_{cum})**	**Level B (SPL_{rms})**	**Level A (SPL_{cum})**	**Level B (SPL_{rms})**
Mysticetes								
Blue Whale*	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Fin Whale*	13.2	23.2	12.9	25.9	12.8	25.8	13.2	25.9
Humpback Whale	9.9	16.6	8.9	18.4	9.3	17.3	9.9	18.4
Minke Whale	15.0	33.1	13.7	41.9	13.5	39.7	15.0	41.9
North Atlantic Right Whale*	9.5	19.1	9.5	24.8	8.0	22.1	9.5	24.8
Sei Whale*	1.0	2.2	1.0	2.6	0.8	2.2	1.0	2.6
Odontocetes								
Atlantic Spotted Dolphin	0.0	8.0	0.0	7.7	0.0	4.0	0.0	8.0
Atlantic White-Sided Dolphin	0.0	938.5	0.0	1,195.3	0.0	1,121.3	0.0	1,195.3
Bottlenose Dolphin	0.0	750.7	0.0	886.9	0.0	892.2	0.0	892.2
Common Dolphin	0.0	4,812.6	0.0	6,136.2	0.0	5,455.9	0.0	6,136.2
Harbor Porpoise	2.5	334.9	2.5	402.5	2.6	380.3	2.6	402.5
Pilot Whales	0.0	100.7	0.0	125.3	0.0	123.4	0.0	125.3
Risso's Dolphin	0.0	8.6	0.0	11.2	0.0	9.4	0.0	11.2
Sperm Whale*	0.0	2.8	0.0	3.3	0.0	3.2	0.0	3.3
Pinnipeds								
Gray Seal	3.3	762.9	4.0	937.0	3.6	868.1	4.0	937.0
Harbor Seal	5.6	1,000.1	6.3	1,183.1	6.9	1,054.7	6.9	1,183.1

* Denotes species listed under the Endangered Species Act

[1] Exposure estimates are a result of animal movement modelling.

Table 24. Maximum estimated Level A and Level B take from installation of 102, 7/12 m WTG monopile foundations and 1 OCS-DC piled jacket foundation using an IHC S-4000 hammer assuming 10 dB of noise attenuation among the 5 modeled installation scenarios. Level B exposure modeling[1] take estimates are based on the unweighted distances to the 160 dB level. "Static" Level B take estimates are from the standard density X area method described in the text, not from exposure modeling.

	Exposure Modeling Take Estimates					
Species	**Level A (SPL_{cum})**	**Level B (SPL_{rms})**	**Static Level B Take Estimates**	**PSO Data Take Estimate**	**Mean Group Size**	**Highest Level B Take**
Mysticetes						
Blue Whale*	N/A	N/A	0.1	-	1.0	1
Fin Whale*	13.2	27.2	40.9	25.5	1.8	41
Humpback Whale	9.9	19.7	24.6	76.5	2.0	77
Minke Whale	15.0	41.9	27.8	15.7	1.2	42
North Atlantic Right Whale*	9.5	24.8	27.7	3.9	2.4	28
Sei Whale*	1.0	2.6	3.2	1.0	1.6	4
Odontocetes						
Atlantic Spotted Dolphin	0.0	8.0	16.6	-	29.0	29
Atlantic White-Sided Dolphin	0.0	1,195.3	812.4	9.9	27.9	1,196
Bottlenose Dolphin	0.0	909.3	861.6	109.9	7.8	910
Common Dolphin	0.0	6,136.2	2,940.4	3,095.1	34.9	6,137
Harbor Porpoise	2.6	402.5	458.5	2.7	2.7	459
Pilot Whales	0.0	127.0	96.2	-	8.4	127
Risso's Dolphin	0.0	11.2	10.5	7.7	5.4	12
Sperm Whale*	0.0	3.5	3.8	-	1.5	4
Pinnipeds						
Gray Seal	4.2	962.8	480.3	7.4	1.4	963
Harbor Seal	6.9	1,183.1	1,079.1	9.1	1.4	1,184

* Denotes species listed under the Endangered Species Act
[1] Exposure estimates are a result of animal movement modelling.

6.4 Export Cable Landfall Construction

Installation of the SRWEC landfall will be accomplished using a horizontal directional drilling (HDD) methodology. HDD will be used to connect the SRWEC offshore cable to the Onshore Transmission Cable at the Landfall and to cross the Intercoastal Waterway (ICW) from Fire Island to mainland Long Island. The drilling equipment will be located onshore and used to create a borehole, one for each cable, from shore to an exit point on the seafloor approximately 0.5 mi (800 m) offshore. Where each borehole exits to the seabed surface, casing pipe supported by sheet pile "goal posts" may be temporarily installed to collect drilling mud from the borehole exit point.

There would be up to 2 casing pipes which would be installed from a construction barge using a pneumatic pipe ramming tool (e.g., Grundoram Taurus or similar). Installation of a single casing pipe may take up to 3 hours of pneumatic hammering on each of 2 days for installation. Installation time will

be dependent on the number of pauses required to weld additional sections onto the casing pipe. For both casing pipes, this would mean a total of 4 days of installation. Removal of the casing pipes is anticipated to require approximately the same amount of pneumatic hammering and overall time, or less, meaning the pneumatic pipe ramming tool may be used for up to 3 hours per day on up to 8 days.

Up to 6 goal posts may be installed to support the casing pipe between the barge and the penetration point on the seabed. Each goal post would be composed of 2 vertical sheet piles installed using a vibratory hammer such as an APE model 300 (or similar). A horizontal cross beam connecting the two sheet piles would then be installed to provide support to the casing pipe. Up to 10 additional sheet piles may be installed per borehole to help anchor the barge and support the construction activities. This results in a total of up to 22 sheet piles per borehole and 2 boreholes bringing the overall total to 44 sheet piles. Sheet piles used for the goal posts and supports would be up to 30 m (100 ft) long, 0.6 m (2 ft) wide, and 1 inch thick. Installation of the goal posts would require up to 6 days per borehole, or up to 12 days total for both boreholes. Removal of the goal posts may also involve the use of a vibratory hammer and likely require approximately the same amount of time or less (12 days total for both boreholes) as installation. Thus, use of a vibratory pile driver to install and remove sheet piles may occur on up to 24 days at the landfall location.

All of the sheet pile goal posts would be installed first, followed by installation of the casing pipe. The installation of these components would occur on separate days and the Level B threshold distances are different for the two components, so the potential take has been calculated separately for installation of the goal posts and casing pipe as describe further below.

6.4.1 Marine Mammal Densities

The landfall construction activities will take place where the SRWEC comes to shore on Fire Island near Smith Point. To select marine mammal density grid cells from the Roberts et al. (2016; 2017; 2018; 2021) data representative of the area around the landfall location, a 10-km perimeter was created in GIS (ESRI 2017). This perimeter was then intersected with the density grid cells to select cells adjacent to the landfall location (Figure 10). The average density of each species in each month was then calculated from the selected grid cells (Table 25) and an annual average density was calculated by averaging across all 12 months (Table 26). Since the exact timing of landfall construction is uncertain but is likely to occur within a 1–2 month period, the maximum average monthly density for each species was selected and used to calculate potential takes from landfall construction.

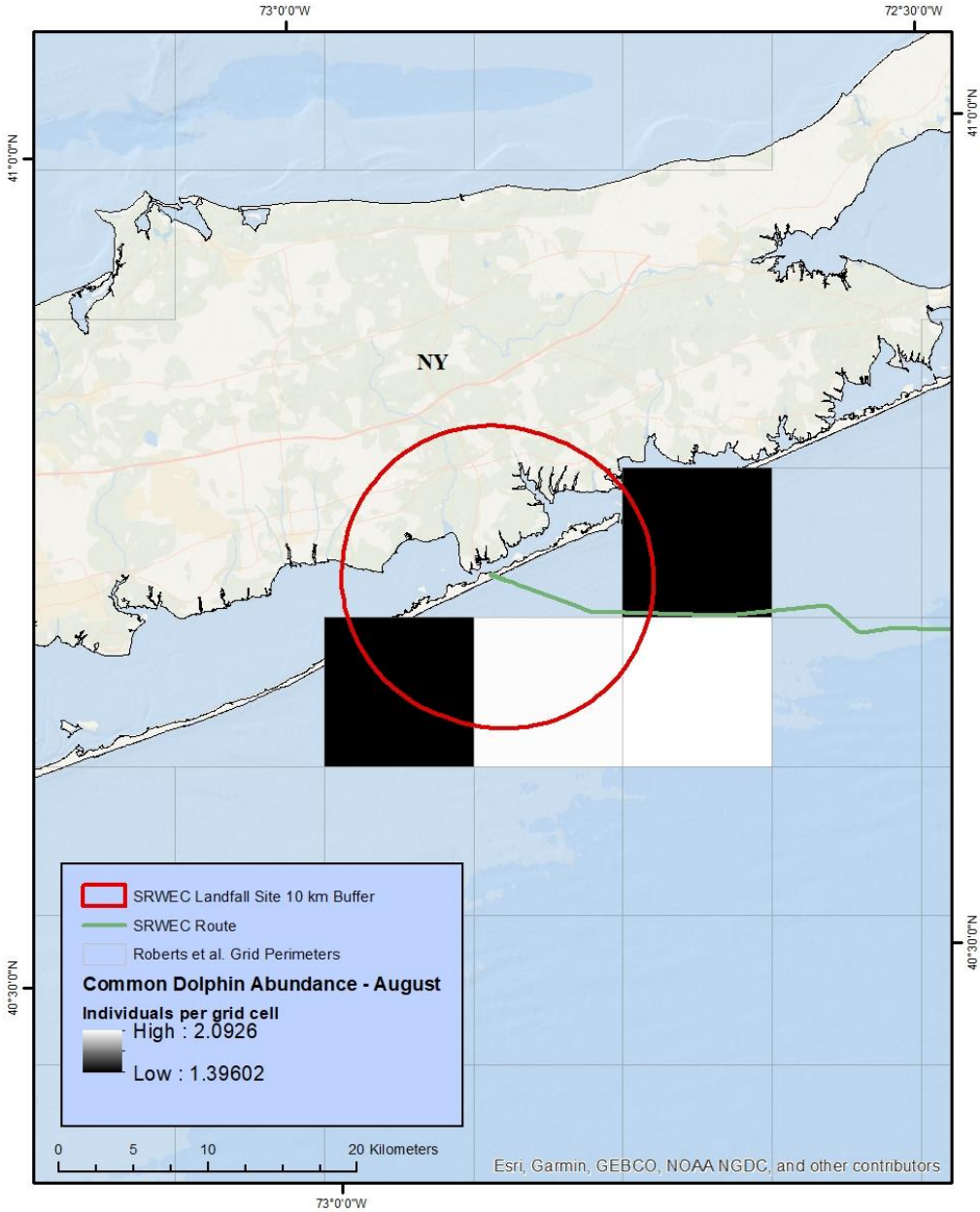


Figure 10. Location of the SRWEC landfall site and marine mammal density grid cells from Roberts et al. (2016; 2017; 2018; 2021) used for calculating representative monthly marine mammal densities.

Table 25. Average monthly marine mammal densities near the SRWEC landfall site

	Monthly Average Densities (Individuals/km²)											
Species	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Mysticetes												
Blue Whale*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Fin Whale*	0.0018	0.0017	0.0017	0.0031	0.0027	0.0028	0.0035	0.0032	0.0026	0.0017	0.0013	0.0013
Humpback Whale	0.0003	0.0002	0.0003	0.0019	0.0018	0.0019	0.0008	0.0010	0.0042	0.0018	0.0005	0.0003
Minke Whale	0.0005	0.0007	0.0007	0.0016	0.0023	0.0020	0.0007	0.0004	0.0004	0.0007	0.0003	0.0004
North Atlantic Right Whale*	0.0053	0.0068	0.0076	0.0093	0.0029	0.0002	0.0000	0.0000	0.0000	0.0001	0.0004	0.0022
Sei Whale*	0.0000	0.0000	0.0000	0.0003	0.0003	0.0002	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000
Odontocetes												
Atlantic Spotted Dolphin	0.0000	0.0000	0.0000	0.0001	0.0002	0.0003	0.0007	0.0008	0.0009	0.0010	0.0006	0.0001
Atlantic White-Sided Dolphin	0.0297	0.0158	0.0176	0.0377	0.0608	0.0580	0.0383	0.0207	0.0229	0.0328	0.0319	0.0415
Bottlenose Dolphin	0.0056	0.0005	0.0001	0.0026	0.0035	0.0076	0.0144	0.0159	0.0254	0.0208	0.0097	0.0063
Common Dolphin	0.1564	0.0276	0.0106	0.0266	0.0558	0.0578	0.0562	0.0827	0.1393	0.1731	0.1288	0.2565
Harbor Porpoise	0.0400	0.0989	0.1578	0.0839	0.0464	0.0030	0.0021	0.0022	0.0019	0.0026	0.0115	0.0176
Pilot Whales	0.0086	0.0086	0.0086	0.0086	0.0086	0.0086	0.0086	0.0086	0.0086	0.0086	0.0086	0.0086
Risso's Dolphin	0.0001	0.0001	0.0000	0.0000	0.0001	0.0001	0.0003	0.0004	0.0003	0.0001	0.0001	0.0003
Sperm Whale*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0003	0.0003	0.0001	0.0001	0.0001	0.0000
Pinnipeds												
Seals (Harbor and Gray)	0.0278	0.0871	0.0605	0.0297	0.0342	0.0108	0.0032	0.0014	0.0026	0.0045	0.0027	0.0159

* Denotes species listed under the Endangered Species Act

Table 26. Annual average and maximum monthly average marine mammal densities near the SRWEC landfall site and the month in which the maximum density occurs.

Species	Annual Average Density (Ind/km²)	Maximum Monthly Density (Ind/km²)	Maximum Density Month
Mysticetes			
Blue Whale*	0.0000	0.0000	Annual
Fin Whale*	0.0010	0.0015	April
Humpback Whale	0.0003	0.0008	December
Minke Whale	0.0002	0.0006	April
North Atlantic Right Whale*	0.0005	0.0014	February
Sei Whale*	0.0000	0.0001	April
Odontocetes			
Atlantic Spotted Dolphin	0.0001	0.0004	September
Atlantic White-Sided Dolphin	0.0026	0.0054	April
Bottlenose Dolphin	0.0408	0.1081	July
Common Dolphin	0.0194	0.0748	December
Harbor Porpoise	0.0210	0.0550	January
Pilot Whales	0.0004	0.0004	Annual
Risso's Dolphin	0.0000	0.0000	August
Sperm Whale*	0.0001	0.0003	June
Pinnipeds			
Seals (Harbor and Gray)	0.0366	0.0972	February

* Denotes species listed under the Endangered Species Act

6.4.2 Area Potentially Exposed to Sounds Above Threshold Levels from Cable Landfall Construction

The use of a Grundoram (or similar) pneumatic hammer to install and remove temporary casing pipe will produce impulsive sounds. To estimate distances to Level A and Level B thresholds acoustic modeling was performed at the anticipated HDD exit pit location approximately 0.5 mi (800 m) offshore of the landfall site. The modeling used a winter sound speed profile and assumed up to 3 hours of pneumatic hammer use per day for 2 days to install each casing pipe. Assuming 180 strikes per minute over 3 hours of operations results in up to 32,400 total strikes per day. Additional information used in the modeling is provided in Table 27 and Appendix A.

Results of the casing pipe installation acoustic modeling are shown in Table 28. The estimated distance to the Level B threshold, 920 m, is only slightly greater than the approximate 805 m (0.5 mile) distance to shore from the construction site. For simplicity, the entire area of a circle with 920 m radius (pi × r^2 where r is 920 m) was calculated (2.66 km^2) and used as the area ensonified above the Level B threshold from casing pipe installation.

For low-frequency cetaceans, high-frequency cetaceans, and seals, the estimated distances to Level A SEL_{cum} thresholds are larger than the Level B SPL thresholds. This is due to the high strike rate of the pneumatic hammer resulting in a high number of strikes per day. However, low-frequency cetaceans are unlikely to occur close to this nearshore site and individuals of any species are not expected to remain

within the estimated SEL_{cum} threshold distances for the entire duration of piling. With the implementation of planned monitoring and mitigation (see Section 11 and Appendix A), no Level A takes are anticipated.

Table 27. Casing pipe installation acoustic modeling assumptions.

Parameter	Model Input
Hammer Energy	18 kJ
Pile Length	30 m
Pile Diameter	1.2 m
Pile Wall Thickness	2.54 cm
Seabed Penetration	10 m
Angle of Installation	11-12 degrees
Time to Install 1 Casing Pipe	6 hrs
Number of Casing Pipes per Day	0.5
Duration of Hammering per Day	3 hrs
Strikes per Minute	180
Number of Hammer Strikes per Day	32,400

Table 28. Acoustic ranges ($R_{95\%}$) in meters to Level A (PTS) and Level B disturbance thresholds from impact pile driving during casing pipe installation for marine mammal functional hearing groups assuming a winter sound speed profile.

	Range (m)	
Marine Mammal Hearing Group	Level A SEL_{cum} Thresholds (dB re 1 μPa²·s)	Level B SPL_{rms} Threshold (160 dB re 1 μPa)
Low-frequency	3,870	920
Mid-frequency	230	920
High-frequency	3,950	920
Phocid pinniped	1,290	920

Acoustic modeling at the HDD exit pit location was also performed to determine threshold distances from installation of sheet piles to create the casing pipe support "goal posts" and support the construction barge. The modeling assumed the use of an APE model 300 vibratory hammer to drive the sheet piles vertically to 10 m below the seabed. For modeling purposes, it was assumed that each pile would require 2 hours to install and up to 4 piles would be installed per day (Table 29).

Results of the sheet pile installation acoustic modeling are shown in Table 30. The estimated distance to the Level B threshold, 9.74 km, is much greater than the approximate 805 m (0.5 mile) distance to shore from the construction site. The shoreline adjacent to this location is quite linear (Figure 10) and effectively splits a circle of 9.74 km in half. Thus, the area of a circle with 9.74 km radius ($pi \times r^2$ where r is 9.74 km) was calculated and divided in half resulting in a Level B ensonified area of 149 km^2 from sheet pile installation.

The distances to Level A SEL_{cum} thresholds are relatively short and assume animals would remain within those distances for the entire 8-hour duration of pile driving in a day. This, in addition to the

planned monitoring and mitigation around the landfall construction activities (see Section 11.3), means Level A takes are not anticipated or requested.

Table 29. Sheet pile installation acoustic modeling assumptions.

Parameter	Model Input
Vibratory Hammer	APE 300
Pile Type	Sheet Pile
Pile Length	30 m
Pile Width	0.6 m
Pile Wall Thickness	2.54 cm
Seabed Penetration	10 m
Time to Install 1 Pile	2 hrs
Number of Piles per Day	4

Table 30. Acoustic ranges ($R_{95\%}$) in meters to Level A (PTS) and Level B disturbance thresholds from vibratory pile driving during sheet pile installation for marine mammal functional hearing groups assuming a winter sound speed profile.

	Range (m)	
Marine Mammal Hearing Group	Level A SEL_{cum} Thresholds (dB re 1 $\mu Pa^2 \cdot s$)	Level B SPL_{rms} Threshold (120 dB re 1 μPa)
Low-frequency	5	9,740
Mid-frequency	-	9,740
High-frequency	190	9,740
Phocid pinniped	10	9,740

6.4.3 Estimated Takes from Cable Landfall Construction

Installation and removal of sheet piles may require vibratory pile driving on up to 12 days per cable borehole and 24 days in total for the two cables. Assuming a daily ensonified area of 149 km^2, the total area ensonified by vibratory pile driving would be 3,576 km^2. This value was multiplied by the densities in Table 26 to calculate the density based-takes shown in the Sheet Pile column of Table 31. Casing pipe installation and removal may require a total of 8 days, 4 days for each casing pipe. Assuming a daily ensonified area of 0.92 km^2, the total ensonified area would be 21.3 km^2. This value was multiplied by the densities in Table 26 to calculate the estimated Level B takes shown in the Casing Pipe column of Table 31. As described above, no Level A takes from landfall construction activities are anticipated or requested.

Table 31. Estimated Level B take from Export Cable landfall construction.

Species	Density-based Take by Landfall Installation Activity		Total Density-based Take Estimate	PSO Data Take Estimate	Mean Group Size	Highest Level B Take
	Sheet Pile	Casing Pipe				
Mysticetes						
Blue Whale*	0.0	0.0	0.0	-	1.0	1
Fin Whale*	5.3	0.0	5.3	7.8	1.8	8
Humpback Whale	3.0	0.0	3.0	23.5	2.0	24
Minke Whale	2.2	0.0	2.2	4.8	1.2	5
North Atlantic Right Whale*	5.2	0.0	5.2	1.2	2.4	6
Sei Whale*	0.2	0.0	0.2	0.3	1.6	2
Odontocetes						
Atlantic Spotted Dolphin	1.3	0.0	1.3	-	29.0	29
Atlantic White-Sided Dolphin	19.5	0.1	19.6	3.0	27.9	28
Bottlenose Dolphin	386.4	2.3	388.7	33.8	7.8	389
Common Dolphin	267.5	1.6	269.1	952.3	34.9	953
Harbor Porpoise	196.9	1.2	198.0	0.8	2.7	199
Pilot Whales	1.4	0.0	1.4	-	8.4	9
Risso's Dolphin	0.1	0.0	0.1	2.4	5.4	6
Sperm Whale*	0.9	0.0	0.9	-	1.5	2
Pinnipeds						
Gray Seal	107.0	0.6	107.7	2.3	1.4	108
Harbor Seal	240.4	1.4	241.9	2.8	1.4	242

6.5 HRG Surveys – Construction Phase

HRG surveys will take place within the Sunrise Wind Farm (SRWF) as well as along the Sunrise Wind Export Cable (SRWEC). For some species, marine mammal densities may differ between the more nearshore areas along the SRWEC and the more offshore location of the SRWF. For that reason, separate densities were calculated for the two areas and the total anticipated survey effort was similarly split between the two locations as described below.

6.5.1 Marine Mammal Densities

Marine mammal densities in and around the SRWF were calculated to estimate takes from WTG and OCS-DC foundation installations using a 50 km perimeter around the SRWF (Appendix A). This is appropriate given the larger zones of potential impact from the sounds produced by impact pile driving of the foundations. Since potential impacts from sounds produced by HRG survey equipment will be limited to much shorter distances, densities for the SRWF and SRWEC were calculated using a 10 km perimeter around those areas. To select marine mammal density grid cells from the Roberts et al. (2016; 2017; 2018; 2021) data representative of the area within and immediately adjacent to the SRWF and SRWEC, a 10-km perimeter of each area was created in GIS (ESRI 2017). This perimeter was then intersected with the density grid cells to select cells in and around the SRWF (Figure 11) and SRWEC (Figure 12). The average density of each species in each month was then calculated from the selected grid cells for the SRWF (Table 32) and the SRWEC (Table 33) and an annual average density was calculated by averaging

across all 12 months. Since HRG surveys may occur at any time of year, the average monthly density for each species was selected (Table 34 and Table 35) and used to calculated potential takes from HRG survey that may occur throughout the entire year.

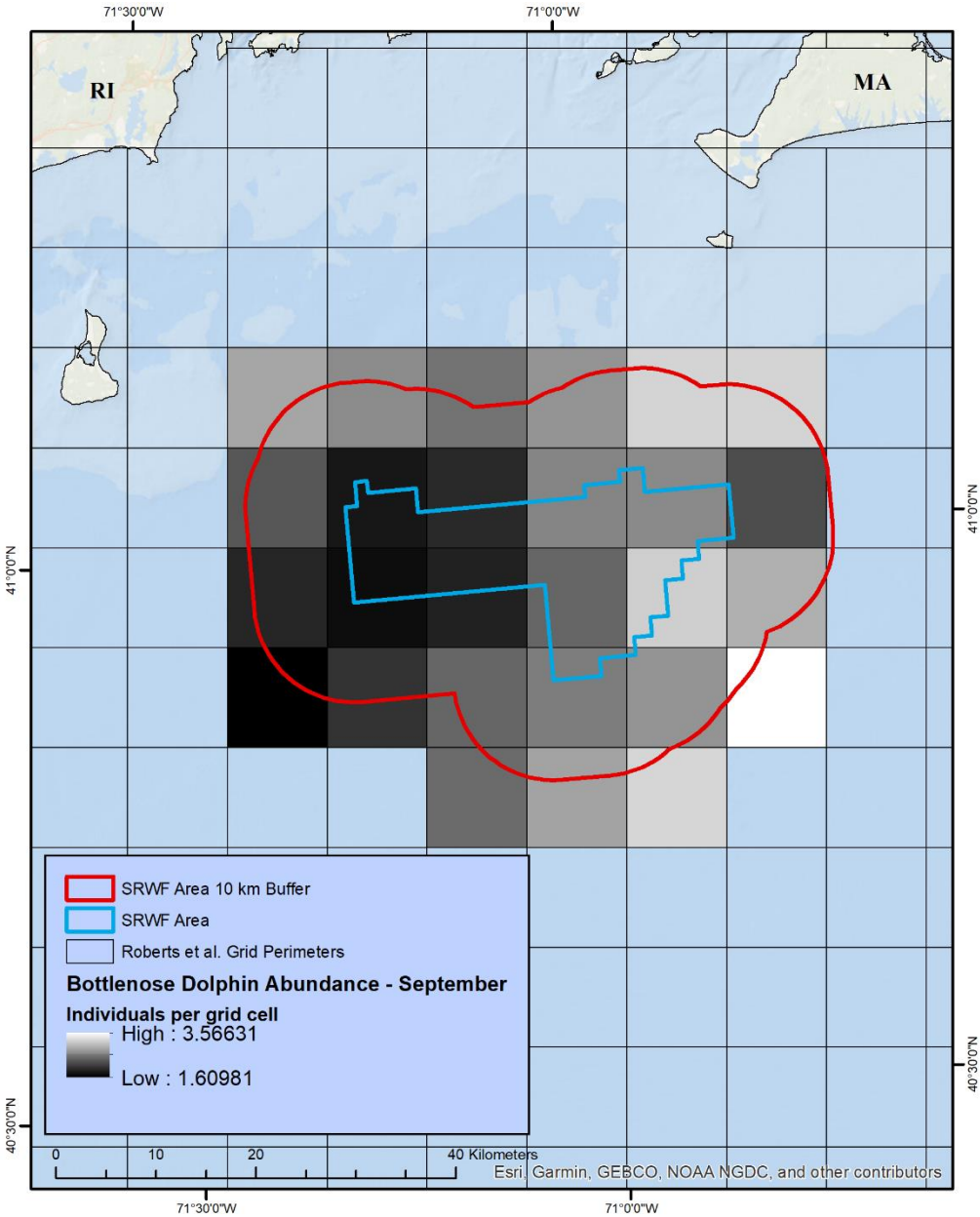


Figure 11. Location of the SRWF and marine mammal density grid cells from Roberts et al. (2016; 2017; 2018; 2021) used for calculating representative monthly marine mammal densities.

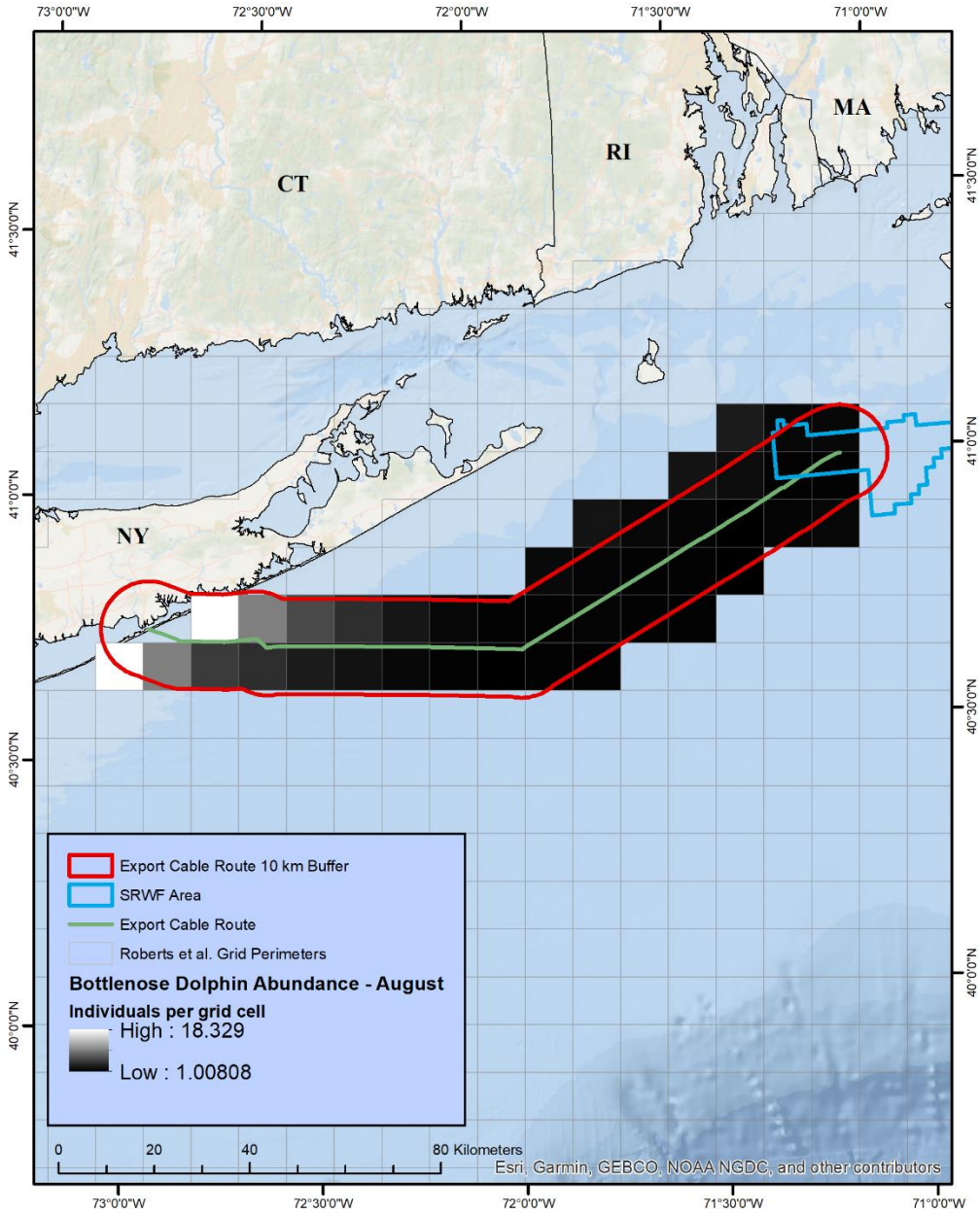


Figure 12. Location of the SRWEC and marine mammal density grid cells from Roberts et al. (2016; 2017; 2018; 2021) used for calculating representative monthly marine mammal densities.

Table 32. Average monthly marine mammal densities from within 10 km of the SRWF.

	Monthly Average Densities (Individuals/km²)											
Species	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Mysticetes												
Blue Whale*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Fin Whale*	0.0018	0.0017	0.0017	0.0031	0.0027	0.0028	0.0035	0.0032	0.0026	0.0017	0.0013	0.0013
Humpback Whale	0.0003	0.0002	0.0003	0.0019	0.0018	0.0019	0.0008	0.0010	0.0042	0.0018	0.0005	0.0003
Minke Whale	0.0005	0.0007	0.0007	0.0016	0.0023	0.0020	0.0007	0.0004	0.0004	0.0007	0.0003	0.0004
North Atlantic Right Whale*	0.0053	0.0068	0.0076	0.0093	0.0029	0.0002	0.0000	0.0000	0.0000	0.0001	0.0004	0.0022
Sei Whale*	0.0000	0.0000	0.0000	0.0003	0.0003	0.0002	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000
Odontocetes												
Atlantic Spotted Dolphin	0.0000	0.0000	0.0000	0.0001	0.0002	0.0003	0.0007	0.0008	0.0009	0.0010	0.0006	0.0001
Atlantic White-Sided Dolphin	0.0297	0.0158	0.0176	0.0377	0.0608	0.0580	0.0383	0.0207	0.0229	0.0328	0.0319	0.0415
Bottlenose Dolphin	0.0056	0.0005	0.0001	0.0026	0.0035	0.0076	0.0144	0.0159	0.0254	0.0208	0.0097	0.0063
Common Dolphin	0.1564	0.0276	0.0106	0.0266	0.0558	0.0578	0.0562	0.0827	0.1393	0.1731	0.1288	0.2565
Harbor Porpoise	0.0400	0.0989	0.1578	0.0839	0.0464	0.0030	0.0021	0.0022	0.0019	0.0026	0.0115	0.0176
Pilot Whales	0.0086	0.0086	0.0086	0.0086	0.0086	0.0086	0.0086	0.0086	0.0086	0.0086	0.0086	0.0086
Risso's Dolphin	0.0001	0.0001	0.0000	0.0000	0.0001	0.0001	0.0003	0.0004	0.0003	0.0001	0.0001	0.0003
Sperm Whale*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0003	0.0003	0.0001	0.0001	0.0001	0.0000
Pinnipeds												
Seals (Harbor and Gray)	0.0278	0.0871	0.0605	0.0297	0.0342	0.0108	0.0032	0.0014	0.0026	0.0045	0.0027	0.0159

Table 33. Average monthly marine mammal densities from within 10 km of the SRWEC.

	Monthly Average Densities (Individuals/km²)											
Species	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Mysticetes												
Blue Whale*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Fin Whale*	0.0016	0.0016	0.0016	0.0032	0.0025	0.0030	0.0033	0.0032	0.0033	0.0016	0.0012	0.0012
Humpback Whale	0.0003	0.0002	0.0002	0.0017	0.0013	0.0017	0.0005	0.0003	0.0013	0.0008	0.0005	0.0004
Minke Whale	0.0005	0.0006	0.0006	0.0017	0.0021	0.0016	0.0005	0.0003	0.0004	0.0007	0.0002	0.0003
North Atlantic Right Whale*	0.0030	0.0042	0.0052	0.0067	0.0019	0.0001	0.0000	0.0000	0.0000	0.0000	0.0003	0.0012
Sei Whale*	0.0000	0.0000	0.0000	0.0002	0.0002	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Odontocetes												
Atlantic Spotted Dolphin	0.0000	0.0000	0.0000	0.0001	0.0001	0.0002	0.0003	0.0004	0.0005	0.0007	0.0007	0.0001
Atlantic White-Sided Dolphin	0.0219	0.0113	0.0123	0.0325	0.0434	0.0368	0.0214	0.0096	0.0130	0.0227	0.0231	0.0287
Bottlenose Dolphin	0.0071	0.0009	0.0002	0.0031	0.0065	0.0201	0.0235	0.0247	0.0227	0.0162	0.0089	0.0082
Common Dolphin	0.2153	0.0442	0.0153	0.0291	0.0498	0.0645	0.0667	0.0891	0.1165	0.1422	0.1203	0.2793
Harbor Porpoise	0.0412	0.1095	0.1397	0.0800	0.0355	0.0015	0.0011	0.0012	0.0009	0.0018	0.0126	0.0245
Pilot Whales	0.0081	0.0081	0.0081	0.0081	0.0081	0.0081	0.0081	0.0081	0.0081	0.0081	0.0081	0.0081
Risso's Dolphin	0.0001	0.0001	0.0000	0.0000	0.0001	0.0001	0.0004	0.0006	0.0003	0.0001	0.0001	0.0003
Sperm Whale*	0.0000	0.0000	0.0000	0.0000	0.0001	0.0002	0.0004	0.0003	0.0001	0.0001	0.0001	0.0000
Pinnipeds												
Seals (Harbor and Gray)	0.0362	0.0861	0.0637	0.0195	0.0338	0.0102	0.0034	0.0012	0.0020	0.0049	0.0030	0.0216

Table 34. Annual average marine mammal densities within 10 km of the SRWF.

Species	Annual Average Density (Ind./km²)
Mysticetes	
Blue Whale*	0.0000
Fin Whale*	0.0023
Humpback Whale	0.0013
Minke Whale	0.0009
North Atlantic Right Whale*	0.0029
Sei Whale*	0.0001
Odontocetes	
Atlantic Spotted Dolphin	0.0004
Atlantic White-Sided Dolphin	0.0340
Bottlenose Dolphin	0.0094
Common Dolphin	0.0976
Harbor Porpoise	0.0390
Pilot Whales	0.0086
Risso's Dolphin	0.0002
Sperm Whale*	0.0001
Pinnipeds	
Seals (Harbor and Gray)	0.0234

* Denotes species listed under the Endangered Species Act

Table 35. Annual average marine mammal densities within 10 km of the SRWEC.

Species	Annual Average Density (Ind/km²)
Mysticetes	
Blue Whale*	0.0000
Fin Whale*	0.0023
Humpback Whale	0.0008
Minke Whale	0.0008
North Atlantic Right Whale*	0.0019
Sei Whale*	0.0001
Odontocetes	
Atlantic Spotted Dolphin	0.0002
Atlantic White-Sided Dolphin	0.0231
Bottlenose Dolphin	0.0118
Common Dolphin	0.1027
Harbor Porpoise	0.0375
Pilot Whales	0.0081
Risso's Dolphin	0.0002
Sperm Whale*	0.0001
Pinnipeds	
Seals (Harbor and Gray)	0.0238

* Denotes species listed under the Endangered Species Act

6.5.2 Area Potentially Exposed to Sounds Above Threshold Levels from HRG Surveys-Construction Phase

As described in Section 1.1.4, several different types of equipment may be used during HRG surveys, including single-beam echosounders, multi-beam echosounders, side scan sonars, non-parametric sub-bottom profilers, parametric sub-bottom profilers, boomers, and sparkers. Only the sounds produced by sub-bottom profilers (SBPs), boomers, and sparkers have the potential to cause incidental take so representative instruments were modeled and distances to threshold levels determined as described below.

Shallow-penetration, non-impulsive, non-parametric SBPs (compressed high-intensity radiated pulses [CHIRP SBPs]) are used to map the near-surface stratigraphy (top 0 to 5 m (0 to 16 ft) of sediment below the seabed. A CHIRP SBP system emits "swept" sound pulses that increase in frequency from approximately 2 to 20 kHz over the duration of the pulse. The pulse length and frequency range can be adjusted to meet Project variables. These shallow-penetration SPBs are typically mounted on a pole, rather than towed, either over the side of the vessel or through a moon pool in the bottom of the hull, reducing the likelihood that an animal would be exposed to the signal.

Medium-penetration, impulsive boomers are used to map deeper subsurface stratigraphy as needed. A boomer is a broad-band sound source operating in the 3.5 Hertz (Hz) to 10 kHz frequency range. This system is commonly mounted on a sled and towed behind the vessel.

Medium-penetration, impulsive sparkers are used to map deeper subsurface stratigraphy as needed. Sparkers create acoustic pulses from 50 Hz to 4 kHz omnidirectionally from the source that can penetrate several hundred meters into the seafloor. Sparkers are typically towed behind the vessel with adjacent hydrophone arrays to receive the return signals.

Although the final equipment choices will vary depending on the final survey design, vessel availability, make and model updates, and survey contractor selection, all sources that are representative of those that could be employed during the HRG surveys and have the expected potential to result in exposure of marine mammals and potentially result in take, are provided in Table 36 along with details of the parameters used in acoustic analyses.

The Dura-spark measurements and specifications provided in Crocker and Fratantonio (2016) were used for all sparker systems proposed for the survey. These include variants of the Dura-spark sparker system and various configurations of the GeoMarine Geo-Source sparker system. The data provided in Crocker and Fratantonio (2016) represent the most applicable data for similar sparker systems with comparable operating methods and settings when manufacturer or other reliable measurements are not available. Crocker and Fratantonio (2016) provide S-Boom measurements using two different power sources (CSP–D700 and CSP–N). The CSP–D700 power source was used in the 700 J measurements but not in the 1,000 J measurements. The CSP–N source was measured for both 700 J and 1,000 J operations but resulted in a lower SL; therefore, the single maximum SL value was used for both operational levels of the S-Boom.

Table 36. Summary of representative HRG Survey equipment and operating parameters used to calculate distances to incidental take threshold levels.

Equipment Type	Representative Model	Operating Frequency (kHz)	Source Level SPL_{rms} (dB)	Source Level 0-pk (dB)	Pulse Duration (ms)	Repetition Rate (Hz)	Beamwidth (degrees)	Information Source
Sub-bottom Profiler	EdgeTech 216	2 – 16	195	-	20	6	24	MAN
	EdgeTech 424	4 – 24	176	-	3.4	2	71	CF
	Edgetech 512	0.7 – 12	179	-	9	8	80	CF
	GeoPulse 5430A	2 – 17	196	-	50	10	55	MAN
	Teledyn Benthos Chirp III - TTV 170	2 – 17	197	-	60	15	100	MAN
Sparker	Applied Acoustics Dura-Spark UHD (400 tips, 500 J)	0.3 – 1.2	203	211	1.1	4	Omni	CF
Boomer	Applied Acoustics triple plate S-Boom (700–1,000 J)	0.1 – 5	205	211	0.6	4	80	CF

- = not applicable; CF = Crocker and Fratantonio (2016); MAN = Manufactures Specifications
Source Levels are given in dB re 1 µPa @ 1m

To estimate the potential for Level A take from the HRG survey sources, the SEL_{cum} metric was applied to non-impulsive sources to estimate the range to acoustic thresholds. Because impulsive sources use dual metrics (SEL_{cum} and SPL_{pk}) for Level A exposure criteria, the metric resulting in the largest isopleth distance was used for exposure estimation. Weighting factor adjustments (WFAs) for Level A isopleths used to account for differences in marine mammal hearing were determined by examining the frequency range and spectral densities for each source. The selected WFAs were then compared to the Applicable Frequencies Table located in the WFA tab of the NMFS User Spreadsheet Tool (NMFS

2018a). If the determined frequency was lower than the applicable frequency for all hearing groups, it was entered as the WFA. When the frequency of a source exceeded the applicable frequency for a certain hearing group, an additional worksheet was created that applied the "use" frequency of the exceeded hearing group as indicated by NMFS (NMFS 2018a).

The User Spreadsheet does not calculate distances to Level B thresholds; the range to the Level B thresholds was determined by applying spherical spreading loss to the SL for that equipment. The operational depth and directionality can greatly influence how the sound propagates and can influence the resulting isopleth distance, so these parameters were considered for sources that had reported beamwidths. Surface-towed omnidirectional sources (e.g., sparkers, boomers) and equipment with wide (more than 180 degrees) reported beamwidths are expected to propagate farther in the horizontal direction and produce larger ensonified fields. For these sources, the rate of TL was estimated using spherical spreading loss to calculate the distance to the Level B threshold.

Sources that project a narrow beam, often in frequencies above 10 kHz directed at the seabed, are expected to have smaller isopleths and less horizontal propagation due to the directionality of the source and faster attenuation rate of higher frequencies. Narrow beamwidths allow geophysical equipment to be highly directional, focusing its energy on the vertical direction and minimizing horizontal propagation, which greatly reduces the possibility of direct path exposure to receivers (i.e., marine mammals) from sounds emitted by these sources. Therefore, for sources with beamwidths less than 180 degrees, isopleth distances were calculated following NMFS OPR interim guidance (NMFS 2020c) to account for the influence of beamwidth and frequency on the horizontal propagation of these sources. The estimated distances to Level A and Level B HRG survey isopleths calculated for each marine mammal hearing group are given in Table 37.

Table 37. Distances to weighted Level A and unweighted Level B threshold for each HRG sound source or comparable sound source category for each marine mammal hearing group.

Equipment Type	Representative Model	Distance to Level A Threshold (m)					Level B (m)
		LF (SEL_{cum})	MF (SEL_{cum})	HF (SEL_{cum})	HF (SPL_{0-pk})	PW (SEL_{cum})	All (SPL_{rms})
Sub-bottom Profiler	EdgeTech 216	<1	<1	2.9	NA	0	9
	EdgeTech 424	0	0	0	NA	0	4
	Edgetech 512	0	0	<1	NA	0	6
	GeoPulse 5430A	<1	<1	36.5	NA	<1	21
	Teledyn Benthos Chirp III - TTV 170	01-Jan	<1	16.9	NA	<1	48
Sparker	Applied Acoustics Dura-Spark UHD (700 tips, 1,000 J)	<1	0	0	4.7	<1	34
	Applied Acoustics Dura-Spark UHD (400 tips, 500 J)	<1	0	0	2.8	<1	141
	Applied Acoustics Dura-Spark UHD (400 tips, 500 J)	<1	0	0	2.8	<1	141
Boomer	Applied Acoustics triple plate S-Boom (700–1,000 J)	<1	0	0	2.8	<1	141

LF = low-frequency cetaceans; MF = mid-frequency cetaceans; HF = high-frequency cetaceans; PW = phocid pinnipeds in water.
= not applicable; CF = Crocker and Fratantonio (2016); MAN = Manufactures Specifications
Source Levels are given in dB re 1 µPa @ 1m

The largest Level A threshold distances was 36.5 m across all representative instruments and with the implementation of planned monitoring and mitigation measures, no Level A takes are anticipated or requested for HRG surveys.

The largest modeled distance to the Level B threshold from HRG survey equipment was 141 m from a sparker. Although a sparker may not be used at all times during HRG surveys, this distance was used in calculating the area exposed to sounds above 160 dB SPL_{rms} for all HRG survey activity. This was done by assuming an average of 70 km of survey activity would be completed daily by each survey vessel when active. The 70 km of survey line was then buffered on all sides by the 141 m distance to estimate a daily ensonified area of 19.8 km^2.

During construction, it is estimated that 12,604 km of HRG surveys will occur within the SRWF and 11,946 km will occur along the SRWEC. Assuming 70 km is surveyed per day, that results in 180 days of survey activity in the SRWF and 171 days of survey activity along the SRWEC. Multiplying the daily ensonified area by the number of days of survey activity within each area results in a total ensonified area of 3,566 km^2 in the SRWF and 3,380 km^2 along the SRWEC. The construction phase HRG surveys are expected to occur over approximately 2 years, so the total survey activity and associated ensonified area have been split evenly across 2 years.

6.5.3 Estimated Takes from HRG Surveys – Construction Phase

To calculate potential takes from HRG surveys within the SRWF during year 1 of the construction phase, the annual average marine mammal densities in Table 34 were multiplied by half of the total ensonified area expected within the Sunrise Wind Farm and the results are shown in the SRWF column in Table 38. The same calculation was performed for the Sunrise Wind Export Cable (SRWEC) using marine mammal densities in Table 35 and the results are shown in the SRWEC column of Table 38. The same method was used to calculated potential takes from HRG surveys during year 2 of the construction phase as shown in

Table 39. No Level A takes for this activity are anticipated or requested.

Table 38. Estimated Level B take from HRG surveys during year 1 of the construction phase of the Project. SRWF = Sunrise Wind Farm, SRWEC = Sunrise Wind Export Cable.

Species	Year1 Construction Phase Take by Survey		Total Density-based Take Estimate	PSO Data Take Estimate	Mean Group Size	Highest Level B Take
	SRWF	SRWEC				
Mysticetes						
Blue Whale*	0.0	0.0	0.0	-	1.0	1
Fin Whale*	4.0	3.9	7.9	43.0	1.8	44
Humpback Whale	2.3	1.3	3.5	129.0	2.0	130
Minke Whale	1.6	1.4	2.9	26.5	1.2	27
North Atlantic Right Whale*	5.2	3.2	8.4	6.6	2.4	9
Sei Whale*	0.1	0.1	0.2	1.7	1.6	2
Odontocetes						
Atlantic Spotted Dolphin	0.7	0.4	1.1	-	29.0	29
Atlantic White-Sided Dolphin	60.6	39.0	99.5	16.7	27.9	100
Bottlenose Dolphin	16.7	20.0	36.7	185.3	7.8	186
Common Dolphin	174.0	173.6	347.6	5,218.8	34.9	5,219
Harbor Porpoise	69.5	63.3	132.8	4.6	2.7	133
Pilot Whales	15.3	13.7	29.1	-	8.4	30
Risso's Dolphin	0.3	0.3	0.6	13.0	5.4	13
Sperm Whale*	0.1	0.2	0.3	-	1.5	2
Pinnipeds						
Gray Seal	12.8	12.4	25.2	12.5	1.4	26
Harbor Seal	28.8	27.8	56.7	15.3	0.0	57

* Denotes species listed under the Endangered Species Act

Table 39. Estimated Level B take from HRG surveys during year 2 of the construction phase of the Project. SRWF = Sunrise Wind Farm, SRWEC = Sunrise Wind Export Cable.

Species	Year 2 Construction Phase Take by Survey		Total Density-based Take Estimate	PSO Data Take Estimate	Mean Group Size	Highest Level B Take
	LA	ECR				
Mysticetes						
Blue Whale*	0.0	0.0	0.0	-	1.0	1
Fin Whale*	4.0	3.9	7.9	43.0	1.8	44
Humpback Whale	2.3	1.3	3.5	129.0	2.0	130
Minke Whale	1.6	1.4	2.9	26.5	1.2	27
North Atlantic Right Whale*	5.2	3.2	8.4	6.6	2.4	9
Sei Whale*	0.1	0.1	0.2	1.7	1.6	2
Odontocetes						
Atlantic Spotted Dolphin	0.7	0.4	1.1	-	29.0	29
Atlantic White-Sided Dolphin	60.6	39.0	99.5	16.7	27.9	100
Bottlenose Dolphin	16.7	20.0	36.7	185.3	7.8	186
Common Dolphin	174.0	173.6	347.6	5,218.8	34.9	5,219
Harbor Porpoise	69.5	63.3	132.8	4.6	2.7	133
Pilot Whales	15.3	13.7	29.1	-	8.4	30
Risso's Dolphin	0.3	0.3	0.6	13.0	5.4	13
Sperm Whale*	0.1	0.2	0.3	-	1.5	2
Pinnipeds						
Gray Seal	12.8	12.4	25.2	12.5	1.4	26
Harbor Seal	28.8	27.8	56.7	15.3	0.0	57

* Denotes species listed under the Endangered Species Act

6.6 HRG Surveys – Operations Phase

HRG surveys will be carried out on a routine basis during the 3 years of operations expected under the requested incidental take regulations. Potential takes for these HRG surveys during the operations phase were calculated using the same approach as described for the construction phase but assume a reduced level of survey effort on an annual basis as described below.

6.6.1 Marine Mammal Densities

The same annual average densities used to calculate potential takes from HRG surveys during the construction phase shown in Table 34 and Table 35 were used to calculate potential takes from HRG surveys during the operations phase.

6.6.2 Area Potentially Exposed to Sounds Above Threshold Levels from HRG Surveys-Operations Phase

On an annual basis during operations, it is estimated that 2,898 km of HRG surveys will occur within the SRWF and 3,413 km will occur along the SRWEC. Assuming 70 km is surveyed per day results in 41.4 days of survey activity in the SRWF and 48.8 days of survey activity along the SRWEC each year. Multiplying the daily ensonified area by the number of days of survey activity within each area

results in an annual ensonified area of 820 km^2 in the SRWF and 966 km^2 along the SRWEC. Over the three years of operations that would occur during the five-year period covered by the requested regulations, the total ensonified area in the SRWF would be 2,460 km^2 and along the SRWEC would be 2,897 km^2.

6.6.3 Estimated Takes from HRG Surveys- Operations Phase

The density-based take estimate for one year during the operations phase was calculated for the SRWEC and the SRWF in the same manner as described in Section 6.5.3. This value was then compared against the PSO data take estimate and the mean group size of each species and the largest value was selected as the annual estimated take during the three years of operations (Table 40). The annual estimated take was then multiplied by three to calculate the total take over the three years of operations. No Level A takes for this activity are anticipated or requested.

Table 40. Estimated Level B take from HRG surveys during operations. SRWF = Sunrise Wind Farm, SRWEC = Sunrise Wind Export Cable.

Species	Annual Operations Phase Take by Survey Area		Annual Total Density-based Take Estimate	Annual PSO Data Take Estimate	Mean Group Size	Highest Annual Level B Take	3-year Level B Take
	SRWF	SRWEC					
Mysticetes							
Blue Whale*	0.0	0.0	0.0	-	1.0	1	3
Fin Whale*	1.9	2.2	4.1	22.1	1.8	23	69
Humpback Whale	1.0	0.7	1.8	66.3	2.0	67	201
Minke Whale	0.7	0.8	1.5	13.6	1.2	14	42
North Atlantic Right Whale*	2.4	1.8	4.2	3.4	2.4	5	15
Sei Whale*	0.1	0.1	0.1	0.9	1.6	2	6
Odontocetes							
Atlantic Spotted Dolphin	0.3	0.2	0.6	-	29.0	29	87
Atlantic White-Sided Dolphin	27.9	22.3	50.1	8.6	27.9	51	153
Bottlenose Dolphin	7.7	11.4	19.1	95.3	7.8	96	288
Common Dolphin	80.0	99.2	179.2	2,683.2	34.9	2,684	8,052
Harbor Porpoise	32.0	36.2	68.1	2.4	2.7	69	207
Pilot Whales	7.1	7.9	14.9	-	8.4	15	45
Risso's Dolphin	0.1	0.2	0.3	6.7	5.4	7	21
Sperm Whale*	0.1	0.1	0.2	-	1.5	2	6
Pinnipeds							
Gray Seal	5.9	7.1	13.0	6.4	1.4	13	39
Harbor Seal	13.3	15.9	29.2	7.9	1.4	30	90

* Denotes species listed under the Endangered Species Act

6.7 UXO/MEC Detonations

For UXO/MECs that are positively identified in proximity to planned activities on the seabed, several alternative strategies will be considered prior to detonating the UXO/MEC in place. These may include relocating the activity away from the UXO/MEC (avoidance), moving the UXO/MEC away from the activity (lift and shift), cutting the UXO/MEC open to apportion large ammunition or deactivate fused munitions, using shaped charges to reduce the net explosive yield of a UXO/MEC (low-order detonation), or using shaped charges to ignite the explosive materials and allow them to burn at a slow rate rather than detonate instantaneously (deflagration). Only after these alternatives are considered would a decision to detonate the UXO/MEC in place be made. To detonate a UXO/MEC, a small charge would be placed on the UXO/MEC and detonated causing the UXO/MEC to then detonate.

The exact number and type of UXO/MECs in the Project area are not yet known. As a conservative approach, it is currently assumed that up to 3 UXO/MECs in the SRWF may have to be detonated in place and none along the SRWEC route. If necessary, these detonations would occur on 3 different days. To avoid times when sensitive marine mammal species are more likely to be present, UXO/MEC detonations are only planned to occur during the months from May through November.

6.7.1 Marine Mammal Densities

In-situ UXO/MEC detonations would not occur during the months from December through April. The maximum average monthly densities from May through November calculated from within 10 km of the Sunrise Wind Farm (Figure 11) were selected and the months from which they were calculated are shown in Table 41.

6.7.2 Area Potentially Exposed to Sounds Above Threshold Levels from UXO/MEC detonation

The type and net explosive weight of UXO/MECs that may be detonated are not known at this time. To capture a range of potential UXO/MECs, five categories or “bins” of net explosive weight established by the U.S. Navy (2017) were selected for acoustic modeling (Table 42). Sound propagation away from detonations is affected by acoustic reflections from the sea surface and seabed. Water depth and seabed properties will influence the sound exposure levels and sound pressure levels at distance from detonations. Their influence is complex but can be predicted accurately by acoustic models. Two sites (S3 and S4 in Appendix B) were chosen within the nearby Revolution Wind Farm for this modeling assessment. The geo-acoustic properties of the seabed within the Revolution Wind Farm where the acoustic modeling was performed and the Sunrise Wind Farm are very similar and the water depths in the Sunrise Wind Farm are the same or only slightly deeper (maximum depth of 55 m in the Sunrise Wind Farm versus the deepest modeled site in the Revolution Wind Farm of 45 m). Exact locations for the modeling sites are shown in Figure 1 of Appendix B.

Table 41. Maximum average monthly marine mammal densities in the SRWF from only May through November and the month in which the maximum density occurs.

Species	Maximum Monthly Density (Ind./km²)	Maximum Density Month
Mysticetes		
Blue Whale*	0.0000	Annual
Fin Whale*	0.0035	July
Humpback Whale	0.0042	September
Minke Whale	0.0023	May
North Atlantic Right Whale*	0.0029	May
Sei Whale*	0.0003	May
Odontocetes		
Atlantic Spotted Dolphin	0.0010	October
Atlantic White-Sided Dolphin	0.0608	May
Bottlenose Dolphin	0.0254	September
Common Dolphin	0.2565	December
Harbor Porpoise	0.0464	May
Pilot Whales	0.0086	Annual
Risso's Dolphin	0.0004	August
Sperm Whale*	0.0003	July
Pinnipeds		
Seals (Harbor and Gray)	0.0342	May

* Denotes species listed under the Endangered Species Act

Table 42. Navy "bins" and corresponding maximum charge weights (equivalent TNT) modeled.

Navy Bin Designation	Maximum Equivalent Weight (TNT)	
	kg	lbs
E4	2.3	5
E6	9.1	20
E8	45.5	100
E10	227	500
E12	454	1000

Modeling of acoustic fields generated by UXO/MEC detonations was performed using a combination of semi-empirical and physics-based computational models. The source pressure function used for estimating PK and impulse (J_p) metrics was calculated with an empirical model that approximates the rapid conversion (within approximately 1 μs for high explosive) of solid explosive to gaseous form in a small gas bubble under high pressure, followed by an exponential pressure decay as that bubble expands. The shape and amplitude of the pressure versus time signature of the shock pulse changes with distance from the detonation location due to non-linear propagation effects caused by its high peak pressure. This initial empirical model is only valid close to the source (within tens of meters),

so alternative formulae were used beyond those distances to a point where the sound pressure decay with range transitions to the spherical spreading model.

The calculation of SEL and SPL levels is dependent on the entire pressure waveform, including the initial shock pulse (described above) and the subsequent oscillation of the gas bubble. The negative phase pressure troughs and bubble pulse peaks following the shock pulse are responsible for most of the low frequency energy of the overall waveform. The SEL and SPL thresholds for injury and disturbance occur at distances of many water depths in the relatively shallow waters of the Project. As a results, the sound field becomes increasingly influenced by the contributions of sound energy reflected from the sea surface and sea bottom multiples times. To account for this, the modeling was carried out in decidecade frequency bands using the marine operation noise model (MONM, JASCO Applied Sciences). This model applied a parabolic equation approach for frequencies below 4 kHz and a Gaussian beam ray trace model at higher frequencies. In this location, sound speed profiles change little with depth, so these environments do not have strong seasonal dependence. The propagation modeling was performed using a sound speed profile representative of September, which is slightly downward refracting and therefore conservative, and also represents the most likely time of year for UXO removal activities. Additional technical details of the modeling methods, assumptions and environmental parameters used as inputs can be found in Appendix B.

A NAS similar to those described for monopile foundation installations is planned to be used during any UXO/MEC detonations. The reasons a NAS may not be used would be limited to instances where boulders or other obstructions on the seafloor prevented the effective deployment of a NAS or posed a risk to successful retrieval of the NAS after completion of the UXO/MEC detonation. Use of a NAS is expected to achieve at least the same 10 dB of attenuation assumed for monopile installation. This is based on an assessment of UXO/MEC-clearance activity in European waters summarized by Bellmann and Betke (2021). As a contingency in case a NAS cannot be placed properly around a UXO because of the presence of boulders or other obstructions on the seafloor, acoustic modeling was also conducted assuming no use of a NAS (unmitigated).

As described in Section 6.2, potential impacts to marine mammals from underwater explosions are assessed using separate criteria for mortality, non-auditory injury, gastrointestinal injury, auditory injury, and behavioral responses. Since marine mammal densities representative of the SRWF include water depths similar to UXO/MEC acoustic modeling Sites 3 and 4 and there is relatively little difference between the results from those two sites, the largest range to the thresholds from either Site 3 or 4, both with and without 10 dB of mitigation, was selected for each UXO/MEC size class and marine mammal size class or hearing group and summarized here. In all cases, distances to mortality (Table 43), non-auditory lung injury (Table 44), and gastrointestinal injury (Table 45) thresholds were shorter than to auditory injury thresholds (Table 46). Since the mitigation and monitoring measures described in Section 11 and Appendix C are designed to avoid mortality or non-auditory injuries as well as potential auditory injury for most species, only the auditory injury (PTS) threshold distances are used here for the calculation of potential Level A takes.

In the case of a single UXO/MEC detonation per day, as is planned here, TTS onset serves as the Level B take threshold. As was done for the Level A PTS threshold above, the largest modeled ranges to the TTS onset threshold assuming 10 dB of mitigation for each UXO/MEC size class was selected from modeling results at Sites 3 and 4 to represent the Level B range within the SRWF (Table 47).

Table 43. Ranges (in meters) to the onset of mortality thresholds in the SRWF for five UXO/MEC size classes with and without 10 dB mitigation. Thresholds are based on animal mass and submersion depth (see Section 6.2 and Appendix B).

	$R_{95\%}$ Distance (m)									
	E4		E6		E8		E10		E12	
Hearing Group	**Calf/Pup**	**Adult**	**Calf/Pup**	**Adult**	**Calf/Pup**	**Adult**	**Calf/Pup**	**Adult**	**Calf/Pup**	**Adult**
	Assuming 10 dB reduction from mitigation									
Baleen and Sperm Whales	5	5	6	5	20	6	68	19	109	31
Pilot and Minke Whales	5	5	10	5	32	10	106	32	162	57
Beaked Whales	6	5	17	8	58	25	164	86	234	135
Dolphins, *Kogia*, Pinnipdes	12	5	31	16	108	54	247	155	332	224
Porpoises	14	6	40	18	122	63	270	173	353	243
	Assuming no reduction from mitigation									
Baleen and Sperm Whales	8	5	23	7	80	22	227	77	334	121
Pilot and Minke Whales	14	5	37	12	123	38	325	125	453	194
Beaked Whales	23	11	68	30	199	100	455	275	602	392
Dolphins, *Kogia*, Pinnipdes	47	22	130	63	328	186	637	434	814	580
Porpoises	58	25	152	73	361	212	690	477	868	628

Table 44. Ranges (in meters) to the onset of non-auditory lung injury impulse thresholds in the SRWF for five UXO/MEC size classes with and without 10 dB mitigation. Thresholds are based on animal mass and submersion depth (see Section 6.2 and Appendix B).

	$R_{95\%}$ Distance (m)									
	E4		E6		E8		E10		E12	
Hearing Group	**Calf/Pup**	**Adult**	**Calf/Pup**	**Adult**	**Calf/Pup**	**Adult**	**Calf/Pup**	**Adult**	**Calf/Pup**	**Adult**
	Assuming 10 dB reduction from mitigation									
Baleen and Sperm Whales	5	5	15	5	51	14	156	49	237	81
Pilot and Minke Whales	9	5	24	7	83	25	230	84	330	132
Beaked Whales	15	7	41	19	135	66	331	192	448	282
Dolphins, *Kogia*, Pinnipdes	29	14	88	38	231	126	471	315	606	429
Porpoises	34	16	103	46	261	145	512	347	648	465
	Assuming no reduction from mitigation									
Baleen and Sperm Whales	21	6	60	17	181	58	463	172	648	262
Pilot and Minke Whales	33	10	96	29	270	98	631	270	843	402
Beaked Whales	59	26	156	77	412	222	846	546	1084	746
Dolphins, *Kogia*, Pinnipdes	118	54	283	145	630	389	1148	815	1421	1052
Porpoises	138	65	324	167	695	435	1228	878	1518	1127

Table 45. Ranges (in meters) to the onset of gastrointestinal injury impulse thresholds in the SRWF for five UXO/MEC size classes with and without 10 dB mitigation. Thresholds are based on animal mass and submersion depth (see Section 6.2 and Appendix B).

Hearing Group	L_{pk} Threshold (dB re 1 µPa)	R_{max} Distance (m)				
		E4	E6	E8	E10	E12
		Assuming 10 dB reduction from mitigation				
Onset Gastrointestinal Injury	237	21	34	58	99	125
		Assuming no reduction from mitigation				
Onset Gastrointestinal Injury	237	61	97	167	285	359

Table 46. Ranges to Level A take SEL_{cum} PTS-onset thresholds in the SRWF for five UXO/MEC charge sizes with and without 10 dB mitigation and the maximum area exposed.

Hearing Group	SELThreshold (dB re 1 µPa^2·s)	$R_{95\%}$ Distance (km)					Single Detonation Maximum Area (km^2)
		E4	E6	E8	E10	E12	
		Assuming 10 dB reduction from mitigation					
Low-frequency	183	0.385	0.757	1.58	2.93	3.61	40.9
Mid-frequency	185	<0.050	<0.050	0.085	0.323	0.412	0.5
High-frequency	155	1.75	2.59	3.9	5.4	6.19	120.4
Phocid pinnipeds	185	0.089	0.204	0.538	1.02	1.48	6.9
		Assuming no reduction from mitigation					
Low-frequency	183	1.54	2.72	4.75	7.28	8.54	229.1
Mid-frequency	185	0.161	0.358	0.684	1.14	1.48	6.9
High-frequency	155	4.3	5.75	7.71	9.89	10.9	373.3
Phocid pinnipeds	185	0.607	1.12	2.17	3.74	4.52	64.2

Table 47. Ranges to Level B take SEL_{cum} TTS-onset thresholds in the SRWF for five UXO/MEC charge sizes with and without 10 dB mitigation and the maximum area exposed.

Hearing Group	SELThreshold (dB re 1 μPa² ·s)	$R_{95\%}$ Distance (km)					Single Detonation Maximum Area (km²)
		E4	E6	E8	E10	E12	
		Assuming 10 dB reduction from mitigation					
Low-frequency	183	2.74	4.45	7.21	10.3	11.8	437.4
Mid-frequency	185	0.41	0.707	1.23	2.03	2.48	19.3
High-frequency	155	6.14	7.84	10.1	12.6	13.7	589.6
Phocid pinnipeds	185	1.21	2.18	3.81	5.97	7.02	154.8
		Assuming no reduction from mitigation					
Low-frequency	183	7.0	9.85	13.6	17.4	19.3	1170.2
Mid-frequency	185	1.45	2.21	3.49	5.04	5.84	107.1
High-frequency	155	10.7	13.0	15.8	18.7	20.2	1281.9
Phocid pinnipeds	185	4.07	6.07	8.85	12.0	13.3	555.7

Since the size and type of UXO/MECs that may be detonated is currently unknown, all area calculations were made using the largest UXO/MEC size class (E12). The E12 ranges to Level A and Level B thresholds within the SRWF, Table 46 and Table 47, respectively, were used as radii to calculate the area of a circle (pi × r^2 where r is the range to the threshold level) for each marine mammal hearing group. The results represent the largest area potentially ensonified above threshold levels from a single detonation within the SRWF and are shown in the final column of Table 46 and Table 47.

6.7.3 Estimated Takes from UXO/MEC detonation

Based on the available information, up to three (3) UXO/MEC detonations may be necessary within the SRWF and none are expected along the SRWEC route. The maximum areas to Level A and Level B thresholds from a single detonation in the SRWF assuming 10 dB of noise reduction shown in Table 46 and Table 47, respectively, were therefore multiplied by 3 and then multiplied by the marine mammal densities shown in Table 41 to calculate the potential take from UXO/MEC detonations in the SRWF shown in Table 48. In the unlikely event that a NAS cannot be used during a UXO/MEC detonation, takes were also calculated using the unmitigated threshold distances in Table 46 and Table 47 and the results are shown in

Table 49.

Monitoring and mitigation measures described in Section 11.5 are designed to prevent Level A take of most species. However, given the relatively large distances to the high-frequency cetacean SEL PTS threshold applicable to harbor porpoise and the difficulty with detecting this species, Level A take of 17 harbor porpoise is requested. Similarly, seals are difficult to detect at longer ranges and although the distances to the phocid hearing group SEL PTS threshold is not as large as those for high-frequency cetaceans, it may not be possible with the planned monitoring and mitigation measures to detect all seals within the threshold distances so Level A take of 1 gray seal and 1 harbor seal is requested.

Table 48. Estimated Level A and Level B take from potential UXO/MEC detonations in SRWF assuming 10 dB of mitigation.

Species	Level A Density-based Take Estimate	Level B Density-based Take Estimate	PSO Data Take Estimate	Mean Group Size	Highest Level B Take
Mysticetes					
Blue Whale*	0.0	0.0	-	1.0	1
Fin Whale*	0.4	4.6	0.7	1.8	5
Humpback Whale	0.5	5.5	2.2	2.0	6
Minke Whale	0.3	3.0	0.5	1.2	3
North Atlantic Right Whale*	0.4	3.9	0.1	2.4	4
Sei Whale*	0.0	0.3	0.0	1.6	2
Odontocetes					
Atlantic Spotted Dolphin	0.0	0.1	-	29.0	29
Atlantic White-Sided Dolphin	0.1	3.5	0.3	27.9	28
Bottlenose Dolphin	0.0	1.5	3.2	7.8	8
Common Dolphin	0.4	14.9	89.3	34.9	90
Harbor Porpoise	16.8	82.1	0.1	2.7	83
Pilot Whales	0.0	0.5	-	8.4	9
Risso's Dolphin	0.0	0.0	0.2	5.4	6
Sperm Whale*	0.0	0.0	-	1.5	2
Pinnipeds					
Gray Seal	0.2	4.9	0.2	0.4	5
Harbor Seal	0.5	11.0	0.3	1.0	11

* Denotes species listed under the Endangered Species Act

Table 49. Estimated Level A and Level B take from potential UXO/MEC detonations in the SRWF assuming no mitigation.

Species	Level A Density-based Take Estimate	Level B Density-based Take Estimate	PSO Data Take Estimate	Mean Group Size	Highest Level B Take
Mysticetes					
Blue Whale*	0.0	0.0	-	1.0	1
Fin Whale*	2.4	12.2	0.7	1.8	13
Humpback Whale	2.9	14.7	2.2	2.0	15
Minke Whale	1.6	8.0	0.5	1.2	8
North Atlantic Right Whale*	2.0	10.3	0.1	2.4	11
Sei Whale*	0.2	0.9	0.0	1.6	2
Odontocetes					
Atlantic Spotted Dolphin	0.0	0.3	-	29.0	29
Atlantic White-Sided Dolphin	1.3	19.6	0.3	27.9	28
Bottlenose Dolphin	0.5	8.2	3.2	7.8	9
Common Dolphin	5.3	82.5	89.3	34.9	90
Harbor Porpoise	52.0	178.6	0.1	2.7	179
Pilot Whales	0.2	2.8	-	8.4	9
Risso's Dolphin	0.0	0.1	0.2	5.4	6
Sperm Whale*	0.0	0.1	-	1.5	2
Pinnipeds					
Gray Seal	2.0	17.5	0.2	0.4	18
Harbor Seal	4.6	39.4	0.3	1.0	40

* Denotes species listed under the Endangered Species Act

6.8 Total Requested Take

The estimated Level B take from each activity is summarized in Table 50 and the total requested take for the project was calculated by summing the estimated takes across all activities. The requested Level B take was divided by the most recent abundance estimate in the Draft 2021 NMFS Stock Assessment Report (Hayes et al. 2021) to calculate the percent of each stock for which take is requested. A small number of Level A takes is requested for humpback whales from monopile installations and for harbor porpoise, gray seals, and harbor seals from potential UXO/MEC detonations (Table 51).

Construction activities are planned to occur in the first 2 years of the requested regulations, depending on the timing of issuance and logistical considerations. The same amount of construction activity would occur whether it occurs within a single year or extends partially into a second year. HRG surveys during operations will occur annually for the duration of the requested regulations.

Table 50. Summary of the estimated Level B take from all activities and the total requested Level B take for the project. The percent of NMFS stock abundance is calculated from the 5 year total requested take.

	Year 1 (Maximum)	Year 2	Year 3	Year 4	Year 5	5 Year Total	NMFS Stock Abundance[a]	Percent of NMFS Stock Abundace[a]
Mysticetes								
Blue Whale*	4	1	1	1	1	7	402	1.7
Fin Whale*	98	44	23	23	23	210	6,802	3.1
Humpback Whale	237	130	67	67	67	567	1,396	40.6
Minke Whale	77	27	14	14	14	145	21,968	0.7
North Atlantic Right Whale*	47	9	5	5	5	70	368	19.0
Sei Whale*	10	2	2	2	2	18	6,292	0.3
Odontocetes								
Atlantic Spotted Dolphin	102	15	29	29	29	203	39,921	0.5
Atlantic White-Sided Dolphin	1,350	100	51	51	51	1,603	93,233	1.7
Bottlenose Dolphin	1,493	186	96	96	96	1,966	62,851	3.1
Common Dolphin	12,046	5,219	2,684	2,684	2,684	25,317	172,974	14.6
Harbor Porpoise	874	133	69	69	69	1,214	95,543	1.3
Pilot Whales	175	30	15	15	15	249	68,139	0.4
Risso's Dolphin	36	13	7	7	7	70	35,215	0.2
Sperm Whale*	9	1	2	2	2	16	4,349	0.4
Pinnipeds								
Gray Seal	1,102	26	13	13	13	1,166	27,300	4.3
Harbor Seal	1,476	57	30	30	30	1,623	61,336	2.6

* Denotes species listed under the Endangered Species Act

Table 51. Summary of the requested Level A take from all activities.

Species	Requested Level A Take	
	WTG & OCS-DC Foundation Installation	UXO Detonations
Mysticetes		
Humpback Whale	10	-
Odontocetes		
Harbor Porpoise	-	17
Pinnipeds		
Gray Seal	-	1
Harbor Seal	-	1

7 Anticipated Impact of the Activity

The ability to hear and transmit sound (echolocation and vocalization) is vital for marine mammals to perform basic life functions, such as foraging, navigating, communicating, and avoiding predators. Marine mammals use sound to gather and understand information about their current environment, including detection of prey, predators, and conspecifics, and phenomena such as wind, waves, and rain, as well as anthropogenic sounds (Richardson et al. 1995). The distances to which a sound travels through the water and remains audible depends on existing environmental conditions and propagation characteristics (e.g., sea floor topography, stratification, and ambient noise levels) and characteristics of the sound such as SLs and frequency (Richardson et al. 1995). The Project may impact marine mammals behaviorally and physiologically from temporary increases in underwater noise during construction, HRG surveys, or UXO/MEC detonation. The effects of underwater sounds could include one or more of the following: masking of natural sounds, behavioral disturbance, temporary or permanent hearing impairment (TTS or PTS), or non-auditory physical or physiological effects (Richardson et al. 1995; Nowacek et al. 2007; Southall et al. 2007a). The level of impact on marine mammals will vary depending on the species and its sensitivity to sound, life stage, orientation and distance between the marine mammal and the activity, the intensity and duration of the activity, and environmental conditions affecting sound propagation.

7.1 Potential Effects of Project Activities on Marine Mammals

7.1.1 Masking

Masking is the obscuring of sounds of interest by interfering sounds, generally at similar frequencies. Introduced underwater sound will, through masking, reduce the effective listening area and/or communication distance of a marine mammal species if the frequency of the source is close to that used as a signal by the marine mammal, and if the anthropogenic sound is present for a significant fraction of the time (Richardson et al. 1995; Clark et al. 2009; Jensen et al. 2009; Gervaise et al. 2012; Hatch et al. 2012; Rice et al. 2014a; Erbe et al. 2016; Tennessen and Parks 2016; Guan and Miner 2020). If little or no overlap occurs between the introduced sound and the frequencies used by the species, listening and communication are not expected to be disrupted. Similarly, if the introduced sound is present only infrequently, very little to no masking would occur. In addition to the frequency and duration

of the masking sound, strength, temporal pattern, and location of the introduced sound also play a role in the extent of the masking (Madsen et al. 2002; Branstetter et al. 2013a; Branstetter et al. 2013b; Branstetter et al. 2016; Erbe et al. 2016; Sills et al. 2017).

In the event that masking would occur, it could impact biological functions such as communication, navigation, socializing, mating, foraging, and predator detection (Paiva et al. 2015). Although masking effects of pulsed sounds on marine mammal calls and other natural sounds are expected to be limited, there are few specific studies. Sounds from seismic surveys, which are impulsive like impact pile driving sounds, have been estimated to substantially reduce the communication space of baleen whales (Gedamke 2011; Wittekind et al. 2016), as has vessel noise (Hatch et al. 2012; Putland et al. 2017; Cholewiak et al. 2018). Similarly, David (2006) speculated that noise generated by pile driving with a 6 t diesel hammer has the potential to mask bottlenose dolphin vocalizations at 9 kHz within 10 to 15 km from the source if the vocalization is strong and up to 40 km if the call is weak. The biological repercussions of a loss of listening area or communication space, to the extent that this occurs, are unknown.

Some cetaceans, including baleen whales, continue calling in the presence of impulsive sounds from pile driving (Fernandez-Betelu et al. 2021) and seismic pulses (Greene and Richardson 1988; McDonald et al. 1995; Smultea et al. 2004; Holst et al. 2005; Holst et al. 2006; Dunn and Hernandez 2009; Holst et al. 2011; Nieukirk et al. 2012; Thode et al. 2012; Bröker et al. 2013; Cerchio et al. 2014; Sciacca et al. 2016). Other cetaceans are known to increase the source levels of their calls, shift their peak frequencies, or otherwise modify their vocal behavior (increase or decrease call rates) in response to pulsed sounds from pile driving (Fernandez-Betelu et al. 2021), airguns (Clark and Gagnon 2006; Di Iorio and Clark 2010; Castellote et al. 2012; Blackwell et al. 2013; Blackwell et al. 2015), or vessel noise (e.g., (Richardson et al. 1995; Nieukirk et al. 2005; Scheifele et al. 2005; Parks et al. 2007; Di Iorio and Clark 2009; Hanser et al. 2009; Holst et al. 2009; Parks et al. 2009; Parks et al. 2010; McKenna 2011; Castellote et al. 2012; Melcón et al. 2012; Parks et al. 2012; Risch et al. 2012; Tyack and Janik 2013; Luís et al. 2014; Sairanen 2014; Papale et al. 2015; Wang et al. 2015; Dahlheim and Castellote 2016; Gospić and Picciulin 2016; Heiler et al. 2016; Martins et al. 2016; O'Brien et al. 2016; Parks et al. 2016; Bittencourt et al. 2017). Similarly, harbor seals have been shown to increase the minimum frequency and amplitude of their calls in response to vessel noise (Matthews 2017). This behavior could, in turn, minimize potential impacts of masking. However, Holt et al. (2015) reported that changes in vocal modifications can have increased energetic costs for individual marine mammals. It is not known how often these types of vocal responses occur upon exposure to impulsive sounds. If marine mammals exposed to sounds sometimes respond by changing their vocal behavior, this adaptation, along with directional hearing and preadaptation to tolerate some masking by natural sounds (Richardson et al. 1995) would all reduce the importance of masking.

Given the higher duty cycle of impact pile driving (one strike every ~two seconds) compared to most airgun surveys (one pulse every ~10 seconds), there may be a somewhat greater potential for masking to occur during impact pile driving. In this project, however, impact pile driving is not expected to occur for more than approximately four hours at one time for monopile installation and 6 hours per pile for piled jacket installation. Compared to the 24 hour per day operation of airguns during most seismic surveys, the total time during which masking from impact pile driving might occur would be much lower.

The potential masking from vibratory pile driving (a continuous sound) is expected to be less than that for impulsive sounds from impact pile driving and airguns. A recent study compared potential

impacts to marine mammals from two different geophysical survey sources—a non-impulsive source, the marine vibrator (MV), to a strong impulsive source, an airgun array. Potential impacts were assessed by comparing signal level, duration, and bandwidth, which are all parameters known to contribute to masking. The MV array was found to ensonify the marine environment for periods 36–67% longer than the airgun array (Matthews et al. 2018). The longer duration of MV sounds, relative to airgun pulses, increases the potential for MV sound to mask signals of interest to marine mammals. However, despite longer signal durations, MV arrays were found to be less likely than airgun arrays to result in masking for most species because the distances within which MV sounds may be perceived were smaller, and the main frequencies produced by the MV source did not overlap with the hearing ranges of most marine mammals (Matthews et al. 2018). The higher the peak pressure level (SPL_{pk}), cumulative sound exposure level (SEL_{cum}), and sound pressure level (SPL_{rms}) of airgun sounds means that the distances within which masking might occur were 2 to more than 5 times greater for the airgun arrays than the MV arrays (Matthews et al. 2018). Thus, the lower amplitude of non-impulsive MV sounds resulted in smaller ranges of potential masking than those predicted for airgun arrays (Matthews et al. 2018).

Low-frequency cetaceans such as baleen whales are likely to be more susceptible to masking by low-frequency noise, such as from pile driving and vessel sounds. In contrast, masking effects from those activities are expected to be negligible in the case of smaller odontocetes and pinnipeds, given that sounds important to them occur predominantly at higher frequencies. Significant masking effects would be unlikely during impact pile driving (and also UXO/MEC explosions) given the intermittent nature of these sounds and short signal duration (Madsen et al. 2006). Similarly, even though it is a continuous sound, the potential for masking is deemed to be minimal during vibratory pile driving, as these sounds tend to have lower amplitudes resulting in smaller ranges. Some of the HRG survey equipment produces sounds within the frequency range of smaller cetaceans and pinnipeds and could therefore result in masking of some biologically important sounds. However, the impulsive nature of these sounds, source levels, short distances over which they would be audible, and continuous movement of the survey vessel suggest that any masking experienced by marine mammals would be localized and short term.

7.1.2 Behavioral Disturbance

Disturbance includes a variety of effects, including subtle to conspicuous changes in behavior, movement, and displacement. Marine mammals' behavioral responses to noise range from no response to mild aversion, to panic and flight (Southall et al. 2007b). Underwater explosions can also result in behavioral changes such as disturbance to regular migration and movement patterns, feeding, mating, calving/pupping, and resting (von Benda-Beckmann et al. 2015). Behavioral reactions of marine mammals to sound are difficult to predict in the absence of site- and context-specific data; reactions to sound, if any, depend on species, state of maturity, experience, current activity, reproductive state, time of day, and many other factors (Richardson et al. 1995; Southall et al. 2007a; Ellison et al. 2012; Ellison et al. 2018). Behavioral responses to noise in the marine environment can interfere with the motivation and attention of an animal (Branstetter et al. 2018), and can lead to decreased foraging efficiency or displacement from preferred feeding habitats, and interfere with other biological functions. If a sound source displaces marine mammals from an important feeding or breeding area for a prolonged period, impacts on individuals and populations could be significant (Lusseau and Bejder 2007; Weilgart 2007; New et al. 2013b; Nowacek et al. 2015; Forney et al. 2017). Wisniewska et al. (2018) suggested that a decrease in foraging success could have long-term fitness consequences. However, Kastelein et al. (2019) surmised that if disturbance by noise would displace a marine mammal (e.g., harbor porpoise)

from a feeding area or otherwise impair foraging ability for only a short period of time (e.g., 1 day), it would be able to compensate by increasing its food consumption following the disturbance. In some cases, behavioral responses to sound may in turn reduce the overall exposure to that sound (Finneran 2015; Wensveen et al. 2015).

7.1.2.1 Pile Driving

Studies specific to behavioral responses of marine mammals to offshore wind developments have primarily been conducted on harbor porpoise (Tougaard et al. 2009a; Tougaard et al. 2009b; Bailey et al. 2010; Brandt et al. 2011; Dähne et al. 2013a; Thompson et al. 2013b; Dähne et al. 2017) and harbor and gray seals (Edrén et al. 2010; Russell et al. 2016). Generally, these studies showed some avoidance during periods of construction activity, followed by continued use of the area after construction activities were completed. Harbor porpoises are known to be fairly responsive to anthropogenic sounds (Richardson et al. 1995) and often avoid pile driving activities (Tougaard et al. 2009a; Brandt et al. 2011; Dähne et al. 2013a; Haelters et al. 2015; Dähne et al. 2017). Bailey et al. (2010) suggested that for harbor porpoise, behavioral disturbance from impact pile driving may occur up to 70 km away (based on a threshold of 90 $dB_{p\text{-}p}$ re 1 µPa), with major disturbance at distances up to 20 km (based on a threshold of 155 $dB_{p\text{-}p}$ re 1 µPa). Dähne et al. (2013a) reported avoidance by harbor porpoise of pile-driving activities during construction of an offshore wind farm in the German North Sea. Aerial survey data showed a strong avoidance response within 20 km from the activities, whereas static acoustic monitoring showed fewer detections within 10.8 km from the sound source, and increased click rates between 25 and 50 km from pile driving. Additionally, porpoise click intervals during exposure increased in duration as piling duration increased. Although avoidance by harbor porpoises was also reported during and several hours after pile driving for an offshore wind farm in the German Bight, the avoidance extent was smaller (up to 12 km) as bubble curtains were used to reduce sound levels by as much as 12 dB (Dähne et al. 2017).

During impact pile driving at Horns Rev I wind farm in the Danish North Sea, harbor porpoise acoustic activity decreased; however, it resumed to baseline levels 3 to 4.5 hours (h) after the cessation of pile driving activities (Tougaard et al. 2003; Tougaard et al. 2005). Tougaard et al. (2003) reported that effects of pile driving activity on harbor porpoises were documented at distances of 10–15 km from the activity and included a decrease in feeding behaviors and a decline in the number of porpoises in the Horns Rev area during the construction period as compared to periods before and after construction. There were fewer circling porpoises during pile driving and significantly more traveling within 15 km of the construction site (Tougaard et al. 2005). Based on Tougaard et al. (2005; 2009a; 2011), behavioral effects extended as far as 20–25 km from the construction site. There was complete recovery of acoustic activity during the first year of regular operation of the wind farm; the acoustic activity was actually higher during operation than prior to construction (Tougaard et al. 2006b; Teilmann et al. 2008).

In contrast to the "Before After Control Impact" sampling design used during previous studies at Horn Rev wind farm, a gradient sampling design showed that the behavioral responses of harbor porpoises to pile driving were longer than previously reported. Brandt et al. (2011) recorded no porpoise clicks for at least 1 h at a distance of 2.6 km from the construction site at Horns Rev II, with reduced acoustic activity for 24–72 h. Out to a distance of 4.7 km, the recovery time was still longer than 16 h – the time between pile driving events; recovery time decreased with increasing distance from the construction site (Brandt et al. 2011). At a distance of ~22 km, negative effects were no longer detectable; rather, a temporary increase in click activity was apparent, possibly as a result of porpoises leaving the area near the construction site (Brandt et al. 2011).

During pile driving activities (using both vibratory and impact techniques) at the Nysted offshore wind farm off the coast of Denmark, a significant decrease in harbor porpoise echolocation activities and presumably abundance was reported within the construction area and in a reference area 10–15 km from the wind farm (Carstensen et al. 2006; Teilmann et al. 2008) . Carstensen et al. (2006) reported a medium-term porpoise response to construction activities in general and a short-term response to ramming/ vibration activities. Porpoises appeared to have left the area during piling but returned after several days (Tougaard et al. 2006a). Two years after construction, echolocation activity and presumably porpoise abundance were still significantly reduced in the wind farm but had returned to baseline levels at the reference sites (Tougaard et al. 2006a; Teilmann et al. 2008).

Teilmann et al. (2006) speculated as to the cause of the negative effect of construction persisting longer for porpoises at Nysted than at Horns Rev. Porpoises at Horns Rev may have been more tolerant to disturbance, since the area is thought to be important to porpoises as a feeding ground; the Horns Rev area has much higher densities of animals compared to Nysted (Teilmann et al. 2006). Another explanation proposed by Teilmann et al. (2006) took into account that the Nysted wind farm is located in a sheltered area whereas Horns Rev is exposed to wind and waves with higher background noise. Thus, noise from construction may be more audible to porpoises at Nysted compared to Horns Rev. Graham et al. (2017) reported that vibratory pile driving had a greater effect on reducing the probability of harbor porpoise occurrence in a construction area compared with impact pile driving.

Scheidat et al. (2011) suggested that harbor porpoise distribution was fairly quick to recover after construction of the Dutch offshore wind farm Egmond aan Zee, as acoustic activity of harbor porpoises was greater during the 3 years of operation than the 2 years prior to construction. In addition, Leopold and Camphuysen (2008) noted that construction of wind farm Egmond aan Zee did not lead to increased strandings in the area. Harbor porpoises near pile driving activities in Scotland may have exhibited a short-term response within 1–2 km of the installation site, but this was a short-term effect lasting no longer than 2–3 days (Thompson et al. 2010). Harbor porpoise occurrence decreased (as indicated by a decline in echolocation clicks) during pile-driving activities at Scottish offshore windfarms; displacement was reported to occur at distances of up to 12 km from the activities (Benhemma-Le Gall et al. 2021). Changes in buzzing activity relative to pile-driving occurred at two windfarm sites, but results were variable (Benhemma-Le Gall et al. 2021).

During the construction of a harbor wall in Demark, which involved pile driving of 175 wooden piles, a 40 m-long bubble curtain was constructed in hopes of reducing noise effects on three harbor porpoises in a facility on the opposite side of the harbor (Lucke et al. 2011). The bubble curtain was found to be helpful in reducing the piling noise, and the initial avoidance behavior of the harbor porpoises to the piling sound was no longer apparent after installation of the bubble curtain (Lucke et al. 2011).

A captive harbor porpoise exposed to vibratory pile driving sounds displayed an increase in respiration rates and jumps; however, this animal demonstrated rapid habituation to the sound (i.e., respiration rates decreasing towards baseline levels), after just 10 minutes (Kastelein et al. 2013). By the fourth and fifth replication, the harbor porpoise produced more clicks in response to the 140 dB re 1 μPa playback noise (Kastelein et al. 2013). An increase in click number suggests the harbor porpoises were compensating for the increased noise level. Auditory masking did not likely occur as the pile driving noise peak frequency was below 10 kHz and any energy above 60 kHz was below ambient levels (Kastelein et al. 2013).

There have also been some studies regarding the impact of pile driving on dolphins. Graham et al. (2017) reported that bottlenose dolphins spent less time in a construction area when impact or vibratory piling was occurring. The longer duration of non-impulsive sounds produced by vibratory pile driving may result in greater temporal potential for behavioral disturbance; however, responses are expected to be short-term. In a study assessing the effects of vibratory pile driver noise on the echolocation and vigilance in bottlenose dolphins, five dolphins were required to scan their enclosure and indicate the occurrences of phantom echoes during five different source levels of vibratory pile driver playback sound—no-playback control, 100, 120, 130, and 140 dB re 1 µPa (Branstetter et al. 2018). The initial cessation of echolocation activity during the first 140 dB re 1 µPa exposure suggests a shift of attention from the task to the noise source and/or a decrease in motivation to perform a task. The continued performance decrement for the post-exposure condition, in which there was no noise exposure, suggests the animals' motivation state was a major, if not primary factor, influencing target detection performance and vigilant behavior. Rapid acclimation to the noise exposure was demonstrated by all animals within the study.

Paiva et al. (2015) reported a significant decrease in the number of Indo-Pacific bottlenose dolphin (*Tursiops aduncus*) detections during pile driving activities, which included vibratory and impact driving. In another study, Indo-Pacific humpback dolphins (*Sousa chinensis*) exposed to $L_{p,rms}$ of 170 dB remained within 300 to 500 m of the percussive pile driving area before, during, and after operations; although some dolphins temporarily abandoned the work area, their numbers returned close to those seen pre-construction during the follow-up survey seven months after construction activities ended (Würsig and Green 2002). During construction activities at windfarms located 20–75 km from coastal waters where bottlenose dolphins occur in Moray Firth, North Sea, dolphin vocalizations were detected acoustically during pile driving, but a temporary increase in call detections was reported (Fernandez-Betelu et al. 2021).

The effects of pile driving on the distribution and behavior of pinnipeds may be small in comparison to the effects on cetaceans. Ringed seals exposed to pile driving pulses exhibited little or no reaction at a shallow water site in the Alaskan Beaufort Sea; at the closest point (63 m), received levels were 151 dB re 1 μPa_{rms} and 145 dB re 1 $\mu Pa^2 \cdot s$ L_E (Blackwell et al. 2004). In contrast, harbor seals may be more response to pile driving sound. At the Horns Rev wind farm, no seals were observed during ship-based surveys in the wind farm during pile driving (Tougaard et al. 2006b). However, animals were sighted in the wind farm during other construction activities, although at apparently lower numbers than during baseline conditions (Tougaard et al. 2006b). Bailey et al. (2010) suggested minor disturbance within 14 km (based on a threshold of $L_{p,pk\text{-}pk}$ 160 dB re 1 µPa), and major disturbance within 215 m (based on a threshold of $L_{p,p\text{-}p}$ 200 dB re 1 µPa) of pile driving activities for harbor and grey seals. Russell et al. (2016) reported displacement of harbor seals during piling when received levels were between $L_{p,pk\text{-}pk}$ 166 and 178 re 1µPa. Although displaced during active pile driving, harbor seals were then observed to return to a normal distribution (distribution measured during the non-piling scenario) within 2 h of cessation of pile driving (Russell et al. 2016). Using data from tagged harbor seals, Whyte et al. (2020) estimated that seal densities would be reduced within 25 km of pile driving activities or above single strike SELs of 145 dB re 1 $\mu Pa^2 s$. Teilmann et al. (2006) speculated that harbor porpoise may be more tolerant to disturbance at good foraging areas. Similarly, Hastie et al. (2021) found that captive grey seals made foraging decisions consistent with a risk versus profit approach, which led to diminished foraging success by seals at low-density prey patches compared with high-density pretty patches during exposure to playbacks of pile driving sounds. Based on population modeling and taking into account potential

behavioral and auditory effects from pile driving noise from offshore windfarms, Thompson et al. (2013a) reported no long-term changes in the viability of the population of harbor seals at Moray Firth.

Remote video monitoring showed that harbor seal haul-out behavior was affected by pile driving at an offshore wind farm (Nysted) in the western Baltic (Edrén et al. 2004; Edrén et al. 2010). The authors found a short-term reduction in the number of seals hauled out at nearby beaches during periods with pile driving versus periods with no pile driving. Sound levels were not measured, and observations of seals in the water were not made. The authors suggest that seals may have spent more time in the water because this is a typical response to disturbance or the seals may have used an alternate haul-out site. However, both aerial surveys and remote video monitoring did not show a long-term decrease in the number of seals hauled out from baseline conditions to the construction period (Edrén et al. 2004; Thomsen et al. 2006; Edrén et al. 2010). Hauled out harbor seals did not seem to be affected by pile driving noise during construction activities in San Francisco Bay (Caltrans 2004). Similarly, Teilmann et al. (2006) noted that the reactions of harbor seals to construction activities appeared to be short-term because aerial surveys did not reveal any decrease in overall abundance during the 2002–2003 construction period or 2004–2005 operation period (Teilmann et al. 2006). However, Skeate et al. (2012) suggested a likely link between windfarm construction (e.g., pile driving) and a statistically significant decrease in the number of hauled out harbor seals nearby.

7.1.2.2 HRG Surveys

A number of studies have considered impacts from seismic airguns that produce a similar impulsive sound to impact pile driving. The effects of sounds from HRG surveys could include either masking of natural sounds or behavioral disturbance (Richardson et al. 1995; Nowacek et al. 2007; Southall et al. 2007a). Most types of HRG survey equipment produce impulsive sounds that could have similar effects on marine mammals as described previously for impact pile driving; however, the sounds produced by HRG survey equipment are typically at higher frequencies, lower source levels, and have a much higher repetition rate than impact pile driving. This means that injurious takes are very unlikely.

Baleen whales generally tend to avoid impulsive sounds from operating airguns, but avoidance radii vary greatly (Richardson et al. 1995; Gordon et al. 2003). Whales are often reported to show no overt reactions to impulsive sounds from large arrays of airguns at distances beyond a few kilometers, even though the airgun pulses remain well above ambient noise levels out to much longer distances. As noted earlier, some cetaceans are known to increase the source levels of their calls, shift their peak frequencies, or otherwise modify their vocal behavior (increase or decrease call rates) in response to pulsed sounds from airguns (Clark and Gagnon 2006; Castellote et al. 2012; Blackwell et al. 2013; Blackwell et al. 2015). Di Iorio and Clark (2010) found that blue whales in the St. Lawrence Estuary increased their call rates during operations by a lower-energy seismic source. The sparker used during the study emitted frequencies of 30–450 Hz with a relatively low source level of 193 $dB_{pk\text{-}pk}$ re 1 μPa.

Baleen whales exposed to strong sound pulses from airguns often react by moving away from and/or around the sound source. Some of the major studies and reviews on this topic are Gordon et al. (2003); Johnson et al. (2007); Ljungblad et al. (1988); Malme et al. (1984); Malme et al. (1985); Malme et al. (1988); McCauley et al. (1998); McCauley et al. (2000); Miller et al. (1999); Miller et al. (2005); Moulton and Holst (2010); Nowacek et al. (2007); Richardson et al. (1986); Richardson et al. (1995); Richardson et al. (1999; 2010); Richardson and Malme (1993); Stone (2015); Stone and Tasker (2006); and Weir (2008). Studies of bowhead, humpback, and gray whales have shown that impulsive sounds from seismic airguns with received levels of 160–170 dB re 1 μPa SPL seem to cause obvious avoidance

behavior in a substantial portion of the animals exposed (Richardson et al. 1995; 2015). A study conducted across 880,000 km^2 of the East Atlantic Ocean saw an 88% (82-92%) reduction in sightings of baleen whales and a 53% (41-63%) reduction in toothed whale sightings during active seismic surveys when compared to control surveys (Kavanagh et al. 2019). However, this reflected a redistribution of the animals within the entire study area where overall sighting densities remained unaffected (Kavanagh et al. 2019). Studies near the United Kingdom, Newfoundland and Angola, in the Gulf of Mexico, off Central America, and Alaska have shown localized avoidance of seismic surveys by these species (whales), although, dolphins, porpoises and seals are often seen by observers on active seismic vessels, occasionally at close distances (e.g., bow riding).

While most baleen whales often show only slight overt responses to operating airgun arrays (Stone and Tasker 2006; Weir 2008; Stone 2015; Kavanagh et al. 2019), strong avoidance reactions by several species of baleen whales have been observed. Experiments with a single airgun (327.7–1,638 cubic centimeters [20–100 cubic inches] in size) showed that bowhead, humpback, and gray whales (*Eschrichtius robustus*) all showed localized avoidance (Malme et al. 1984; Malme and Miles 1985; Malme et al. 1986; Richardson et al. 1986; Malme et al. 1988; McCauley et al. 1998; McCauley et al. 2000; Kavanagh et al. 2019). More recent studies have shown that some species of baleen whale (bowhead and humpback whales in particular) at times show strong avoidance at received levels lower than 160–170 dB re 1 μPa SPL.

When observing migrating bowhead, humpback, and gray whales, the changes in behavior appeared to be of little or no biological consequence to the animals—they simply avoided the sound source by displacing their migration route to varying degrees, but within the natural boundaries of the migration corridors (Malme et al. 1984; Malme and Miles 1985; Richardson et al. 1995; Dunlop et al. 2017). The largest documented avoidance radii involved migrating bowhead whales, which avoided an operating seismic vessel by 20–30 km (65.6–98.4 mi) (Miller et al. 1999; Richardson et al. 1999). In contrast to migrating whales, feeding bowhead whales show much smaller avoidance distances (Miller et al. 2005; Harris et al. 2007), presumably because moving away from a food concentration has greater cost to the whales than does a course deviation during migration.

Groups of humpback whales migrating towards feeding grounds have been observed responding to seismic activity by changing the magnitude and rates of typical behaviors (singing, socializing with conspecifics, using social signals, and migratory travel), specifically through change in movement patterns, dive/respiratory parameters and rates of breaching (Dunlop et al. 2017; Dunlop et al. 2020). Groups of both humpbacks and female-calf groups exposed to the active seismic array made a 1 km per hour slower progression during southern migration compared to most unexposed baseline groups (largely due to divergence off their normal course rather than a slowing down of travel speed) (Dunlop et al. 2017). Similarly, in response to the seismic airgun array, adult pairs reduced their migration speed by 2.5 km per hour, which resulted in traveling at a speed of approximately half of their initial travel time (Dunlop et al. 2017). Resting female-calf pairs have been found to show avoidance responses at received levels as low as 129 dB re $1\mu Pa^2s$ while migrating humpback whales demonstrated changes in migration at received levels of 144-151 dB re $1\mu Pa^2s$ (McCauley 2003; Dunlop et al. 2017).

There is nearly no available information on marine mammal behavioral responses to multibeam echosounder sounds (MBES) (Southall et al. 2013). Much of the literature on marine mammal response to sonars relates to the types of sonars used in naval operations, including low-frequency, mid-frequency, and high-frequency active sonars (Southall et al. 2016). However, the MBES sounds are quite different

from naval sonars. Ping duration of the MBES is very short relative to naval sonars. Also, at any given location, an individual marine mammal would be in the beam of the MBES for much less time given the generally downward orientation of the beam and its narrow fore-aft beamwidth; naval sonars often use near-horizontally-directed sound. In addition, naval sonars have higher duty cycles. These factors would all reduce the sound energy received from the MBES relative to that from naval sonars.

In September 2013, the operation of a MBES was linked to a mass stranding of melon-headed whales off Madagascar (Southall et al. 2013). During May–June 2008, ~100 melon-headed whales entered and stranded in the Loza Lagoon system in northwest Madagascar at the same time that a 12-kHz echosounder survey was being conducted ~65 km away off the coast. In conducting a retrospective review of available information on the event, an independent scientific review panel concluded that the Kongsberg EM 120 MBES was the most plausible behavioral trigger for the animals initially entering the lagoon system and eventually stranding. The independent scientific review panel, however, identified that an unequivocal conclusion on causality of the event was not possible because of the lack of information about the event and a number of potentially contributing factors. Additionally, the independent review panel report indicated that this incident was likely the result of a complicated confluence of environmental, social, and other factors that have a very low probability of occurring again in the future but recommended that the potential be considered in environmental planning. Leading scientific experts knowledgeable about MBESs expressed concerns about the independent scientific review panel analyses and findings (Bernstein 2013).

During a recent study, group vocal periods (GVP) were used as proxies to assess foraging behavior of Cuvier's beaked whales during multibeam mapping in southern California (Varghese et al. 2021). The study found that there was no significant difference between GVP during multibeam mapping and non-exposure periods, suggesting that the level of foraging likely did not change during multibeam mapping. During an analogous study assessing naval sonar (McCarthy et al. 2011), significantly fewer GVPs were recorded during sonar transmission (McCarthy et al. 2011; Varghese et al. 2021). In the fall of 2006, an Ocean Acoustic Waveguide Remote Sensing (OAWRS) experiment was carried out in the Gulf of Maine (Gong et al. 2014); the OAWRS emitted three frequency-modulated (FM) pulses centered at frequencies of 415, 734, and 949 Hz (Risch et al. 2012). Risch et al. (2012) found a reduction in humpback whale song in the Stellwagen Bank National Marine Sanctuary during OAWRS activities that were carried out ~200 km away; received levels in the sanctuary were 88–110 dB re 1 µPa. In contrast, Gong et al. (2014) reported no effect of the OAWRS signals on humpback whale vocalizations in the Gulf of Maine. Range to the source, ambient noise, and/or behavioral state may have differentially influenced the behavioral responses of humpbacks in the two areas (Risch et al. 2014a).

Deng et al. (2014) measured the spectral properties of pulses transmitted by three 200-kHz echosounders and found that they generated weaker sounds at frequencies below the center frequency (90–130 kHz). These sounds are within the hearing range of some marine mammals, and the authors suggested that they could be strong enough to elicit behavioral responses within close proximity to the sources, although they would be well below potentially harmful levels. Hastie et al. (2014) reported behavioral responses by gray seals to echosounders with frequencies of 200 and 375 kHz. Short-finned pilot whales increased their heading variance in response to an EK60 echosounder with a resonant frequency of 38 kHz (Quick et al. 2017), and significantly fewer beaked whale vocalizations were detected while an EK60 echosounder was active vs. passive (Cholewiak et al. 2017).

When comparing the potential for behavioral response to non-impulsive sounds from an MV source versus impulsive sounds from an airgun array using the current NMFS criteria of 120 dB re 1 µPa SPL_{rms} for non-impulsive sounds and 160 dB SPL_{rms} for impulsive sounds (NOAA 2005), models predicted longer distances to the behavioral thresholds for the non-impulsive MV source than the airgun source (Matthews et al. 2018). The difference in source levels between the two source types (29.5 dB on average) is generally less than the difference between the behavioral thresholds (40 dB). Consequently, longer distances to the behavioral thresholds were found for the MV source than the airgun source, and more animals were predicted to be exposed to sound levels above behavioral thresholds for the MV than the airgun. However, these criteria do not incorporate known differences in the frequency-dependent hearing sensitivity of different marine mammal species or individual variation in the likelihood of behavioral response, nor is there agreement that the 120 dB re 1 µPa is an appropriate threshold for MV sources. When the more realistic, frequency-weighted, multiple-step functions proposed by Wood et al. (2012) and DoN (2012) are used for comparative purposes, the result is reversed and fewer animals (by about an order of magnitude) are predicted to be exposed to sound levels above behavioral thresholds for the MV than for airgun arrays. This is primarily caused by the higher source levels (i.e., sound pressure amplitude) of airgun arrays resulting in longer distances to behavioral response thresholds that are nearly equivalent for the two source types using these criteria. However, these results do not directly incorporate context-dependent factors that may affect the likelihood of behavioral response, such as feeding, breeding, or migrating behaviors or the previous exposure history of individuals.

7.1.2.3 Summary

Since the Project area is not located in an important feeding area, most responses to the planned pile driving, HRG surveys, and UXO/MEC detonations are expected to consist of avoidance behavior, where the animals simply avoid the area around the activity and continue on their migratory path, resulting in little overall impact to individual animals. Overall, odontocete and pinniped reactions to strong impulsive sounds are variable and, at least for delphinids and some porpoises, seem to be confined to a smaller radius than has been observed for some mysticetes. Any displacement would only last for the duration that the sound source is active in that location, with animals resuming regular behavior once the sound source passes. If a marine mammal reacts to an underwater sound by slightly changing its behavior or moving a small distance, the impacts of the change are unlikely to be significant to the individual, let alone the stock or population (New et al. 2013a).

7.1.3 Hearing Impairment

Temporary or permanent hearing impairment is a possibility when marine mammals are exposed to very strong sounds. TTS has been demonstrated and studied in certain captive odontocetes and pinnipeds exposed to strong sounds (Southall et al. 2007a; Finneran 2015). There are empirical data on the sound exposures that elicit onset of TTS in captive bottlenose dolphins, belugas, porpoise, and three species of pinnipeds (Finneran 2015). The majority of these data concern non-impulse sound, but there are some limited published data concerning TTS onset upon exposure to pile driving (Kastelein et al. 2015a; Kastelein et al. 2016), a single pulse of sound from a watergun (Finneran et al. 2002), and to multiple pulses from an airgun (Finneran 2015). No TTS was detected when spotted or ringed seals were exposed to impulsive sounds (Reichmuth et al. 2016). A detailed review of TTS data from marine mammals can be found in Southall et al. (Southall et al. 2007b; Southall et al. 2019). In general, harbor seals and harbor porpoise appear to be more susceptible to TTS than other pinnipeds or cetaceans (Finneran 2015). There

have not been any field studies that have examined TTS or permanent hearing damage (i.e., PTS) in free-ranging marine mammals exposed to anthropogenic sounds. However, some studies have shown that bottlenose dolphins can decrease their hearing sensitivity in order to mitigate the impacts of exposure to loud sounds (Nachtigall and Supin 2014; Nachtigall and Supin 2015; Nachtigall et al. 2016; Nachtigall et al. 2018; Finneran 2020; Kastelein et al. 2020).

TTS is the mildest form of hearing impairment that can occur during exposure to a strong sound (Kryter 1985). While experiencing TTS, the hearing threshold rises, and a sound must be stronger in order to be heard. It is a temporary phenomenon, and (especially when mild) is not considered to represent physical damage or "injury" (Southall et al. 2007a; Le Prell et al. 2012). Rather, the onset of TTS has been considered an indicator that, if the animal is exposed to higher levels of that sound, physical damage is ultimately a possibility. However, research has shown that sound exposure can cause cochlear neural degeneration, even when threshold shifts and hair cell damage are reversible (Liberman et al. 2016). These findings have raised some questions as to whether TTS should continue to be considered a non-injurious effect (Weilgart 2014; Tougaard et al. 2015; Tougaard et al. 2016; Houser 2021). When PTS occurs, there is physical damage to the sound receptors in the ear, due to neural cell damage and loss of hair cell bodies (Koschinski 2011). In some cases, there can be total or partial deafness, whereas in other cases, the animal has an impaired ability to hear sounds in specific frequency ranges (Kryter 1985). Physical damage to a mammal's hearing apparatus can occur if it is exposed to sound impulses that have very high peak pressures, especially if they have very short rise times. Rise time is the time interval required for sound pressure to increase from the baseline pressure to peak pressure. Permanent damage can also occur from the accumulation of sound energy over time.

Kastelein et al. (2015b; 2016) reported TTS in the hearing threshold of captive harbor porpoise during playbacks of pile driving sounds. TTS was measured in two captive harbor porpoises after being exposed to recorded impact pile driving sounds with an average received single-strike sound exposure level (SEL_{ss}) of 145 dB re 1 μPa^2s, with exposure duration ranging from 15 minutes to 6 hours (SEL_{cum} ranged from 173 to 187 dB re 1 μPa^2s). Although the pulses had most of their energy in the low frequencies, multiple pulses caused reduced hearing at higher frequencies in the porpoise. It is generally assumed that the effect on hearing is directly related to total received energy; however, this assumption is likely an over-simplification (Finneran 2012). Frequency, duration of the exposure, and occurrence of gaps within the exposure can also influence the auditory effect (Finneran 2012, 2015; Supin et al. 2016; Kastelein et al. 2019).

Unlike during studies with captive animals, during project activities an animal would be able to move away from the sound source, as avoidance behavior has been demonstrated for many marine mammals subjected to loud sounds, thereby reducing the potential for impacts to their hearing ability. There is no specific evidence that exposure to pulses from pile driving or other activities in unrestricted environments is likely to lead to PTS for any marine mammals. Using data from tagged harbor seals, Whyte et al. (2020) estimated that TTS occurrence would be low for free-ranging harbor seals exposed to pile driving sounds. Based on simulation, Schaffeld et al. (2020) reported that TTS in harbor porpoises could only be avoided during multiple exposures to pile driving pulses, if a combination of exclusion zones regulations, previous deterrence by scaring devices, and a soft start were employed as mitigation measures. Similarly, Thompson et al. (2020) recommended a combination of deterrent devices, minimizing hammer energy, and extended soft starts to minimize risks to marine mammals from pile driving. It has been predicted that harbor porpoises and harbor seals could be exposed to TTS without the use of noise mitigation systems (Dähne et al. 2013b; Stöber and Thomsen 2019).

Bailey et al. (2010) measured pile driving sounds during the construction of a wind farm in Scotland and predicting the expected peak broadband sound levels associated with TTS; the peak broadband pressure levels estimated to cause TTS onset in mid-frequency cetaceans (at 224 $dB_{0\text{-}pk}$ re 1 μPa) and pinnipeds (212 $dB_{0\text{-}pk}$ re 1 μPa) would occur within 10 m of pile driving and 40 m, respectively. Through extrapolation of research focused on TTS onset in marine mammals, Bailey et al. (2010) showed that pile driving sounds may cause PTS. Based on regulatory criteria, the peak broadband pressure levels estimated to cause PTS onset in mid-frequency cetaceans (230 $dB_{0\text{-}pk}$ re 1 μPa) and pinnipeds (218 $dB_{0\text{-}pk}$ re 1 μPa) would occur within 5 m and 20 m, respectively (Bailey et al. 2010). Based on the closest measurement of pile-driving noise recorded at 100 m, Bailey et al (2010) indicated that no form of injury or hearing impairment should have occurred at distances greater than 100 m from piling activity.

Based on empirical measurements of pile driving sounds, there appears to be little risk for hearing impairment to marine mammals from vibratory pile driving, given the sound levels from vibratory pile driving are not expected to exceed 165 dB re 1 μPa_{rms} beyond 10 m (Illingworth and Rodkin 2007, 2017). Distances to injury thresholds for marine mammals are shorter for non-impulsive sounds when compared to impulsive sounds (Matthews et al. 2018). Thus, it is unlikely that marine mammals would be exposed to vibratory pile driving at a sufficiently high level for a sufficiently long period to cause more than mild TTS. For non-impulsive sounds (such as vibratory pile driving), Southall et al. (2019) estimated that the received levels would have to exceed the TTS threshold by 20 dB, on an SEL basis, for there to be risk of PTS.

To experience any potential hearing impairment from HRG sources, marine mammals would have to occur in very close proximity (36.5 m) to the survey equipment (Appendix A). This is because the relatively high frequency sounds produced by the survey equipment attenuate rapidly in water. With the implementation of planned monitoring and mitigation measures like pre-start watches and exclusion zones (Appendix C), hearing impairment caused by HRG sources is extremely unlikely to occur. Most types of HRG survey equipment produce impulsive sounds that could have similar effects on marine mammals as described previously for impact pile driving; however, the sounds produced by HRG survey equipment are typically at higher frequencies, lower source levels, and have a much higher repetition rate than impact pile driving. This means that injurious takes are very unlikely. Lurton (2016) modeled MBES radiation characteristics (pulse design, source level, and radiation directivity pattern) applied to a low-frequency (12-kHz), 240-dB source-level system. Using Southall et al. (Southall et al. 2007b) thresholds, he found that injury impacts were possible only at very short distances, e.g., at 5 m for maximum SPL and 12 m for cumulative SEL for cetaceans; corresponding distances for behavioral response were 9 m and 70 m. For pinnipeds, "all ranges are multiplied by a factor of 4" (Lurton 2016).

Although it is unlikely that pile driving activities and HRG surveys would cause PTS in many marine mammals, caution is warranted given the limited knowledge about noise-induced hearing damage in marine mammals, the lack of knowledge about TTS and PTS thresholds in many species, and the seemingly greater susceptibility of certain species (e.g., harbor porpoise and harbor seal) to TTS and presumably also PTS. The avoidance reactions of some marine mammals, along with commonly applied monitoring and mitigation measures would reduce the probability of exposure of marine mammals to sounds strong enough to induce PTS. However, the rapid changes in pressure and short signal rise time involved in explosions may lead to PTS (Ketten 1995; von Benda-Beckmann et al. 2015). Marine mammals that communicate in the high-frequency range, such as harbor porpoise, are particularly sensitive to the effects of underwater explosions. Hearing damage and other physical injuries have been

reported for cetaceans (Ketten et al. 1993; Ketten 1995) and pinnipeds (Fitch and Young 1948; Danil and St. Leger 2011).

The criteria used in the exposure modeling (Section 6.2) (NMFS 2018a) reflect the most recent scientific review and conclusions of NMFS regarding sound levels that could cause PTS. Based on the exposure modeling results, the number of marine mammals that may experience hearing impairment is quite small, even when planned mitigation measures are not considered. Taking into account that extensive monitoring and mitigation measures will be applied (Appendix C), the likelihood of the Project causing PTS in a marine mammal is considered unlikely.

7.1.4 Non-auditory Physical Effects

Non-auditory physical effects may also occur in marine mammals exposed to strong underwater pulsed sound. Possible types of non-auditory physiological effects or injuries that might (in theory) occur in mammals close to a strong sound source include stress, neurological effects, bubble formation, and other types of organ or tissue damage (Cox et al. 2006; Southall et al. 2007b; Tal et al. 2015). Rolland et al. (2012) showed that ship noise causes increased stress in right whales. Wright et al. (2011), Atkinson et al.(2015), Houser et al. (2016), and Lyamin et al. (2016) also reported that sound could be a potential source of stress for marine mammals. Marine mammals close to underwater detonations of high explosives can be killed or severely injured (Koschinski 2011; Merchant et al. 2020), and the auditory organs are especially susceptible to injury (Ketten et al. 1993; Ketten 1995). Studies also indicate that smaller cetacean species are at greatest risk for shock wave or blast injuries (Ketten 2004). Hearing damage and other physical injuries have been reported for cetaceans (Ketten et al. 1993; Ketten 1995) and pinnipeds (Fitch and Young 1948; Danil and St. Leger 2011). Intense shock waves, because of their high peak pressures and rapid changes in pressure, can cause severe damage to animals. The most severe damage takes place at boundaries between tissues of different density. Different velocities are imparted to tissues of different densities, and this can physically disrupt the tissues. Gas-containing organs, particularly the lungs and gastrointestinal tract, are especially susceptible (Yelverton et al. 1975; Hill 1978). Lung injuries can include laceration and rupture of the alveoli and blood vessels, which in turn can lead to hemorrhage, creation of air embolisms, and breathing difficulties. Intestinal walls can bruise or rupture, with subsequent hemorrhage and escape of gut contents into the body cavity. The behavior of the pressure wave in the water column depends on water depth, sediment, sea state, stratification of the water column, temperature, salinity and other variables (Koschinski and Kock 2009; Salomons et al. 2021). Therefore, the specific effects on a given marine mammal will depend on all of these factors, as well as species, body size, the distance of the animal from the blast site, and the charge weight of the UXO/MEC in question (Hannay 2021).

Impacts associated with UXO/MEC detonation for the proposed Project are expected to be negligible given the fact that any required detonations will be timed to occur no more than once per day, and noise from these activities will not exceed the 160 dB Level B impulsive threshold for marine mammals; the relatively low number of UXO/MECs identified in the Project area, and the adoption of extensive mitigation measures, such as bubble curtains (Section 11.5), which will reduce or eliminate Level A and Level B harassment. Bubble curtains have been shown to effectively reduce the sound pressure and the shock wave from detonations (Schmidtke et al. 2009). Adverse effects are therefore not anticipated on marine mammal stocks or populations.

7.2 Population Level Effects

NMFS provides best available estimates of abundance (N_{best}) for all marine mammal stocks under their jurisdiction in their annual Stock Assessment Reports (Hayes et al. 2020). In most cases, NMFS considers these to be underestimates because the full known range of the stock was not surveyed, the estimate did not include availability-bias correction for submerged animals, or there may be uncertainty regarding population structure (Hayes et al. 2017). Marine mammal abundance estimates are also available from Duke University Marine Geospatial Ecological Laboratory habitat-based models Roberts et al. (2016; 2017; 2018; 2021). Since the modeling included availability-bias corrections the abundance estimates can be larger than the SAR N_{best} abundance estimates. However, the Roberts et al. (2016; 2017; 2018; 2021) models only provide estimates of abundance for the U.S. Atlantic EEZ which is a smaller area than occupied by the stocks defined by NMFS. By defining most stocks as inclusive of animals in the larger northwest Atlantic Ocean, including areas outside of the U.S. Atlantic EEZ, the SAR N_{best} abundance estimates are larger for nearly all species. Thus, the SAR N_{best} abundance estimates were used to calculate the percentage of each population or stock that could potentially receive Level A or Level B sound exposures during the Project construction activity (Table XX).

8 Anticipated Impacts on Subsistence Uses

NOAA Office of Protected Resources defines “subsistence” as the use of marine mammals taken by Alaskan Natives for food, clothing, shelter, heating, transportation, and other uses necessary to maintain the life of the taker or those who depend upon the taker to provide them with such subsistence. There are no traditional subsistence hunting areas in the vicinity of the proposed Project Area and there are no activities related to the Project that may impact species or stocks of marine mammals that are used for subsistence purposes elsewhere. Therefore, there will be no effect on the availability of marine mammals for subsistence uses.

9 Anticipated Impacts on Habitat

This section addresses the potential loss or modification of marine mammal habitat resulting from the construction activities and the likelihood of restoration of that habitat. For clarity, potential impacts have been categorized as short-term or long-term in the following subsections. Short-term impacts are those that might occur from the actual construction activities but largely resolve once construction is completed. Long-term impacts are those that might persist after construction is completed including during the operations phase of the SRWF.

9.1 Short-Term Impacts

A variety of impact producing factors (i.e., seafloor disturbance, turbidity, physical presence of vessels and equipment, vessel discharges, and noise) with the potential to temporarily affect marine mammal habitat, including prey availability, may be expected as a result of the proposed activities. The marine mammal species found within the Project Area feed on various pelagic and benthic fish species, cephalopods, and crustaceans. Elevated noise levels, installation of structures that disturb the seafloor, and other factors associated with project vessels and equipment may cause some prey species to leave the immediate area of operations, temporarily reducing the availability of prey within the area and thus disrupting feeding behavior and efficiency. Displaced prey species are expected to return shortly after

construction is completed. Although pathological or physiological effects are also possible (Hawkins and Popper 2017; Weilgart 2017) the number of prey items affected would be a very small percentage of the stocks available in the region.

The most common behavioral responses by fish to anthropogenic noise are avoidance, alteration of swimming speed and direction, and alteration of schooling behavior (Vabø et al. 2002; Handegard and Tjøstheim 2005; Sarà et al. 2007; Becker et al. 2013). Increased sound levels from the construction activities and during underwater explosions have the potential to affect local prey populations, which might indirectly affect marine mammals by altering prey abundance, behavior, and distribution (McCauley 2003; Popper and Hastings 2009; Slabbekoom et al. 2010; Danil and St. Leger 2011; von Benda-Beckmann et al. 2015). Marine fish are typically sensitive to noise in the 100 to 500 Hz range, which coincides with the primary frequency range of vessels and pile driving activities. Noise generated by both impact and vibratory pile driving, as well as other project activities, has the potential to elicit behavioral responses in fish, and impact pile driving and/or UXO/MEC detonation also have the potential to cause injury or even mortality as a result of the high peak pressure levels near the source (Yelverton et al. 1975; Hastings and Popper 2005).

Harding et al. (2016) performed laboratory-based experiments on Atlantic salmon exposed to underwater playback of pile driving noise at SPLs of 149.4-153.7 dB re 1µPa; the results showed that there were no observed differences in salmon behavior when exposed to piling noise. Juvenile coho salmon displayed no avoidance behavior from exposure to a real impact-piling event when positioned in cages that were positioned close to the noise source (Ruggerone et al. 2008). However, other studies have shown behavioral effects in response to impulsive pile driving sounds on European seabass (*Dicentrarchus labrax*), including increased startle responses, swimming speeds, diving behaviors, and school cohesion (Neo et al. 2014), increased opercula beat rates (a sign of stress), increased energy expenditure on alert and defensive behaviors (e.g., inspection of the experimental area), and decreased inspection of possible predators (Spiga et al. 2017). Both studies showed similar behavioral effects when fish were exposed to continuous drilling sounds, but behavioral recovery times were significantly slower for the impulsive sounds versus the continuous sounds (Neo et al. 2014; Spiga et al. 2017).

Laboratory pile driving studies demonstrated swim bladder damage in Chinook salmon and documented tissue damage in other species (Halvorsen et al. 2012). A similar study saw ruptured swim bladders and/or kidney hemorrhaging in fish which had been exposed to ~96 pile strikes with a sound exposure level (SEL_{ss}) of 183 dB (Casper et al. 2017). Casper et al. (2017) found that physical injuries sustained by the fish increased in both severity and number as the cumulative sound exposure level (SEL_{cum}) increased with higher per-strike energy and total number of strikes. Hart Crowser et al. (2009) and Houghton et al. (2010) exposed caged juvenile coho salmon (*Oncorhynchus kisutch*) to sounds from vibratory pile driving with maximum peak SPLs of 177 to 195 dB re 1 µPa and SELs of 174.8 to 190.6 dB re 1 µPa. They reported no mortalities or behavioral abnormalities; pile driving did not affect the feeding ability of the juvenile coho salmon. Squid are an extremely important food chain component for many higher order marine predators, and while limited information is available for noise impacts on invertebrate species, squid are known to be able to detect particle motion. Jones et al. (2020) reported alarm responses of squid in response to playbacks of pile driving noise in a laboratory setting, but there appeared to be some rapid, short-term habituation; however, similar startle responses were noted when squid were exposed again 24 hours later. Crustaceans have also shown behavioral responses to pile driving (Tidau and Briffa 2016). Disturbances associated with noise produced by construction activities are expected to be short-term and temporary with minor impacts to marine mammal prey species.

Seafloor disturbance is expected during seafloor preparation, pile driving, placement of scour protection, installation of the inter-array cables, and SRWEC installation, and UXO/MEC detonation. The disturbance would be limited to within 220 m of WTG and OCS-DC foundations, and within 30-m wide corridors along cable routes. Vessel anchoring may disturb small areas of seafloor outside of the 30-m wide cable corridor. All seafloor disturbance and associated water turbidity is expected to be short-term and temporary with minimal effects on marine mammal habitat or prey items.

Potential discharges from vessels and other construction equipment will be localized near their source and are not expected to adversely affect prey species or habitat. While the physical presence of vessels and deployed equipment may produce avoidance behavior, night lighting may serve to attract fishes and squid. Neither physical presence nor night lighting are expected to adversely affect prey species.

9.2 Long-Term Impacts

The presence of the SRWF foundations (monopiles and piled jacket), 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 (Wilhelmsson et al. 2006; Reubens et al. 2013; Bergström et al. 2014; Coates et al. 2014). Artificial structures can create increased habitat heterogeneity important for species diversity and density (Langhamer 2012). The WTG and OCS-DC 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).

Seafloor disturbance is not quantified for the operation and maintenance phase of the SRWF and SRWEC as it is expected to be infrequent and minimal. Numerous studies have documented significantly higher fish concentrations including species like cod and pouting (*Trisopterus luscus*), flounder (*Platichthys flesus*), eelpout (*Zoarces viviparus*), and eel (*Anguila anguilla*) near the foundations 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, at these structures fish can take advantage of the shelter provided 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 marine mammals.

During operations, the OCS-DC will discharge NCCW and non-contact stormwater. The NCCW does not come into contact with process operations and will only be used to covey heat from the facility. Although chlorine will be used to limit biofouling during operation of the OCS-DC, the dosage will be adjusted so that it is completely consumed within the system. Raw seawater will be withdrawn through a CWIS to dissipate heat produced through the AC to DC conversion; this heated water will be discharged via a dump caisson (single outlet vertical pipe) as thermal effluent to the marine receiving waters. Chlorine concentration of the effluent would be near zero.

The discharge of heated seawater into the ocean could have adverse impacts on the marine environment immediately surrounding the dump caisson, due to increased water temperatures and decreased dissolved oxygen (Vallero 2019). The influx of warm water can also cause increases in metabolic rates of some species and reduced reproductive capabilities. However, any adverse effects would be very localized around the dump caisson, as the thermal plume is not expected to extend beyond 30 m of the dump caisson, which is well within the regulatory mixing zone of 100 m distance from the point of discharge in the receiving water. This water would cool quite quickly when it mixes with the surrounding waters. In addition, the amount of heated seawater that would be discharged is very small relative to the waters surrounding the Project Area. Because the site of discharge is located in offshore waters, the effects are likely to be less impactful than they would be in coastal waters. A very small percentage of the fish and invertebrate populations that occur in the North Atlantic are likely to be adversely affected by increased temperatures from the localized thermal plume.

The rate at which seawater would be taken is slow enough (0.1525 m/s [0.5 ft/s]) to prevent the impingement of juvenile and adult life stages of finfish and other mobile organisms. However, egg or larval life stages of fish as well as invertebrates present in the vicinity of the intake would be susceptible to entrainment. The intake is highly localized and does not extend within 5 m of the pre-installation seafloor grade or 30 m of the surface. Thus, benthic or surface-dwelling zooplankton would not be affected. It is possible that entrained individuals would survive passage through the CWIS due to the short residence time in the system, a maximum temperature of only 32°C, and the potential removal of organisms from heated effluent exposure via the coarse filter (designed to filter suspended solids and organisms larger than 500 microns). EPRI (2000) identifies 33°C as an upper threshold discharge temperature for many organisms to survive entrainment in power plants along the Hudson River, NY. The entrainment is estimated to be a very small percentage (<0.1%) of the fish and invertebrate populations that occur in the North Atlantic. Further details, including hydraulic zone of influence and hydrothermal modelling and a more thorough ichthyoplankton entrainment assessment, are provided in the NPDES application.

There are numerous design and operational technologies available to minimize, reduce, or eliminate the impacts associated with entrainment of egg and larval life states. As entrainment rates are directly proportional to water flow, the most effective alternatives are primarily focused on minimizing water use and include closed-cycle cooling (mechanical draft cooling and natural draft cooling), sub-sea heat exchange, alternative water sources, water reuse, and variable frequency drive (VFD) technology. The efficacy and feasibility of implementing each of the flow-reducing alternatives is described in the NPDES application. For instance, closed-cycle cooling systems are designed to transfer a facility's waste heat to the environment and recycle the water in a closed loop back to the heat exchange system. Both mechanical and natural draft cooling systems are based on cooling towers that are relatively large in comparison to the system being cooled. For an offshore convertor station, such a cooling tower would be approximately the same size as the OCS-DC platform and likely require its own topside platform; thus, doubling the platform spatial requirements and introducing the need for a larger and/or additional foundation. Also, the relatively warm air temperatures that are typical in the vicinity of the OCS-DC for six months of the year are not sufficient cool enough to act as natural cooling for the OCS-DC without prohibitively large cooling systems. Using VFD, the CWIS of the OCS-DC has been designed to minimize the cooling water volumes required to the greatest extent practicable. This technology is recognized as a BTA for minimizing entrainment impacts and along with other design features should be considered as such for the OCS-DC.

10 Anticipated Effects of Habitat Impacts on Marine Mammals

The loss or modification of marine mammal habitat could arise from alteration of benthic habitats, introduced noise, physical presence of vessels and equipment, and vessel discharges as described in the previous section. These impacts could be short- or long-term in nature. The anticipated effects on marine mammals resulting from impacts to their habitat are summarized below.

10.1 Short-Term Impacts

Marine mammals use sound to navigate, communicate, find prey, and avoid predators. Acoustic "space" within their habitat must be available for species to conduct these activities. If noise levels within critical frequency bands preclude animals from accessing or utilizing the acoustic space of that habitat, then availability and quality of that habitat has been diminished. Thus, anthropogenic noise can be viewed as a form of habitat fragmentation resulting in a loss of acoustic space for marine mammals that could otherwise be occupied by vocalizations or other ecologically significant acoustic cues (Rice et al. 2014b). The sounds that marine mammals produce and hear will vary in terms of dominant frequency, bandwidth, energy, temporal pattern, and directionality. The same variables in ambient noise will, therefore, affect a marine mammal's acoustic resource availability. Acoustic propagation modeling conducted by JASCO (Appendix A) partially accounts for spectral characteristics of the sound received by animals through the application of NMFS marine mammal weighting functions, and it can be assumed animals within the behavior threshold isopleths may encounter a partial loss of acoustic space. Therefore, marine mammals may experience some short-term loss of acoustic habitat, but the nature and duration of this loss due to the temporary nature of the proposed activities is not expected to represent a significant loss of acoustic habitat.

Due to the small and short-term footprint of potential sediment disturbance caused by installation of the WTG and OCS-DC foundations or the IAC and SRWEC combined with the availability of similar benthic habitat in and around the Project Area, it is expected that impacts to benthic habitats and associated prey from construction activities would have negligible effects on marine mammals.

Habitat impacts on marine mammals resulting from UXO/MEC detonation may take two forms: 1) the acoustic energy introduced into the water column from the blast itself, which could directly impact marine mammals as described in Section 7 and 2) the mortality or displacement of potential marine mammal prey in the immediate vicinity of the blast. Due to the short duration of any required detonation events, the relatively small number of potential UXO/MECs identified in the Project Area, the comprehensive mitigation and monitoring measures proposed to exclude marine mammals from the immediate vicinity of the blast site, and the fact that marine mammals are highly mobile and able to leave the impacted area during these short-term detonation events, any habitat-related impacts to marine mammals are anticipated to be temporary and negligible.

10.2 Long-Term Impacts

The long-term habitat alteration due to the presence of WTG and OCS-DC foundations and associated scour protection will provide hard-bottom habitat for potential marine mammal prey species and may increase the availability of prey species as discussed in Section 9.2. This could potentially alter marine mammal distribution and behavior patterns by increasing the number of marine mammals using this habitat for foraging. However, the effects of habitat alteration associated with the physical presence

of the foundations and scour protection will not be universal across all marine mammal species since only some species are likely to use prey that become associated with those structures.

Pinnipeds and some odontocete species are likely to benefit the most from increases in the availability of prey species that are attracted to the physical structures. Numerous surveys at offshore wind farms, oil and gas platforms, and artificial reef sites have documented increased abundance of smaller odontocete, and pinniped species attracted to the increase in pelagic fish and benthic prey availability (Hammar et al. 2010; Lindeboom et al. 2011; Mikkelsen et al. 2013; Russell et al. 2014; Arnould et al. 2015). Studies examining harbor seal distribution around wind farms have shown seal numbers inside the wind farm to be recovered following construction; however, fewer seals were present on the nearby land sites (Snyder and Kaiser 2009; Vellejo et al. 2017). Harbor porpoise activity around the Danish wind farm "Nysted" showed a significant decline in echolocation activity following construction that gradually increased but did not return to baseline levels (Hammar et al. 2010; Teilmann and Carstensen 2012), while no change in activity was observed around the Danish wind farm "Rodsand II" after construction (Hammar et al. 2010). Projects to restore artificial reefs noted an increase in the presence of harbor porpoises at the new artificial reef site compared to surrounding habitats, and it was hypothesized they were following prey species (Mikkelsen et al. 2013).

Currently there are no quantitative data on how large whale species (i.e., mysticetes) may be impacted by offshore windfarms (Kraus et al. 2019). Navigation through or foraging within the SRWF is not expected to be impeded by the presence of the WTG and OCS-DC foundations. Additionally, wakes in water currents created by the presence of the foundations are not expected to affect pelagic fish, plankton, or benthic species, so marine mammals foraging on these species are unlikely to be adversely affected. Given the likely benefits to some marine mammal species from increased prey abundance and the uncertain, but likely minimal negative impacts on large whales from the presence of the widely spaced foundations, overall impacts to marine mammal habitat are anticipated to be negligible.

11 Mitigation Measures

Sunrise Wind is committed to minimizing impacts to marine mammal species through a comprehensive monitoring and mitigation program. The mitigation measures to be implemented include, but are not limited to, the following:

1. Noise attenuation through use of a noise mitigation system;
2. Seasonal restrictions;
3. Standard PSO training and equipment requirements;
4. Visual monitoring; including low visibility monitoring tools;
5. Passive acoustic monitoring;
6. Establishment and monitoring of shutdown zones (SZs)
7. Pre-start clearance;
8. Ramp-up (soft start) procedures;
9. Operations monitoring;
10. Operational shutdowns and delay;
11. Sound source measurements of at least one foundation installation
12. Survey sighting coordination;

13. Vessel strike avoidance procedures; and
14. Data recording and reporting procedures.

The selection and implementation of appropriate mitigation measures will consider safety, practical application, and effectiveness. While protection of marine mammals is a top priority, environmental and human health and safety is the very highest priority when working in the offshore environment; therefore, revisions or exceptions to monitoring and mitigation measures described in the PSMMP may be made under certain circumstances. Sunrise Wind has and will continue to engage with NMFS to further refine specific details of the PSMMP to be implemented during construction of the SRWF and SRWEC.

All monitoring and mitigation measures to be conducted during the Project will be described in a PSMMP (Appendix C). The materials in this section summarize the main points of the PSMMP. The PSMMP (Appendix C) will include 4 different monitoring plans. These plans include a vessel strike avoidance plan (PSMMP Attachment 6), sound field verification plan (PSMMP Attachment 7), passive acoustic monitoring (PAM) plan, and pile driving and marine mammal monitoring plan. Each plan is to be submitted to NMFS for review and approval at least 90 days prior to commencement of construction activities.

The monitoring and mitigation methods described here are intended to reduce or eliminate exposure of marine mammals to underwater sound levels that could constitute "take" under the MMPA. Many of the monitoring and mitigation measures are applicable across all project activities while others will be specific to the following activities:

- WTG and OCS-DC foundation installation using impact pile driving,
- Cable landfall construction using vibratory pile driving,
- High resolution geophysical (HRG) surveys, and
- In-Situ UXO/MEC disposal.

11.1 Standard Mitigation and Monitoring Requirements for all Activities

11.1.1 Protected Species Observer (PSO) and Passive Acoustic Monitoring (PAM) Operator training, experience and responsibilities

- All PSOs and PAM operators will have completed a NMFS-approved PSO training course.
- The PSO field team and the PAM team will have a lead observer (Lead PSO and PAM Lead) who will have experience in the northwestern Atlantic Ocean. Additionally, the PAM Lead will have experience with the call types of mysticetes needing to be mitigated/monitored.
- Remaining PSOs and PAM operators will have received the necessary training and approvals and have and the ability to work with the relevant software and equipment.
- PSOs and PAM operators will complete a Permits and Environmental Compliance Plan (PECP) training and a two-day training and refresher session with the PSO provider and Project compliance representatives conducted before the anticipated start of Project activities (further details in Sections 3.3.3 & 3.3.4 of the PSMMP).
- Any PSO or PAM operator on duty will have authority to delay the start of operations or to call for a shutdown based on their visual observations or acoustic detections.

11.1.2 Visual Monitoring

- No individual visual PSO will work more than 4 consecutive hours without a 2 consecutive hour break, or longer than 12 hours during a 24-hour period.
- Each PSO will be provided with one 8-hour break per 24-hour period to sleep.
- Observations will be conducted from the best available vantage point(s) on the vessels (stable, elevated platform from which PSOs have an unobstructed 360° view of the water).
- PSOs will systematically scan with the naked eye and a 7 x 50 reticle binocular, supplemented with night-vision equipment when needed.
- When monitoring at night or in low visibility conditions, PSOs will monitor for marine mammals and other protected species using night-vision goggles with thermal clip-ons, a hand-held spotlight, and/or a mounted thermal camera system.
- Activities with larger monitoring zones (>2 km) will use 25 x 150 mm "big eye" binoculars.
- Vessel personnel will be instructed to report any sightings to the PSO team as soon as they are able and it is safe to do so.
    - Vessel personnel communication to the PSO team will be dependent on the vessel. However, means of communication may include: phone, hand-held radio, or face-to-face verbal communication.
- Members of the monitoring team will consult with NMFS' NARW reporting system for the presence of NARWs in the Project Area.

11.1.3 Acoustic Monitoring (WTG and OCS-DC foundation installation only)

- Deployment of PAM system will be outside the perimeter of the shutdown zone.
- 4-hour PAM operator rotations for 24-hour operation vessels.

11.1.4 Vessel Strike Avoidance

In addition to the Base Conditions below, Sunrise Wind will implement a Standard Plan and/or an Adaptive Plan, which will include additional measures when travelling within established NARW DMAs. as presented below. These three plans are intended to be interchangeable and implemented throughout both the construction and operations phases of the project. Sunrise Wind will submit a final NARW Vessel Strike Avoidance Plan at least 90 days prior to commencement of vessel use that further details the Adaptive Plan and specific monitoring equipment to be used. The plan will, at a minimum, describe how PAM, in combination with visual observations, will be conducted to ensure the transit corridor is clear of NARWs. The plan will also provide details on the vessel-based observer protocols on transiting vessels.

11.1.4.1 Base Conditions- General measures

- All personnel working offshore will receive training on marine mammal awareness and vessel strike avoidance measures.
- Vessel Personnel will maintain a vigilant watch for marine mammals and slow down or maneuver vessels as appropriate to avoid striking marine mammals.
- Sunrise Wind will establish a situational awareness network for marine mammal detections through the integration of sighting communication tools such as Mysticetus, Whale Alert, Whale Map, etc. Sighting information will be made available to all project vessels through the established network. Sunrise Wind's Marine Coordination Center will serve to coordinate and

maintain a Common Operating Picture. In addition, systems within the Marine Coordination Center, along with field personnel, will:

- Monitor the NMFS North Atlantic right whale reporting systems daily;
- Monitor Coast Guard VHF Channel 16 throughout the day to receive notifications of any sightings; and,
- Monitor any existing real-time acoustic networks.

11.1.4.2 Base Conditions- Separation Distances

- Vessels will maintain, to the extent practicable, separation distances of:
  - > 500 m distance from any sighted NARW or unidentified large marine mammals
  - > 100 m from all other whales
  - > 50 m for dolphins, porpoises, and seals

11.1.4.3 Base Conditions- Speed restrictions

- Vessels will comply with NMFS regulations and speed restrictions and state regulations as applicable for NARW.
- All vessels 65 ft (20 m) or longer subject to the jurisdiction of the U.S. will comply with the 10-knot speed restriction when entering or departing a port or place subject to U.S. jurisdiction, and in any SMA during NARW migratory and calving periods from November 1 to April 30.
- Situational Awareness/Common Operating Picture: Sunrise Wind will establish a situational awareness network for marine mammal detections through the integration of sighting communication tools such as Mysticetus, Whale Alert, WhaleMap, etc. Sighting information will be made available to all project vessels through the established network. Sunrise Winds Marine Coordination Center will serve to coordinate and maintain a Common Operating Picture. In addition, systems within the Marine Coordination Center, along with field personnel, will:
  - Monitor the NMFS North Atlantic right whale reporting systems daily;
  - Monitor Coast Guard VHF Channel 16 throughout the day to receive
  - notifications of any sighting; and
  - Monitor any existing real-time acoustic networks.
- A complete vessel speed plan will be included in the PSMMP (PSMMP Attachment 7).

11.1.4.4 Standard Plan

- Implement Base Conditions as described above.
- **Between November 1st and April 30th**: Vessels of all sizes will operate port to port (from ports in NJ, NY, MD, DE, and VA) at 10 knots or less between November 1 and April 30 except for vessels while transiting in Narragansett Bay or Long Island Sound which have not been demonstrated by best available science to provide consistent habitat for North Atlantic right whales. Vessels transiting from other ports outside those described will operate at 10 knots or less when within any active SMA or within the Wind Development Area (WDA), including the Sunrise Wind Farm and Sunrise Wind Export Cable.
- **Year Round**: Vessels of all sizes will operate at 10 knots or less in any Dynamic Management Areas (DMAs)
- **Between May 1st and September 30th**: All underway vessels operating at >10 knots will have a dedicated visual observer (or NMFS approved automated visual detection system) 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). 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

11.1.4.5 Adaptive Plan

The Standard Plan outlined above will be adhered to except in cases where crew safety is at risk, and/or labor restrictions, vessel availability, costs to the project, or other unforeseen circumstance make these measures impracticable. To address these situations, an *Adaptive Plan* will be developed in consultation with NMFS to allow modification of speed restrictions for vessels. Should Sunrise Wind choose not to implement this *Adaptive Plan*, or a component of the *Adaptive Plan* is offline (e.g., equipment technical issues), Sunrise Wind will default to the *Standard Plan* (described above). The Adaptive Plan will not apply to vessels subject to speed reductions in SMAs as designated by NOAA's Vessel Strike Reduction Rule.

- **Year Round**: A semi-permanent acoustic network comprising near real-time bottom mounted and/or mobile acoustic monitoring platforms will be installed year-round such that confirmed North Atlantic right whale detections are regularly transmitted to a central information portal and disseminated through the situational awareness network.
  - The transit corridor and WDA will be divided into detection action zones.
  - Localized detections of NARW in an action zone would trigger a slow-down to 10 knots or less in the respective zone for the following 12 hours. Each subsequent detection would trigger a 12-hour reset. A zone slow-down expires when there has been no further visual or acoustic detection in the past 12 hours within the triggered zone.
  - The detection action zone's size will be defined based on efficacy of PAM equipment deployed and subject to NMFS approval as part of the NARW Vessel Strike Avoidance Plan.
- **Year Round**: All underway vessels (transiting or surveying) operating > 10 knots will have a dedicated visual observer (or NMFS approved automated visual detection system) 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). 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.
- **Year-round**: if any DMA is established that overlaps with an area where a project vessel would operate, that vessel, regardless of size when entering the DMA, may transit that area at a speed of 10 knots or less. Any active action zones within the DMA may trigger a slow down as described above.

If PAM and/or thermal systems are offline, the Standard Plan measures will apply for the respective zone (where PAM is offline) or vessel (if automated visual systems are offline).

11.1.5 Data Recording

- All sightings of marine mammals visually observed or acoustically detected will be recorded.
- All data will be recorded using industry-standard software.
- Data recorded will include information related to ongoing operations, observation methods and effort, visibility conditions, marine mammal detections, and any mitigation actions requested and enacted.

11.1.6 Reporting

- If a stranded, entangled, injured, or dead protected species is observed, the sighting will be reported within 24 hours to NMFS RWSAS hotline
- If a protected species is injured or killed as a result of Project activities, the vessel captain or PSO on board will report it to the NMFS Office of Protected Resources (OPR) and Greater Atlantic Regional Fisheries Office immediately, no later than within 24 hours.
    - Activity operations will cease until NMFS OPR is able to review the circumstances of the incident and determine what, if any, additional measures are appropriate before continuing operations.
    - Additionally, immediate reporting should be made to: NOAA Fisheries Marine Mammal and Sea Turtle Stranding and Entanglement Hotline (866-755-6622) or alternative electronic reporting systems as approved by the NOAA stranding program, as well as the U.S. Coast Guard.
- Any NARW sightings will be reported as soon as feasible and no later than within 24 hours to the NMFS RWSAS hotline or via the WhaleAlert Application.
- Data and Final Reports will be prepared using the following protocols:
    - A QA/QC'd database of all sightings and associated details (e.g., distance from vessel, behavior, species, group size/composition) within and outside of the designated shutdown zones, monitoring effort, environmental conditions, and Project-related activity will be provided after field operations and reporting are complete;
    - Weekly PSO/PAM reports (during construction activity) will be submitted every Wednesday following a Sunday-Saturday week;
    - Final reports will follow a standardized format for PSO reporting from activities requiring marine mammal mitigation and monitoring;
    - An annual visual and acoustic monitoring report will be provided to NMFS and to BOEM on April 1st of every year of the Rule summarizing the prior year's activities.

11.2 WTG and OCS-DC Foundation Installation – Impact Pile Driving

11.2.1 Monitoring Equipment

	Standard Daytime		Monitoring during Nighttime and Low Visibility	
Item	**Number on Construction Vessel**	**Number on Additional Vessel**	**Number on Construction Vessel**	**Number on Additional Vessel**
Reticle binoculars	2	2		
Mounted thermal/IR camera system[2]	1	1	1	1
Mounted "big-eye" binocular	1	1		
Monitoring station for real time PAM system[3]	1	1	1	1
Hand-held or wearable NVDs	0	0	2	2
IR spotlights	0	0	2	2
Mysticetus data collection software system	1	1	1	1
PSO-dedicated VHF radios	2	2	2	2
Digital single-lens reflex camera equipped with 300-mm lens	1	1		

[1] The camera systems will be automated with detection alerts that will be checked by a PSO on duty; however, cameras will not be manned by a dedicated observer.
[2] The selected PAM system will transmit real time data to PAM monitoring stations on the vessels and/or a shore side monitoring station.

11.2.2 Visual Monitoring

- 6 - 8 visual and PAM operators[4] on the impact pile driving vessel and four to eight visual and PAM operators on any additional marine mammal monitoring vessel.
- 2 visual PSOs will be watch on each construction and additional vessel during pre-start clearance, throughout impact pile driving, and 30 minutes after piling is completed.

11.2.3 *Daytime Visual Monitoring*

- PSOs will monitor for 30 minutes before and after each piling event.
- 2 PSOs will monitor the shutdown zone with the naked eye and reticle binoculars while one PSO periodically scans outside the shutdown zone using the mounted big eye binoculars.
- The secondary vessel will be positioned and circling at the outer limit of the Large Whale shutdown zone.

11.2.4 *Daytime Periods of Reduced Visibility*

- If the monitoring zone is obscured, the 2 PSOs on watch will continue to monitor the shutdown zone using thermal camera systems and handheld NVDs (as able).
- All PSOs on duty will be in contact with the on-duty PAM operator who will monitor the PAM systems for acoustic detections of marine mammals that are vocalizing in the area.

[4] PAM operators may be located on shore.

11.2.5 Nighttime Visual: Construction Piling and Secondary Vessel

During nighttime operations, night vision equipment (night vision goggles) and infrared/thermal imaging technology will be used. Recent studies have concluded that the use of infrared/thermal imaging technology allow for the detection of marine mammals at night (Verfuss et al. 2018). Guazzo et al (2019) showed that probability of detecting a large whale blow by a commercially available infrared camera was similar at night as during the day; camera monitoring distance was 2.1 km from an elevated vantage point at night versus 3 km for daylight visual monitoring from the same location. The following nighttime piling monitoring and mitigation methods use the best current available technology to mitigate potential impacts and result in the least practicable adverse impact.

- Visual PSOs will rotate in pairs: one observing with an NVD and one monitoring the IR thermal imaging camera system[5].
- Deck lights will be extinguished or dimmed during night observations when using NVDs; however, if the deck lights must remain on for safety reasons, the PSO will attempt to use the NVDs in areas away from potential interference by these lights. If a PSO is still unable to observe the required visual zones, piling would not occur.
- The use of thermal camera systems for mitigation purposes warrants additional application in the field as both a standalone tool and in conjunction with other alternative monitoring methods (e.g., night vision binoculars).

11.2.6 Acoustic Monitoring

- PAM operator will monitor during all pre-start clearance periods, piling, and post-piling monitoring periods (daylight, reduced visibility, and nighttime monitoring).
- 1 PAM operator on duty during both daytime and nighttime/low visibility monitoring.
- Real-time PAM systems require at least one PAM operator 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.
- PAM operator will inform the PSOs on duty of animal detections approaching or within applicable ranges of interest to the pile-driving activity.
- The PAM system will be deployed with a capable of monitoring up to 10 km radii from the pile.
- A Passive Acoustic Monitoring (PAM) Plan must be submitted to NMFS and BOEM for review and approval at least 90 days prior to the planned start of pile driving.

11.2.7 Shutdown Zones

Summer distances were determined from the modeling conducted assuming a summer sound speed profile. These distances will be used to implement shutdown zones during the months identified in the acoustic modeling report as being represented by the summer sound speed profile (April – November). Winter distances were determined from the modeling conducted assuming a winter sound speed profile. These distances will be used to implement shutdown zones during the months identified in the acoustic modeling report as being represented by the winter sound speed profile (December – March).

[5] In support of the request for nighttime piling, Ørsted is assessing the opportunity to conduct a marine mammal monitoring field demonstration project in the spring of 2022. Additional details on the project and further engagement will follow.

11.2.7.1 WTG Summer Distances (May-November):

- Mysticete whales (low-frequency cetaceans): 3,700 m
- North Atlantic Right Whale Visual Detection: any distance
- North Atlantic Right Whale Acoustic Detection: 3,700 m
- Sperm whale (mid-frequency cetacean): 3,700 m
- Mid-frequency cetaceans (except sperm whales): NAS
- Harbor porpoise (high-frequency cetacean): 200
- Seals: 100 m

11.2.7.2 WTG Winter Distances (December):

- Mysticete whales (low-frequency cetaceans): 4,300 m
- North Atlantic Right Whale Visual Detection: any distance
- North Atlantic Right Whale Acoustic Detection: 4,300 m
- Sperm whale (mid-frequency cetacean): 4,300 m
- Mid-frequency cetaceans (except sperm whales): NAS
- Harbor porpoise (high-frequency cetacean): NAS
- Seals: 100 m

11.2.7.3 OCS-DC Summer Distances (May–November)

- Mysticete whales (low-frequency cetaceans): 5,600 m
- North Atlantic Right Whale Visual Detection: any distance
- North Atlantic Right Whale Acoustic Detection: 5,600 m
- Sperm whale (mid-frequency cetacean): 5,600 m
- Mid-frequency cetaceans (except sperm whales): NAS
- Harbor porpoise (high-frequency cetacean): 900 m
- Seals: 1,800 m

11.2.7.4 OCS-DC Winter Distances (December)

- Mysticete whales (low-frequency cetaceans): 6,500 m
- North Atlantic Right Whale Visual Detection: any distance
- North Atlantic Right Whale Acoustic Detection: 6,500 m
- Sperm whale (mid-frequency cetacean): 6,500 m
- Mid-frequency cetaceans (except sperm whales): NAS
- Harbor porpoise (high-frequency cetacean): 600 m
- Seals: 1,800 m

11.2.8 Pre-Start Clearance

- Piling may be initiated any time with in a 24-hour period.
- A 60- minute pre-start clearance period will be implemented for impact pile driving activities.
- Prior to the beginning of each pile driving event, visual PSOs and PAM operators will monitor the Level B harassment zone at least 60 minutes prior to the start of pile driving, during all pile driving activities and continue at all times during impact pile driving.

- All clearance zones will be confirmed to be free of marine mammals prior to initiating ramp-up and the large whale clearance zone (3,700 m or as modified) will be fully visible and the NARW acoustic zone monitored for the least 30-minutes prior to commencing ramp-up.
- If a marine mammal is observed entering or within the relevant clearance zones prior to the initiation of pile driving activity, pile driving activity will be delayed and will not begin until either the marine mammal(s) has voluntarily left the respective clearance zones and been visually or acoustically confirmed beyond that clearance zone, or, when the additional time period has elapsed with no further sighting or acoustic detection (i.e., 15 minutes for small odontocetes and 30 minutes for all other species).

11.2.9 Soft Start

- Ramp-up is required prior to the initiation of HRG sources (boomers, sparkers, Chirps)
- Each monopile installation will begin with a minimum of 20-minute ramp-up (soft-start) procedure as technically feasible.
- Soft-start procedure will not begin until the shutdown zone has been cleared by the visual PSO or PAM operators.
- If a marine mammal is detected within or about to enter the applicable shutdown zone (or a NARW sighted at any distance), prior to or during the soft-start procedure, pile driving will be delayed until the animal has been observed exiting the shutdown zone or until an additional time period has elapsed with no further sighting (i.e., 15 minutes for small odontocetes and 30 minutes for all other species).

11.2.10 Shutdowns

- If a marine mammal is detected entering or within the respective shutdown zones after pile driving has commenced, an immediate shutdown of pile driving will be implemented unless SRW determines shutdown is not feasible due to an imminent risk of injury or loss of life to an individual.
- If shutdown is called for but it is determined that shutdown is not feasible due to risk of injury or loss of life, there will be a reduction of hammer energy.
- Following shutdown, pile driving will only be initiated once all shutdown zones are confirmed by PSOs to be clear of marine mammals for the minimum species-specific time periods.
- The shutdown zone will be continually monitored by PSOs and PAM during any pauses in pile driving.
- If a marine mammal is sighted within the shutdown zone during a pause in piling, piling will be delayed until the animal(s) has moved outside the shutdown zone or when 30 minutes have elapsed without redetection for whales, including the NARW, or 15 minutes have elapsed without redetection of dolphin, porpoises, and seals.

11.2.11 Post-Piling Monitoring

- PSOs will continue to survey the monitoring zone throughout the duration of pile installation and for a minimum of 30 minutes after piling has been completed.

11.2.12 Noise Attenuation

- The Project will use a noise attenuation system (NAS) for all piling events and is committed to achieving ranges associated with 10 dB of noise attenuation. The type and number of NAS to be used during construction have not yet been determined but will consist of a double big bubble curtain or a single bubble curtain paired with an additional sound attenuation device or a double big bubble curtain. Based on prior measurements this combination of NAS is reasonably expected to achieve greater than 10 dB broadband attenuation of impact pile driving sounds (described further in Section 6.3.2).

11.2.13 Sound Measurements

- Measurements of the installation of at least three monopile foundations will be made and results used to modify shutdown zones, as appropriate.
- For each monopile measures, Sunrise Wind will estimate ranges to Level A and Level B harassment isopleths by extrapolating from in-situ measurements at multiple distances from the monopile including at least one measurement location of 750 m from the monopile.
- A sound field verification plan will be submitted to NMFS for review and approval at least 90 days prior to planned start of pile driving.
- This will include procedures for how measurement results will be used to justify any requested changes to planned monitoring and mitigation distances.

11.3 Landfall Construction Installation (Vibratory or Impulsive Pile Driving)

11.3.1 Monitoring Equipment

- 2 sets of reticle binoculars
- 2 hand-held or wearable NVDs
- 2 IR spotlights
- 1 data collection software system
- 2 PSO-dedicated VHF radios
- 1 digital single-lens reflex camera equipped with 300-mm lens

11.3.2 Visual Monitoring

- All observations will take place from one of the construction vessels stationed at or near the vibratory piling location.
- 2 PSOs on duty on the construction vessel.
- PSOs will continue to survey the shutdown zone using visual protocols throughout the installation of each cofferdam sheet pile and for a minimum of 30 minutes after piling has been completed.

11.3.3 *Daytime Visual Monitoring*

- 2 PSOs will maintain watch during the pre-start clearance period, throughout vibratory pile driving, and 30 minutes after piling is completed.
- 2 PSOs will conduct observations concurrently.
- 1 observer will monitor the clearance zone and shutdown zone with the naked eye and reticle binoculars; one PSO will monitor in the same way but will periodically scan outside the shutdown zone.

11.3.4 ***Daytime Visual Monitoring During Periods of Low Visibility***

- 1 PSO will monitor the clearance and shutdown zone with the mounted IR camera while the other maintains visual watch with the naked eye/binoculars.

11.3.5 ***Nighttime Visual***

- Construction at the landfall site will not occur at night.

11.3.6 Acoustic Monitoring

- No PAM operators will be needed due to the likelihood of masking effects of the vibratory pile driving activities which will result in ineffective acoustic monitoring opportunities.

11.3.7 Shutdown Zones

11.3.7.1 Vibratory Sheet Pile Driving

- Mysticete whales (low-frequency cetaceans): 50 m
- Sperm whale (mid-frequency cetacean): 50 m
- Mid-frequency cetaceans except sperm whales: 50 m
- Harbor porpoise (high-frequency cetacean): 200 m
- Seals: 10 m

11.3.7.2 Casing Pipe Impact Pile Driving

- Mysticete whales (low-frequency cetaceans): 500 m
- Sperm whale (mid-frequency cetacean): 100 m
- Mid-frequency cetaceans except sperm whales: 100 m
- Harbor porpoise (high-frequency cetacean): 500 m
- Seals: 100 m

11.3.8 Pre-Start Clearance

- PSOs will monitor the shutdown zone for 30 minutes prior to the start of vibratory pile driving.
- If a marine mammal is observed entering or within the respective clearance zone piling cannot commence until the animal has exited the clearance zone or time has elapsed since the last sighting (30 minutes for large whales, 15 minutes for dolphins, porpoises, and pinnipeds).

11.3.9 Soft Start

- Soft-start will not be initiated if the shutdown zone cannot be adequately monitored (i.e., obscured by fog, inclement weather, poor lighting conditions) for a 30-minute period.

11.3.10 Shutdowns

- If a marine mammal is observed entering or within the respective shutdown zones after sheet pile installation has commenced, a shutdown will be implemented as long has health and safety is not compromised.
- The shutdown zone must be continually monitored by PSOs during any pauses in vibratory pile driving, activities will be delayed until the animal(s) has moved outside the shutdown zone or when 30 minutes have elapsed without redetection for whales, including NARW, or 15 minutes have elapsed without redetection of dolphins, porpoises, and seals.

11.3.11 Sound Measurements

- Measurements of the installation of sheet piles using a vibratory hammer will be made during landfall construction activities.
- Measurements will provide verification of modeled ranges to the harassment threshold isopleths and provide sound measurement data collected using International Organization for Standardization (ISO)-standard methodology for comparison among projects and to inform future projects.
- A sound field verification plan will be submitted to NMFS for review and approval at least 90 days prior to the planned start of vibratory and/or impulsive pile driving for landfall construction.
- This will include procedures for how measurement results will be used to justify any requested changes to planned monitoring and mitigation distances, if necessary.

11.4 HRG Surveys

The following mitigation and monitoring measures for HRG surveys apply only to sound sources with operating frequencies below 180 kHz. There are no mitigation or monitoring protocols required for sources operating >180 kHz.

Additionally, shutdown, pre-start clearance, and ramp-up procedures will not be conducted during HRG survey operations using only non-impulsive sources (*e.g.*, USBL and parametric sub-bottom profilers) other than non-parametric sub-bottom profilers (*e.g.*, CHIRPs). Pre-clearance and ramp-up, but not shutdown, will be conducted when using non-impulsive, non-parametric sub-bottom profilers.

11.4.1 Monitoring Equipment

- 2 pairs of reticle binoculars
- 1 mounted thermal/ infrared (IR) camera system during nighttime and low visibility conditions
- 2 hand-held or wearable night vision devices (NVDs)
- 2 IR spotlights
- 1 data collection software system
- 2 PSO-dedicated very high frequency (VHF) radios
- 1 digital single-lens reflex camera equipped with a 300-mm lens

11.4.2 Visual Monitoring

- 4 - 6 PSOs on all 24-hour survey vessels
- 2 – 3 PSOs on all daylight only (~12-hour) survey vessels
- The PSOs will begin observation of the shutdown zones prior to initiation of HRG survey operations and will continue throughout the survey activity and/or while equipment operating below 180 kHz is in use.
- PSOs will monitor the NMFS NARW reporting systems including WhaleAlert and RWSAS once every 4-hour shift during Project-related activities.

11.4.3 Daytime Visual Monitoring (period between nautical twilight rise and set for the region)

- 1 PSO on watch during all pre-clearance periods and all source operations and 30 minutes post operations.
- PSOs will use reticle binoculars and the naked eye to scan the monitoring zone for marine mammals.

11.4.4 Nighttime and Low Visibility Visual Observations

- The lead PSO will determine if conditions warrant implementing reduced visibility protocols.
- 2 PSOs on watch during all pre-clearance periods, all operations, and 30 minutes post operations following use of HRG sources operating below 180 kHz.
- Each PSO will use the most appropriate available technology (e.g., IR camera and NVD) and viewing locations to monitor the shutdown zones and maintain vessel separation distances.

11.4.5 Shutdown Zones

- North Atlantic right whale: 500 m
- Mysticete whales (low-frequency cetaceans): 100 m
- Sperm whale, Risso's dolphin, long-finned pilot whale, and short-finned pilot whale (mid-frequency cetaceans): 100 m
- Atlantic white-sided dolphin, Atlantic spotted dolphin, short-beaked common dolphin, coastal bottlenose dolphin, and offshore common bottlenose dolphin (mid-frequency cetaceans): No shutdown zone
- Harbor porpoise (high-frequency cetacean): 100 m
- Seals: 100 m

11.4.6 Pre-Start Clearance

- Prior to the initiation of equipment ramp-up, PSOs and PAM operators will conduct a 30- minute clearance period of the CZs to monitor for marine mammals.
- The CZ must be visible using the naked eye or appropriate visual technology during the entire clearance period for operations to start; if the CZs are not visible, source operations <180 kHz will not commence.
- If a marine mammal is observed within its respective CZ during pre-start clearance period, ramp-up will not begin until the animal(s) has been observed exiting its respective CZ or until an additional time period has elapsed with no further sighting (i.e., 15 minutes for small odontocetes and 30 minutes for all other species).

11.4.7 Ramp up

- Ramp-up will not be initiated during periods of inclement conditions or if the CZs cannot be adequately monitored by the PSOs, using the appropriate visual technology for a 30-minute period immediately prior to ramp-up.
- Ramp-up will begin by powering up the smallest acoustic HRG equipment at its lowest practical power output appropriate for the survey followed by a gradual increase and addition of other acoustic sources (as able).

- If a marine mammal is detected within or about to enter its respective CZ, ramp-up will be delayed.
- Ramp-up will continue once the animal has been observed exiting its respective shutdown zone or until an additional time period has elapsed with no further sighting (i.e., 15 minutes for small odontocetes and 30 minutes for all other species).

11.4.8 Shutdowns

- Shutdown of impulsive, non-parametric HRG survey equipment other than CHRIP sub-bottom profilers operating at frequencies <180 kHz is required if a marine mammal is sighted at or within its respective shutdown zone.
- Shutdowns will not be implemented for dolphins that voluntarily approach the survey vessel.
- Subsequent restart of the survey equipment will be initiated using the same procedure described above during pre-start clearance.
- If the acoustic source is shut down for reasons other than mitigation (e.g., mechanical difficulty) for less than 30 minutes, it will be reactivated without ramp-up if PSOs have maintained constant observation and no detections of any marine mammal have occurred within the respective shutdown zones.
- If the acoustic source is shut down for a period longer than 30 minutes or PSOs were unable to maintain constant observation, then ramp-up and pre-start clearance procedures will be initiated.

11.5 UXO/MEC Disposal

For UXO/MECs that are positively identified in proximity to planned activities on the seabed, several alternative strategies will be considered prior to detonating the UXO/MEC in place. These may include relocating the activity away from the UXO/MEC (avoidance), moving the UXO/MEC away from the activity (lift and shift), cutting the UXO/MEC open to apportion large ammunition or deactivate fused munitions, using shaped charges to reduce the net explosive yield of a UXO/MEC (low-order detonation), or using shaped charges to ignite the explosive materials and allow them to burn at a slow rate rather than detonate instantaneously (deflagration). Only after these alternatives are considered would a decision to detonate the UXO/MEC in place be made. If deflagration is conducted, mitigation and a monitoring measure would be implemented as if it was a high order detonation based on UXO/MEC size. Decision on removal method will be made in consultation with a UXO/MEC specialist and in coordination with the agencies with regulatory oversite of UXO/MEC. For detonations that cannot be avoided due to safety considerations, a number of mitigation measures will be employed by Sunrise Wind. No more than a single UXO/MEC will be detonated in a 24-hour period.

11.5.1 Monitoring Equipment

The equipment to be used during monitoring of UXO/MEC detonation is shown in Table 52.

11.5.2 Pre-Start Clearance

All mitigation and monitoring zones assume the use of a NAS resulting in a 10 dB reduction of noise levels. Mitigation and monitoring zones specific to marine mammal hearing groups for the five different charge weight bins are presented in Table 53 as summarized from the propagation modeling report (Appendix B).

Table 52: Personnel and Equipment Use for all Marine Mammal Monitoring Vessels during Pre-start Clearance and Post-detonation Monitoring

Item	Daytime Number on Each PSO Vessel
Reticle binoculars	2
Mounted "big-eye" binocular	1
Monitoring station for real time PAM system[1]	1
Data collection software system	1
PSO-dedicated VHF radios	2
Digital single-lens reflex camera equipped with 300-mm lens	1

PSO = protected species observer; VHF=very high frequency.

[1]The selected PAM system will transmit real time data to PAM monitoring stations on the vessels and/or a shore side monitoring station.

Table 53: Mitigation and Monitoring Zones Associated with In-Situ UXO/MEC Detonation of Binned Charge Weights, with a 10 dB Noise Attenuation System.

Marine Mammal Hearing Groups	UXO/MEC Charge Weight[1]				
	E4 (2.3 kg)	E6 (9.1 kg)	E8 (45.4 kg)	E10 (227 kg)	E12 (454 kg)
	Pre-Start Clearance Zone[2] (m)	Pre-Start Clearance Zone (m)	Pre-Start Clearance Zone (m)	Pre-Start Clearance Zone (m)	Pre-Start Clearance Zone (m)
Sunrise Wind Farm					
Low-Frequency Cetaceans	400	800	1,600	3,000	3,700
Mid-Frequency Cetaceans	50	50	100	400	500
High-Frequency Cetaceans	1,800	2,600	3,900	5,400	6,200
Phocid Pinnipeds	100	250	600	1,100	1,500

kg = kilograms; m = meters

[1] UXO/MEC charge weights are groups of similar munitions defined by the U.S. Navy and binned into five categories (E4-E12) by weight (equivalent weight in TNT). For this assessment, four project sites (S1-S4) were chosen and modeled (see Hannay and Zykov 2021) for the detonation of each charge weight bin.

[2] Pre-start clearance zones were calculated by selecting the largest Level A threshold (the larger of either the PK or SEL noise metric). The chosen values were the most conservative per charge weight bin across each of the four modeled sites. A 20 percent buffer was then added to the modeled distances and zones were rounded up for PSO clarity.

Table 54: Mitigation and Monitoring Zones Associated with Unmitigated UXO/MEC Detonation of Binned Charge Weights.

Marine Mammal Hearing Group	UXO/MEC Charge Weight1									
	E4 (2.3 kg)		E6 (9.1 kg)		E8 (45.5 kg)		E10 (227 kg)		E12 (454 kg)	
	Pre-Start Clearance Zone2 (m)	Level B Monitoring Zone3 (m)	Pre-Start Clearance Zone (m)	Level B Monitoring Zone (m)	Pre-Start Clearance Zone (m)	Level B Monitoring Zone (m)	Pre-Start Clearance Zone (m)	Level B Monitoring Zone (m)	Pre-Start Clearance Zone (m)	Level B Monitoring Zone (m)
Sunrise Wind Farm										
Low-Frequency Cetaceans	1,710	7,340	2,810	10,300	4,880	13,900	7,520	17,500	8,800	19,300
Mid-Frequency Cetaceans	214	1,520	385	2,290	714	3,490	1,220	5,040	1,540	5,860
High-Frequency Cetaceans	4,300	11,200	5,750	13,400	7,810	16,000	12,775	19,100	16,098	20,200
Phocid Pinnipeds	804	4,200	1,310	6,200	2,190	9,060	3,740	12,000	4,520	13,300

* = denotes species listed under the Endangered Species Act; kg = kilograms; m = meters; PK = peak pressure level; SEL = sound exposure level.

[1] UXO/MEC charge weights are groups of similar munitions defined by the U.S. Navy and binned into five categories (E4-E12) by weight (equivalent weight in TNT). For this assessment, four project sites (S1-S4) were chosen and modeled (see Hannay and Zykov 2021, Appendix B) for the detonation of each charge weight bin.

[2] Pre-start clearance zones were calculated by selecting the largest Level A threshold (the larger of either the PK or SEL noise metric). The chosen values were the most conservative per charge weight bin across each of the four modeled sites.

[3] Level B monitoring zones were calculated by selecting the largest TTS threshold (the larger of either the PK or SEL noise metric). The chosen values were the most conservative per charge weight bin across each of the four modeled sites.

- A 60-minute pre-start clearance period will be implemented prior to any in-situ UXO/MEC detonation.
- The maximum Low Frequency Level A zone, which constitutes the pre-start clearance zone (see distances to low-frequency cetacean thresholds in Table 53 & Table 54) must be fully visible for at least 60 minutes prior to commencing detonation.
- All marine mammals must be confirmed to be out of the clearance zone prior to initiating detonation.
- If a marine mammal is observed entering or within the relevant clearance zones prior to the initiation of detonation, the detonation must be delayed.
- The detonation may commence when either the marine mammal(s) has voluntarily left the respective clearance zone and been visually confirmed beyond that clearance zone, or when 60 minutes have elapsed without redetection for whales, including the NARW, or 15 minutes have elapsed without redetection of dolphins, porpoises, and seals.

11.5.3 Visual Monitoring

- The number of vessels deployed will depend on Level B harassment zone size and safety set back distance from detonation. A sufficient number of vessels will be deployed to cover the pre-start clearance and shutdown zones 100%.
- PSOs will visually monitor the maximum Low Frequency (Large Whale) Level A zone which constitutes the pre-start clearance zone. This zone encompasses the maximum Level A exposure ranges for all marine mammal species except harbor porpoise, where Level A take has been requested due to the large zone sizes associated with High Frequency cetaceans.

11.5.3.1 Primary Vessel Measures

- 2 PSOs on duty on the primary vessel
- Visual PSOs will survey the Level B harassment zone at least 60 minutes prior to a detonation event
- 2 PSOs will maintain watch at all times during the pre-start clearance period and 60-minutes after the detonation event
- There will be a PAM operator on duty conducting acoustic monitoring in coordination with the visual PSOs during all pre-start clearance periods and post-detonation monitoring periods.

11.5.3.2 *Additional Vessel Measures*

- Visual monitoring will be conducted on an additional vessel following the same methods as stated for the primary vessel in addition to the following measures when monitoring zones have radii greater than 2,000 m.
- 2 PSOs on duty on the additional vessel
- 2 PSOs will maintain watch at all times during the pre-start clearance period and 60-minutes after the detonation event.

- Based on the pre-start clearance zones for low-frequency cetaceans shown in Table 53, an additional vessel will be used in the specified locations for the following UXO/MEC charge weight bins:
    - Sunrise Wind Export Cable :
        - Bins E10 and E12
    - Sunrise Wind Farm
        - Bins E10 and E12

11.5.4 Visual Monitoring: Aerial Alternative

Aerial surveys are typically limited by low cloud ceilings, aircraft availability, survey duration, and HSE considerations and therefore are not considered feasible or practical for all detonation monitoring. However, some scenarios may necessitate the use of an aerial platform. For mitigated or unmitigated detonations with clearance zones greater than 5 km, deployment of sufficient vessels may not be feasible or practical. For these events, visual monitoring will be conducted from an aerial platform. The intent of the aerial visual monitoring is to provide complete visual coverage of the UXO/MEC clearance zones using the following protocols:

- During the pre-start clearance period and 60 minutes after the detonation event as flight time allows, two PSOs will be deployed on an aerial platform.
- Surveys will be conducted in a grid with 1 km line spacing, encompassing the clearance zone.
- PSOs will monitor the clearance zones with the naked eye and reticle binoculars.
- Aerial PSOs may exceed 4-hour watch duration but will be limited by total flight duration not likely to exceed 6 hours.
- PSOs will visually monitor the maximum Low-Frequency (Large Whale) Level A zone which constitutes the pre-start clearance zone. This zone encompasses the maximum Level A exposure ranges for all marine mammal species except harbor porpoise, where Level A take has been requested due to the large zone sizes associated with High-Frequency cetaceans.
- There will be a PAM operator on duty (see Section 11.5.5) conducting acoustic monitoring in coordination with the visual PSOs during all pre-start clearance periods and post-detonation monitoring periods.
- Acoustic monitoring, as described in Section 11.5.5.

11.5.5 Acoustic Monitoring

- Only 1 PAM team for all deployed PSO vessels.
- PAM will be conducted in the daylight only as no UXO/MEC will be detonated during nighttime hours.
- There will be a PAM operator stationed on at least one of the dedicated monitoring vessels (primary or additional) in addition to the PSO; or located remotely/onshore.
- PAM will begin 60 minutes prior to a detonation event.
- PAM operator will be on duty during all pre-start clearance periods and post-detonation monitoring periods.

- Acoustic monitoring will include, and extend beyond the Large Whale Pre-Start Clearance Zone (Section 11.5.2).
- For real-time PAM systems, at least 1 PAM operator will 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. No archival recording systems will be used.
- PAM operator will inform the Lead PSO on duty of animal detections approaching or within applicable ranges of interest to the detonation activity via the data collection software system.
- PAM operators will acoustically monitor a zone that encompasses a minimum of a 10 km radius around the source.
- PAM devices used will include independent (e.g., autonomous or moored remote) systems.

11.5.6 Noise Attenuation

- Sunrise Wind will use an NAS for all detonation events as feasible and is committed to achieving the modeled ranges associated with 10 dB of noise attenuation (see Section 6.3.2). Zones without 10 dB attenuation would be implemented if use of a big bubble curtain was not feasible due to location, depth, or safety related constraints (unmitigated distances to thresholds are available in Appendix B). If a NAS system is not feasible, Sunrise Wind will implement mitigation measures for the larger unmitigated zone sizes with deployment of vessels adequate to cover the entire clearance zones.

11.5.7 Seasonal Restriction

- No in-situ UXO/MEC detonations are planned between December and April. As part of the federal consistency review for the Project and work in Rhode Island and New York state waters, it is expected that in-situ UXO/MEC disposal will also be subject to state specific seasonal restrictions.

11.5.8 Post-UXO/MEC Detonation Monitoring

- Post-detonation monitoring will occur for 30 minutes.

11.5.9 Sound Measurements

- Acoustic measurements will be made during any UXO/MEC detonations.
- Measurements will provide verification of modeled ranges to the modeled harassment threshold isopleths and provide acoustic measurement data collected using International Organization for Standardization (ISO)-standard methodology (ISO 2017) for comparison among projects and to inform future projects.
- A sound field verification plan for UXO/MEC detonation will be submitted to NMFS for review and approval at least 90 days prior to planned start of UXO/MEC detonations.

12 Arctic Plan of Cooperation

This section of the application must be completed only for activities that occur offshore of Alaska and north of 60° N latitude. The proposed activities will take place off the US northeast coast in the

Atlantic Ocean and, therefore, will not have an adverse effect on the availability of marine mammals for subsistence uses.

13 Monitoring and Reporting

Marine mammal monitoring efforts around Project activities are currently summarized in Section 11 and will be updated in the PSMMP (Attachment 8 of Appendix C).

Reporting Injured or Dead Marine Mammals. Sunrise Wind will ensure that sightings of any injured or dead protected species are reported to the Greater Atlantic (Northeast) Region Marine Mammal and Sea Turtle Stranding and Entanglement Hotline (866-755-NOAA [6622] or current) within 24 hours of sighting, regardless of whether the injury or death is caused by a Project vessel. In addition, if the injury or death was caused by a collision with a Project vessel, Sunrise Wind will ensure that NMFS is notified of the strike within 24-hours. The notification of such strike will include the date and location (latitude/longitude) of the strike, the name of the vessel involved, and the species identification or a description of the animal, if possible. If a Project activity is responsible for the injury or death, Sunrise Wind will supply a vessel to assist in any salvage effort as requested by NMFS.

Reporting Observed Impacts to Species. The observer will report any observations concerning impacts on marine mammals to NMFS within 48 hours. Any observed takes of listed marine mammals resulting in injury or mortality must be reported within 24 hours to NMFS.

Report of Activities and Observations. Sunrise Wind will provide NMFS with a report within 90 calendar days following the completion of construction activities, including a summary of the construction activities and an estimate of the number of marine mammals taken during these activities. During construction, weekly reports briefly summarizing sightings, detections, and activities will be provided to NMFS and BOEM on the Wednesday following a Sunday-Saturday period.

Report Information. Data on all protected-species observations will be recorded and based on standards of marine mammal observer collection data by the PSOs. The information will include dates, times, and locations of survey operations; time of operation; location and weather; details of marine mammal sightings (e.g., species, numbers, behavior); and details of any observed taking (e.g., behavioral disturbances or injury/mortality).

14 Suggested Means of Coordination

To minimize the likelihood that impacts will occur to species, stocks, and subsistence use of marine mammals, all Project activities will be conducted in accordance with federal, state, and local regulations. To further minimize potential impacts from the planned Project, Orsted will continue to cooperate with NMFS and other appropriate federal agencies (e.g., BOEM, USFWS), the State of Rhode Island, and the state of New York.

While no direct research on marine mammals or marine mammal stocks is expected from the Project, there is the opportunity for the proposed activity to contribute greatly to the noise characterization in the region and to specific sound source measurements.

Data acquired during the Visual and Acoustic Monitoring Program may provide valuable information to direct or refine future research on marine mammal species present in the area. Sighting

data (e.g., date, time, weather conditions, species identification, approximate sighting distance, direction, heading in relation to sound sources, behavioral observations) may be useful in designing the location and scope of future marine mammal survey and monitoring programs.

All marine mammal data collected by Sunrise Wind during marine construction activities will be provided to NMFS, BOEM, and other interested government agencies. In addition, the data, upon request, will be made available to educational institutions and environmental groups.

The PSMMP also provides a framework for long-term ecological monitoring as part of Sunrise Wind development and operations.

Literature Cited

73 FR 60173. 2008. Endangered fish and wildlife; final rule to implement speed restrictions to reduce the threat of ship collisions with North Atlantic right whales. Page 19.

81 FR 62260. 2016. Endangered and threatened species; identification of 14 distinct population segments of the humpback whale (*Megaptera novaeangliae*) and revision of species-wide listing; final rule. Page 62.

[DoN] Department of the Navy (U.S.). 2012. Final Supplemental Environmental Impact Statement/Supplemental Overseas Environmental Impact Statement for Surveillance Towed Array Sensor System Low Frequency Active (SURTASS LFA) Sonar. Department of the Navy, Chief of Naval Operations.

[NOAA] National Oceanic and Atmospheric Administration. 2005. Notice of Public Scoping and Intent to Prepare an Environmental Impact Statement. Federal Register **70**:1871-1875.

ACS. 2018. Pilot Whale.

Agler, B. A., R. L. Schooley, S. E. Frohock, S. K. Katona, and I. E. Seipt. 1993. Reproduction of photographically identified fin whales, *Balaenoptera physalus*, from the Gulf of Maine. Journal of Mammalogy **74**:577-587.

Aguilar, A. 1986. A review of old Basque whaling and its effect on the right whales (*Eubalaena glacialis*) of the North Atlantic. Reports of the International Whaling Commission Special Issue **10**:191-199.

AIS-Inc. 2019. A.I.S Inc. Protected Species Observer Final Report 2018/2019 BOEM Lease OCS-A 0486.

AMCS. 2020. AMSEAS Responds to Three Whales in Two Days.

Arnould, J. P. Y., J. Monk, D. Ierodiaconou, M. A. Hindell, J. Semmens, A. J. Hoskins, D. P. Costa, K. Abernathy, and G. J. Marshall. 2015. Use of anthropogenic sea floor Structures by Australian fur seals: potential positive ecological impacts of marine industrial development? PLoS One **10**:e0130581.

Atkinson, S., D. E. Crocker, D. Houser, and K. Mashburn. 2015. Stress physiology in marine mammals: How well do they fit the terrestrial model? Journal of Comparative Physiology B **185**:463-486.

Bailey, H., B. Senior, D. Simmons, J. Rusin, G. Picken, and P. M. Thompson. 2010. Assessing underwater noise levels during pile-driving at an offshore windfarm and its potential effects on marine mammals. Marine Pollution Bulletin **60**:888-897.

Becker, E. A., A. K. Whitfield, P. D. Cowley, J. Järnegren, and T. F. Næsje. 2013. Does boat traffic cause displacement of fish in estuaries? . Marine Pollution Bulletin **75**:168-173.

Bellmann, M. A. 2014. Overview of existing noise mitigation systems for reducing pile-driving noise. Page 11 inter-noise 2014, Melbourne, Australia.

Bellmann, M. A. 2019. Results from noise measurements in European offshore wind farms. Presentation at Orsted Underwater Noise Mini Workshop.*in* Orsted Underwater Noise Mini Workshop, Washington, D.C.

Bellmann, M. A., and K. Betke. 2021. Expert opinion report regarding underwater noise emissions during UXO-clearance activity and possible options for noise mitigation. ITAP GmbH.

Bellmann, M. A., J. Brinkmann, J. May, T. Wendt, S. Gerlach, and P. Remmers. 2020a. Underwater noise during the impulse pile-driving procedure: Influencing factors on pile-driving noise and technical possibilities to comply with noise mitigation values. Supported by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (Bundesministerium für Umwelt, Naturschutz und nukleare Sicherheit (BMU)), FKZ UM16 881500. Commissioned and managed by the Federal Maritime and Hydrographic Agency (Bundesamt für Seeschifffahrt und Hydrographie (BSH)). Page 137 *in* N. C. a. N. S. Federal Ministry for the Environment, editor.

Bellmann, M. A., A. May, T. Wendt, S. Gerlach, P. Remmers, and J. Brinkmann. 2020b. Underwater noise during percussive pile driving: Influencing factors on pile-driving noise and technical

possibilities to comply with noise mitigation values. Federal Ministry for the Environment, Nature Conservation and Nuclear Safety.

Benhemma-Le Gall, A., I. M. Graham, N. D. Merchant, and P. M. Thompson. 2021. Broad-Scale Responses of Harbor Porpoises to Pile-Driving and Vessel Activities During Offshore Windfarm Construction. Frontiers in Marine Science **8**:735.

Bennett, B. 2021. Protected Species Observer Technical Report Revolution Wind (REV) BOEM Lease 0CS-0486 (*M/V Deep Helder and R/V Dolphin*).

Bergström, L., L. Kautsky, T. Malm, R. Rosenberg, M. Wahlberg, N. Åstrand Capetillo, and D. Wilhelmsson. 2014. Effects of offshore wind farms on marine wildlife—a generalized impact assessment. Environmental Research Letters **9**:034012.

Bergström, L., F. Sundqvist, and U. Bergström. 2013. Effects of an offshore wind farm on temporal and spatial patterns in the demersal fish community. Marine Ecology Progress Series **485**:199-210.

Bernstein, L. 2013. The Washington Post: health, science, and environment. Panel links underwater mapping sonar to whale stranding for first time. Washington Post.

Betke, K. 2008. Measurement of Wind Turbine Construction Noise at Horns Rev II (1256-08-a-KB). Institut für technische und angewandte Physik GmbH (ITAP) for BioConsultSH., Husun, Germany.

Bigg, M. A. 1981. Harbor seal - *Phoco vitulina* and *P. largha*. Pages 1-27 *in* S. H. Ridgway and R. J. Harrison, editors. Handbook of marine mammals. Vol. 2: seals. Academic Press, London, U.K.

Bittencourt, L., I. M. S. Lima, L. G. Andrade, R. R. Carvalho, T. L. Bisi, J. Lailson-Brito, and A. F. Azevedo. 2017. Underwater noise in an impacted environment can affect Guiana dolphin communication. Marine Pollution Bulletin **114**:1130-1134.

Bjørge, A., G. Desportes, G. Waring, and Rosing-Asvid. 2010. The harbour seal (Phoca vitulina) – a global perspective. NAMMCO Scientific Publications **8**:7-10.

Blackwell, S. B., J. W. Lawson, and M. T. Williams. 2004. Tolerance by ringed seals (Phoca hispida) to impact pipe driving and construction sounds at an oil production island. Journal of Acoustical Society of America **115**:2346-2357.

Blackwell, S. B., C. S. Nations, T. L. McDonald, C. R. Greene, A. M. Thode, M. Guerra, and A. M. Macrander. 2013. Effects of airgun sounds on bowhead whale calling rates in the Alaskan Beaufort Sea. Marine Mammal Science **29**:E342-E365.

Blackwell, S. B., C. S. Nations, T. L. McDonald, A. M. Thode, D. Mathias, K. H. Kim, C. R. Greene, Jr., and A. M. Macrander. 2015. Effects of airgun sounds on bowhead whale calling rates: evidence for two behavioral thresholds. PLoS One **10**:e0125720.

Boehlert, G. W., and A. B. Gill. 2010. Environmental and ecological effects of ocean renewable energy development: a current synthesis. Oceanography **23**:68-81.

BOEM. 2013. Commercial wind lease issuance and site assessment activities on the Atlantic Outer Continental Shelf in Massachusetts, Rhode Island, New York, and New Jersey wind energy areas. NER-2012-9211. Endangered Species Act Section 7 consultation biological opinion. Page 255.

BOEM. 2014a. Atlantic OCS proposed geological and geophysical activities, Mid-Atlantic and South Atlantic Planning Areas. Final programmatic environmental impact statement. OCS EIS/EA BOEM 2014-001, New Orleans, LA.

BOEM. 2014b. Commercial wind lease issuance and site assessment activities on the Atlantic Outer Continental Shelf offshore Massachusetts. OCS EIS/EA BOEM 2014-603.

BOEM. 2019. Field Observations During Wind Turbine Operations at the Block Island Wind Farm, Rhode Island. OCS Study BOEM 2019-028.

Bonacci-Sullivan, L. 2018. Summary Report of the New York Bight Sea Turtle Workshop. New York State Department of Environmental Conservation

Bonar, P. A. J., I. G. Bryden, and A. G. L. Borthwick. 2015. Social and ecological impacts of marine energy development. . Renewable and Sustainable Energy Reviews **47**:486-495.

Bonner, W. N., S. H. Ridgway, and H. J. Harrison. 1971. Grey seal Halichoerus grypus fabricus. Handbook of Marine Mammals. London: Academic Press, Inc.

Brandt, M. J., A. Diederichs, K. Betke, and G. Nehls. 2011. Responses of harbour porpoises to pile driving at the Horns Rev II offshore wind farm in the Danish North Sea. Marine Ecology Progress Series **421**:205-216.

Branstetter, B. K., K. L. Bakhtiari, J. S. Trickey, and J. J. Finneran. 2016. Hearing mechanisms and noise metrics related to auditory masking in bottlenose dolphins (*Tursiops truncatus*). Pages 109-116 *in* A. Popper and A. Hawkins, editors. The effects of noise on aquatic life II. Springer, New York, NY.

Branstetter, B. K., V. Bowman, D. Houser, M. Tormey, P. Banks, J. Finneran, and A. K. Jenkins. 2018. Effects of vibratory pile driver noise on echolocation and vigilance in bottlenose dolphins (*Tursiops truncatus*). Acoustical Society of America **143**:429-439.

Branstetter, B. K., J. S. Trickey, H. Aihara, J. J. Finneran, and T. R. Liberman. 2013a. Time and frequency metrics related to auditory masking of a 10 kHz tone in bottlenose dolphins (*Tursiops truncatus*). Journal of the Acoustical Society of America **134**:4556-4565.

Branstetter, B. K., J. S. Trickey, K. Bakhtiari, A. Black, and H. Aihara. 2013b. Auditory masking patterns in bottlenose dolphins (*Tursiops truncatus*) with natural, anthropogenic, and synthesized noise. Journal of the Acoustical Society of America **133**:1811-1818.

Bröker, K. C., C. Vanman, and B. Martin. 2013. Monitoring of marine mammals and the sound scape during a seismic survey in two license blocks in the Baffin Bay, West Greenland, in 2012. Abstracts of the 20th Biennial Conference on the Biology of Marine Mammals, Dunedin, New Zealand.

Brown, M. W., D. Fenton, K. Smedbol, C. Merriman, K. Robichaud-Leblanc, and J. D. Conway. 2009. Recovery strategy for the North Atlantic right whale (*Eubalaena glacialis*) in Atlantic Canadian waters [Final]. Species at Risk Act Recovery Strategy Series.

Buehler, D., R. Oestman, J. Reyff, K. Pommerenck, and B. Mitchell. 2015. Technical guidance for assessment and mitigation of the hydroacoustic effects of pile driving on fish. Contract No. 43A0306, Sacramento, CA.

Burns, J. J. 2002. Harbor seal and spotted seal *Phoca vitulina* and *P. largha*. Pages 552-560 *in* W. F. Perrin, B. Wursig, and J. G. M. Thewissen, editors. Encyclopedia of Marine Mammals. Academic Press, San Diego, CA.

Caltrans. 2004. Revised marine mammal monitoring plan—San Francisco-Oakland Bay Bridge east span seismic safety project.*in* California Department of Transportation, editor.

Cañadas, A., and P. Hammond. 2008. Abundance and habitat preferences of the short-beaked common dolphin Delphinus delphis in the southwestern Mediterranean: implications or conservation. Endangered Species Research **4**:309-331.

Carstensen, J., O. D. Henriksen, and J. Teilmann. 2006. Impacts on harbor porpoise to pile driving at the Horns Rev II offshore wind farm in the Danish North Sea. Marine Ecology Progress Series **421**:205-216.

Casper, B. M., M. B. Halvorsen, T. J. Carlson, and A. Popper. 2017. Onset of barotrauma injuries related to number of pile driving strike exposures in hybrid striped bass. Journal of Acoustical Society of America **141**:4380-4387.

Castellote, M., C. W. Clark, and M. O. Lammers. 2012. Acoustic and behavioural changes by fin whales (*Balaenoptera physalus*) in response to shipping and airgun noise. Biological Conservation **147**:115-122.

Center for Coastal Studies. 2017. Cape Cod seals.

Cerchio, S., S. Strindberg, T. Collins, C. Bennett, and H. Rosenbaum. 2014. Seismic surveys negatively affect humpback whale singing activity off northern Angola. PLoS One **9**:e86464.

CeTAP. 1982. A characterization of marine mammals and turtles in the Mid- and North Atlantic areas of the U.S. Outer Continental Shelf. Final report of the Cetacean and Turtle Assessment Program. Under Contract AA551-CT8-48, Kingston, RI.

Charif, R. A., Y. Shiu, C. A. Muirhead, C. W. Clark, S. E. Parks, and A. N. Rice. 2020. Phenological changes in North Atlantic right whale habitat use in Massachusetts Bay. Global Change Biology **26**:734-745.

Cholewiak, D., C. W. Clark, D. Ponirakis, A. Frankel, L. T. Hatch, D. Risch, J. E. Stanistreet, M. Thompson, E. Vu, and S. M. Van Parijs. 2018. Communicating amidst the noise: modeling the aggregate influence of ambient and vessel noise on baleen whale communication space in a national marine sanctuary. Endangered Species Research **36**:59-75.

Cholewiak, D., A. Izzi, D. Palka, P. Corkeron, and S. M. Van Parijs. 2017. Beaked whales demonstrate a marked acoustic response to the use of shipboard echosounders. Society for Marine Mammalogy's 22nd Biennial Conference on the Biology of Marine Mammals, Halifax, NS, Canada.

Cipriano, F. 2018. Atlantic white-sided dolphin. Encyclopedia of Marine Mammals:49-51.

Clark, C. W. 1995. Annex M1. Application of US Navy underwater hydrophone arrays for scientific research on whales. Reports of the International Whaling Commission **45**:210-212.

Clark, C. W., W. T. Ellison, B. L. Southall, L. Hatch, S. M. Van Parijs, A. Frankel, and D. Ponirakis. 2009. Acoustic masking in marine ecosystems: intuitions, analysis, and implication. Marine Ecology Progress Series **395**:201-222.

Clark, C. W., and G. C. Gagnon. 2006. Considering the temporal and spatial scales of noise exposures from seismic surveys on baleen whales.*in* International Whaling Commission (IWC), editor.

Coates, D. A., Y. Deschutter, M. Vincx, and J. Vanaverbeke. 2014. Enrichment and shifts in macrobenthic

assemblages in an offshore wind farm area in the Belgian part of the North Sea. Marine Environmental Research **95**.

Cotter, M. P. 2019. Aerial Surveys for Protected Marine Species in the Norfolk Canyon Region: 2018 Annual Progress Report.*in* U.S. Fleet Forces Command, editor., Virginia Beach, VA.

Cox, T. M., T. J. Ragen, A. J. Read, E. Vos, R. W. Baird, K. Balcomb, J. Barlow, J. Caldwell, T. Cranford, L. Crum, A. D'Amico, G. D'Spain, A. Fernandez, J. Finneran, R. Gentry, W. Gerth, F. Gulland, J. Hildebrand, D. Houser, T. Hullar, P. D. Jepson, D. Ketten, C. D. MacLeod, P. Miller, S. Moore, D. C. Mountain, D. Palka, P. Ponganis, S. Rommel, T. Rowles, B. Taylor, P. Tyack, D. Wartzok, R. Gisiner, J. Mead, and L. Benner. 2006. Understanding the impacts of anthropogenic sound on beaked whales. Journal of Cetacean Research and Management **7**:177-187.

Cranford, T. W., and P. Krysl. 2015. Fin whale sound reception mechanisms: Skull vibration enables low-frequency hearing. PLoS One **10(1)**.

CRESLI. 2020. Coastal Research Education Society of Long Island, Inc Seal Research.

Crocker, S. E., and F. D. Fratantonio. 2016. Characteristics of sounds emitted during high-resolution marine geophysical surveys. OCS Study BOEM 2016-044, Herndon, VA.

Dahlheim, M., and M. Castellote. 2016. Changes in the acoustic behavior of gray whales *Eschrichtius robustus* in response to noise. Endangered Species Research **31**:227-242.

Dähne, M., A. Gilles, K. Lucke, V. Peschko, S. Adler, K. Krügel, J. Sundermeyer, and U. Siebert. 2013a. Effects of pile-driving on harbour porpoises (*Phocoena phocoena*) at the first offshore wind farm in Germany. Environmental Research Letters **8**:025002.

Dähne, M., J. Tougaard, J. Carstensen, A. Rose, and J. Nabe-Nielsen. 2017. Bubble curtains attenuate noise from offshore wind farm construction and reduce temporary habitat loss for harbour porpoises. Marine Ecology Progress Series **580**:221-237.

Dähne, M., U. K. Verfuß, A. Brandecker, U. Siebert, and H. Benke. 2013b. Methodology and results of calibration of tonal click detectors for small odontocetes (C-PODs). Journal of the Acoustical Society of America **134**:2514-2522.

Danil, K., and J. St. Leger. 2011. Seabird and dolphin mortality associated with underwater detonation exercises. Marine Technology Society Journal **45**:89-95.

David, J. A. 2006. Likely sensitivity of bottlenose dolphins to pile-driving noise. Water and Environment Journal **20**:48-54.

Davies, J. R. 1957. The Geography of the Gray Seal. Journal of Mammalogy **38**:297-310.

Davies, K. T., M. Brown, P. K. Hamilton, A. R. Knowlton, C. Taggart, and A. S. M. Vanderlaan. 2019. Variation in North Atlantic right whale eubalaena glacialis occurnece in the Bay of Fundy, Canada, over three decades. Endangered Species Research **39**:159-171.

Davies, K. T. A., and S. W. Brillant. 2019. Mass human-caused mortality spurs federal action to protect endangered North Atlantic right whales in Canada. Marine Policy **104**:157-162.

Davies, K. T. A., A. S. M. Vanderlaan, R. K. Smedbol, and C. T. Taggart. 2015. Oceanographic connectivity between right whale critical habitats in Canada and its influence on whale abundance indices during 1987–2009. Journal of Marine Systems **150**:80-90.

Davis, G. E., M. F. Baumgartner, J. M. Bonnell, J. Bell, C. Berchok, J. Bort Thornton, S. Brault, G. Buchanan, R. A. Charif, D. Cholewiak, C. W. Clark, P. Corkeron, J. Delarue, K. Dudzinski, L. Hatch, J. Hildebrand, L. Hodge, H. Klinck, S. Kraus, B. Martin, D. K. Mellinger, H. Moors-Murphy, S. Nieukirk, D. P. Nowacek, S. Parks, A. J. Read, A. N. Rice, D. Risch, A. Sirovic, M. Soldevilla, K. Stafford, J. E. Stanistreet, E. Summers, S. Todd, A. Warde, and S. M. Van Parijs. 2017. Long-term passive acoustic recordings track the changing distribution of North Atlantic right whales (Eubalaena glacialis) from 2004 to 2014. Scientific Reports **7**:13460.

Davis, G. E., M. F. Baumgartner, P. J. Corkeron, J. Bell, C. Berchok, J. M. Bonnell, J. Bort Thornton, S. Brault, G. A. Buchanan, D. Cholewiak, C. W. Clark, J. Delarue, L. Hatch, H. Klinck, S. Kraus, B. Martin, D. K. Mellinger, H. Moors-Murphy, S. Nieukirk, D. P. Nowacek, S. Parks, D. Parry, N. Pegg, A. J. Read, A. N. Rice, D. Risch, A. Scott, M. S. Soldevilla, K. M. Stafford, J. E. Stanistreet, E. Summers, S. Todd, and S. M. Van Parijs. 2020. Exploring movement patterns and changing distributions of baleen whales in the western North Atlantic using a decade of passive acoustic data. Global Change Biology **n/a**.

Deng, Z. D., B. Southall, T. J. Carlson, J. Xu, J. J. Martinez, M. A. Weiland, and J. M. Ingraham. 2014. 200-kHz commercial sonar systems generate lower frequency side lobes audible to some marine mammals. PLoS One **9**:95315.

Di Iorio, L., and C. W. Clark. 2009. Exposure to seismic survey alters blue whale acoustic communication. Biology Letters **6**:51-54.

Di Iorio, L., and C. W. Clark. 2010. Exposure to seismic survey alters blue whale acoustic communication. Biology Letters **6**:51-54.

DiGiovanni, R. A., and A. M. Sabrosky. 2010. A note on seal watching in the Northeast United States NAMMCO Scientific Publications **8**:373-377.

DoC. 2016. 50 CFR Part 226: Endangered and Threatened Species; Critical Habitat for Endangered North Atlantic Right Whale; Final Rule.*in* D. o. Commerce, editor.

DoN (U.S. Department of the Navy). 2005. Marine Resources Assessment for the Northeast Operating Areas: Atlantic City, Narragansett Bay, and Boston. Final Report. Norfolk, VA.

DoN (U.S. Department of the Navy). 2017. Marine species monitoring report for the U.S. Navy's Atlantic Fleet Training and Testing (AFTT) - 2016 annual report. Norfolk, VA.

Donovan, G. P. 1991. A review of IWC Stock Boundaries. Reports of the International Whaling Commission:39-68.

Dufault, S., and R. A. Davis. 1999. Whale monitoring aboard *The Cat*, final report 1998. Prepared for Bay Ferries Ltd. LGL Project No. TA2235, King City, ON.

Dunlop, R., R. D. McCauley, and M. Noad. 2020. Ships and air guns reduce social interactions in humpback whales at greater ranges than other behavioral impacts. Marine Pollution Bulletin **154**:111072.

Dunlop, R., J. Noad, R. McCauley, L. Scott-Hayward, E. Kniest, and R. W. Slade. 2017. Determining the behavioural dose–response relationship of marine mammals to air gun noise and source proximity. Journal of Experimental Biology **220**:2878-2886.

Dunn, R. A., and O. Hernandez. 2009. Tracking blue whales in the eastern tropical Pacific with an ocean-bottom seismometer and hydrophone array. Journal of the Acoustical Society of America **126**:1084-1094.

Edrén, S. M., S. M. Andersen, J. Teilmann, J. Carstensen, P. B. Harders, R. Dietz, and L. A. Miller. 2010. The effect of a large Danish offshore wind farm on harbor and gray seal haul-out behavior. Marine Mammal Science **26**:614-634.

Edrén, S. M., J. Teilmann, R. Dietz, and J. Carstensen. 2004. Effect of the construction of Nysted Offshore Wind Farm on seals in Rødsand seal sanctuary based on remote video monitoring. Technical report to Energi E2 A/S for the Ministry of the Environment, Denmark., Ministry of the Environment, Denmark.

Ellison, W. T., B. L. Southall, C. W. Clark, and A. S. Frankel. 2012. A new context-based approach to assess marine mammal behavioral responses to anthropogenic sounds. Conservation Biology **26**:21-28.

Ellison, W. T., B. L. Southall, A. S. Frankel, K. Vigness-Raposa, and C. W. Clark. 2018. An acoustic scene perspective on spatial, temporal, and spectral aspects of marine mammal behavioral responses to noise. Aquatic Mammals **44**:239-243.

Engelhaupt, A., J. M. Aschettino, D. Engelhaupt, A. DiMatteo, M. RIchlen, and M. P. Cotter. 2019. VACAPES Outer Continental Shelf Cetacean Study, Virginia Beach, Virginia: 2018 Annual Progress Report.*in* U.S. Fleet Forces Command, editor., Virginia Beach, VA.

EPRI. 2000. Review of Entrainment Survival Studies 1970-2000. 1000757, Palo Alto, CA.

Erbe, C. 2009. Underwater noise from pile driving in Moreton Bay, Qld. Acoustics Australia **37**:87-92.

Erbe, C., R. Dunlop, C. Jenner, M. N. Jenner, R. McCauley, I. M. Parnum, E. C. M. Parsons, T. Rogers, and C. Salgado Kent. 2017. Review of Underwater and In-Air Sounds Emitted by Australian and Antarctic Marine Mammals. Acoustic Australia 179.

Erbe, C., C. Reichmuth, K. Cunningham, K. Lucke, and R. Dooling. 2016. Communication masking in marine mammals: a review and research strategy. Marine Pollution Bulletin **103**:15-38.

ESRI. 2017. ArcGIS Desktop: Release 10.6.1. Environmental Systems Research Institute., Redlands, California.

Fernandez-Betelu, O., I. M. Graham, K. L. Brookes, B. J. Cheney, T. R. Barton, and P. M. Thompson. 2021. Far-field effects of impulsive noise on coastal bottlenose dolphins. Frontiers in Marine Science **8**:664230.

Finneran, J. 2020. Conditional attenuation of dolphin monaural and binaural auditory evoked potentials after preferential stimulation of one ear. Journal of Acoustical Society of America **147**:2302-2313.

Finneran, J. J. 2012. Auditory effects of underwater noise in odontocetes. Pages 197-202 *in* A. N. Popper and A. Hawkins, editors. The effects of noise on aquatic life. Advances in Experimental Medicine and Biology, vol. 730. Springer Science+Business Media, New York.

Finneran, J. J. 2015. Noise-induced hearing loss in marine mammals: a review of temporary threshold shift studies from 1996 to 2015. The Journal of the Acoustical Society of America **138**:1702-1726.

Finneran, J. J., C. E. Schlundt, R. Dear, D. A. Carder, and S. H. Ridgway. 2002. Temporary shift in masked hearing thresholds in odontocetes after exposure to single underwater impulses from a seismic watergun. Journal of the Acoustical Society of America **111**:2929-2940.

Fitch, J. E., and P. H. Young. 1948. Use and effect of explosives in California coastal waters. Pages 53-70 *in* C. F. a. Game, editor.

Forney, K. A., B. L. Southall, E. Slooten, S. Dawson, A. J. Read, R. W. Baird, and R. L. Brownell, Jr. 2017. Nowhere to go: noise impact assessments for marine mammal populations with high site fidelity. Endangered Species Research **32**:391-413.

Ganley, L. C., S. Brault, and C. A. Mayo. 2019. What we see is not what there is: estimating North Atlantic right whale *Eubalaena glacialis* local abundance. Endangered Species Research **38**:101-113.

Gedamke, J. 2011. Ocean basin scale loss of whale communication space: potential impacts of a distant seismic survey. Pages 105-106 19th Biennal Conference of Biology and Marine Mammals, Tampa, Florida.

Gervaise, C., Y. Simard, N. Roy, B. Kinda, and N. Menard. 2012. Shipping noise in whale habitat: characteristics, sources, budget, and impact on belugas in Saguenay-St. Lawrence Marine Park hub. Journal of the Acoustical Society of America **132**:76-89.

Gong, Z., A. D. Jain, D. Tran, D. H. Yi, F. Wu, A. Zorn, P. Ratilal, and N. C. Makris. 2014. Ecosystem scale acoustic sensing reveals humpback whale behavior synchronous with herring spawning processes and re-evaluation finds no effect of sonar on humpback song occurrence in the Gulf of Maine in fall 2006. PLoS One **9**:104733.

Gordon, J., D. Gillespie, J. Potter, A. Frantzis, M. P. Simmonds, R. Swift, and N. M. Thompson Duprey. 2003. A review of the effects of seismic surveys on marine mammals. Marine Technology Society Journal **37**:16-34.

Gospić, N. R., and M. Picciulin. 2016. Changes in whistle structure of resident bottlenose dolphins in relation to underwater noise and boat traffic. Marine Pollution Bulletin **105**:193-198.

Gowans, S., and H. Whitehead. 1995. Distribution and habitat partitioning by smaall odontocetes in the Gully, a submarine canyon on the Scotian Shelf. Canadian Journal of Zoology **73**:1599-1608.

Graham, A., and J. Cooke. 2008. The effects of noise disturbance from various recreational boating activities common to inland waters on the cardiac physiology of a freshwater fish, the largemouth bass (Micropterus salmoides). . Aquatic Conservation: Marine and Freshwater Ecosystems **18**.

Graham, I. M., E. Pirotta, N. D. Merchant, A. Farcas, T. R. Barton, B. Cheney, G. Hastie, and P. M. Thompson. 2017. Responses of bottlenose dolphins and harbor porpoises to impact and vibration piling noise during

harbor construction. Ecosphere **8**.

Greene, C. R., Jr., and W. J. Richardson. 1988. Characteristics of marine seismic survey sounds in the Beaufort Sea. Journal of the Acoustical Society of America **83**:2246-2254.

Guan, S., and R. Miner. 2020. Underwater noise characterization of down-the-hole pile driving activities off Biorka Island, Alaska. Marine Pollution Bulletin **160**.

Guazzo, R. A., D. W. Weller, H. Europe, J. W. Durban, G. D'Spain, and J. Hildebrand. 2019. Migrating eastern North Pacific gray whale call and blow rates estimated from acoustic recordings, infrared camera video, and visual sightings. Scientific Reports **9**:12617.

Haelters, J., V. Dulière, L. Vigin, and S. Degraer. 2015. Towards a numerical model to simulate the observed displacement of harbour porpoises Phocoena phocoena due to pile driving in Belgian waters. Hydrobiologia **756**:105-116.

Halvorsen, M. B., D. Zeddies, W. T. Ellison, D. R. Chicoine, and A. Popper. 2012. Effects of mid-frequency active sonar on hearing fish. Journal of Acoustical Society of America **131**:599-607.

Hamazaki, T. 2002. Spatiotemporal prediction models of cetacean habitats in the mid-western North Atlantic Ocean (from Cape Hatteras, North Carolina, USA to Nova Scotia, Canada). Marine Mammal Science **18**:920-939.

Hammar, L., S. Andersson, and R. Rosenberg. 2010. Adapting Offshore Wind Power Foundations to Local Environment.

Hammill, M. O., V. Lesage, Y. Dubé, and L. N. Measures. 2001. Oil and gas exploration in the southeastern Gulf of St. Lawrence: a review of information on pinnipeds and cetaceans in the area. DFO Can. Sci. Advis. Sec. Res. Doc. 2001/115, Ottawa, ON.

Hamran, E. 2014. Distribution and vocal behavior of Atlantic white-sided dolphins (Lagenorhynchus acutus) in northern Norway. University of Nordland.

Handegard, N. O., and D. Tjøstheim. 2005. When fish meet a trawling vessel: examining the behaviour of gadoids using a free-floating buoy and acoustic split-beam tracking. Canadian Journal of Fisheries and Aquatic Sciences **62**:2409-2422.

Hannay, D. E. 2021. Underwater acoustic modeling of Unexploded Ordnance for Ørsted Wind Farm Construction, US East Coast. Technical Memorandum. JASCO Applied Sciences (USA) Inc., Silver Spring, MD.

Hannay, D. E., and M. Zykov. 2021. Underwater Acoustic Modeling of Detonations of Unexploded Ordnance (UXO) for Ørsted Wind Farm Construction, US East Coast. JASCO Applied Sciences (USA) Inc., Silver Spring, MD.

Hanser, S. F., L. R. Doyle, A. Szabo, F. A. Sharpe, and B. McCowan. 2009. Bubble-net feeding humpback whales in Southeast Alaska change their vocalization patterns in the presence of moderate vessel noise. Abstracts of the 18th Biennial Conference on the Biology of Marine Mammals, Quebec, Canada.

Harding, H., R. Bruintjes, A. N. Radford, and S. D. Simpson. 2016. Measurement of hearing in Atlantic salmon (Salmo salar) using auditory evoked potentials, and effects of pile driving playback on salmon behaviour and physiology.

Harrington, M. 2020. As calls flood seal center, agency cautions beachgoers on sightings.

Harris, R., T. Elliott, and R. A. Davis. 2007. Results of mitigation and monitoring program, Beaufort Span 2-D marine seismic program, open-water season 2006 TA4319-1).

Hart-Crowser, and I. a. Rodkin. 2009. Acoustic Monitoring and In-situ Exposures of Juvenile Coho Salmon to Pile Driving Noise at the Port of Anchorage Marine Terminal Redevelopment Project Knik Arm, Anchorage, Alaska. 12684-03.

Hastie, G., C. Donovan, T. Gotz, and V. M. Janik. 2014. Behavioral responses of grey seals (Halichoerus grypus) to high frequency sonar. Marine Pollution Bulletin **79**:205-210.

Hastie, G., P. Lepper, J. C. McKnight, R. Milne, D. J. F. Russell, and D. Thompson. 2021. Acoustic risk balancing by marine mammals: anthropogenic noise can influence the foraging decisions by seals. Journal of Applied Ecology **58**:1854-1863.

Hastings, M. C., and A. N. Popper. 2005. Effects of sound on fish. Contract No. 43A0139, Task Order 1, Sacramento, CA.

Hatch, L. T., C. W. Clark, S. M. Van Parijs, A. S. Frankel, and D. W. Ponirakis. 2012. Quantifying loss of acoustic communication space for right whales in and around a U.S. National Marine Sanctuary. Conservation Biology **26**:983-994.

Hawkins, A., and A. Popper. 2017. A sound approach to assessing the impact of underwater noise on marine fishes and invertebrates. ICES Journal of Marine Science **74**:635-651.

Hayes, S. A., E. Josephson, K. Maze-Foley, and P. E. Rosel. 2021. Draft U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments 2021. Woods Hole, MA.

Hayes, S. A., E. Josephson, K. Maze-Foley, and P. E. Rosel, eds. 2017. US Atlantic and Gulf of Mexico marine mammal stock assessments - 2016. NOAA Tech. Memo. NMFS-NE-241, Woods Hole, MA.

Hayes, S. A., E. Josephson, K. Maze-Foley, and P. E. Rosel, eds. 2018. US Atlantic and Gulf of Mexico marine mammal stock assessments - 2017. NOAA Tech. Memo. NMFS-NE-245, Woods Hole, MA.

Hayes, S. A., E. Josephson, K. Maze-Foley, and P. E. Rosel, eds. 2019. US Atlantic and Gulf of Mexico marine mammal stock assessments - 2019. NOAA Tech. Memo, NMFS- NE- 264, Woods Hole, MA.

Hayes, S. A., E. Josephson, K. Maze-Foley, and P. E. Rosel, eds. 2020. US Atlantic and Gulf of Mexico marine mammal stock assessments- 2020. NOAA Tech. Memo, NMFS-NE- 271, Woods Hole, MA.

Heiler, J., S. H. Elwen, H. J. Kriesell, and T. Gridley. 2016. Changes in bottlenose dolphin whistle parameters related to vessel presence, surface behaviour and group composition. Animal Behaviour **117**:167-177.

Hill, S. H. 1978. A guide to the effects of underwater shock waves on Arctic marine mammals and fish. Institute of Marine Sciences, Patricia Bay, Sidney, B.C.

Holst, M., J. Beland, B. Mactavish, J. R. Nicolas, B. Hurley, and B. Dawe. 2011. Visual-acoustic survey of cetaceans during a seismic study near Taiwan, April-July 2009. Abstracts of the 19th Biennial Conference on the Biology of Marine Mammals, Tampa, FL.

Holst, M., D. P. Noren, V. Veirs, C. K. Emmons, and S. Veirs. 2009. Speaking up: Killer whales (Orcinus orca) increase their call amplitude in response to vessel noise. Journal of the Acoustical Society of America **125**:EL27-EL32.

Holst, M., W. J. Richardson, W. R. Koski, M. Smultea, B. Haley, M. W. Fitzgerald, and M. Rawson. 2006. Effects of large and small-source seismic surveys on marine mammals and sea turtles. AGU Spring Meeting Abstracts, Baltimore, MD.

Holst, M., M. Smultea, W. R. Koski, and B. Haley. 2005. Marine mammal and sea turtle monitoring during Lamont-Doherty Earth Observatory's Marine Seismic Program off the Northern Yucatán Peninsula in the Gulf of Mexico, January-Feburary 2004. Lamont-Doherty Earth Observatory of Columbia University, Palisades, NY.

Holt, M. M., D. P. Noren, R. C. Dunkin, and T. M. Williams. 2015. Vocal performance affects metabolic rate in dolphins: implications for animals communicating in noisy environments. Journal of Experimental Biology **218**:1647-1654.

Houghton, J., J. Starkes, J. Stutes, M. Harvey, J. Reyff, and D. Erikson. 2010. Acoustic monitoring and in-situ exposures of juvenile coho salmon to pile driving noise at the Port of Anchorage Marine Terminal Redevelopment Project, Knik Arm, Alaska. Alaska Marine Science Symposium, Anchorage, AK.

Houser, D. 2021. When is Temporary Threshold Shift Injurious to Marine Mammals. Journal of Marine Science and Engineering **9**.

Houser, D., C. D. Champagne, D. E. Crocker, N. M. Kellar, J. Cockrem, T. A. Romano, R. Booth, and S. K. Wasser. 2016. Natural variation in stress hormones, comparisons across matrices, and impacts resulting from induced stress in the bottlenose dolphin. Pages 467-471 *in* A. Popper and A. Hawkins, editors. The effects of noise on aquatic life II. Springer, New York, NY.

Illingworth, and Rodkin. 2007. Technical Guidance for Assessment and Mitigation of the Hydroacoustic Effects of Pile Driving on Fish. California Department of Transportation, Sacramento, CA.

Illingworth, and Rodkin. 2017. Pile-Driving Noise Measurements at Atlantic Fleet Naval Installations: 28 May 2013-28 April 2016. HDR Environmental for NAVFAC.

Illinworth & Rodkin. 2007. Compendium of pile driving sound data. Prepared for the California Department of Transportation. Petalum, CA.

ISO. 2017. Underwater acoustics — Measurement of radiated underwater sound from percussive pile driving. International Organization for Standardization, Geneva, Switzerland., Geneva, Switzerland.

IUCN. 2020. IUCN Red List of Threatened Species.

Jefferson, T. A., S. Leatherwood, and M. A. Webber. 1993. FAO species identification guide. Marine mammals of the world. FAO, Rome, Italy.

Jefferson, T. A., M. A. Webber, and R. Pitman. 2008. Marine Mammals of the World: A comprehensive Guide to their Identification. London, UK.

Jensen, F. H., L. Bejder, M. Wahlberg, N. Aguilar Soto, M. Johnson, and P. T. Madsen. 2009. Vessel noise effects on delphinid communication. Marine Ecology Progress Series **395**:161-175.

Johnson, S. R., W. J. Richardson, S. B. Yazvenko, S. A. Blokhin, G. Gailey, M. R. Jenkerson, S. K. Meier, H. R. Melton, M. W. Newcomer, A. S. Perlov, S. A. Rutenko, B. Wursig, C. R. Martin, and D. E. Egging. 2007. A western gray whale mitigation and monitoring program for a 3-D seismic survey, Sakhalin Island, Russia. Environmental Monitoring and Assessment **134**:1-19.

Jones, D. V., and D. Rees. 2020. Haul-out Counts and Photo-Identification of Pinnipeds in Chesapeake Bay and Eastern Shore, Virginia: 2018/2019 Annual Progress Report. Final Report., Norfolk, VA.

Jones, I. T., J. A. Stanley, and T. A. Mooney. 2020. Impulsive pile driving noise elicits alarm responses in squid (Doryteuthis pealeii). Marine Pollution Bulletin **150**:110792.

Kastelein, R., R. Gransier, M. Marijt, and L. Hoek. 2015a. Hearing frequencies of a harbor porpoise (*Phocoena phocoena*) temporarily affected by played back offshore pile driving sounds. Journal of Acoustical Society of America **137**:556-564.

Kastelein, R. A., R. Gransier, J. Schop, and L. Hoek. 2015b. Effects of exposure to intermittent and continuous 6-7 kHz sonar sweeps on harbor porpoise (*Phocoena phocoena*) hearing. Journal of the Acoustical Society of America **137**:1623-1633.

Kastelein, R. A., L. Helder-Hoek, S. A. Cornelisse, A. M. von Benda-Beckmann, F. P. A. Lam, C. A. F. de Jong, and D. Ketten. 2020. Lack of reproducibility of temporary hearing threshold shifts in a harbor porpoise after exposure to repeated airgun sounds. Journal of Acoustical Society of America **148**:556-565.

Kastelein, R. A., L. Helder-Hoek, J. Covi, and R. Gransier. 2016. Pile driving playback sounds and temporary threshold shoft in harbor porpoises (Phocoena phocoena): Effect of exposure duration. Journal of Acoustical Society of America **139**:2842-2851.

Kastelein, R. A., L. Helder-Hoek, and R. Gransier. 2019. Frequency of greatest temporary hearing threshold shift in harbor seals (Phoca vitulina) depends on fatiguing sound level. Journal of Acoustical Society of America **145**:1353-1362.

Kastelein, R. A., D. van Heerden, R. Gransier, and L. Hoek. 2013. Behavioral responses of a harbor porpoise (*Phocoena phocoena*) to playbacks of broadband pile driving sounds. Marine Environmental Research **92**:206-214.

Kavanagh, A. S., M. Nykanen, W. Hunt, N. Richardson, and M. J. Jessopp. 2019. Seismic surveys reduce cetacean sightings across a large marine ecosystem. Scientific Reports **9**:19164.

Kenney, R. D., and K. J. Vigness-Raposa. 2010. Marine mammals and sea turtles of Narragansett Bay, Block Island Sound, Rhode Island Sound, and nearby waters: an analysis of existing data for the Rhode Island Ocean Special Area Management Plan. Pages 634-970 *in* Rhode Island Coastal Resources Management Council, editor. Rhode Island Ocean Special Area Management Plan Volume 2. Appendix A: technical reports for the Rhode Island Ocean Special Area Management Plan.

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

Kenney, R. D., H. E. Winn, and J. D. J. Macaulay. 1995. Cetaceans in the Great Sound Channel, 1979-1989: Right whale (Eubalaena glacialis) Continental Shelf Research **15**:385-414.

Ketten, D. 1995. Estimates of blast injury and acoustic trauma zones for marine mammals from underwater explosions. Sensory Systems of Aquatic Mammals:391-407.

Ketten, D. 2004. Experimental measures of blask and acoustic trauma in marine mammals. N000149711030.

Ketten, D., S. Cramer, J. Arruda, D. C. Mountain, and A. Zosuls. 2014. Inner ear frequency maps: First stage audiogram moddels for mysticetes, In: The 5th International Meeting of Effects of Sound in the Ocean on Marine Mammals.

Ketten, D. R., J. Lien, and S. Todd. 1993. Blast injury in humpback whale ears: evidence and implications. Journal of the Acoustical Society of America **94**:1849-1850.

Koschinski, S. 2011. Underwater noise pollution from munitions clearance and disposal, possible effects on marine vertebrates, and its mitigation. Marine Technology Society Journal **45**:80-88.

Koschinski, S., and K. H. Kock. 2009. Underwater unexploded ordnance- methods for a cetacean-friendly removal of explosives as alternatives to blasting.

Koschinski, S., and K. Ludemann. 2013. Development of Noise Mitigation Measures in Offshore Wind Farm Construction. Commissioned by the Federal Agency for Nature Conservation (Bundesamt für Naturschutz, BfN). Nehmten and Hamburg, Germany.

Kraus, S., R. D. Kenney, and L. Thomas. 2019. A Framework for Studying the Effects of Offshore Wind Development on Marine Mammals and Sea Turtles., Massachusetts Clean Energy Center and Bureau of Ocean Energy Management Boston, MA.

Kraus, S. D., S. Leiter, K. Stone, B. Wikgren, C. Mayo, P. Hughes, R. D. Kenney, C. W. Clark, A. N. Rice, B. Estabrook, and J. Tielens. 2016. Northeast large pelagic survey collaborative aerial and acoustic surveys for large whales and sea turtles. OCS Study BOEM 2016-054, Sterling, VA.

Krone, R., R. Gutow, T. Brey, J. Dannheim, and A. Schroeder. 2013. Mobile demersal megafauna at artificial structures in the German Bight- Likely effects of offshore wind farm development. Estuarine, Coastal and Shelf Science **125**:1-9.

Kryter, K. D. 1985. The Effects of Noise on Man. Academic Press, Orlando, FL.

Langhamer, O. 2012. Artificial Reef Effect in relation to Offshore Renewable Energy Conversion: State of the Art. The Scientific World Journal **386713**.

Langhamer, O., and D. Wilhelmsson. 2009. Colonization of dish and crabs of wave energy foundations and the effects of manufactures holes- a field experiment. Marine Environmental Research **68**:151-157.

Lavigueur, L., and M. O. Hammill. 1993. Distribution and seasonal movements of grey seals, Halichoerus grypus, born in the Gulf of St. Lawrence and eastern Nova Scotia shore. Canadian Field-Naturalist **107**:329-340.

Le Prell, C. G., D. Henderson, R. R. Fay, and A. Popper. 2012. Noise induced hearing loss: Scientific advances.*in* N. Y. S. S. B. Media, editor.

Leopold, M., and K. Camphuysen. 2008. Did the pile driving during the construction of the offshore wind farm Egmond aan Zee, the Netherlands, impact porpoises? , Wageningen IMARES Report.

Lesage, V., K. Gavrilchuk, R. D. Andrews, and R. Sears. 2017. Foraging areas, migratory movements, and winter destinations of blue whales from the western North Atlantic. Endangered Species Research **34**.

Lesage, V., J.-F. Gosselin, J. W. Lawson, I. McQuinn, H. Moors-Murphy, S. Plourde, R. Sears, and P. Simard. 2018. Habitats important to blue whales (Balaenoptera musculus) in the western North Atlantic.*in* DFO Can. Sci. Advis. Sec., editor.

Liberman, M. C., M. Epstein, S. S. Cleveland, H. Wang, and S. F. Maison. 2016. Toward a differential diagnosis of hidden hearing loss in humans. PLoS One **11**:E0162726.

Lindeboom, H. J., H. J. Kouwenhoven, M. J. N. Bergman, S. Bouma, S. Brasseur, R. Daan, R. C. Fijn, D. de Haan, S. Dirksen, R. van Hal, R. Hille Ris Lambers, R. ter Hofstede, K. L. Krijgsveld, M. Leopold, and M. Scheidat. 2011. Short-term ecological effects of an offshore wind farm in the Dutch coastal zone; a compilation. Environmental Research Letters **6**:035101.

Ljungblad, D. K., B. Wursig, S. L. Swartz, and J. M. Keene. 1988. Observations on the behavioral responses of bowhead whale (Balaena mysticetus) to active geophysical vessels in the Alaskan Beaufort Sea. Arcttic **41**:183-194.

Long-Island-Pulse. 2017. Where to Seal Watch on Long Island.

Lucke, K., P. A. Lepper, M.-A. Blanchet, and U. Siebert. 2011. The use of an air bubble curtain to reduce the received sound levels for harbor porpoises (Phocoena phocoena). Journal of the Acoustical Society of America **130**:3406-3412.

Luís, A. R., M. N. Couchinho, and M. E. Santos. 2014. Changes in the acoustic behavior of resident bottlenose dolphins near operating vessels. Marine Mammal Science **30**:1417-1426.

Lurton, X. 2016. Modelling of the sound field radiated by multibeam echosounders for acoustical impact assessment. Applied Acoustics **101**:201-216.

Lusseau, D., and L. Bejder. 2007. The long-term consequences of short-term respones to disturbance experiences from whalewatching impact assessment. International Journal of Comparative Psychology **20**:228-236.

Lyamin, O. I., S. M. Korneva, V. V. Rozhnov, and L. M. Mukhametov. 2016. Cardiorespiratory responses to acoustic noise in belugas. Page 1292 *in* A. Popper and A. Hawkins, editors. The effects of noise on aquatic life II. Springer, New York, NY.

MacGillivray, A. O., R. Racca, and Z. Li. 2014. Marine mammal audibility of selected shallow-water survey sources. Journal of the Acoustical Society of America **135**:EL35-EL40.

Madsen, P. T., B. Mohl, B. K. Nielsen, and M. Wahlberg. 2002. Male sperm whale behaviour during exposures to distant seismic survey pulses. Aquatic Mammals **28**:231-240.

Madsen, P. T., M. Wahlberg, J. Tougaard, K. Lucke, and P. Tyack. 2006. Wind turbine underwater noise and marine mammals: implications of current knowledge and data needs. Marine Ecology Progress Series **309**:279-295.

Malme, C. I., and P. R. Miles. 1985. Behavioral responses of marine mammals (gray whales) to seismic discharges. Proceedings of the Workshop on Effects of Explosives Use in the Marine Environment, Halifax, NS.

Malme, C. I., P. R. Miles, C. W. Clark, P. Tyack, and J. E. Bird. 1984. Investigations of the Potential Effects of Underwater Noise from Petroleum Industry Activities on Migrating Gray Whale Behavior. Phase II: January 1984 migration (5586). Cambridge, MA

Malme, C. I., B. Wursig, J. E. Bird, and P. Tyack. 1986. Behavioral responses of gray whales to industrial noise: feeding observations and predictive modeling. U.S. Dep. Commer., NOAA, OCSEAP Final Rep. 56(1988):393-600. OCS Study MMS 88-0048.

Malme, C. I., B. Wursig, J. E. Bird, and P. Tyack. 1988. Observations of feeding gray whale responses to controlled industrial noise exposure. University of Alaska, Geophysical Institute, Fairbanks, AK.

Mansfield, A. W. 1966. The gray seal in eastern Canadian waters. Canadian Audubon Magazine:161-166.

Martins, D. T. L., M. R. Rossi-Santos, and F. J. D. Lima Silva. 2016. Effects of anthropogenic noise on the acoustic behaviour of *Sotalia guianensis* (Van Bénéden, 1864) in Pipa, North-eastern Brazil. Journal of the Marine Biological Association of the United Kingdom **98**:215-222.

Matthews, L. P. 2017. Harbor seal (Phoca vitulina) reproductive advertisement behavior and the effects of vessel noise. Syracuse University.

Matthews, L. P., S. Parks, C. M. Fournet, J. Gabriel, J. N. Womble, and H. Klinck. 2017. Source levels and call parameters of harbor seal breeding vocalizations near a terrestrial haulout site in Glacier Bay National Park and Preserve. The Journal of the Acoustical Society of America **141**:273-280.

Matthews, M.-N. R., D. S. Ireland, R. Brune, Z. D. G., J. R. Christian, G. Warner, T. J. Deveau, H. Frouin-Mouy, S. L. Denes, C. Pyć, V. D. Moulton, and D. E. Hannay. 2018. Determining the Environmental Impact of Marine Vibrator Technology. Final Report.

Mayo, C. A., L. Ganley, C. Hudak, A, S. Brault, M. Marx, K, E. Burke, and M. W. Brown. 2018. Distribution, demography, and behavior of North Atlantic right whales (*Eubalaena glacialis*) in Cape Cod Bay, Massachusetts, 1998–2013. Marine Mammal Science **0**.

Mayo, C. A., and M. K. Marx. 1990. Surface foraging behaviour of the North Atlantic right whale, *Eubalaena glacialis*, and associated zooplankton characteristics. Canadian Journal of Zoology **68**:2214-2220.

McCarthy, E., D. Moretti, L. Thomas, N. DiMarzio, R. Morrissey, S. Jarvis, J. Ward, A. Izzi, and A. Dilley. 2011. Changes in spatial and temporal distribution and vocal behavior of Blainville's beaked whales (Mesoplodon densirostris) during multiship exercises with mid-frequency sonar. Marine Mammal Science **27**:206-226.

McCauley, R. 2003. High intensity anthropogenic sound damages fish ears. Journal of Acoustical Society of America **113**.

McCauley, R., J. Fewtrell, A. Duncan, C. Jenner, M.-N. Jenner, J. D. Penrose, and K. A. McCabe. 2000. Marine seismic surveys: Analysis and propagation of air-gun signals; and effects of air-gun exposure on humpback whales, sea turtles, fishes and squid (R99-15). Western Australia.

McCauley, R. D., M. N. Jenner, C. Jenner, K. A. McCabe, and J. Murdoch. 1998. The response of humpback whales (*Megaptera novaeangliae*) to offshore seismic survey noise. Preliminary results of observations about a working seismic vessel and experimental exposures. The APPEA Journal **38**:692-707.

McDonald, M., J. Hildebrand, and S. L. Mesnick. 2009. Worldwide decline in tonal frequencies of blue whale songs. Endangered Species Research **9**.

McDonald, M. A., J. A. Hildebrand, and S. C. Webb. 1995. Blue and fin whales observed on a seafloor array in the northeast Pacific. Journal of the Acoustical Society of America **98**:712-721.

McKenna, M. F. 2011. Blue whale response to underwater noise from commerical ships. University of California, San Diego.

McQuinn, I., J.-F. Gosselin, M.-N. Bourassa, A. Mosnier, J. F. St-Pierre, S. Plourde, V. Lesage, and A. Raymond. 2016. The spatial association of blue whales (Balaenoptera musculus) with krill patches (Thysanoessa spp. and Meganyctiphanes novegica) in the estuary and northwestern Gulf of St. Lawrence.*in* DFO Can. Sci. Advis. Sec., editor.

Melcón, M. L., A. J. Cummins, S. M. Kerosky, L. K. Roche, S. M. Wiggins, and J. A. Hildebrand. 2012. Blue whales respond to anthropogenic noise. PLoS One **7**:e32681.

Merchant, N. D., M. Andersson, T. Box, F. Le Courtois, D. Cronin, N. Holdsworth, N. Kinneging, S. Mendes, T. Merck, J. Mouat, and A. Norro. 2020. Impulsive noise pollution in the Northeast Atlantic: Reported activity during 2015-2017. Marine Pollution Bulletin **152**.

Meyer-Gutbrod, E. L., C. H. Greene, K. Davies, and G. J. David. 2021. Ocean Regime Shift is Driving Collapse o the North Atlantic Right Whale Population. Oceanography **34**:22-31.

Mikkelsen, L., K. N. Mouritsen, K. Dahl, J. Teilmann, and J. Tougaard. 2013. Re-established stony reef attracts harbour propoises Phocoena phocoena. Marine Ecology Progress Series **481**:239-248.

Miller, B., R. E. Elliott, W. R. Koski, V. D. Moulton, and W. J. Richardson. 1999. Whales In W. J. Richardson (Ed.), Marine mammal and acoustical monitoring of Western Geophysical's open-water seismic program in the Alaskan Beaufort Sea, 1998.

Miller, B., V. D. Moulton, A. R. Davis, M. Holst, P. Millman, A. MacGillivray, and D. E. Hannay. 2005. Monitoring seismic effects on marine mammals—southeastern Beaufort Sea, 2001-2002., Columbus, OH.

Moulton, V. D., and M. Holst. 2010. Effects of seismic survey sound on cetaceans in the Northwest Atlantic. Natural Resources Canada, St. John's, Canada.

Muirhead, C. A., A. Warde, I. S. Biedron, A. N. Mihnovets, C. W. Clark, and A. N. Rice. 2018. Seasonal occurence of blue, fin, and North Atlantic right whales in the New York Bight. Aquatic Conservation: Marine and Freshwater Ecosystems **28**.

Nachtigall, P. E., and A. Y. Supin. 2014. Conditioned hearing sensitivity reduction in a bottlenose dolphin (Tursiops truncatus). The Journal of Experimental Biology **217**:2806-2813.

Nachtigall, P. E., and A. Y. Supin. 2015. Conditioned frequency-dependent hearing sensitivity reduction in the bottlenose dolphin (Tursiops truncatus). The Journal of Experimental Biology **218**:999-1005.

Nachtigall, P. E., A. Y. Supin, J.-A. Estaban, and A. F. Pacini. 2016. Learning and extinction of conditioned hearing sensation change in the beluga whale (Delphinapterus leucas). Journal of Comparative Physiology A **202**:105-113.

Nachtigall, P. E., A. Y. Supin, A. F. Pacini, and R. A. Kastelein. 2018. Four odontocete species change hearing levels when warned of impending loud sound. Integrative Zoology **13**:160-165.

Navy, D. o. t. 2007. Navy OPAREA Density Estimates (NODE) for the GOMEX OPAREA. Norfolk, Virginia: Naval Facilities Engineering Command, Atlantic Contract N62470-02-D-9997, Task Order 0046.*in* D. o. t. Navy, editor. Geo-Marine, Hampton, VA.

Nehls, G., A. Rose, A. Diederichs, M. A. Bellmann, and H. Pehlke. 2016. Noise Mitigation During Pile Driving Efficiently Reduces Disturbance of Marine Mammals. Pages 755-762 The Effects of Noise on Aquatic Life II, Springer, NY.

Neo, Y. Y., J. Seitz, R. A. Kastelein, H. V. Winter, C. ten Cate, and H. Slabbekoorn. 2014. Temporal structure of sound affects behavioural recovery from noise impact in European seabass. Biological Conservation **178**:65-73.

New, L. F., J. Harwood, L. Thomas, C. Donovan, J. S. Clark, G. Hastie, P. M. Thompson, B. Cheney, L. Scott-Hayward, and D. Lusseau. 2013a. Modelling the biological significance of behavioural change in coastal bottlenose dolphins in response to disturbance. Functional Ecology **27**:314-322.

New, L. F., D. J. Moretti, S. K. Hooker, D. P. Costa, and S. E. Simmons. 2013b. Using energetic models to investigate the survival and reproduction of beaked whales (family Ziphiidae). PLoS One **8**:e68725.

Nieukirk, S. L., D. K. Mellinger, J. Hildebrand, M. A. McDonald, and R. P. Dziak. 2005. Downward shift in the frequency of blue whale vocalizations. Abstracts of the 16th Biennial Conference on the Biology of Marine Mammals, San Diego, CA.

Nieukirk, S. L., D. K. Mellinger, S. E. Moore, K. Klinck, R. P. Dziak, and J. Goslin. 2012. Sounds from airguns and fin whales recorded in the mid-Atlantic Ocean, 1999-2009. Journal of the Acoustical Society of America **131**:1102-1112.

Nieukirk, S. L., K. M. Stafford, D. K. Mellinger, R. P. Dziak, and C. G. Fox. 2004. Low-frequency whale and seismic airgun sounds recorded in the mid-Atlantic Ocean. Journal of the Acoustical Society of America **115**:1832-1843.

NMFS. 1991. Final Recovery Plan for the Humpback Whale (*Megaptera novaeangliae*). Report prepared by the humpback whale recovery team for the National Marine Fisheries Service. Silver Spring, MA.

NMFS. 1993. Stellwagen Bank Management Plan and Final Environmental Impact Statement.

NMFS. 2017. 2017 Annual Report of a Comprehensive Assessment of Marine Mammal, Marine Turtle, and Seabird Abundance and Spatial Distribution in US waters of the Western North Atlantic Ocean – AMAPPS II.

NMFS. 2018a. 2018 revision to: technical guidance for assessing the effects of anthropogenic sound on marine mammal hearing (version 2.0). Underwater thresholds for onset of permanent and temporary threshold shifts. Silver Spring, MD.

NMFS. 2018b. 2018 Revisions to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Verson 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts. NOAA Technical Memorandum NMFS-OPR-59.

NMFS. 2019. Cetacean & Sound Mapping.

NMFS. 2020a. 2018-2020 Pinniped Unusual Mortality Event Along the Northeast Coast.

NMFS. 2020b. Atlantic Marine Assessment Program for Protected Species.

NMFS. 2020c. Interim recommendation for sound source level and propagation analysis for high resolution geophysical (HRG) sources.

NMFS. 2020d. North Atlantic Right Whale Seasonal Management Areas (SMA) Map & GIS Data.

NMFS. 2020e. Reducing Vessel Strikes to North Atlantic Right Whales.

NMFS. 2021a. Atlantic white-sided dolphin (*Lagenorhynchus acutus*) overview. .

NMFS. 2021b. Common bottlenose dolphin *(Tursiops truncatus)* overview.

NMFS. 2021c. Fin whale (*Balaenoptera physalus*) overview.

NMFS. 2021d. Gray seal (*Halichoerus grypus atlantica*) overview.

NMFS. 2021e. Harbor seal (*Phoca vitulina*) overview.

NMFS. 2021f. Humpback whale (*Megaptera novaeangliae*) overview.

NMFS. 2021g. Long-finned pilot whale (*Globicephala melas*) overview.

NMFS. 2021h. Minke whale (*Balaenoptera acutorostrata*) overview.

NMFS. 2021i. North Atlantic right whale (*Eubalaena glacialis*) overview.

NMFS. 2021j. Sei Whale (*Balaenoptera borealis*) overview.

NMFS. 2021k. Short-beaked common dolphin (*Delphinus delphis*) overview.

NMFS. 2021l. Takes of Marine Mammals Incidental to Specified Activities; Taking Marine Mammals Incidental to Marine Site Characterization Surveys Off of Massachusetts and Rhode Island.*in* N. N. O. a. A. A. N. M. F. Service and d. o. Commerce, editors.

NMFS. 2021m. Taking and Importing Marine Mammals; Taking Marine Mammals Incidental to Geophysical Surveys Related to Oil and Gas Activities in the Gulf of Mexico. .*in* National Marine Fisheries Service, National Oceanic and Atmospheric Administration, and D. o. Commerce, editors. 50 CFR Part 217.

NMFS. 2022a. 2016-2022 Humpback Whale Unusual Mortality Event Along the Atlantic Coast.

NMFS. 2022b. 2017-2022 Minke Whale Unusual Mortality Event along the Atlantic Coast

NMFS. 2022c. 2017-2022 North Atlantic Right Whale Unusual Mortality Event.

Normandeau, and APM. 2019a. Digital Aerial Baseline Survey of Marine Wildlife in Support of Offshore Wind Energy, Summer 2018 Taxonomic Analysis Summary Report.

Normandeau, and APM. 2019b. Digital Aerial Baseline Survey of Marine Wildlife in Support of Offshore Wind Energy.

Normandeau, and APM. 2019c. Digital Aerial Baseline Survey of Marine Wildlife in Support of Offshore Wind Energy. Second Annual Report Summer 2016 – Spring 2018 Fourth Interim Report.

Normandeau, and APM. 2019d. Normandeau and APM 2019c. Digital Aerial Baseline Survey of Marine Wildlife in Support of Offshore Wind Energy, Fall 2018 Taxonomic Analysis Summary Report.

Normandeau, and APM. 2020. Digital Aerial Baseline Survey of Marine Wildlife in Support of Offshore Wind Energy- Winter 2018-2019 Taxonomic Analysis Summary Report.

Nowacek, D. P., C. W. Clark, D. Mann, P. J. O. Miller, H. C. Rosenbaum, J. S. Golden, M. Jasny, J. Kraska, and B. L. Southall. 2015. Marine seismic surveys and ocean noise: time for coordinated and prudent planning. Frontiers in Ecology and the Environment **13**:378-386.

Nowacek, D. P., L. H. Thorne, D. W. Johnston, and P. L. Tyack. 2007. Responses of cetaceans to anthropogenic noise. Mammal Review **37**:81-115.

NYSERDA. 2017. New York State Offshore Wind Master Plan. Marine Mammals and Sea Turtles Study. NYSERDA Report.

O'Brien, M., S. E. Beck, S. Berrow, M. Andre, M. Van der Schaar, I. O'Connor, and E. P. McKeown. 2016. The Use of Deep Water Berths and the Effect of Noise on Bottlenose Dolphins in the Shannon Estuary cSAC, New York, NY.

OBIS. 2021. Ocean Biodiversity Information System.

Pace, R. M., III. 2021. Revisions and Further Evaluations of the Right Whale Abundance Model: Improvements for Hypothesis Testing.*in* U.S. Dep. Commer., editor. NOAA, Woods Hole, Massachusetts.

Pacini, A. F., P. E. Nachtigal, L. N. Kloepper, M. Linnenschmidt, A. Sogorb, and S. Matias. 2010. Audiogram of a formerly stranded long-finned pilot whale (Globicephala melas) measured using auditory evoked potentials The Journal of Experimental Biology **213**.

Paiva, E. G., C. Salgado Kent, M. Gagnon, R. McCauley, and H. Finn. 2015. Reduced detection of Indo-Pacific bottlenose dolphins (Tursiops aduncus) in an Inner Harbour channel during pile driving activities. Aquatic Mammals **41**:455-468.

Palka, D. L., S. Chavez-Rosales, E. Josephson, D. Cholewiak, H. L. Haas, L. Garrison, M. Jones, D. Sigourney, G. Waring, M. Jech, E. Broughton, M. Soldevilla, G. Davis, A. DeAngelis, C. R. Sasso, M. V. Winton, R. J. Smolowitz, G. Fay, E. LaBrecque, J. B. Leiness, Dettloff, M. Warden, K. Murray, and C. Orphanides. 2017. Atlantic Marine Assessment Program for Protected Species: 2010-2014. OCS Study BOEM 2017-071, Washington, D.C.

Papale, E., M. Gamba, M. Perez-Gil, V. M. Martin, and C. Giacoma. 2015. Dolphins adjust species-specific frequency parameters to compensate for increasing background noise. PLoS One **10**:e0121711.

Parks, S., D. A. Cusano, S. van Parijs, and D. Nowacek. 2019. Acoustic crypsis in communication by North Atlantic right whale mother-calf pairs on the calving grounds. Biology Letters **15**.

Parks, S., K. Groch, P. A. C. Flores, R. S. Sousa-Lima, and I. Urazghildiiev. 2016. Humans, Fish, and Whales: How Right Whales Modify Calling Behavior in Response to Shifting Background Noise Conditions, New York, NY.

Parks, S. E., D. R. Ketten, J. T. O'Malley, and J. Arruda. 2007. Anatomical predictions of hearing in the North Atlantic right whale. The Anatomical Record **290**:734-744.

Parks, S. E., I. Urazghildiiev, and C. W. Clark. 2009. Variability in ambient noise levels and call parameters of North Atlantic right whales in three habitat areas. Journal of the Acoustical Society of America **125**:1230-1239.

Parks, S. E., J. D. Warren, K. Stamieszkin, C. A. Mayo, and D. N. Wiley. 2012. Dangerous dining: surface foraging of North Atlantic right whales increases risk of vessel collisions. Biology Letters **8**:57-60.

Parks, S. E., D. N. Wiley, M. T. Weinrich, and A. Bocconcelli. 2010. Behavioral differences affect passive acoustic detectability of foraging North Atlantic right and humpback whales. Journal of the Acoustical Society of America **128**:2483.

Payne, P. M., and L. A. Selzer. 1989. The distribution, abundance, and selected prey of the harbor seal, Phoca vitulina concolor, in southern New England. Marine Mammal Science **5**:173-192.

Pettis, H., R. M. Pace, III, and P. K. Hamilton. 2021. North Atlantic Right Whale Consortium 2020 Annual Report Card. Report to the North Atlantic Right Whale Consortium. .

Pile-Dynamics. 2010. GRLWEAP.

Popper, A. N., and M. C. Hastings. 2009. The effects of anthropogenic sources of sound on fishes. Journal of Fish Biology **75**:455-489.

Putland, R. L., N. D. Merchant, A. Farcas, and C. A. Radford. 2017. Vessel noise cuts down communication space for vocalizing fish and marine mammals. Global Change Biology **2017**:1-14.

Quick, N., L. Scott-Hayward, D. Sadykova, D. Nowacek, and A. J. Read. 2017. Effects of a scientific echo sounder on the behavior of short-finned pilot whales (Globicephala macrorhynchus). Canadian Journal of Fisheries and Aquatic Sciences **74**:716-726.

Quintana-Rizzo, E., S. M. Leiter, T. V. N. Cole, M. N. Hagbloom, A. R. Knowlton, P. Nagelkirk, O. O'Brien, C. B. Khan, A. Henry, P. A. Duley, L. M. Crowe, C. A. Mayo, and S. Kraus. 2021. Residency, demographics, and movement patterns of North Atlantic right whales *Eubalaena glacialis* in an offshore wind energy development area in southern New England, USA. Endangered Species Research **45**:251-268.

Ramp, C., and R. Sears. 2013. Distribution, densities, and annual occurrence of individual blue whales (Balaenoptera musculus) in the Gulf of St. Lawrence, Canada from 1980-2008.*in* DFO Can. Sci. Advis. Sec., editor.

Rankin, R. W., and J. Barlow. 2005. Source of the North Pacific "boing" sound atributed to minke whales. Journal of the Acoustical Society of America **118**.

Record, N. R., J. A. Runge, D. E. Pendleton, W. M. Balch, K. T. A. Davies, A. J. Pershing, C. L. Johnson, K. Stamieszkin, R. Ji, Z. Feng, S. D. Kraus, R. D. Kenney, C. A. Hudak, C. A. Mayo, C. Chen, J. E. Salisbury, and C. R. S. Thompson. 2019. Rapid climate-driven circulation changes threaten conservation of endangered North Atlantic right whales. Oceanography **32**.

Reeves, R. R. 1992. The Sierra Club handbook of seals and sirenians., Sierra Club Books, San Francisco.

Reeves, R. R., and A. J. Read. 2003. Bottlenose dolphin, harbor porpoise, sperm whale and other toothed cetaceans., John Hopkins University Press, Baltimore, MD.

Reeves, R. R., and H. Whitehead. 1997. Status of the sperm whale, *Physeter macrocephalus*, in Canada. Canadian Field-Naturalist **111**:293-307.

Reichmuth, C., A. Ghoul, and J. M. Sills. 2016. Low-frequency temporary threshold shift not observed in spotted or ringed seals exposed to single air gun impulses. Journal of the Acoustical Society of America **140**:2646-2658.

Reubens, J. T., U. Braeckman, J. Vanaverbeke, C. Van Colen, S. Degraer, and M. Vincx. 2013. Aggregation at windmill artificial reefs: CPUE of Atlantic cod (Gadus morhua) and pouting (Trisopterus luscus) at different habitats in the Belgian part of the North Sea. Fisheries Research **139**.

RI-CRMC. 2010. Rhode Island Ocean Special Area Management Plan. Adopted by the RI CRMC on October 19, 2010.

RI-DEM. 2020. Rhode Island Wildlife Action Plan (RI WAP).

RI.gov. 2021. Rhode Island Endangered Species.

Rice, A. N., K. J. Palmer, J. T. Tielens, C. A. Muirhead, and C. W. Clark. 2014a. Potential Bryde's whale (*Balaenoptera edeni*) calls recorded in the northern Gulf of Mexico. Journal of the Acoustical Society of America **135**:3066-3076.

Rice, A. N., J. T. Tielens, B. J. Estabrook, C. A. Muirhead, A. Rahaman, M. Guerra, and C. W. Clark. 2014b. Variation of ocean acoustic environments along the western North Atlantic coast: a case study in context of the right whale migration route. Ecological Informatics **21**:89-99.

Richardson, D. T., and V. Rough. 1993. A field guide to whales, porpoises, and seals from Cape Cod to Newfoundland. Washington, DC: Smithsonian Institution Press.

Richardson, W. J., C. R. Greene, Jr., C. I. Malme, and D. H. Thomson. 1995. Marine mammals and noise. Academic Press, San Diego, CA.

Richardson, W. J., and C. I. Malme. 1993. Man-made noise and behavioral responses. Society for Marine Mammalogy:631-700.

Richardson, W. J., G. W. Miller, and C. R. Greene, Jr. 1999. Displacement of migrating bowhead whales by sounds from seismic surveys in shallow waters of the Beaufort Sea [abstract]. Journal of the Acoustical Society of America **106**:2281.

Richardson, W. J., B. Wursig, and C. R. J. Green. 1986. Reactions of bowhead whales, *Balaena mysticetus*, to seismic exploration in the Canadian Beaufort Sea. Journal of the Acoustical Society of America **79**:1117-1128.

Risch, D., P. Corkeron, W. T. Ellison, and S. M. Van Parijs. 2014a. Formal comment to Gong et al.: Ecosystem scale acoustic sensing reveals humpback whale behavior synchronous with herring spawning processes and

re-evaluation finds no effect of sonar on humpback song occurrence in the Gulf of Maine in fall 2006. PLoS One **9**:109225.

Risch, D., P. J. Corkeron, W. T. Ellison, and S. M. Van Parijs. 2012. Changes in humpback whale song occurrence in response to an acoustic source 200 km away. PLoS One **7**:e29741.

Risch, D., U. siebert, and S. M. Van Parijs. 2014b. Individual calling behavior and movement of North Atlantic minke whales (*Balaenoptera acutorostrata*). Behaviour **157**.

Roberts, J. J., B. D. Best, L. Mannocci, E. Fujioka, P. N. Halpin, D. L. Palka, L. P. Garrison, K. D. Mullin, T. V. N. Cole, C. B. Khan, W. A. McLellan, D. A. Pabst, and G. G. Lockhart. 2016. Habitat-based cetacean density models for the U.S. Atlantic and Gulf of Mexico. Scientific Reports **6**:22615.

Roberts, J. J., L. Mannocci, and P. N. Halpin. 2017. Final project report: marine species density data gap assessments and update for the AFTT study area, 2016-2017 (opt. year 1). Document version 1.4. Report prepared for Naval Facilities Engineering Command, Atlantic by Duke University Marine Geospatial Ecology Lab, Durham, NC.

Roberts, J. J., L. Mannocci, R. S. Schick, and P. N. Halpin. 2018. Final project report: marine species density data gap assessments and update for the AFTT study area, 2017-2018 (opt. year 2). Document version 1.2 (unpublished report). Report prepared for Naval Facilities Engineering Command, Atlantic by Duke University Marine Geospatial Ecology Lab, Durham, NC.

Roberts, J. J., R. S. Schick, and P. N. Halpin. 2020. Final Project Report: Marine Species Density Data Gap Assessments and Update for the AFTT Study Area, 2018-2020 (Option Year 3). Document version 1.4. Report prepared for Naval facilities Engineering Command, Atlantic by the Duke University Marine Geospatial Ecology Lab. Scientific Reports.

Roberts, J. J., R. S. Schick, and P. N. Halpin. 2021. Final Project Report; Marine Species Density Data Gap Assessments and Update for the AFTT Study Area, 2020 (Option Year 4). Document version 1.0 (DRAFT). Report prepared for Naval Facilities Engineering Command, Atlantic by the Duke University Marine Geospatial Ecology Lab, Durham, NC.

Rolland, R. M., S. E. Parks, K. E. Hunt, M. Castellote, P. J. Corkeron, D. P. Nowacek, S. K. Wasser, and S. D. Kraus. 2012. Evidence that ship noise increases stress in right whales. Proceedings of the Royal Society B **279**:2363-2368.

Rone, B. K., D. S. Pace, and M. Richard. 2012. A simple photograph-based approach for discriminating between free-ranging long-finned (*Globicephala melas*) and short-finned (*G. macrorhynchus*)pilot whales off the east coast of the United States. Marine Mammal Science **28**.

Rosel, P. E., L. Hansen, and A. A. Hohn. 2009. Restricted dispersal in a continuously distributed marine species: common bottlenose dolphins *Tursiops truncatus* in coastal waters of the western North Atlantic. Molecular Ecology **18**:5030-5045.

Ruggerone, G. T., S. Goodman, and R. Milner. 2008. Behavioural Responses and Survival of Juvenile Coho Salmon Exposed to Pile Driving Sounds. Natural Resources Consultants, Inc.

Russell, D. J. F., S. M. J. M. Brasseur, D. Thompson, G. D. Hastie, V. M. Janik, G. Aarts, B. T. McClintock, J. Matthiopoulos, S. E. W. Moss, and B. McConnell. 2014. Marine mammals trace anthropogenic structures at sea. Current Biology **24**:R638-R639.

Russell, D. J. F., G. Hastie, D. Thompson, V. M. Janik, P. Hammond, L. Scott-Hayward, J. Matthiopoulos, E. L. Jones, and B. J. McConnell. 2016. Avoidance of wind farms by harbour seals is limited to pile driving activities. Journal of Applied Ecology **53**:1642-1652.

Rustemeier, J., T. Grießmann, and R. Rolfes. 2012. Underwater sound mitigation of bubble curtains with different bubble size distributions. Acoustical Society of America **17**:070055.

Sadove, S. S., and P. Cardinale. 1993. Species composition and distribution of marine mammals and sea turtles in the New York Bight., Okeanos Ocean Research Foundation for the US Fish and Wildlife Service Southern New England.

Sairanen, E. E. 2014. Baltic Sea underwater soundscape: Weather and ship induced sounds and the effect of shipping on harbor porpoise (Phocoena phocoena) activity. (M.Sc.). University of Helsinki, Finland.

Salomons, E. M., B. Binnerts, K. Betke, and A. M. von Benda-Beckmann. 2021. Noise of underwater explosions in the North Sea. A comparison of experimental data and model predictions. Journal of Acoustical Society of America **149**:1878-1888.

Sarà, G., J. M. Dean, D. Amato, G. Buscaino, A. Oliveri, S. Genovese, S. Ferro, G. Buffa, M. L. Martire, and S. Mazzola. 2007. Effect of boat noise on the behaviour of bluefin tuna Thunnus thynnus in the Mediterranean. Sea Marine Ecology Program.

Schaffeld, T., J. G. Schnitzler, A. Ruser, B. Woelfing, J. Baltzer, and U. Siebert. 2020. Effects of multiple exposures to pile driving noise on harbor porpoise hearing during simulated flights—An evaluation tool. The Journal of the Acoustical Society of America **147**:685-697.

Scheidat, M., J. Tougaard, S. Brasseur, J. Carstensen, T. van Polanen Petel, J. Teilmann, and P. Reijnders. 2011. Harbour porpoises (*Phocoena phocoena*) and wind farms: a case study in the Dutch North Sea. Environmental Research Letters **6**:025102.

Scheifele, P. M., S. Andrew, R. A. Cooper, M. Darre, F. E. Musiek, and L. Max. 2005. Indication of a Lombard vocal response in the St. Lawrence River beluga. Journal of the Acoustical Society of America **117**:1486-1492.

Schmidtke, E., B. Nutzel, and S. Ludwig. 2009. Risk mitigation for sea mammals- the use of air bubbles against shock waves Pages 269-270 NAG/DAGA International Conference on Acoustics 2009, Rotterdam.

Schusterman, R. J., R. F. Balliet, and S. St. John. 1970. Vocal displays under water by the gray seal, the harbor seal, and the stellar sea lion. Psychonomic Science **18**:303-305.

Sciacca, V., S. Viola, S. Pulvirenti, G. Riccobene, F. Caruso, E. De Domenico, and G. Pavan. 2016. Shipping noise and seismic airgun surveys in the Ionian Sea: potential impact on Mediterranean fin whale. Page 10 The Effects of Noise on Aquatic Life. Acoustical Society of America, Dublin, Ireland.

Sears, R., C. L. K. Burton, and G. Vikingson. 2005. Review of blue whale (Balaenoptera musculus) photo-identification distribution data in the North Atlantic, including the first long range match between Iceland and Mauritania.*in* 16th Biennial Conference on the Biology of Marine Mammals 12-16 December 2005, San Diego, CA.

Sears, R., and J. Calambokidis. 2002. COSEWIC Assessment and update status report on the blue whale Balaenoptera musculus, Atlantic population and Pacific population, in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, Ontario.

Sergeant, D. E., A. W. Mansfield, and B. Beck. 1970. Inshore Records of Cetacea for Eastern Canada. Journal of the Fisheries Research Board of Canada **27**:1903-1915.

Sills, J. M., B. L. Southall, and C. Reichmuth. 2017. The influence of temporally varying noise from seismic air guns on the detection of underwater sounds by seals. Journal of the Acoustical Society of America **141**:996-1008.

Simard, Y., N. Roy, S. Giard, and F. Aulanier. 2019. North Atlantic right whale shift to the Gulf of St. Lawrence in 2015, revealed by long-term passive acoustics. Endangered Species Research **40**:271-284.

Skeate, E. R., M. R. Perrow, and J. J. Gilroy. 2012. Likely effects of construction of Scroby Sands offshore wind farm on a mixed population of harbour *Phoca vitulina* and grey *Halichoerus grypus* seals. Marine Pollution Bulletin **64**:872-881.

Slabbekoom, H., N. Bouton, I. V. Opzeeland, A. Coers, C. t. Cate, and A. Popper. 2010. A noisy spring: the impact of globally rising underwater sound levels on fish. Trends in Ecology and Evolution **25**:419-427.

Smultea. 2019. Protected Species Observer Technical Report MAW01 Geotechnical Survey Bay State Wind Massachusetts (2019). Lease Area OCS-A 0500.

Smultea. 2020. Protected Species Observer Technical Report for the Orsted Sunrise Wind Project, BOEM Lease Areas OCS-A 0487/0500, Offshore New York, 2019-2020.

Smultea, M., M. Holst, W. R. Koski, and S. Stoltz Roi. 2004. Marine mammal monitoring during Lamont-Doherty Earth Observatory's seismic program in the southeast Caribbean Sea and adjacent Atlantic Ocean, April–June 2004 TA2822-26).

Snyder, B., and M. J. Kaiser. 2009. Ecological and economic cost-benefit analysis of offshore wind energy. Renewable Energy **34**:1567-1578.

Southall, B., A. E. Bowles, W. T. Ellison, J. Finneran, R. Gentry, C. R. Greene, Jr., D. Kastak, D. Ketten, J. H. Miller, P. E. Nachtigal, W. J. Richardson, J. A. Thomas, and P. Tyack. 2007a. Marine mammal noise exposure criteria: Initial scientific recommendations. Aquatic Mammals **33**.

Southall, B. L., A. E. Bowles, W. T. Ellison, J. J. Finneran, R. L. Gentry, C. R. J. Greene, D. Kastak, D. R. Ketten, J. H. Miller, P. E. Nachtigall, W. J. Richardson, J. A. Thomas, and P. L. Tyack. 2007b. Marine mammal noise exposure criteria: initial scientific recommendations. Aquatic Mammals **33**:411-522.

Southall, B. L., J. J. Finneran, C. Reichmuth, P. E. Nachtigall, D. R. Ketten, A. E. Bowles, W. T. Ellison, D. P. Nowacek, and P. L. Tyack. 2019. Marine mammal noise exposure criteria: updated scientific recommendations for residual hearing effects. Aquatic Mammals **45**:125-232.

Southall, B. L., D. P. Nowacek, P. J. O. Miller, and P. L. Tyack. 2016. Experimental field studies to measure behavioral responses of cetaceans to sonar. Endangered Species Research **31**:293-315.

Southall, B. L., T. Rowles, F. Gulland, R. W. Baird, and P. D. Jepson. 2013. Final report of the Independent Scientific Review Panel investigating potential contributing factors to a 2008 mass stranding of melon-headed whales (*Peponocephala electra*) in Antsohihy, Madagascar.

Spiga, I., N. Aldred, and G. S. Caldwell. 2017. Anthropogenic noise compromises the anti-predator behaviour of the European seabass, Dicentrarchus labrax (L.). Marine Pollution Bulletin **122**:297-305.

Stevens, A., D. Hrehorowicz, H. Bateman, J. Ellis, K. Hamilton, M. Plichta, M. Goulton, P. Batard, and P. Mills. 2021. Sunrise Wind Offshore Wind Farm 2020 and 2021 Geotechnical Survey.

Stevens, A., and P. Mills. 2021. Sunrise Wind Ofshore Wind Farm 2019-2020: Protected Species Observer Technical Summary.

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

Stöber, U., and F. Thomsen. 2019. Effects of impact pile driving noise on marine mammals: A comparison of diferent noise exposure criteria. Acoustical Society of America **145**.

Stone, C. J. 2015. Marine mammal observations during seismic surveys from 1994-2010. JNCC Report No. 463a, Peterborough, UK.

Stone, C. J., and M. L. Tasker. 2006. The effects of seismic airguns on cetaceans in UK waters. Journal of Cetacean Research and Management **8**:255-263.

Sunrise-Wind. 2021. Sunrise Wind Farm Construction & Operation Plan.

Supin, A. Y., V. V. Popov, D. I. Nechaev, E. V. Sysueva, and V. V. Rozhnov. 2016. Is sound exposure level a convenient metric to characterize fatiguing sounds? A study in beluga whales. Pages 1123-1129 *in* A. Popper and A. Hawkins, editors. The effects on noise on aquatic life II. Springer, New York, NY.

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

Tal, D., H. Shachar-Berner, D. Hershkovitz, Y. Arieli, and A. Shupak. 2015. Evidence for the initiation of decompression sickness by exposure to intense underwater sound. Journal of Neurophysiology **114**:1521-1529.

Teilmann, J., and J. Carstensen. 2012. Negative long term effects on harbour porpoises from a large scale offshore wind farm in the Baltic—evidence of slow recovery. Environmental Research Letters **7**:045101.

Teilmann, J., J. Tougaard, and J. Carstensen. 2006. Summary on harbour porpoise monitoring 1999-2006 around Nysted and Horns Rev Offshore Wind Farms. Energi E2 A/S and Vattenfall A/S.

Teilmann, J., J. Tougaard, and J. Carstensen. 2008. Effects from offshore wind farms on harbor porpoises in Denmark. San Sebastian, Spain.

Temte, J. L. 1994. Photoperiod control of birth timing in the harbour seal (Phoca vitulina). Journal of Zoology **233**:369-384.

Tennessen, J. B., and S. E. Parks. 2016. Acoustic propagation modeling indicates vocal compensation in noise improves communication range for North Atlantic right whales. Endangered Species Research **30**:225-237.

Tetra-Tech, and LGL. 2020. Final Comprehensive Report for New York Bight Whale Monitoring Aerial Surveys, March 2017-February 2020. . New York State Department of Environmental Conservation, Division of Marine Resources, East Setauket, NY.

Thode, A. M., K. H. Kim, S. B. Blackwell, C. R. Greene, C. S. Nations, T. L. McDonald, and A. M. Macrander. 2012. Automated detection and localization of bowhead whale sounds in the presence of seismic airgun surveys. Journal of the Acoustical Society of America **131**:3726-3747.

Thompson, P. M., K. L. Brookes, I. M. Graham, T. R. Barton, K. Needham, G. Bradbury, and N. D. Merchant. 2013a. Short-term disturbance by a commercial two-dimensional seismic survey does not lead to long-term displacement of harbour porpoises. Proceedings of the Royal Society B **280**:20132001.

Thompson, P. M., I. M. Graham, B. J. Cheney, T. R. Barton, A. Farcas, and N. D. Merchant. 2020. Balancing risks of injury and disturbance to marine mammals when pile driving at offshore windfarms. British Ecological Society.

Thompson, P. M., G. D. Hastie, J. Nedwell, R. Barham, K. L. Brookes, L. S. Cordes, H. Bailey, and N. McLean. 2013b. Framework for assessing impacts of pile-driving noise from offshore wind farm construction on a harbour seal population. Environmental Impact Assessment Review **43**:73-85.

Thompson, P. M., D. Lusseau, T. R. Barton, D. Simmons, J. Rusin, and H. Bailey. 2010. Assessing the responses of coastal cetaceans to the construction of offshore wind turbines. Marine Pollution Bulletin **60**:1200-1208.

Thompson, P. O., W. C. Cummings, and S. J. Ha. 1986. Sounds, source levels, and associated behavior of humpback whales, southeast Alaska. Journal of the Acoustical Society of America **80**:735-740.

Thomsen, F., K. Ludemann, R. Kafemann, and W. Piper. 2006. Effects of offshore wind farm noise on marine mammals and fish. biola, Hamburg, Germany, on behalf of COWRIE Ltd.

Tidau, S., and M. Briffa. 2016. Review on behavioral impacts of aquatic noise on crustaceans. Proceedings of Meetings on Acoustics **27**.

Tollit, D. J., S. P. R. Greenstreet, and P. M. Thompson. 1997. Prey selection by harbour seals, *Phoca vitulina*, in relation to variations in prey abundance. Canadian Journal of Zoology **75**:1508-1518.

Tougaard, J., J. Carstensen, N. I. Bech, and J. Teilmann. 2006a. Final report on the effect of Nysted Offshore wind farm on harbour porpoises. Energi E2 A/S, Roskilde, Denmark.

Tougaard, J., J. Carstensen, O. D. Henriksen, H. Skov, and J. Teilmann. 2003. Short-term effects of the construction of wind turbines on harbour porpoises at Horns Reef. Hedeselskabet, Roskilde.

Tougaard, J., J. Carstensen, H. Skov, and J. Teilmann. 2005. Behavioral reactions of harbour porpoises to underwater noise from pile drivings. 16th Biennial Conference on the Biology of Marine Mammals, San Diego, CA.

Tougaard, J., J. Carstensen, J. Teilmann, H. Skov, and P. Rasmussen. 2009a. Pile driving zone of responsiveness extends beyond 20 km for harbor porpoises (*Phocoena phocoena* (L.)). Journal of the Acoustical Society of America **126**:11-14.

Tougaard, J., O. D. Henriksen, and L. A. Miller. 2009b. Underwater noise from three types of offshore wind turbines: estimation of impact zones for harbor porpoises and harbor seals. Journal of the Acoustical Society of America **125**:3766-3773.

Tougaard, J., J. Teilmann, and J. Carstensen. 2011. Offshore wind energy and marine mammals – is there a conflict? *.in* 19th Biennal Conference of Biology and Marine Mammals Tampa, Florida.

Tougaard, J., S. Tougaard, R. C. Jensen, T. Jensen, J. Teilmann, D. Adelung, N. Liebsch, and G. Muller. 2006b. Harbour seals on Horns Reef before, during and after construction of Horns Rev Offshore wind farm. Vattenfall A/S, Esbierg, Denmark.

Tougaard, J., A. J. Wright, and P. T. Madsen. 2015. Cetacean noise criteria revisited in the light of proposed exposure limits for harbour porpoises. Marine Pollution Bulletin **90**:196-208.

Tougaard, J., A. J. Wright, and P. T. Madsen. 2016. Noise Exposure Criteria for Harbor Porpoises. The Effects of Noise on Aquatic Life **2**:1167-1173.

Tyack, P., and V. M. Janik. 2013. Effects of Noise on Acoustic Signal Production in Marine Mammals. In H. Brumm (Ed.),. Animal Communication and Noise:251-271.

USFWS. 2019. West Indian manatee (*Trichechus manatus.)*.

Vabø, R. K. Olsen, and I. Huse. 2002. The effect of vessel avoidance of wintering Norwegian spring spawning herring. . Fisheries Research **58**:59-77.

Vallero, D. A. 2019. Thermal Pollution. Pages 381-404 *in* T. M. Lecher and D. A. Vallero, editors. Waste: A Handbook for Management. Academic Press.

Van Parijs, S. M., P. Corkeron, J. T. Harvey, S. A. Hayes, D. K. Mellinger, P. Rouget, P. M. Thompson, M. Wahlberg, and K. M. Kovacs. 2003. Patterns in the vocalizations of male harbor seals. Journal of the Acoustical Society of America **113**:3403-3410.

Varghese, H. K., K. Lowell, J. Miksis-Olds, N. DiMarzio, D. Moretti, and L. Mayer. 2021. Spatial analysis of beaked whale foraging during two 12 kHz multibeam echousnder surveys. Frontiers in Marine Science **8**:654184.

Vellejo, G. C., K. Greiiler, E. J. Nelson, R. M. McGregor, S. Canning, F. M. Caryl, and N. McLean. 2017. Responses of Two Marine Top Predators to an Ofshore Windfarm. Ecology and Evolution **7**:8,698-698,708.

Verfuss, U. K., D. Gillespie, J. Gordon, T. A. Marques, B. Miller, R. Plunkett, J. A. Theriault, D. J. Tollit, D. P. Zitterbart, P. Hubert, and L. Thomas. 2018. Comparing methods suitable for monitoring marine mammals in low visibility conditions during seismic surveys. Marine Pollution Bulletin **126**:1-18.

Vigness-Raposa, K. J., R. D. Kenney, M. L. Gonzalez, and P. V. August. 2010. Spatial patterns of humpback whale (*Megaptera novaeangliae*) sightings and survey effort: Insight into North Atlantic population structure. Marine Mammal Science **26**:161-175.

Villadsgaard, A., M. Wahlberg, and J. Tougaard. 2007. Echolocation signals of wild harbour porpoises, Phocoena phocoena. Journal of Experimental Biology **210**:56-64.

von Benda-Beckmann, A. M., G. Aarts, H. Sertlek, K. Lucke, W. C. Verboom, R. A. Kastelein, D. Ketten, R. van Bemmelen, F. P. A. Lam, R. Kirkwood, and M. A. Ainslie. 2015. Assessing the impact of underwater clearance of unexploded ordnance on harbour porpoises (Phocoena phocoena) in the Southern North Sea. Aquatic Mammals **41**:503.

Wang, Z.-T., P. E. Nachtigall, T. Akamatsu, K.-X. Wang, Y.-P. Wu, J.-C. Liu, G.-Q. Duan, H.-J. Cao, and D. Wang. 2015. Passive acoustic monitoring the diel, lunar, seasonal and tidal patterns in the biosonar activity of the Indo-Pacific humpback dolphins (*Sousa chinensis*) in the Pearl River Estuary, China. PLoS One **10**:e0141807.

Waring, G., E. Josephson, and K. Maze-Foley. 2015. U.S. Atlantic and Gulf of Mexico marine mammal stock assessments- 2014. NOAA Tech. Memorandum NMFS-NE-231, Woods Hole, MA.

Waring, G. T., E. Josephson, K. Maze-Foley, and P. E. Rosel. 2016. US Atlantic and Gulf of Mexico marine mammal stock assessments – 2015. NOAA Tech. Memo. NMFS-NE-238.

Watkins, W. A., J. E. George, M. A. Daher, K. Mullin, D. L. Martin, S. H. Haga, and N. A. DiMarzio. 2000. Whale call data for the North Pacific, November 1995 through July 1999. Occurrence of calling whales and source locations from SOSUS and other acoustic systems. Woods Hole Oceanog. Inst. Tech. Rep. WHOI-00-02.

Weilgart, L. 2014. Are We Mitigating Underwater-Noise Producing Activities Adequately?: A Comparision of Level A and Level B Cetacean Takes.*in* International Whaling Commission (IWC), editor.

Weilgart, L. 2017. The impact of ocean noise pollution on fish and invertebrates. OceanCare, Switzerland.

Weilgart, L. S. 2007. The impacts of anthropogenic ocean noise on cetaceans and implications for management. Canadian Journal of Zoology **85**:1091-1116.

Weir, C. R. 2008. Overt responses of humpback whales (*Megaptera novaeangliae*), sperm whales (*Physeter macrocephalus*), and Atlantic spotted dolphins (*Stenella frontalis*) to seismic exploration off Angola. Aquatic Mammals **34**:71-83.

Wensveen, P. J., A. M. von Benda-Beckmann, M. A. Ainslie, F.-P. A. Lam, P. H. Kvadsheim, P. L. Tyack, and P. J. O. Miller. 2015. How effectively do horizontal and vertical response strategies of long-finned pilot whales reduce sound exposure from naval sonar? Marine Environmental Research **106**:68-81.

Whitehead, H. 2002. Estimates of the current global population size and historical trajectory for sperm whales. Marine Ecology Progress Series **242**:295-304.

Whitehead, H. 2003. Sperm whales: Social evolution in the ocean: The University of Chicago Press.

Whitehead, H. 2009. Sperm whale *Physeter macrocephalus*. Pages 1091-1097 *in* W. F. Perrin, B. Würsig, and J. G. M. Thewissen, editors. Encyclopedia of marine mammals, 2nd ed. Academic Press, San Diego, CA.

Whitt, A. D., K. Dudzinski, and J. R. Laliberté. 2013. North Atlantic right whale distribution and seasonal occurrence in nearshore waters off New Jersey, USA, and implications for management. Endangered Species Research **20**:59-69.

Whyte, k. f., D. J. F. Russell, C. Sparling, B. Binnerts, and G. Hastie. 2020. Estimating the effects of pile driving sounds on seals: pitfalls and possibilities. Journal of Acoustical Society of America **147**:3948-3958.

Wilhelmsson, D., T. Malm, and M. C. Ohman. 2006. The influence of offshore windpower on demersal fish. ICES Journal of Marine Science **63**:775-784.

Wisniewska, D. M., M. Johnson, J. Teilmann, U. Siebert, A. Galatius, R. Dietz, and P. T. Madsen. 2018. High rates of vessel noise disrupt foraging in wild harbour porpoises (*Phocoena phocoena*). Proceedings of the Royal Society B **285**:20172314.

Wittekind, D., J. Tougaard, P. Stilz, M. Dahne, K. Lucke, C. W. Clark, A. M. von Benda-Beckmann, M. A. Ainslie, and U. Siebert. 2016. Development of a model to assess masking potential for marine mammals by the use of airguns in Antarctic waters.*in* A. Popper and A. Hawkins, editors. The effects of noise on aquatic life II. Springer, New York, NY.

Wood, J., B. L. Southall, and D. J. Tollit. 2012. PG&E offshore 3-D seismic survey project EIR - marine mammal technical draft report.

Wright, A. J., T. Deak, and E. C. M. Parsons. 2011. Size matters: management of stress responses and chronic stress in beaked whales and other marine mammals may require larger exclusion zones. Marine Pollution Bulletin **63**:5-9.

Würsig, B., and C. R. Green, Jr. 2002. Underwater sounds near a fuel receiving facility in western Hong Kong: relevance to dolphins. Marine Environmental Research **54**:129-145.

Yelverton, J. T., D. R. Richmond, W. Hicks, K. Saunders, and E. R. Fletcher. 1975. The relationship between fish size and their response to underwater blast. Page 44 *in* D. N. Agency, editor., Washington, DC.

Zoidis, A. M., K. Lomac-MacNair, D. S. Ireland, M. Rickard, K. A. McKown, and M. Schlesinger. 2021. Distribution and density of six large whale species in the New York Bight from monthly aerial surveys 2017 to 2020. Continental Shelf Research **230**.

Appendix A – WTG Monopile and OCS-DC Piled-jacket Foundation Installation Sound Exposure Modeling Report

Appendix B – Underwater Acoustic Modelling of Detonations of Unexploded Ordinance (UXO/MEC)

Appendix C – Protected Species Monitoring and Mitigation Plan