Atlantic Shores Offshore Wind

Atlantic Shores South Project

Biological Assessment

For National Marine Fisheries Service

December 2023

U.S. Department of the Interior
Bureau of Ocean Energy Management
Office of Renewable Energy Programs

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

This page intentionally left blank.

1. INTRODUCTION

The Energy Policy Act of 2005, Public Law No. 109-58, added Section 8(p)(1)(C) to the Outer Continental Shelf Lands Act (OCSLA), which grants the Secretary of the Interior the authority to issue leases, easements, or rights-of-way on the Outer Continental Shelf (OCS) for the purpose of renewable energy development (43 United States Code [U.S.C.] § 1337(p)(1)(C)). The Secretary delegated this authority to the former Minerals Management Service, now the Bureau of Ocean Energy Management (BOEM). On April 22, 2009, BOEM (formerly the Bureau of Ocean Energy Management, Regulation, and Enforcement) promulgated final regulations implementing this authority at 30 Code of Federal Regulations (CFR) § 585.

This biological assessment (BA) has been prepared pursuant to Section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. § 1531 et seq.), to evaluate potential effects of the Proposed Action, described herein, on ESA-listed species and designated critical habitat under the jurisdiction of the National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS) (50 CFR 402.14). In addition to providing a comprehensive description of the Proposed Action, this BA defines the action area, describes species potentially affected by the Proposed Action, and provides an analysis and determination of how the Proposed Action may affect listed species and/or their habitats. The activities being considered include all proposed federal actions associated with the construction, operations, and decommissioning of the proposed Project including approving the Construction and Operations Plan (COP) for the Atlantic Shores South Project on the OCS offshore of New Jersey (the Project). Effects on ESA-listed species under the oversight of the U.S. Fish and Wildlife Service (USFWS) are analyzed under a separate BA document for consultation.

Atlantic Shores Offshore Wind, LLC (Atlantic Shores or the Applicant), has submitted the COP for the Atlantic Shores South Project to BOEM for review and approval. Consistent with the requirements of 30 CFR 585.620 to 585.638, COP submittal occurs after BOEM grants a lease for the Proposed Action and the Applicant completes all studies and surveys defined in their site assessment plan (SAP). BOEM's renewable energy development process is described in Section 1.1.

The Atlantic Shores South Project with up to 200 wind turbine generators (WTGs) would be composed of two wind energy facilities: the 1,510-megawatt (MW) Project 1 with between 105 and 136 WTGs and Project 2 with between 64 and 95 WTGs. Atlantic Shores has a goal of 1,327 MW for Project 2, which would align with the interconnection service agreements and interconnection construction service agreements Atlantic Shores intends to execute for both projects with the regional transmission organization, PJM. All WTGs and associated offshore substations (OSSs) and submarine transmission cable networks connecting the WTGs to the OSS (inter-array cables) and linking the OSSs (interlink cables) would be located in BOEM Renewable Energy Lease Area OCS-A 0499 (Lease Area), located within the New Jersey Wind Energy Area (WEA).

1.1. RENEWABLE ENERGY PROCESS

Under BOEM's renewable energy regulations, the issuance of leases and subsequent approval of wind energy development on the OCS is a phased decision-making process. BOEM's wind energy program occurs in four distinct phases, defined below. Phases 1 through 3 have already been completed for the Project:

1. Planning and Analysis (complete). The first phase of the renewable energy process is to identify suitable areas to be considered for wind energy leases through collaborative, consultative, and analytical processes using the state's task forces; public information meetings; and input from the states, Native American tribes, and other stakeholders.

2. Lease Issuance (complete). The second phase is the issuance of a commercial wind energy lease. The competitive lease process is set forth at 30 CFR 585.210 to 585.225, and the noncompetitive process is set forth at 30 CFR 585.230 to 585.232. A commercial lease gives the lessee the exclusive right to subsequently seek BOEM approval for the development of the leasehold. The lease does not grant the lessee the right to construct any facilities; rather, the lease grants the right to use the leased area to develop its plans, which must be approved by BOEM before the lessee can move on to the next phase of the process (30 CFR 585.600 and 585.601).
3. Approval of a SAP (complete). The third phase of the renewable energy development process is the submission of a SAP, which contains the lessee's detailed proposal for the construction of a meteorological tower and/or the installation of meteorological buoys on the leasehold (30 CFR 585.605 to 585.618). The lessee's SAP must be approved by BOEM before it conducts these "site assessment" activities on the leasehold. BOEM may approve, approve with modification, or disapprove a lessee's SAP (30 CFR 585.613). As a condition of SAP approval, meteorological towers will be required to have visibility sensors to collect data on climatic conditions above and beyond wind speed, direction and other associated metrics generally collected at meteorological towers. These data will assist BOEM and USFWS with evaluating the impacts of future offshore wind facilities on threatened and endangered birds, migratory birds, and bats.
4. Approval of a COP. The fourth and final phase of the process is the submission of a COP; a detailed plan for the construction and operation of a wind energy farm on the lease (30 CFR 585.620 to 585.638). BOEM approval of a COP is a precondition to the construction of any wind energy facility on the OCS (30 CFR 585.628). As with a SAP, BOEM may approve, approve with modification, or disapprove a lessee's COP (30 CFR 585.628).

As part of the first phase, BOEM prepared a BA on the issuance of commercial wind leases and site characterization activities on the Atlantic OCS within the identified WEAs off of Massachusetts, Rhode Island, and New Jersey and the unsolicited proposed development areas off New York in October 2012. On April 10, 2013, NMFS issued a programmatic biological opinion for commercial wind lease issuance and site assessment activities on the Atlantic OCS in Massachusetts, Rhode Island, New York, and New Jersey WEAs (NMFS 2013). The full history of BOEM's planning and leasing activities for the Lease Area offshore of New Jersey is summarized in **Table 1-1**.

As part of the fourth phase, the Applicant has completed site characterization activities and has developed a COP in accordance with BOEM regulations. Atlantic Shores filed their COP with BOEM on March 26, 2021. An updated COP was submitted on September 24, 2021, and a revised COP was submitted on December 17, 2021 and May 3, 2023. BOEM issued an NOI to prepare an Environmental Impact Statement (EIS) under the National Environmental Policy Act (NEPA) on September 30, 2021, to assess the potential impacts of the Proposed Action and Alternatives (86 FR 33351). A draft EIS was published on May 19, 2023.

BOEM is consulting on the proposed approval of the COP for the Project as well as other permits and approvals from other agencies that are associated with the approval of the COP. BOEM is the lead federal agency for purposes of Section 7 consultation; the other action agencies are the Bureau of Safety and Environmental Enforcement (BSEE), the U.S. Army Corps of Engineers (USACE), the U.S. Environmental Protection Agency (EPA), the U.S. Coast Guard (USCG), and the NMFS Office of Protected Resources. BOEM submitted a draft BA on August 2, 2022. NMFS provided comments on the draft BA on October 3, 2022, and BOEM submitted a revised draft BA, addressing comments received from NMFS and other action agencies, on May 19, 2023.

Table 1-1. History of BOEM Planning and Leasing of Commercial Lease Area OCS-A 0499 Offshore of New Jersey

Year	Milestone
2011	On April 20, 2011, BOEM published a Call for Information and Nominations for Commercial Leasing for Wind Power on the OCS Offshore New Jersey in the Federal Register. The public comment period for the call closed on June 6, 2011. In response, BOEM received 11 commercial indications of interest. After analyzing AIS data and holding discussions with stakeholders, BOEM removed OCS Blocks Wilmington NJ18–02 Block 6740 and Block 6790 (A, B, C, D, E, F, G, H, I, J, K, M, N) and Block 6840 (A) to alleviate navigational safety concerns resulting from vessel transits out of the New York Harbor.
2012	On February 3, 2012, BOEM published in the Federal Register a Notice of Availability of a final EA and FONSI for commercial wind lease issuance and site assessment activities on the Atlantic OCS offshore of New Jersey, Delaware, Maryland, and Virginia.
2014	On July 21, 2014, BOEM published a Proposed Sale Notice requesting public comments on the proposal to auction two leases offshore of New Jersey for commercial wind energy development.
2015	On September 25, 2015, BOEM published a Final Sale Notice, which stated that a commercial lease sale would be held on November 9, 2015, for the WEA offshore of New Jersey. The New Jersey WEA was auctioned as two leases. RES America Developments, Inc. was the winner of Lease Area OCS-A 0498, and US Wind, Inc. was the winner of lease OCS-A 0499.
2016	On March 17, 2016, BOEM received a request to extend the preliminary term for commercial Lease Area OCS-A 0499 from March 1, 2017 to March 1, 2018. BOEM approved the request on June 10, 2016.
2018	On January 29, 2018, BOEM received a second request to extend the preliminary term for commercial Lease Area OCS-A 0499 from March 1, 2018 to March 1, 2019. BOEM approved the request on February 14, 2018.
2018	On November 16, 2018, BOEM received an application from U.S. Wind Inc. to assign 100% of commercial Lease Area OCS-A 0499 to EDF Renewables Development, Inc. BOEM approved the assignment on December 4, 2018.
2019	On April 29, 2019, BOEM received an application from EDF Renewables Development, Inc. to assign 100% of commercial Lease Area OCS-A 0499 to Atlantic Shores Offshore Wind, LLC. BOEM approved the assignment on August 13, 2019.
2019	On December 8, 2019, Atlantic Shores submitted a SAP for commercial Lease Area OCS-A 0499, which was subsequently revised on February 4, 2020, March 26, 2020, April 6, 2020, August 21, 2020, September 17, 2020, and November 16, 2020. BOEM approved the SAP on April 8, 2021.
2021	On March 25, 2021, Atlantic Shores submitted its COP for the construction and installation, operations and maintenance, and conceptual decommissioning of the Project within the Lease Area. Updates to the COP, supporting appendices, and GIS data were submitted on August 25, 2021; September 24, 2021; October 20, 2021; December 17, 20, and 22, 2021; January 17, 18, and 31, 2022; March 9, and 28, 2022; April 29, 2022; August 4, 19, and 26, 2022; September 1, 2022; October 13 and 17, 2022; November 14 and 23, 2022; December 12, 21, and 30, 2022; January 10, 18, and 20, 2023; February 2, 6, 10, 13, and 25, 2023; March 7, 10, 14, 16, and 31, 2023; April 6, 13, and 14, 2023; and May 3, 2023.
2021	On September 28, 2021, BOEM received an application from Atlantic Shores Offshore Wind, LLC to assign 100% interest in the southern portion of Lease Area OCS-A 0499 (which contains the Atlantic Shores South Project 1 and 2 areas) to Atlantic Shores Offshore Wind Project 1, LLC and Atlantic Shores Offshore Wind Project 2, LLC, with each entity having a 50% interest.

2021	On September 30, 2021, BOEM published a Notice of Intent to Prepare an Environmental Impact Statement for the Atlantic Shores Offshore Wind South Project offshore New Jersey (86 FR 54231).
2022	On April 19, 2022, the northern portion of Lease Area OCS-A 0499 was retained by Atlantic Shores Offshore Wind, LLC and given a new lease number (OCS-A 0549) by BOEM, while the southern portion retains the original lease number assigned by BOEM: OCS-A 0499

AIS = Automatic Identification System; Atlantic Shores = Atlantic Shores Offshore Wind, LLC; BOEM = Bureau of Ocean Energy Management; COP = Construction and Operations Plan; EA = Environmental Assessment; FONSI = Finding of No Significant Impact; OCS = Outer Continental Shelf; SAP = Site Assessment Plan; WEA = Wind Energy Area

1.1.1 Bureau of Safety and Environmental Enforcement

BSEE's mission is to enforce safety, environmental, and conservation compliance with any associated legal and regulatory requirements during Project construction and future operations. BSEE will be in charge of the review of Facility Design and Fabrication and Installation Reports, oversee inspections and enforcement actions as appropriate, oversee closeout verification efforts, oversee facility removal inspections/monitoring, and oversee bottom clearance confirmation. BSEE, with BOEM, will enforce COP conditions and ESA terms and conditions on the OCS.

1.1.2 U.S. Army Corps of Engineers

USACE regulates discharges of dredged or fill material into waters of the United States and structures or work in navigable waters of the United States, under Section 10 of the Rivers and Harbors Act of 1899 and Section 404 of the Clean Water Act. This work would include the construction of offshore WTGs, scour protection around the base of the WTGs, OSSs, inter-array cables, interlink cables, and offshore export cables. Atlantic Shores has applied for permits from USACE to construct up to 200 offshore WTGs, scour protection around the base of the WTGs, up to 10 OSSs, interarray cables connecting the WTGs to the OSSs, interlink cables connecting the OSSs, and offshore export cables. The export cable routes would originate from the OSSs and would make landfall in Atlantic City and Sea Girt, New Jersey. Atlantic Shores submitted the pre-construction notification/application to USACE on October 14, 2022, and it was deemed complete on November 14, 2022. USACE published a Public Notice for the proposed permit (NAP-2017-01069-84)[1] on May 19, 2023.

Additionally, Atlantic Shores is pursuing a USACE Nationwide Permit 3/Nationwide Permit 13 to install an approximately 356-foot (109-meter) bulkhead composed of steel or composite vinyl sheet piles to support the construction of the proposed O&M facility in Atlantic City, New Jersey, which is considered part of a Connected Action to the Proposed Action. NMFS has completed a programmatic consultation with USACE for Nationwide Permit 13. Activities authorized under the Nationwide Permit would not jeopardize the continued existence of a threatened or endangered species or destroy or adversely modify designated critical habitat. Bulkhead installation would have to comply with the conditions of the Nationwide Permit, on which NMFS consulted, including seasonal work restrictions to protect diadromous fish migrations and spawning activities.

Maintenance dredging at the site of the proposed O&M facility, which would be conducted under the City of Atlantic City's USACE permit (NAP-2021-00573-95), is also considered part of this Connected Action. Under this permit, the City of Atlantic City is authorized to perform 10-year maintenance dredging of 13 city waterways via hydraulic cutterhead or mechanical dredge. NMFS completed informal consultation for the proposed maintenance dredging under the USACE permit on January 27, 2022 and

[1]Available at https://www.nap.usace.army.mil/Portals/39/docs/regulatory/publicnotices/Public%20Notice-2019-01069-84.pdf.

concurred that the proposed dredging complies with all applicable Project Design Criteria and is not likely to adversely affect ESA-listed species under NMFS' jurisdiction.

USACE will enforce ESA terms and conditions landward of the Submerged Lands Act boundary.

1.1.3 U.S. Coast Guard

The USCG administers the permits for Private Aids to Navigation (PATONs) located on structures positioned in or near navigable waters of the United States. PATONs and federal aids to navigation, including radar transponders, lights, sound signals, buoys, and lighthouses, are located throughout the Project area. It is anticipated that USCG approval of additional PATONs during construction of the WTGs and OSSs, and along the offshore export cable corridors will be required. These aids would serve as a visual reference to support safe maritime navigation around Project structures. The USCG will determine the type of aid, lighting, and marking for the proposed marine obstructions or other similar hazards to navigation. The USCG is also responsible for establishing any restricted zones around the offshore facilities and for coordinating traffic during construction of the Project.

Atlantic Shores would prepare the PATONs applications and Local Notice to Mariners for USCG authorization a minimum of 4 months prior to commencement of operations and a minimum of 2 weeks before commencing construction activities, respectively. PATONs for the Project are expected to be limited to marking of the Project structures (i.e., WTGs, OSSs, and met tower). Atlantic Shores anticipates USCG approval in the second quarter of 2024 for Project 1 and Project 2.

All Project vessels would also be required to follow existing state and federal regulations related to ballast and bilge water discharge, including USCG ballast discharge regulations (33 CFR 151.2025).

1.1.4 U.S. Environmental Protection Agency

The OCS Air Regulations, found at 40 CFR 55, establish the applicable air pollution control requirements, including provisions related to permitting, monitoring, reporting, fees, compliance, and enforcement, for facilities subject to Section 328 of the Clean Air Act (42 U.S.C. § 7401 et seq.). The EPA issues OCS Air Permits. Emissions from Project activities on the OCS would be permitted as part of an OCS air permit and must demonstrate compliance with National Ambient Air Quality Standards. Under EPA regulations, the Project's emissions on the OCS must comply with New Jersey air quality requirements given the Project's location within 25 miles (40 kilometers) of New Jersey's seaward boundary. Atlantic Shores submitted an application to EPA for the OCS Air Permit on September 1, 2022. The OCS Air Permit application has not yet been deemed complete. The EPA received additional information from Atlantic Shores on June 30, 2023 and anticipates deeming the permit complete within 30 days of receiving a revised application incorporating the additional information. Once deemed complete, the application will undergo approvability review prior to review for approval. It is anticipated that permit approval would be received one year after the application is deemed complete.

The EPA may also be responsible for issuance of National Pollutant Discharge Elimination System (NPDES) General Permits for construction and operation activities under the Clean Water Act, if authority has not been delegated to a state agency. Atlantic Shores will not be applying for a NPDES permit for industrial discharges, such as non-contact cooling water, as closed-loop OSSs, which do not discharge cooling water, are part of the Proposed Action.

1.1.5 National Marine Fisheries Service

The MMPA of 1972, as amended, and its implementing regulations (50 CFR 216) allow, upon request, the incidental take of small numbers of marine mammals by U.S. citizens who engage in a specified activity (other than commercial fishing) within a specified geographic region. Incidental take is defined under the MMPA as, "harass, hunt, capture, collect, or kill, or attempt to harass, hunt, capture, collect, or kill any marine mammal. This includes, without limitation, any of the following: The collection of dead animals, or parts thereof; the restraint or detention of a marine mammal, no matter how temporary; tagging a marine mammal; the negligent or intentional operation of an aircraft or vessel, or the doing of any other negligent or intentional act which results in disturbing or molesting a marine mammal; and feeding or attempting to feed a marine mammal in the wild" (50 CFR 216.3).

NMFS received a request for authorization to take marine mammals incidental to construction activities related to the Project, which NMFS may authorize under the MMPA. NMFS's issuance of an MMPA incidental take authorization is a major federal action and, in relation to BOEM's action, is considered a Connected Action (40 CFR 1501.9I(1)). The purpose of the NMFS action—which is a direct outcome of Atlantic Shores' request for authorization to take marine mammals incidental to specified activities associated with the Project (e.g., pile driving)—is to evaluate Atlantic Shores' request under requirements of the MMPA (16 USC 1371(a)(5)(D)) and its implementing regulations administered by NMFS and to decide whether to issue the authorization.

On February 28, 2022, Atlantic Shores submitted a request for a rulemaking and Letter of Authorization (LOA) pursuant to Section 101(a)(5) of the MMPA and 50 CFR § 216 Subpart I to allow for the incidental harassment of marine mammals, including ESA-listed fin whale (*Balaenoptera physalus*), North Atlantic right whale (NARW, *Eubalaena glacialis*), sei whale (*B. borealis*), and sperm whale (*Physeter macrocephalus*), resulting from the installation of WTGs, OSSs, and a met tower; performance of high-resolution geophysical (HRG) surveys; and installation and removal of cofferdams at locations of offshore to onshore transition for the export cable routes. In response to comments from NMFS, Atlantic Shores submitted a revised request on August 12, 2022 (Atlantic Shores 2022). Atlantic Shores is including activities in the LOA request that could cause acoustic disturbance to marine mammals during construction of the Project pursuant to 50 CFR § 216.104. The application was reviewed and considered complete on August 25, 2022. NMFS published a Notice of Receipt in the Federal Register on September 29, 2022. Atlantic Shores submitted an update to its application on March 31, 2023 (Atlantic Shores 2023b). Publication of the Proposed Incidental Take Authorization is planned for August 2023.

1.2. ACTION AREA

The action area is defined by 50 CFR 402.02 as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action." The action area for this consultation includes the Project area (i.e., wind farm footprints within the Lease Area; the offshore export cable routes; and the areas where geophysical and geotechnical [G&G] surveys and fisheries and benthic resource monitoring surveys will occur) (**Figure 1-1**) the areas surrounding the Project area that would be ensonified by noise generated by the construction and operations of the proposed Project; and vessel transit routes between the Project area and ports utilized by the Project. Though the majority of vessel trips associated with the Project are expected to originate from regional ports, transport of some Project components and/or Project vessels may originate from ports in the Gulf of Mexico. Though the Port of Corpus Christi has been identified as a potential port that the Project may utilize, final port selection for the Project has not yet been completed; therefore, potential (but not definite) routes to and from the Gulf of Mexico are included in the action area for the purposes of this BA. The selection of final ports is not expected to increase the number of anticipated vessel trips but may affect the origin and destination locations and transit distances. This action area (i.e., the Project area, ensonified area, and vessel transit routes) encompasses all effects of the Proposed Action considered here.

As identified above, the Project area includes the wind farm footprints within the Lease Area, where the majority of construction and survey activities would occur. The Project area also includes the export cable routes from the OSSs to shore. The wind farm footprints within the Lease Area, including WTG and OSS foundations, inter-array cables, and interlink cables would encompass approximately 102,124 acres (413.3 square kilometers) of the Lease Area. The 342 miles (550 kilometers) of export cables, with cable protection (where necessary), are expected to occupy an additional 12 acres (0.05 square kilometers), resulting in a total area of approximately 102,136 acres (413.3 square kilometers) for the Project area. The Project area includes coastal nearshore habitats off New Jersey, adjacent New Jersey state waters, and ocean habitats in the WEA.

Though activities associated with the Proposed Action would mostly occur in the Project area, Project vessels would travel between the Project area and five potential ports, including: the Paulsboro Marine Terminal, Repauno Port & Rail Terminal, and New Jersey Wind Port in New Jersey, Portsmouth Marine Terminal in Virginia, and Port of Corpus Christi in Texas.[2] The action area includes vessel routes between these ports and the Project area.

Additionally, the action area includes the area ensonified by underwater noise associated with the Proposed Action. Based on acoustic modeling conducted for the Atlantic Shores South Project, biologically significant sound levels (i.e., sound levels exceeding regulatory and recommended acoustic thresholds) could extend as far as 8.07 miles (12.99 kilometers) from the pile being driven. The extent of underwater noise impacts associated with impact pile driving would occur beyond the area affected by other activities within the wind farm footprint (e.g., electromagnetic field [EMF], water quality, or benthic impacts associated with installation and operation of inter-array and interlink cables).

1.3. DESCRIPTION OF THE PROPOSED ACTION

The Proposed Action addressed in this BA is defined as the construction, operation and maintenance (O&M), and decommissioning of the Atlantic Shores South Project, which consists of two wind energy facilities referred to as Project 1 and Project 2. Project 1 will be developed under a 1,510 MW Offshore Renewable Energy Credit (OREC) awarded to Atlantic Shores by the New Jersey Board of Public Utilities (NJBPU) on June 30, 2021. Project 2 will be developed to support future OREC solicitations issued by NJBPU. The Project would be sited 8.7 miles (14 kilometers) from the New Jersey shoreline at its closest point in the Lease Area (OCS-A 0499). The Project includes a maximum of 200 WTGs (105 to 136 for Project 1, 64 to 95 for Project 2), 10 OSSs (five each for Project 1 and Project 2), 1 met tower (located within Project 1), four temporary meteorological and oceanographic (metocean) buoys (three for Project 1 and one for Project 2), 584 miles (940 kilometers) of inter-array cables, 37 miles (60 kilometers) of interlink cables, and 342 miles (550 kilometers) of export cables. Export cable landfalls include the Monmouth landfall in Sea Girt, New Jersey and the Atlantic landfall in Atlantic City, New Jersey. Final cable route alignments will be optimized using data from pre-construction geotechnical and geophysical (G&G) surveys and studies. The Project also includes construction of an O&M facility in Atlantic City, New Jersey. Project construction is expected to begin with onshore interconnection cable installation in the first quarter of 2024 and is expected to finish in the first quarter of 2027 when WTG installation and commissioning for Project 2 would be completed. Once construction is completed, a geophysical survey would be conducted to ensure proper installation of Project components, and regular surveys would be conducted during the O&M phase to identify Project components requiring maintenance.

[2] NMFS has previously completed consultation for work proposed at the Paulsboro Marine Terminal (https://repository.library.noaa.gov/view/noaa/44532), Repauno Port & Rail Terminal (https://repository.library.noaa.gov/view/noaa/22741), and New Jersey Wind Port (https://repository.library.noaa.gov/view/noaa/37549) to support utilization of these ports by offshore wind projects.

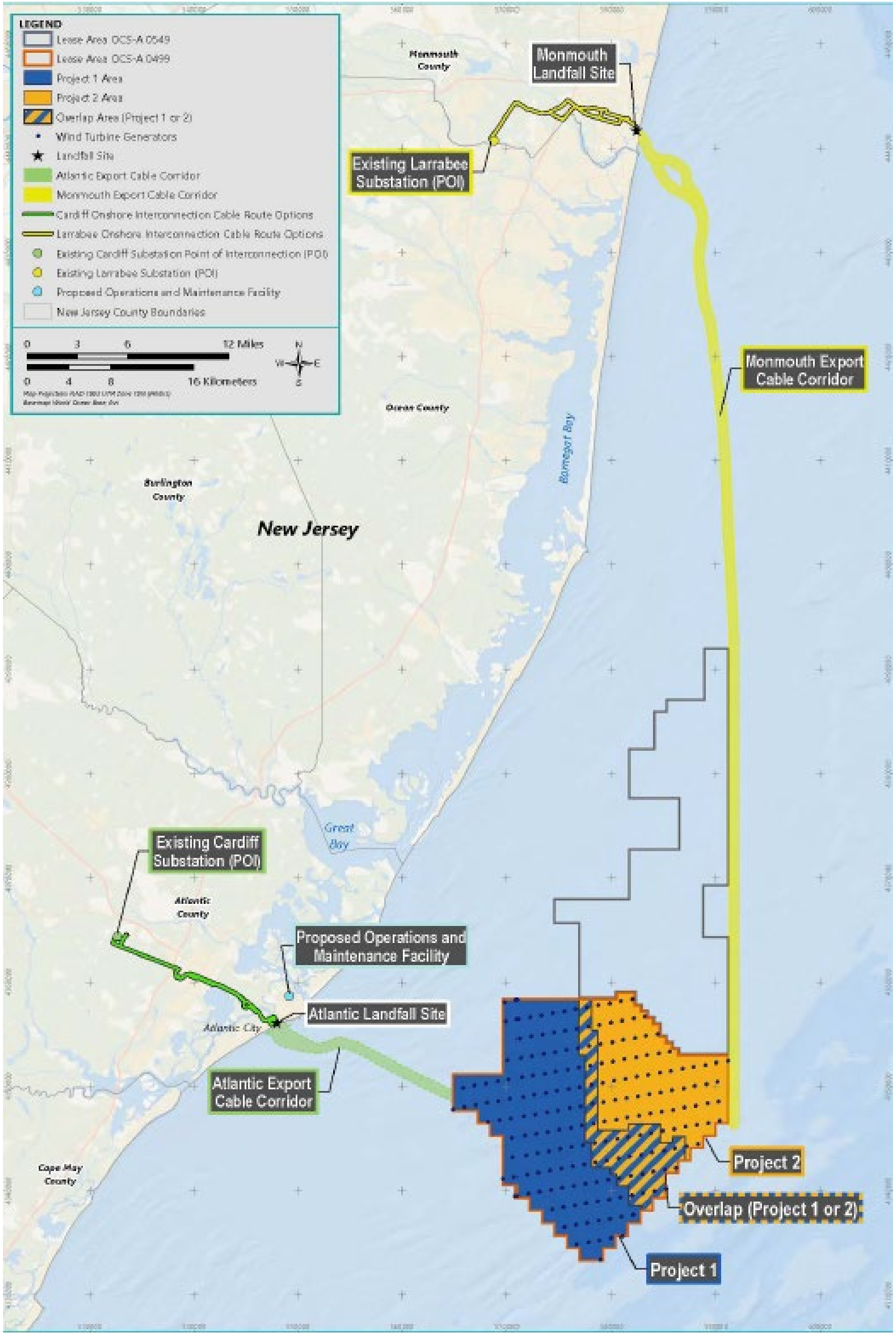

Figure 1-1. Project Area for the Proposed Action

Before a lessee may build an offshore wind energy facility on their commercial wind lease, they must submit a COP for review and approval by BOEM (see 30 CFR 585.620(C)). Pursuant to 30 CFR 585.626, the COP must include a description of all planned facilities, including onshore and support facilities, as well as anticipated easement needs for the Proposed Action. It must also describe all activities related to Proposed Action construction, commercial operations, maintenance, decommissioning, and site clearance procedures. There are benefits to allowing lessees to describe a reasonable range of designs in a COP, because of the complexity, the unpredictability of the environment in which it will be constructed, and the rapid pace of technological development within the industry. In the renewable energy industry, a permit application or plan that describes a reasonable range of designs is referred to as a Project Design Envelope (PDE) approach.

BOEM gives offshore renewable energy lessees the option to use a PDE approach when submitting a COP (U.S. Department of Energy and U.S. Department of the Interior 2016: Action 2.1.3). A PDE approach is a permitting approach that allows a proponent the option to submit a reasonable range of design parameters within its permit application, allows a permitting agency to then analyze the maximum impacts that could occur from the range of design parameters, and may result in the approval of a Proposed Action that is constructed within that range. As the PDE relates to NEPA, the PDE covers the range of alternatives being considered in the EIS in preparation for this Proposed Action.

The Applicant has elected to use a PDE approach for describing the Proposed Action consistent with BOEM policy. Therefore, this BA and associated outcomes of the ESA consultation are anticipated to cover the final action, which will be drawn from the menu of potential alternatives within the identified PDE, that may be authorized by BOEM through the approval of the COP and by the other action agencies through their associated issuance of relevant permits and/or authorizations.

For the purpose of this ESA consultation, the Proposed Action includes two scenarios based on the PDE for WTG foundations. Under ***Scenario 1***, Atlantic Shores would use monopiles for all WTG foundations installed for Projects 1 and 2. Under ***Scenario 2***, Atlantic Shores would use monopiles for all WTG foundations in Project 1 and piled jackets for all WTG foundations in Project 2. Both scenarios are evaluated in the effects analysis presented in Section 3. Under each scenario, multiple foundation types are under consideration for the OSSs and the met tower (**Table 1-2**). For the purpose of the effects analysis, BOEM has evaluated the design alternative for these structures resulting in the greatest potential impact to the environment for each stressor assessed. **Table 1-3** lists the PDE parameters for the Proposed Action. Activities considered in this BA include offshore and upland activities during the construction, O&M, and decommissioning phases of the Project. Construction and installation activities are described in Section 1.3.1, O&M activities are described in Section 1.3.2, and decommissioning activities are described in Section 1.3.3. Monitoring surveys evaluated as part of the Proposed Action are described in Section 1.3.4. Mitigation measures included in the Proposed Action are described in Section 1.3.5.

To support construction of the proposed O&M facility in Atlantic City, bulkhead repair and/or replacement, and maintenance dredging will be required within Atlantic City's Inlet Marina area. Repair or replacement of the bulkhead and maintenance dredging in coordination with Atlantic City's dredging of the adjacent basins would be conducted regardless of the construction and installation of the Project. However, the bulkhead and dredging are necessary for the use of the O&M facility included in the Proposed Action. Therefore, the bulkhead repair/replacement and dredging activities are considered to be a Connected Action under NEPA. The bulkhead site and dredging activities would be conducted entirely within an approximately 20.61-acre (0.08-square kilometer) site.

Table 1-2. Foundations for Scenario 1 and Scenario 2 under the Proposed Action

Structure	Project 1		Project 2	
	Number	Foundation Type	Number	Foundation Type
SCENARIO 1				
WTG	105 to 136	Monopile	64 to 95	Monopile
OSS	2 to 5 (2 large, 2 medium or 5 small)	Small OSS: Monopile, piled jacket, or suction bucket jacket	2 to 5 (2 large, 3 medium or 5 small)	Small OSS: Monopile, piled jacket, or suction bucket jacket
		Medium or large OSS: Piled jacket, suction bucket jacket, or gravity-based structure		Medium or large OSS: Piled jacket, suction bucket jacket, or gravity-based structure
Met tower	1	Monopile, piled jacket, suction bucket jacket, mono-bucket, or gravity-based structure	0	--
SCENARIO 2				
WTG	105 to 136	Monopile	64 to 95	Piled Jacket
OSS	2 to 5 (2 large, 2 medium or 5 small)	Small OSS: Monopile, piled jacket, or suction bucket jacket	2 to 5 (2 large, 3 medium or 5 small)	Small OSS: Monopile, piled jacket, or suction bucket jacket
		Medium or large OSS: Piled jacket, suction bucket jacket, or gravity-based structure		Medium or large OSS: Piled jacket, suction bucket jacket, or gravity-based structure
Met tower	1	Monopile, piled jacket, suction bucket jacket, mono-bucket, or gravity-based structure	0	--

The existing bulkhead at the site of the proposed O&M facility is approximately 250 feet (76 meters) long and composed of multiple sections that are made from steel sheet piles, timbers, and concrete. The existing bulkhead is missing sections, making it unstable and increasing the potential for erosion. Repair and/or replacement of the existing bulkhead is required in order to stabilize the shoreline and prevent additional erosion and would be necessary regardless of whether the Proposed Action is implemented. To repair/replace the existing bulkhead, Atlantic Shores plans to install an approximately 356-foot (109-meter) bulkhead composed of steel or composite vinyl sheet piles. The new bulkhead will be sited externally of the existing bulkhead, as the existing bulkhead will remain in place, unless removal of specific sections is required to safely install the new bulkhead. It is anticipated that the new bulkhead will be supported by anchor piles. As noted in Section 1.1.2, Atlantic Shores intends to pursue a USACE Nationwide Permit 3/Nationwide Permit 13 for this portion of the Connected Action. As described in Section 1.1.2, NMFS has completed a programmatic consultation for USACE's Nationwide Permit 13, and bulkhead repair and/or replacement for the Connected Action would comply with the conditions of the Nationwide Permit, on which NMFS consulted.

Maintenance dredging in Atlantic City's Inlet Marina for the Connected Action would serve to maintain safe navigational depths for transiting vessels by re-establishing water depths consistent with those historically maintained in collaboration with dredging activities of adjacent harbors and waterways and would be implemented independently from the Proposed Action. Maintenance dredging for the Connected Action would include dredging 122,710 cubic yards (93,818 cubic meters) of shoaled sediments from a 17.75-acre (0.07-square kilometer) section of Clam Creek and dredging 20,113 cubic yards (15,377 cubic meters) of shoaled sediments from the 2.86-acre (0.01-square kilometer) footprint of Farley's Marina Fuel to reestablish a water depth of 15 feet (4.6 meters) below Mean Low Water plus 1.0 foot (0.3 meter) of allowable overdredge. Dredging would be accomplished primarily via hydraulic cutterhead dredge. A mechanical dredge would be utilized to access small areas within the marina, canal, or lagoon areas. All dredged material from the site would be removed and disposed of at Dredged Hole #86, a subaqueous borrow pit restoration site in Beach Thorofare in Atlantic City, contingent upon execution of a use agreement between Atlantic City and the New Jersey Department of Transportation Office of Maritime Resources, which owns and operates Dredged Hole #86. As noted in Section 1.1.2, maintenance dredging would be conducted by Atlantic City under USACE permit CENAP-OPR-2021-00573-95, which underwent informal consultation with NMFS and authorizes 10-year maintenance dredging of 13 city waterways, inclusive of Clam Creek and Farley's Marina Fuel. Each maintenance dredging event included within the permit anticipates a duration of approximately 12 weeks, including mobilization and demobilization, dredging, and material placement activities. Maintenance dredging would comply with the Project Design Criteria identified in the permit.

Table 1-3. PDE Parameters for the Proposed Action

PDE Element	Parameter	Maximum Impact
Turbine selection/spacing		
	Number of turbines	200
	Blade tip height above MLLW	1,048.8 ft (319.7 m)
	Spacing	0.6 nm (1.1 km)
	Array area	102,124 ac (413.3 km^2)
Monopile foundation installation	Number of monopiles[1]	211
	Monopile diameter	49.2 ft (15 m)
	Footprint area total (with scour protection)	274 ac (1.1 km^2)
	Installation method	4,400 kJ impact hammer
		15,387 hammer strikes/pile
		9 hours per pile
		211 days of pile driving
Piled jacket foundation installation	Number of pin piles	480
	Pile diameter	16.4 ft (5 m)
	Footprint area total (with scour protection)	79 ac (0.3 km^2)
	Installation method	2,500 kJ impact hammer
		6,750 hammer strikes/pile
		4 hours per pile
		113 days of pile driving
Suction bucket foundation installation	Diameter at seabed	49.2 ft (15 m)
	Footprint area total (with scour protection)	26 ac (0.1 km^2)
Gravity foundation installation	Diameter at seabed	393.7 ft (120 m)
	Footprint area total (with scour protection)	22 ac (0.1 km^2)
Inter-array cable construction	Total length	584 mi (990 km)
	Burial depth	5 to 6.6 ft (1.5 to 2.0 m) target
	Cable protection	307 ac (1.2 km^2)

PDE Element	Parameter	Maximum Impact
	Disturbance area	2,035 ac (8.2 km^2)
Interlink cable construction	Total length	37 mi (60 km)
	Burial depth	5 to 6.6 ft (1.5 to 2.0 m) target
	Cable protection	21 ac (0.08 km^2)
	Disturbance area	179 ac (0.7 km^2)
Export cable construction	Total length	342 mi (550 km)
	Burial depth	5 to 6.6 ft (1.5 to 2.0 m) target
	Cable protection	12 ac (0.05 km^2)
	Disturbance area	1,606 ac (6.5 km^2)
Construction vessels	Number of vessels	51
	Anchoring disturbance	262 ac (1.1 km^2)
	Number of annual round trips	1,745
Operation	Rotor swept area (per turbine/total)	663,317 ft^2 (61,624 m^2) / 132,663,332 ft^2 (12,324,827 m^2)
	WTG oil and grease	606,200 gal (2,294,717 L)
	WTG coolant	820,000 gal (3,104,038 L)
	WTG fuel	80,000 gal (302,833 L)
	OSS oil and grease	370,050 gal (2,801,436 L)
	OSS coolant	10,300 gal (38,990 L)
	OSS fuel	75,000 gal (283,906 L)
	Transmission voltage	Export cable: 275 kV (HVAC), 525 kV (HVDC)
		Interlink cable: 275 kV
		Inter-array cable: 150 kV
	Magnetic field	Peak export: 108 mG
		Peak interarray: 60 mG
	Induced electric field[2]	Peak export: 0.0 mV/m
		Peak interarray: 0.0 mV/m
	Number of annual round trips by O&M vessels	1,861
Decommissioning vessels[3]	Number of vessels	51
	Number of annual round trips	1,745

ac = acre; ft = foot; gal = gallon; HVAC = high voltage alternating current; HVDC = high voltage direct current; kJ = kilojoule; km = kilometer; km^2 = square kilometer; kV = kilovolt; L = liter; m = meter; mG = milligauss; mi = mile; MLLW = mean lower low water; mV/m = millivolt per meter; MW = megawatt; nm = nautical mile

[1] Number of monopiles includes up to 200 WTGs, 10 small OSSs, and 1 met tower

[2] As the electric field from the shielded power cables is blocked by the grounded cable armoring, shielded cables will not be a direct source of any electric field outside the cables.

[3] Decommissioning vessel numbers and trip information are assumed to be the same as construction vessel numbers and trip information.

1.3.1 Construction and Installation

The construction of the Atlantic Shores South Project would result in impacts on aquatic species in the nearshore and offshore waters of the mid-Atlantic OCS associated with offshore activities and in the nearshore waters of New Jersey associated with upland activities for the proposed O&M Facility, proposed to be situated in Atlantic City, NJ inside of Absecon Inlet. Offshore activities for the construction of the Project would include installation of WTGs, OSSs, and a met tower, including their foundations, and installation of inter-array, interlink, and export cables. Upland activities for the construction of the Project would include installation of onshore cables. As noted in Section 1.3, Atlantic Shores has elected to use a PDE approach. PDE parameters for the Atlantic Shores South Project are summarized in **Table 1-3**. The general construction schedule is provided in **Table 1-4**. This schedule is approximated based on several assumptions, including the estimated timeframe in which permits are received, anticipated regulatory seasonal restrictions, environmental conditions, planning, and logistics.

Construction and installation activities for the Proposed Action may be based out of more than one port, and Atlantic Shores has narrowed the list of potential construction ports and staging areas but has not yet finalized these selections. The final port selection for staging and construction will be determined based upon the status of port upgrades to support offshore wind and final construction logistics planning.

Table 1-4. Anticipated Construction Schedule for the Proposed Action

Activity	Expected Duration[1]	Expected Time Frame[2]	Anticipated Start Date	
			Project 1	Project 2
Onshore interconnection cable installation	9-12 months	2024 – 2025	Q1 2024	Q1 2024
Onshore substation and/or converter station construction	18-24 months	2024 – 2026	Q1 2025	Q1 2025
HRG survey activities	12 months	2025 – 2029	Q2 2025	Q2 2025
Export cable installation	6-9 months	2025	Q2 2025	Q3 2025
Cofferdam installation and removal	3 months	2025 – 2026	Q1 2025	Q1 2025
OSS installation and commissioning	5-7 months	2025 – 2026	Q2 2026	Q2 2026
WTG foundation installation	10 months	2026 – 2027	Q1 2026	Q1 2026[3]
Inter-array cable installation	14 months	2026 – 2027	Q2 2026	Q3 2026[4]
WTG installation and commissioning	17 months	2026 – 2027	Q2 2026	Q1 2027[4]

Source: Atlantic Shores 2023a
[1] These durations assume continuous foundation installation without consideration for seasonal pauses or weather delays; anticipated seasonal pauses are reflected in the expected timeframe.
[2] The expected timeframe is indicative of the most probable duration for each activity; the timeframe could shift and/or extend depending on the start of fabrication, and the selected fabrication and installation methods.
[3] The expected timeframe depends on the foundation type. If piled foundations are utilized, pile-driving will follow a proposed schedule from May to December to minimize risk to North Atlantic Right Whale. No simultaneous pile driving is proposed.
[4] The expected timeframe is dependent on the completion of the preceding Project 1 activities (i.e., Project 1 inter-array cable installation and WTG installation) and the Project 2 foundation installation schedule.

Installation of WTGs, OSSs, and Met Tower. The Project would utilize WTGs specially designed for offshore use. The Proposed Action includes installation and operation of up to 200 WTGs, 105 to 136 WTGs for Project 1 and 64 to 95 WTGs for Project 2. The final number of WTG positions required to meet the generation needs for Project 1 and Project 2 will be determined once the WTG supplier for each of the Projects has been selected. Each WTG would extend up to 1,048.8 feet (319.7 meters) above mean lower low water. Minimum spacing between the WTGs would be 0.6 nautical miles (1.1 kilometers) north to south and 1 nautical mile (1.9 kilometers) east-northeast to west-southwest (**Figure 1-2**).

The WTGs would consist of three components: a three-bladed rotor nacelle assembly, the tower, and the foundation. The rotor would drive a variable speed electric generator. The maximum rotor diameter for the Project would be 918.6 feet (280 meters). Integrated sensors on the WTG would detect the wind direction, and the WTG would automatically turn into the wind with a yaw system, housed in the nacelle, along with the drivetrain, electric generator, control system, and power electronics. The rotor nacelle assembly would be located at the top of the tower, a steel tubular structure that supports the assembly and provides the height required to efficiently capture wind energy. The tower may house the power converter and transformer, though these pieces of equipment may also be housed within the nacelle. The tower may also contain the switchgear and inter-array cable terminations, though these pieces of equipment may also be located within the top of the foundation, which would be connected to the tower. Each WTG would contain oils, greases, and fuels used for lubrication, cooling, and hydraulic transmission. Maximum anticipated volumes are provided in **Table 1-3**. At the end of their operational life, these fluids would be disposed of according to applicable regulations and guidelines. Each WTG would also include a Supervisory Control and Data Acquisition (SCADA) system, to allow for remote control and monitoring. Additionally, WTGs would include marking and lighting in accordance with USCG, Federal Aviation Administration (FAA), and BOEM guidelines and regulations. Atlantic Shores would utilize an Aircraft Detection Lighting System (ADLS), subject to FAA and BOEM approval, to minimize light emissions when aircraft are not in the area.

Foundations refer to the steel structures that support both the WTGs and OSSs. The Proposed Action includes several potential foundation types: piled foundations (WTGs, OSSs, and met tower), suction bucket foundations (OSSs and met tower only), and gravity foundations (OSSs and met tower only).

Piled foundations (i.e., monopiles and piled jackets) would be driven into the seabed. For both scenarios under the Proposed Action, piled foundations (either monopile or piled jacket) would be used for all WTGs. Monopiles consist of a single vertical, hollow steel pile which may be connected to a transition piece that attaches the WTG tower to the monopile above the water line or may directly interface with the WTG tower. Monopiles may also be used for small OSS foundations and the met tower. The maximum monopile diameter for the Project would be 49.2 feet (15 meters). Piled jacket foundations are vertical steel lattice structures with three or four legs connected by cross bracing. Each leg is secured to the seabed using piles. For the Proposed Action, each WTG piled jacket foundation, small OSS piled jacket foundation, or met tower foundation is expected to have up to four legs with one 16.4-foot (5-meter) diameter pile per leg. Each medium OSS piled jacket foundation is expected to have up to six legs with up to two 16.4-foot (5-meter) diameter piles per leg. Each large OSS piled jacket foundation is expected to have up to eight legs with up to three 16.4-foot (5-meter) diameter pin piles per leg, totaling 24 pin piles per foundation. For Scenario 1, 200 to 211 monopile foundations (maximum of 200 WTGs, 10 small OSSs, 1 met tower) would be installed (**Table 1-2**). For Scenario 2, 136 to 147 monopile foundations (maximum of 136 WTGs, 10 small OSSs, and 1 met tower) and 95 to 106 jacket foundations (95 WTGs, 10 small OSSs, and 1 met tower) with a maximum of 480 pin piles (96 WTG and met tower foundation with 4 pin piles each and 4 large OSS foundations with 24 pin piles each) would be installed (**Table 1-2**).

As an alternative to piled foundations for the OSSs and met tower, suction bucket foundations (i.e., mono-buckets and suction bucket jackets) may be installed. Mono-buckets consist of a single suction bucket supporting a single tubular structure upon which the structure (e.g., met tower) is mounted, potentially using a transition piece. The suction bucket is generally a hollow steel cylinder capped at one end with the open end facing down into the seabed. A mono-bucket may be used for the met tower foundation. The maximum diameter at the seabed for a mono-bucket jacket would be 115 feet (35 meters). For both Scenario 1 and Scenario 2, up to 1 mono-bucket may be installed for the met tower (**Table 1-2**). Under Scenario 1, this mono-bucket foundation would replace one of the monopile foundations. Under Scenario 2, this mono-bucket foundation would replace either one of the monopile foundations or one of the jacket foundations. Suction bucket jackets consist of vertical steel lattice structures that are fixed to the seabed by suction buckets attached to each leg of the foundation. For the Proposed Action, each small OSS or met tower suction bucket jacket foundation is expected to have up to four legs, each medium OSS suction bucket jacket foundation is expected to have up to six legs, and each large OSS suction bucket jacket foundation is expected to have up to eight legs. Project 1 would have five small OSSs, two medium OSSs, or two large OSSs. Project 2 would have five small OSSs, three medium OSSs, or two large OSSs. The maximum diameter at the seabed for each suction bucket jacket leg would be 49 feet (15 meters). For both Scenario 1 and Scenario 2, up to 11 suction buckets, with a maximum of

44 legs, may be installed for OSSs and/or the met tower (**Table 1-2**). These suction bucket foundations would replace an equivalent number of monopile foundations under Scenario 1 or an equivalent number of monopile or jacket foundations under Scenario 2.

As another alternative to piled foundations for the OSSs and met tower, gravity foundations (i.e., gravity-base structures) may be installed. Gravity-based structures are heavy structures composed of steel or steel-reinforced concrete. The base sits on the seabed and may be filled with ballast material, such as seawater. A column connected to the base and extending vertically towards the sea surface supports the tower structure above it. A transition piece may be used to connect the tower to the base. This foundation type may be used for medium or large OSSs and/or the met tower. For the met tower, the maximum diameter at the seabed would be 181 feet (55 meters). For a medium OSS, the maximum size at the seabed would be 263 by 66 feet (80 by 20 meters). For a large OSS, the maximum size at the seabed would be 394 by 98 feet (120 by 30 meters). The bases would penetrate 10 feet (3 meters) below the seabed. For both Scenario 1 and Scenario 2, up to 6 gravity-based structures may be installed for OSSs and/or the met tower (**Table 1-2**). These gravity foundations would replace an equivalent number of monopile foundations under Scenario 1 or an equivalent number of monopile or jacket foundations under Scenario 2.

All foundation installations may require seabed preparation, particularly gravity foundations, to ensure that the seabed is level, that full contact can be made between the base and the seabed, that the structure stands vertically, or that foundation weight is uniformly distributed. Generally, foundations will be positioned or sized to avoid or minimize the need for seabed preparation, where possible. Seabed preparation may utilize the following techniques or equipment: trailing suction hopper dredge, jetting/controlled flow excavation, or a backhoe/dipper. Seabed preparation for installation of gravity foundations may take three to four days per foundation. Seabed preparation is not generally anticipated for piled or suction bucket foundations but may be required where the seabed is not sufficiently level. The maximum extent of seabed preparation, which assumes that all foundations require seabed preparation, is provided in **Tables 1-5 and 1-6**.

For gravity foundations, a gravel pad may be installed following seabed preparation and prior to foundation installation. Gravel pads are composed of at least one layer of coarse-grained material and may include a lower filter layer of finer material and an upper armor layer of coarser material. Gravel pad installation typically consists of the following steps: lowering of steel frame to set the boundaries for the pad; leveling the surface within the frame; filling the frame with coarse-grained material; leveling the pad; and compacting the pad, possibly injecting the pad with grout.

Table 1-5. Maximum Extent (Acres) of Seabed Preparation under Scenario 1 or Scenario 2 of the Proposed Action

Structure	Scenario 1	Scenario 2
WTGs	332.23	303.44
OSSs[1]	33.94	33.94
Met Tower[2]	2.57	2.57
Total	**368.75**	**339.95**

[1] Maximum seabed preparation would result from the installation of four large OSSs with suction bucket jacket foundations
[2] Maximum seabed preparation would result from the installation of a suction bucket jacket foundation

Table 1-6. Maximum Extent (Acres) of Dredging under Scenario 1 or Scenario 2 of the Proposed Action

Activity	Scenario 1	Scenario 2
Seabed Preparation	368.75	339.95
Sand Bedform Clearing	1,794.09	1,794.09
HDD Entrance/Exit Excavation	0.12	0.12
Total	**2,162.96**	**2,134.17**

[1] Maximum seabed preparation would result from the installation of four large OSSs with suction bucket jacket foundations and a met tower with a suction bucket jacket foundation

Once any necessary seabed preparation is complete, foundations would be installed. Foundation components may be fabricated in the United States or overseas and would be delivered to a third-party marshaling port for final assembly and staging. Vessels would then transport equipment and materials to the Lease Area.

Piled foundations would be installed using a hydraulic impact hammer deployed on a jack-up or heavy lift vessel using dynamic positioning or anchoring. The impact hammer utilized for installation of monopile foundations would have a maximum rated capacity of 4,400 kilojoules and would drive the monopiles up to 262.5 feet (80 meters) into the seabed. The installation of one monopile would require approximately 7 to 9 hours of pile driving and up to two monopiles could be installed per vessel spread per day, assuming no time-of-day restrictions. Atlantic Shores is not proposing any time-of-day restrictions and has noted that piling may be initiated any time within a 24-hour period. Prior to conducting nighttime pile driving activities, Atlantic Shores would prepare and submit a nighttime piling plan to NMFS and BOEM for review and approval. This plan must be submitted at least six months prior to the planned start of pile driving. Without an approved nighttime piling plan, all pile driving would be initiated during day time (i.e., between one hour after civil sunrise to 1.5 hours before civil sunset), and nighttime pile driving could only occur if unforeseen circumstances (e.g., temporary shutdowns caused by marine mammal or sea turtle sightings, weather or metocean conditions, or equipment repair/maintenance or slower-than-anticipated pile driving speeds caused by geotechnical or other factors) prevent the completion of pile driving during daylight hours and it is necessary to continue piling during the night to protect the asset integrity or safety. BOEM will not permit nighttime pile driving unless the Applicant prepares an Alternative Monitoring Plan which is approved by BOEM and NMFS, as described in Section 1.3.5. No concurrent pile driving within the Lease Area is proposed under the Proposed Action. The impact hammer utilized for installation of pin piles for piled jacket foundations would have a maximum rated capacity of 2,500 kilojoules and would drive the pin piles up to 249.3 feet (76 meters) into the seabed. The installation of one WTG or small OSS jacket foundation would require approximately 1 day (three or four pin piles driven per day), assuming 4 hours of pile driving per pile.

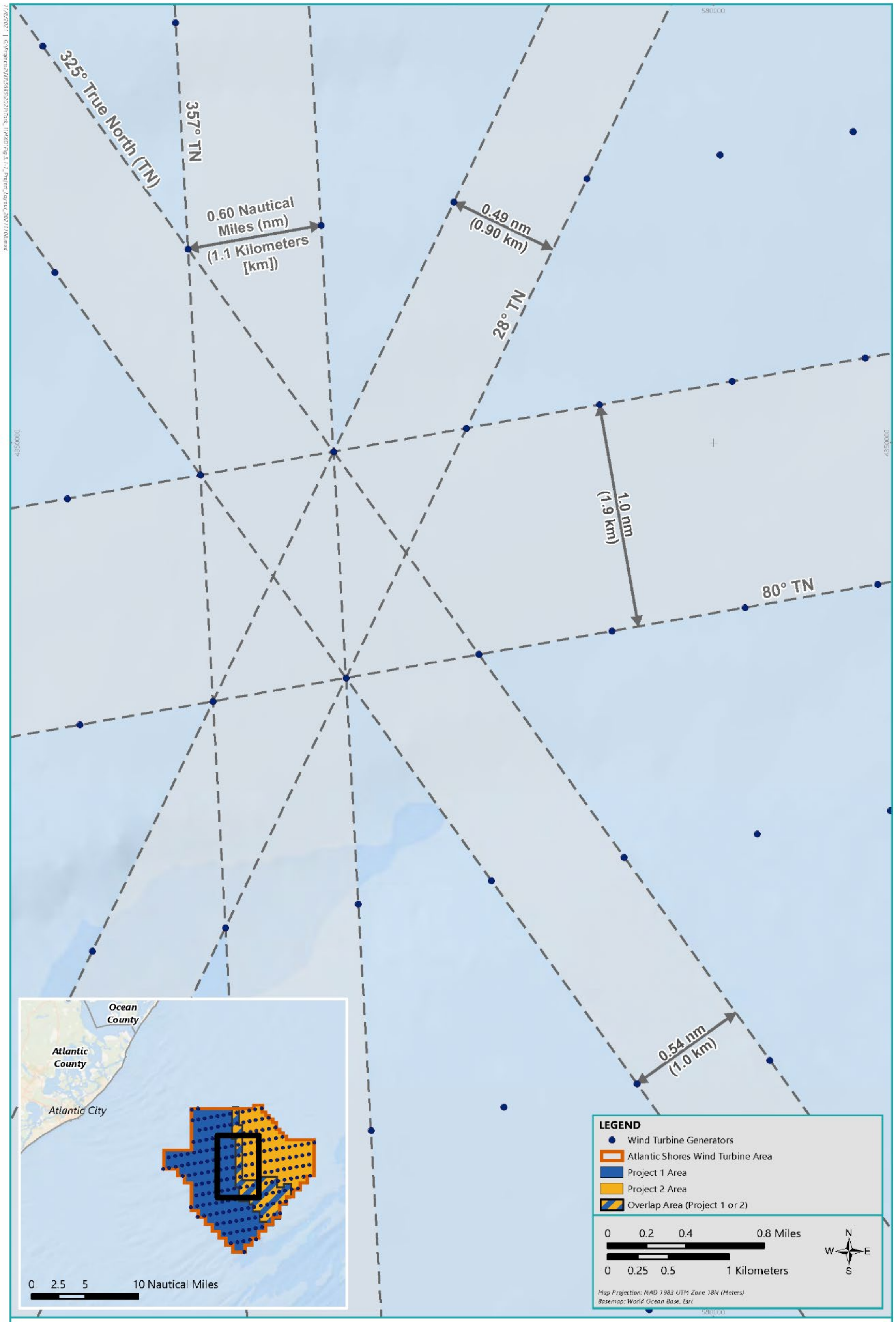

Figure 1-2. WTG Layout in Lease Area

Suction bucket foundations would be installed using jack-up or heavy lift vessels using dynamic positioning or anchoring. A crane located on the installation vessel would lift the foundation from the transport vessel and lower it to the seabed. The weight of the foundation would result in partial penetration into the seabed. Once the foundation is in place, each suction bucket would be sealed, and pumps would be used to remove water from the bucket, creating a negative pressure differential that would embed the bucket in the seabed. Though the flow rate of the pump would be dependent on the final design of the suction bucket foundation, should this foundation type be selected, Atlantic Shores anticipates that flow rate would be selected to be low enough to avoid seabed disturbance. The pump would be equipped with a screen on the intake to protect pump components. Though the screen size would also be dependent on final design of the suction bucket foundation, Atlantic Shores anticipates that a #20 screen would be reasonable for use on the pump. After embedment, the space inside the suction bucket may be backfilled with cement grout, if necessary. The installation of a mono-bucket would require approximately 7 to 9 hours per foundation. The installation of a suction bucket jacket would require up to 15 hours per foundation.

Gravity foundations would be either transported to the Lease Area onboard a large-capacity barge or floated to the Lease Area using multiple tugboats. If transported, a crane located on a heavy lift vessel would lift the foundation from the barge and lower it to the seabed. Floated foundations would be lowered to the seabed by increasing ballast. Once placed on the seabed, additional ballast material (e.g., seawater, sand [potentially sand dredged during sand bedform removal], gravel, or other crushed minerals or stones) may be pumped into the foundation to provide additional stability. Installation of one gravity foundation per vessel spread per day is anticipated.

Scour protection may be installed around WTG and OSS foundations to prevent scouring (i.e., sediment transport or erosion caused by water currents) of the seabed around the foundations. Locations requiring scour protection and the type of protection selected would be based on foundation type and would be determined through all relevant, ongoing, and planned agency consultations as a part of the state and federal permitting processes. Proposed scour protection types for foundations include the following:

- Rock placement: up to three layers of rock with increasing rock size in higher layers
- Rock bags: rock-filled filter unit enclosed by polyester mesh
- Grout- or sand-filled bags: bags filled grout or sand
- Concrete mattresses: high-strength concrete blocks cast around a mesh that secures the blocks in a flexible covering
- Ballast-filled mattresses: mattress filled with ballast material (e.g., sand/water/bentonite mixture)
- Frond mattresses: buoyant fronds with similar functionality to natural seaweed densely built into a mattress

Scour protection would extend up to 269 feet (82 meters) from the base of each WTG foundation and be placed to a depth of up to 8.2 feet (2.5 meters), depending on the chosen design. Placement of scour protection for WTG foundations would result in the modification of up to 252 acres (1.0 square kilometers) of seabed under Scenario 1 or up to 215 acres (0.9 square kilometers) under Scenario 2. For the OSSs, scour protection would extend up to 695.5 feet (212 meters) from the base of each foundation and be placed to a depth of up to 8.2 feet (2.5 meters), depending on the chosen design, resulting in the modification of up to 25 acres (0.1 square kilometers) of seabed under either Scenario 1 or Scenario 2.

Probable vessel classes used to install WTGs and OSSs, with their associated foundations, include bulk carriers, heavy lift vessels, jack-up vessels, jack-up feeders, fall pipe vessels, dredgers, tugboats, barges, service operation vessels, and crew transport vessels (CTVs) (**Table 1-7**). Specifically, bulk carriers, heavy lift vessels, and jack-up vessels would be used to install WTG and OSS foundations. Heavy lift vessels would be used to install OSSs. Jack-up vessels would be used to install WTGs. Fall pipe vessels and dredgers would be used for installation of scour protection. The other vessels would be used to transport construction materials, support construction activities, conduct construction monitoring, and transport construction crews. All vessels, with the exception of CTVs, are anticipated to travel at speeds of 10 knots or less (**Table 1-8**). CTVs are expected to travel at an average speed of 29 knots.

Maximum estimates of simultaneous vessel usage for a single offshore construction activity range from 2 vessels for scour protection installation to 16 vessels for OSS installation. In the unlikely event that all construction activities for Project 1 and Project 2, including HRG surveys, foundation installation, scour protection installation, WTG installation, OSS installation, inter-array cable installation, export cable installation, and fuel bunkering, were to occur simultaneously, up to 51 vessels could be operating at a given time. The total estimated number of vessel round-trips to the Lease Area during construction is 1,745 trips (**Table 1-9**). In addition to vessels, helicopters may potentially be used to support construction activities. The primary use of aircraft during construction would be utilization of helicopters for crew changes on installation vessels. Crew changes are anticipated to occur approximately every 1 to 4 weeks throughout the construction period.

Installation of the WTG foundations would occur over a 10-month period, beginning in the first quarter of 2026 for both Project 1 and Project 2. Installation of the OSS foundations would occur over a 5- to 7-month period, beginning in the second quarter of 2026 for both Project 1 and Project 2 (**Table 1-4**). Time of year restrictions would limit the impact pile driving period to May 1 through December 31 in a given year (see Section 1.3.5 for a full list of mitigation measures for the protection of ESA-listed species).

Installation of Submarine Cables. The Proposed Action includes the installation and operation of offshore submarine cables. Offshore cabling for the Project includes up to 547 miles (880 kilometers) of inter-array cables, 37 miles (60 kilometers) of interlink cables, and 441 miles (710 kilometers) of submarine export cables.

The inter-array cables would connect the WTGs into strings and then connect these strings to the OSSs (**Figure 1-3**). The inter-array cables would consist of three-stranded core high voltage alternating current (HVAC) cables with a transmission capacity of 66 to 150 kilovolts (kV). The Project 1 and Project 2 inter-array cables would have lengths of 273.5 miles (440 kilometers), each.

The Project may use interlink cables to connect the OSSs. Interlink cables would consist of three-stranded core HVAC cables with a transmission capacity of 66 to 275 kV. The Project 1 and Project 2 interlink cables would have lengths of 18.6 miles (30 kilometers), each.

Up to eight submarine export cables, occupying up to two corridors, would connect the proposed Project to the onshore electrical grid. There are three transmission options for the offshore export cables: HVAC transmission, high voltage direct current (HVDC) transmission, and HVAC and HVDC transmission. Project 1 is expected to use HVAC transmission; the transmission option for Project 2 has yet to be selected. Under the HVAC option, Project 1 and Project 2 would each install up to four HVAC cables in separate corridors. Under the HVDC option, Project 1 and Project 2 would each install a two-cable HVDC bundle in separate corridors. Under the HVAC and HVDC option, one project would install up to four HVAC cables and the other would install one HVDC bundle, in either the same or separate corridors. HVAC export cables would have a three-stranded core with a transmission capacity of 230 to 275 kV. HVDC export cables would have a single core with a transmission capacity of 320 to 525 kV.

Two export cable routes are currently being considered (**Figure 1-1**). The Atlantic Export Cable Corridor would depart the Lease Area along its western boundary and travel northwest to the Atlantic Landfall Site in Atlantic City, New Jersey. The Atlantic cable route is approximately 12 miles (19 kilometers) long, and maximum length of each export cable using the Atlantic cable route would be 25 miles (40 kilometers), including the length of cable within the Lease Area and contingency for micrositing. The Monmouth Export Cable Corridor would depart the Lease Area along its eastern boundary and travel north to the

Monmouth Landing Site in Sea Girt, New Jersey. The Monmouth cable route is approximately 61 miles (98 kilometers) long, and the maximum length of each export cable using the Monmouth cable route would be 85 miles (138 kilometers), including the length of cable within the lease area and contingency for micrositing. If four export cables are installed in each export cable corridor, the total maximum export cable length would be 441 miles (710 kilometers). As depicted in **Figures 1-4 and 1-5**, Atlantic Shores has selected export cable landfalls for each export cable route:

- Atlantic Landfall Site: public parking lot bounded by Pacific, South Belmont, and South California Avenues and California Avenue
- Monmouth Landfall Site: U.S. Army National Guard Training Center in Sea Girt, New Jersey

Pre-installation activities, including sand bedform clearing, relocation of boulders, a pre-lay grapnel run, and a pre-lay survey, would be conducted prior to the installation of offshore cables.

Sand bedform clearing would involve the removal of the tops of some mobile sand bedforms to ensure cables can be installed within stable seabed. Project engineers estimate that up to 20 percent of export cable routes, 20 percent of interlink cable routes, and 10 percent of interarray cable routes may require sand bedform clearing, for a total of up to 1,794.09 acres (**Table 1-6**). Such clearing would be completed using one or more typical (trailing suction hopper dredge, controlled flow excavation, route clearance plow) or specialty (cutterhead dredge, backhoe dredging) methods. Material collected during sand bedform clearing may be sidecast; disposed of within surveyed areas exhibiting sand bedforms, which avoids hard bottom areas and allow material to be dispersed by normal currents and tidal actions; used for ballast in gravity-based foundations, if selected; or transported for disposal in another approved area.

Boulder relocation may be required in limited areas along the export cable corridors. Presence of boulders is expected to be minimal, and boulder removal would likely be performed using subsea grab, a method with minimal seabed impact. If more boulders are encountered than expected, a displacement plow may be utilized for boulder removal. A displacement plow is a y-shaped tool configured with an attached boulder board that is towed along the seabed, displacing boulders along its path as it advances. If this method is necessary, the plow would be ballasted to only clear boulders (approximate seabed penetration of 2.6 feet [0.8 meters]), avoiding creation of a deep depression in the seabed. The clearance width of the displacement plow is anticipated to be approximately 33 feet (10 meters). The maximum total length of boulder relocation is estimated at 35.1 miles (71 kilometers), with an additional area of disturbance up to 0.08 square miles (0.22 square kilometers).

A pre-lay grapnel run would be completed approximately two months prior to cable installation to clear final cable alignments of man-made obstructions (e.g., discarded fishing gear). The Applicant expects to make three grapnel runs along each cable alignment. During the pre-lay grapnel run, the seabed would be impacted to a maximum depth of 1.6 feet (0.5 meters).

Pre-lay surveys would be performed along final cable alignments to confirm seabed morphology and bathymetry prior to the start of cable laying operations. These surveys would be performed using a multibeam echosounder.

Once any necessary pre-installation activities are completed, Atlantic Shores would lay and bury the export, interlink, and inter-array cables. Cable lay and burial may be completed using three common methods:

- Simultaneous lay and burial: Cable is directly guided from the installation vessel through the burial tool and laid into the seabed. Atlantic Shores expects to use this method for installation of export cables
- Post-lay burial: Cable is temporarily laid on the seabed then buried in a subsequent, separate operation. This method leaves the cables unprotected between laying and burial operations, but burial can be completed more quickly, minimizing duration of cable installation impacts, and multiple

passes with the burial tool can be completed to reach target burial depth, minimizing the need for cable protection. Atlantic Shores expects to use this method for installation of inter-array and interlink cables

- Pre-lay trenching: A trench is excavated prior to cable installation, cable is laid into the trench, and the trench is backfilled with spoils from trench excavation. This method would be limited to portions of cable alignments where deeper cable burial is required, or firmer sediments are encountered

Atlantic Shores is considering a variety of tools to perform cable lay and burial operations. Final equipment selection will be based upon seabed conditions, cable properties, laying and burying combinations, burial tool systems, and anticipated performance. Three primary tools are under consideration:

- Jet trenching: Involves injecting pressurized water jets into the seabed, creating a trench. This equipment can be used in soft sediments for either simultaneous lay and burial or post-lay burial techniques
- Plowing/jet plowing: As the plow is dragged along the seabed, a trench to the required burial depth is created and held open. As the plow advances, the cable is placed in the trench and displaced sediment is either mechanically returned to the trench or backfills naturally. This equipment is typically used for simultaneous lay and burial
- Mechanical trenching: This tool cuts a narrow trench into the seabed using a jetting sword or excavation chain, and cable is buried in the trench either simultaneously or subsequently. This equipment is generally used in firmer sediments for simultaneous lay and burial, post-lay burial, and pre-lay trenching techniques.

Atlantic Shores anticipates the majority of offshore cable installation will utilize jet trenching equipment or jet plowing. Mechanical trenching is only expected in limited areas. Approximately 80 to 90 percent of offshore cables are expected to require only one pass of the cable installation tool. In the remaining areas, two to four passes may be required to reach target burial depth. Along approximately 5 percent of the export cable corridors, an additional pass may be performed prior to cable installation (i.e., re-pass jetting) to increase the probability of successful cable burial. In shallow portions of the export cable corridor, a fourth tool may be used to perform simultaneous lay and burial: a plow towed by a shallow-water barge with tensioners.

In areas where burial of the cables to the target depth (5 to 6.6 feet [1.5 to 2 meters]) is not feasible, cable protection would be installed on the seabed above the cable as a secondary measure to protect the cables. Cable protection may also be necessary to support the crossing of existing marine infrastructure (e.g., submarine cables or pipelines) (**Figure 1-6**). Atlantic Shores anticipates up to 15 crossings for each of the four export cables along the Monmouth Export Cable Corridor, up to 4 crossings for each of the four export cables along the Atlantic Export Cable Corridor, up to 10 inter-array cable crossings, and up to 2 interlink cable crossings.[3] Any cable crossing would be surveyed. If the existing cable is inactive, it will be cut and removed prior to installation of the proposed cable. For any active cable identified, Atlantic Shores will develop a crossing agreement with the owner. If the depth of the existing cable is sufficient to maintain appropriate vertical separation, Atlantic Shores will bury their cable to target depth at the crossing. If target depth cannot be achieved, cable protection would be installed on top of the proposed cable.

[3] In developing these estimates, Atlantic Shores accounted for the possibility that other offshore cables (e.g., export cables from other offshore wind farms) may be installed prior to the start of the Project's construction.

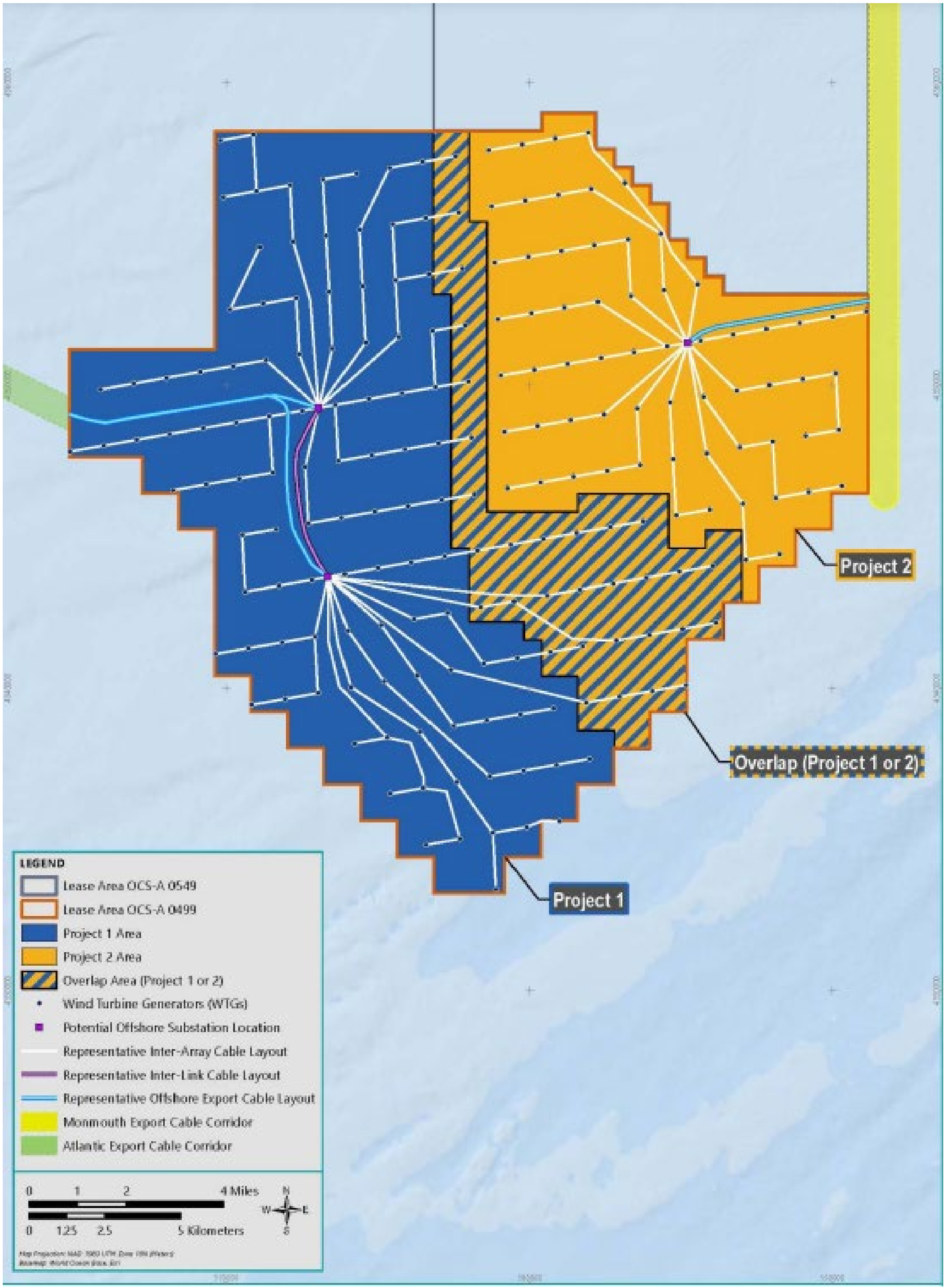

Figure 1-3. Potential Inter-Array Cable Layout

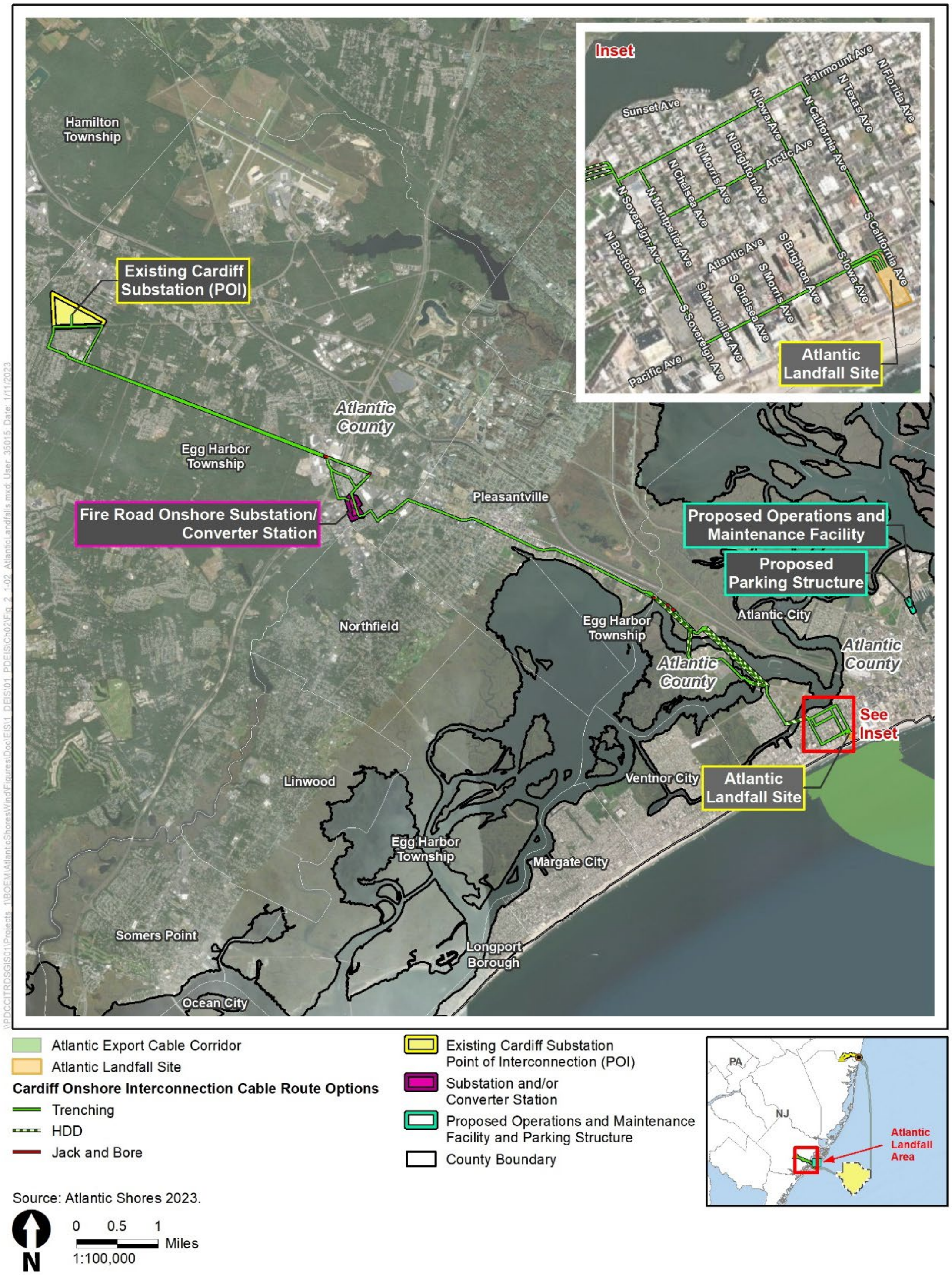

Figure 1-4. Atlantic Landfall Site and Onshore Cable Route

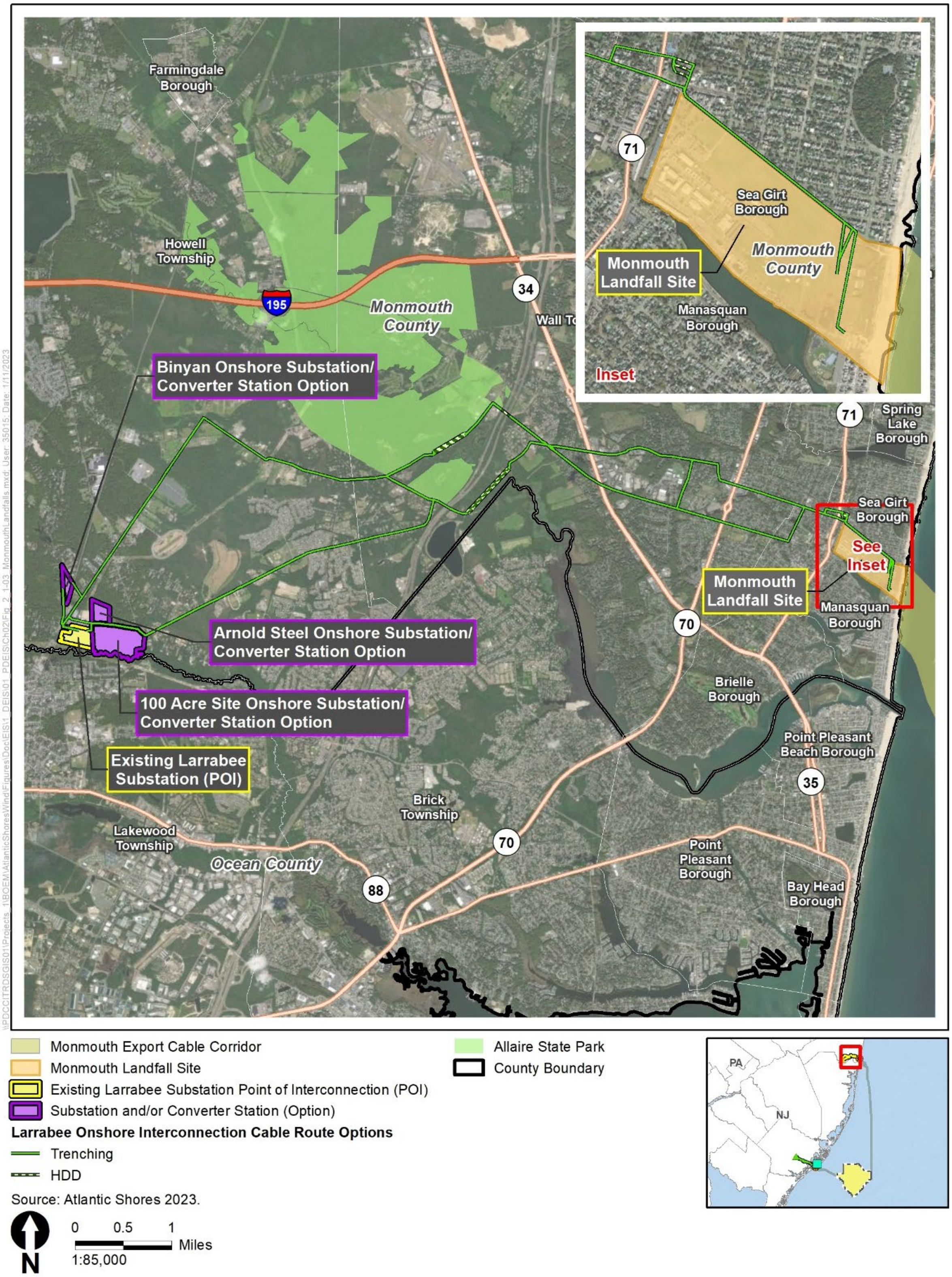

Figure 1-5. Monmouth Landfall Site and Onshore Cable Route

Though Atlantic Shores will work to minimize the amount of cable protection required, the Applicant conservatively assumes that up to 10 percent of offshore cables (i.e., 54.6 miles [88 kilometers] of inter-array cables, 3.8 miles [6 kilometers] of interlink cables, and 44.1 miles [71 kilometers] of export cables) may require cable protection due to insufficient burial depth. Cable protection for insufficient burial depth would extend to a width of up to 41 feet (12.5 meters) and a depth of up to 4.6 feet (1.4 meters). Additionally, cable protection may be required for up to 88 infrastructure crossings. At infrastructure crossings requiring cable protection, protection may cover an area of up to 43,055.6 square feet (4,000 square meters) with a maximum depth of 5.6 feet (1.7 meters). Proposed types of cable protection include the following:

- Rock placement: Up to three layers of rock, with rock size increasing in higher layers
- Concrete mattresses: High-strength concrete blocks cast around mesh that holds the blocks in a flexible covering
- Rock Bags: Rock-filled filter unit enclosed by polyester mesh
- Grout-filled bags: Woven fabric filled with grout
- Half-shell pipes: Composite materials or cast iron that is fixed around a cable

Where cable protection is required, freely-laid rock, if selected as the cable protection type, would be placed using a fallpipe installation method, wherever possible. Alternative rock laying techniques would include placement by vessel crane and side dumping. If concrete mattresses, rock bags, or grout-filled bags are selected for cable protection, they would be deployed using a vessel crane. Half-shell pipes would be installed around the cable on board the cable laying vessel prior to cable installation.

Given the length of the export cables, cable jointing offshore would be required. The end of each cable segment would be held in temporary wet storage on the seabed, which may require temporary cable protection (e.g., concreted mattresses) to be placed over the cable end. Once the cable segments are jointed onboard a jointing vessel, the joints would be buried using either a jet trencher or controlled flow excavation. If sufficient burial is not possible, cable protection would be placed on top of the joint. Depending on the final construction and installation schedule, the ends of the export cables may need to be wet-stored and covered with cable protection until they are pulled into the foundation.

Horizontal directional drilling (HDD) is proposed as the method for the installation of the export cables at the landfall(s). HDD is a trenchless installation method that avoids nearshore and shoreline impacts and allows for deeper cable burial in nearshore environments. To support this installation, both onshore and offshore work areas are required. A backhoe dredge may be required to complete excavation of the offshore HDD entrance/exit. A temporary offshore platform (i.e., a jack-up barge) may be required to support the HDD drilling rig. A temporary cofferdam may also be used, depending on the results of marine surveys. If used, Atlantic Shores anticipates the HDD pit for each cable landfall would be 98.4 by 26.2 feet (30 by 8 meters), resulting in up to 0.12 acres of dredging, if required (**Table 1-6**). Each cofferdam would be composed of approximately 109 sheet piles, with a total of 872 sheet piles for all 8 cofferdams combined, that would be installed using a vibratory hammer. The cofferdams at each landfall site are anticipated to require 8 days to install and 8 days to remove (i.e., 16 total days of vibratory hammer operation at each landfall site).

Probable vessel classes used to install offshore cables include cable installation vessels, dredgers, anchor handling tug supply vessels, fall pipe vessels, transport and anchor handling tugs, tugboats, barges, and service operation vessels (**Table 1-7**). Cable installation vessels would be used to install and bury submarine cables. Fall pipe vessels would be used for installation of cable protection. The other vessels would be used to transport construction materials and support construction activities.

Installation of the export cables would occur over a 6- to 9-month period, beginning in the second quarter of 2025 for Project 1 and the third quarter of 2025 for Project 2. Installation of the inter-array cables would occur over a 14-month period, beginning in the second quarter of 2026 for Project 1 and the third quarter of 2026 for Project 2 (**Table 1-4**).

Installation of Onshore Cables. The Proposed Action includes the installation and operation of up to 26 miles (42 kilometers) of onshore interconnection cables. The onshore interconnection cables would connect to the submarine export cables at the landfall(s). From the landfall sites, interconnection cables would be installed primarily along existing roadways, utility rights-of-way, and bike paths to the proposed onshore substation or converter station sites. From these sites, the interconnection cables would continue to their points of interconnection (POIs). The existing Larabee Substation and existing Cardiff Substation are proposed as POIs for the Proposed Action. The interconnection cables would consist of either three single-core HVAC cables per circuit, with up to four circuits each for Project 1 and Project 2, or two single-core HVDC cables per circuit, with one circuit per route. The transmission capacity of HVAC interconnection cables would be 230 to 275 kV, and the transmission capacity of HVDC interconnection cables would be 320 to 525 kV. The Larabee interconnection cable route would be approximately 12 miles (19.5 kilometers), and the Cardiff interconnection cable route would be approximately 14 miles (23 kilometers).

For the Larabee interconnection cable route, the interconnection cables would connect from the Monmouth Landfall Site to one of the three proposed onshore substation/converter station sites then continue to the Larabee POI (**Figure 1-5**). For the Cardiff interconnection cable route, the interconnection cables would connect from the Atlantic Landfall Site to the proposed substation/converter station on Fire Road then continue to the Cardiff POI (**Figure 1-4)**. Both routes would largely utilize existing linear infrastructure corridors.

Installation of onshore interconnection cables would likely be accomplished using open trenching. Specialized construction techniques may be used at specific locations (e.g., road crossings, wetlands, waterbodies). These specialty techniques would primarily include the following trenchless techniques:

- HDD: Involves drilling a hole in an arc under a surface feature, enlarging the hole, then pulling casing or conduit back through the hole. This technique is typically used to cross under relatively wide features
- Pipe jacking: Involves driving a casing pipe through soil using hydraulic jacks
- Jack-and-bore: Involves excavating bore and receiving pits then conducting drilling and jacking activities from the bore pit to drive the casing into the receiving pit. This technique is typically used to cross under narrower features than HDD

Installation of the onshore cables would occur over a 9- to 12-month period, beginning in the first quarter of 2024 for both Project 1 and Project 2 (**Table 1-4**). Impacts from installation and operation of onshore interconnection cables are not expected to affect ESA-listed species under NMFS jurisdiction. Therefore, these activities are not considered further in this BA.

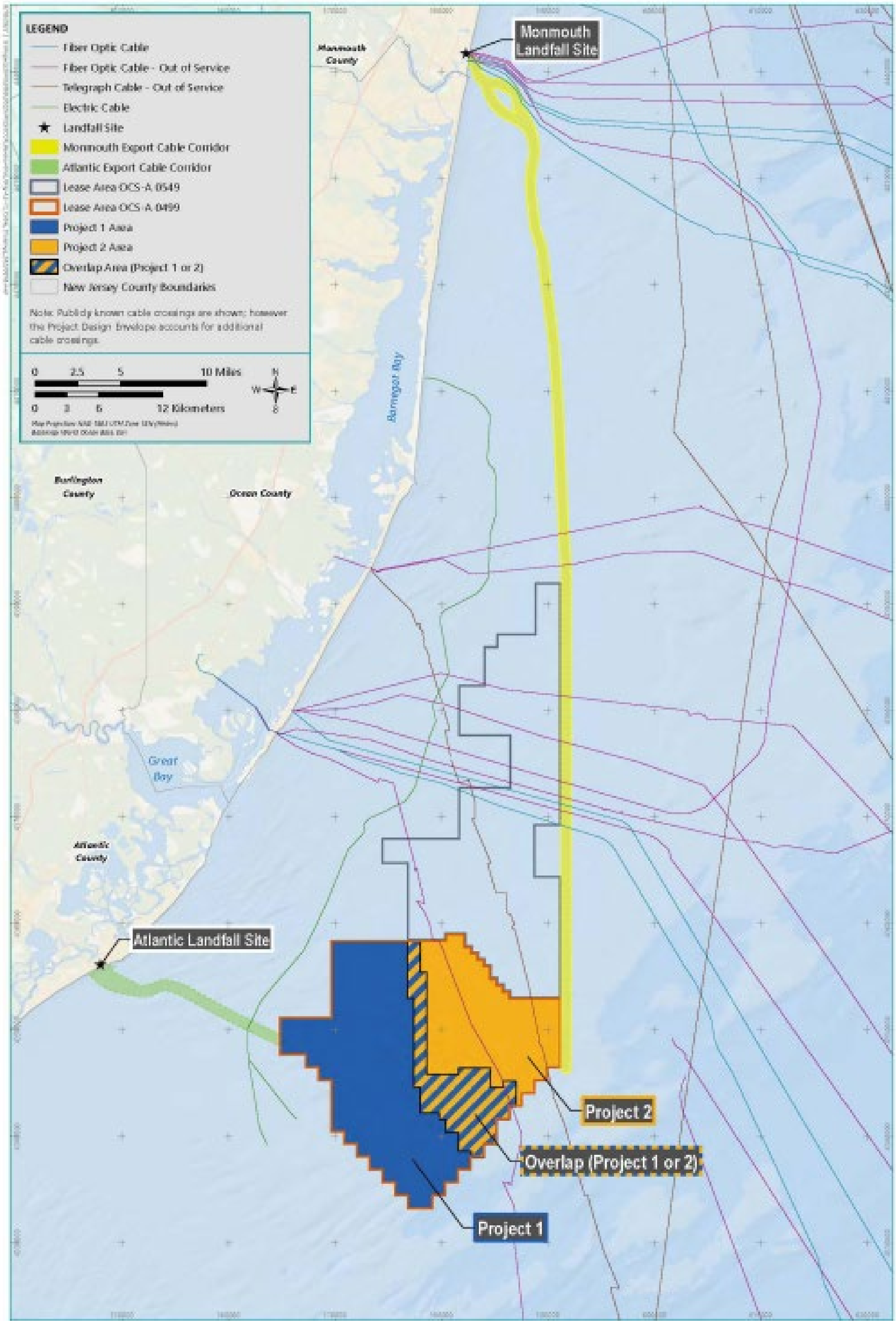

Figure 1-6. Cable Crossings

Construction and installation surveys. HRG and geotechnical surveys would be required pre-construction. Survey activities would include use of side scan sonar, multibeam echosounder, magnetometers, gradiometers, sub-bottom profilers, vibracores, cone penetrometer tests, and deep borings within the wind farm area and along the export cable route.

HRG surveys would be conducted prior to construction to verify site conditions. A munitions and explosives of concern survey may also be included in pre-construction HRG survey activities. A maximum of 60 days of HRG surveys are anticipated in a year. Pre-construction geotechnical surveys would be performed to inform the final design and engineering of each offshore facility.

NMFS (2021i) has completed a programmatic consultation addressing the effects of site assessment and characterization activities anticipated to support siting of offshore wind energy development projects off the U.S. Atlantic coast, including HRG and geotechnical surveys. In its consultation, NMFS (2021i) evaluated potential effects of these activities, including effects to individual animals associated with survey noise exposure; effects of environmental data collection buoy deployment, operation, and retrieval; effects to habitat; and effects of vessel use, and concluded that the site assessment and characterization activities considered are not likely to adversely affect any ESA-listed species or critical habitat. The pre- and post-construction HRG and geotechnical surveys that would be required for the Proposed Action are anticipated to fall within the scope of the programmatic consultation (NMFS 2021i). Any HRG and geotechnical surveys conducted for the Proposed Action would be required to follow BOEM's (2021d) Project Design Criteria and Best Management Practices developed to address the mitigation, monitoring, and reporting conditions identified in the programmatic consultation (NMFS 2021i).

1.3.2 Operations and Maintenance

The O&M of the Atlantic Shores South Project would result in impacts on aquatic species in the nearshore and offshore waters of the mid-Atlantic OCS associated with offshore activities. The O&M activities that are pertinent to this BA are described in this section. Additional information about Project O&M requirements is provided in the COP (Atlantic Shores 2023a).

During operation, the WTGs would be remotely monitored through the SCADA system, which acts as an interface for a number of sensors and controls throughout the wind farm. The SCADA system allows status and performance to be monitored and for systems to be controlled remotely, where required. The WTGs will be regularly inspected and maintained. Generally, WTG O&M activities would include:

- Regularly scheduled inspections and routine maintenance of the WTG mechanical and electrical components
- Annual maintenance campaigns for general upkeep (e.g., bolt tensioning, crack and coating inspection, safety equipment inspection, cleaning, high-voltage component service, and blade inspection)
- Replacement of consumable items (e.g., lubrication, oil changes)

A WTG would be accessible from a door located at the foundation platform. WTG accessibility would include an elevator, ladders, and other access routes. Accessibility routes would be sufficiently sized to accommodate within-nacelle movement of maintenance/inspection personnel, small equipment, and replacement parts. Additionally, auxiliary cranes would be rigged within WTG nacelles and external working platforms.

During O&M, foundations would be inspected above and below the waterline at regular intervals to check for corrosion, cracking, and marine growth. Scheduled maintenance would also include safety inspections and testing; coating touch-up; preventative maintenance of cranes, electrical equipment, and auxiliary equipment; and removal of marine growth. Corrective actions will be taken as necessary to address any issues identified with scour protection.

The submarine export cables would be monitored through either a distributed temperature sensing system, a distributed acoustic sensing system, or online partial discharge monitoring. Cable terminations and hang-offs would be inspected and maintained during scheduled maintenance of WTG and OSS foundations.

Regular cable surveys would be performed to identify potential issues with scour or burial depth. During the first two to five years of operation, cable surveys would be performed annually. The duration of annual surveying will be determined based on the results of the initial surveys. Assuming no abnormal conditions are identified during initial annual surveys, less frequent cable surveys would be conducted over the remaining life of the Project. Post-construction HRG surveys are anticipated to operate during any month of the year for a maximum of 60 vessel days per year, on average, for up to five years, 55 line kilometers per day at a typical speed of 3.5 knots, resulting in an estimated 3,300 line kilometers surveyed annually. Provided that no abnormal conditions are detected during these annual surveys, less frequent HRG surveys would be conducted throughout the remaining life of the Project.

In the unlikely event of cable exposure, the cable would be reburied or cable protection would be applied. Should unplanned repairs be required, the damaged portion of the cable will be spliced and replaced with a new, working segment. This will require the use of various cable installation equipment, as described for construction activities.

During O&M activities, personnel and equipment would primarily be delivered to the Lease Area by service operation vessels and CTVs (**Table 1-7**). During the O&M phase, 5 to 11 vessels are expected to operate in the Lease Area at a given time (**Table 1-8**). During specialized maintenance or repair activities, a maximum of 22 vessels may be required. The estimated number of annual vessel round-trips to the Lease Area during O&M is 1,861 trips (**Table 1-9**). Helicopters may also be used to support O&M activities.

1.3.3 Decommissioning

Decommissioning of the Atlantic Shores South Project would result in impacts on aquatic species in the nearshore and offshore waters of the mid-Atlantic OCS associated with offshore activities.

BOEM's decommissioning requirements are stated in Section 13, *Removal of Property and Restoration of the Leased Area on Termination of Lease*, of the December 2018 Lease for OCS-A 0499. Unless otherwise authorized by BOEM, pursuant to the applicable regulations in 30 CFR Part 585, Atlantic Shores would be required to "remove or decommission all facilities, projects, cables, pipelines, and obstructions and clear the seafloor of all obstructions created by activities on leased area, including any project easement(s) within two years following lease termination, whether by expiration, cancellation, contraction, or relinquishment, in accordance with any approved SAP, COP, or approved Decommissioning Application and applicable regulations in 30 CFR Part 585." When possible, decommissioning would recover valuable recyclable materials, including steel foundation components.

In accordance with BOEM requirements, Atlantic Shores would be required to remove and/or decommission all Project infrastructure and clear the seabed of all obstructions when the Project reaches the end of its 30-year designed service life. Before ceasing operation of individual WTGs or the entire Project and prior to decommissioning and removing Project components, Atlantic Shores would consult with BOEM and submit a decommissioning plan for review and approval. Upon receipt of the necessary BOEM approval and any other required permits, Atlantic Shores would implement the decommissioning plan to remove, and recycle, when possible, equipment and associated materials.

The decommissioning process for the WTGs and OSSs, with their associated foundations, is anticipated to generally be the reverse of installation, with Project components transported to an appropriate disposal and/or recycling facility. All foundations and other Project components would need to be removed 15 feet (4.6 meters) below the mudline, unless other methods are deemed suitable through consultation with the regulatory authorities, including BOEM. Submarine export and inter-array cables would be retired in place or removed in accordance with the BOEM-approved decommissioning plan. Atlantic Shores would need to obtain separate and subsequent approval from BOEM to retire any portion of the Project in place. Project components will be decommissioned using a similar suite of vessels as Project construction, as described in Section 1.3.1.

Vessel classes and numbers for decommissioning are expected to be similar to the construction and installation phase. Therefore, in the unlikely event that all decommissioning activities for Project 1 and Project 2 were to occur simultaneously, up to 51 vessels could be operating at a given time. The total estimated number of vessel round-trips to the Lease Area during decommissioning is 1,745 trips (**Table 1-9**).

Decommissioning activities are expected to result in similar, or lesser, impacts on ESA-listed species as construction activities.

1.3.4 Monitoring Surveys

Biological monitoring studies would also be conducted pre-construction, during construction, and post-construction to support the assessment of Project impacts, including fisheries studies, benthic habitat studies, and regional monitoring initiatives. Atlantic Shores anticipates that commercial fishing vessels or vessels owned by academic institutions would be used to conduct biological monitoring surveys under the Proposed Action. Fixed-wing aircraft may also be used to support environmental monitoring and mitigation.

Fisheries Studies. Proposed fisheries studies include demersal otter trawl surveys, trap surveys, and hydraulic clam dredge surveys (COP Volume II, Appendix II-K, *Fisheries Monitoring Plan*; Atlantic Shores 2023a).

Otter trawl surveys would be conducted within an effects stratum (i.e., within a 0.6 mile [0.9 kilometer] of the borders of the wind turbine area) and within close control (i.e., within 0.6 to 1.7 miles [0.9 to 2.8 kilometers] of the borders of the wind turbine area) and far control (i.e., within 1.7 to 3.5 miles [2.8 to 5.6 kilometers] of the borders of the wind turbine area) strata using the same gear as the Northeast Area Monitoring and Assessment Program trawl survey. An estimated five to nine tows would be conducted per day, and each tow would be limited to 20 minutes. Trawl surveys would occur seasonally (i.e., in winter [December through February], spring [March through May], summer [June through August], and fall [September through November]) with 27 tows occurring each season, resulting in 108 tows annually.

Trap surveys would be conducted along transects from WTGs or OSSs in the wind turbine area using unbaited ventless traps. Each trap would be deployed in a trawl attached to a groundline to prevent gear loss and protected species entanglement. Use of vertical lines for trap deployments will be avoided unless permitting constraints require them or if needed due to logistical reasons. If used, up to twelve vertical lines would be deployed. Trap sampling would occur seasonally (i.e., in winter, spring, summer, and fall) with 72 traps (6 traps along 12 transects) deployed for 2 consecutive one-week sampling periods (i.e., five- to seven-day deployments) in each season, resulting in 576 trap fishing weeks per year. Traps will be deployed in a trawl attached to a groundline to prevent gear loss and protected species entanglement.

Table 1-7. Anticipated Vessel Utilization for the Proposed Action

Vessel	Activity	Construction and Decommissioning						O&M
		Foundations	WTGs	OSSs	Submarine Export Cables	Inter-array Cables	Scour Protection	
Bulk carrier	Foundation installation	X						
Heavy lift vessel	Foundation, OSS installation	X		X				
Jack-up vessel	Foundation, WTG installation	X	X					
Jack-up feeder	Feed jack-up vessel		X					
Fall pipe vessel	Scour and cable protection installation				X	X	X	
Dredger	Dredging				X	X	X	
Cable installation vessel	Cable installation and burial				X	X		
Anchor Handling Tug Supply Vessel	Transport of construction materials				X	X		
Tugboat	Transport/maneuvering of barges, bubble curtain support	X		X				
Barge	Transport of construction materials	X	X	X				
Service operation vessel	Support construction activities, WTG commissioning	X	X		X	X		X
Crew transfer vessel	Transport workers to and from offshore work area, construction monitoring, WTG commissioning	X	X	X				X

Table 1-8. Anticipated Vessel Operations and Characteristics for the Construction and Operations and Maintenance Phases of the Proposed Action

Activity	Vessel Type	Home Port	Count	Total Annual Round Trips	Length (ft)	Width (ft)	Draft (ft)	Operational Speed (knots)
Construction								
Foundation Installation	Barge	NJWP	2-3	64	394-410	98-115	4.3	3-10
	Bubble Curtain Support Vessel (Tugboat)	NJWP	1	11	230-246	49-66	6.9	10
	Crew Transfer Vessel	Atlantic City	1	102	82-98	30-33	1.5	29
	Dredger	NJWP	1	3	640-656	131-148	4.3	10
	Fall Pipe Vessel	TBC	1	28	623-640	131-148	9.25	10
	Jack-Up Vessel	NJWP	1	11	591-607	197	7.5	10
	Towing Tug	NJWP	2-6	96	98-115	33-49	5.5	3-10
OSS Installation	Barge	NJWP	4	12	394-410	98-115	4.3	10
	Crew Transfer Vessel	NJWP	1	7	82-98	30-33	1.5	29
	Heavy Lift Vessel	NJWP	2	2	591-722	131-295	10	10
	Towing Tug	NJWP	4	12	98-115	30-33	5.5	10
WTG Installation	Crew Transfer Vessel	Atlantic City	1	65	82-98	30-33	1.5	29
	Jack-Up Feeder	NJWP	2	100	407-410	128-131	7.5	10
	Jack-Up Vessel	NJWP	1	2	591-607	197	7.5	10
	Service Operations Vessel	NJWP	1	2	295-344	49-66	8	10
Inter-Array Cable Installation	Anchor Handling Vessel	NJWP	2	2	246-262	49-66	8	10
	Cable Burial Vessel	NJWP	1	2	246-541	82-115	9	10
	Cable Installation Vessel	NJWP	1	4	246-541	82-115	9	10
	Dredger	NJWP	1	2	640-656	131-148	4.3	10
	Fall Pipe Vessel	TBC	1	2	623-640	131-148	9.25	10
	Support Vessel (SOV)	NJWP	1	2	295-344	49-66	8	10
Export Cable Installation	Cable Installation Vessel	NJWP	1	4	246-541	82-115	9	10
	Dredger	NJWP	1	2	640-656	131-148	4.3	10
	Fall Pipe Vessel	TBC	1	2	640-656	131-148	9.25	10

Activity	Vessel Type	Home Port	Count	Total Annual Round Trips	Length (ft)	Width (ft)	Draft (ft)	Operational Speed (knots)
	Support Vessel (SOV)	NJWP	1	2	312-328	66	8	10
	Tug	NJWP	1	2	98-115	33-49	5.3	10
Scour Protection Installation	Fall Pipe Vessel	TBC	1	2	623-640	131-148	9.25	10
	Dredger	NJWP	1	2	640-656	131-148	4.3	10
Miscellaneous	Barge	NJWP	1	24	394-410	98-115	4.3	3-10
	Tug	NJWP	1	24	98-115	30-33	5.5	3-10
Operations and Maintenance								
Various	CTV	Atlantic City	5	1,825	82-98	30-33	1.5	29
	Miscellaneous (as needed)	Miscellaneous	5	5	N/A	N/A	N/A	10
	SOV	NJWP	1	32	312-328	66	8	10

Table 1-9. Vessel Trip Summary for the Proposed Action

State	Potential Port(s)	Estimated Trips[1]
Construction		
New Jersey	New Jersey Wind Port	1,250
	Paulsboro	120
	Repauno	20
	Atlantic City	315
Virginia	Portsmouth	20
Texas	Corpus Christi	20
O&M		
New Jersey	New Jersey Wind Port	32
	Paulsboro	2
	Repauno	1
	Atlantic City	1,825[2]
Virginia	Portsmouth	1
Decommissioning[3]		
New Jersey	New Jersey Wind Port	1,250
	Paulsboro	120
	Repauno	20
	Atlantic City	315
Virginia	Portsmouth	20
Texas	Corpus Christi	20

[1] Estimated trips for construction and decommissioning represent total round trips during these phases of the Project. Estimated trips for O&M represent annual round trips during this phase of the Project.
[2] Assumes 5 trips of crew transfer vessels per day for maintenance of the 200 WTGs.
[3] Estimated trips during decommissioning are assumed to be the same as during construction.

Clam dredge surveys would be conducted in the wind turbine area and in control areas outside the wind turbine area using the same gear as the New Jersey Department of Environmental Protection's inventory of New Jersey's surf clam resources survey. Clam dredge surveys would be conducted once per year in the summer, with 48 tows conducted annually.

Fisheries studies would occur for at least one year prior to construction, during construction, and in the three years following construction. All fisheries surveys would use bycatch reduction gear and methods whenever possible. Specifically, all surveys will comply with the Atlantic Large Whale Take Reduction Program, Harbor Porpoise Take Reduction Program, and Bottlenose Dolphin Take Reduction Program. The trawl and clam dredge surveys will comply with the Atlantic Trawl Take Reduction Strategy. For the trap survey, there will be no wet storage of gear, vertical lines will be avoided by the use of ropeless gear or reduced to twelve total lines if ropeless gear cannot be utilized, and biodegradable components will be used wherever possible.

Benthic Habitat Studies. Proposed benthic habitat studies include grab sampling and underwater imagery (COP Volume II, Appendix II-H, *Benthic Monitoring Plan*; Atlantic Shores 2023a).

Grab sampling would be conducted in the wind turbine area and export cable corridors with a benthic grab sampler. Grab sampling would occur once per year in the year prior to construction activities, within the first year after Project completion, in the third year after Project completion, and potentially in the fifth year after Project completion, with 378 grabs collected during each annual sampling event.

Underwater imaging would include video survey transects in the wind turbine area and within the export cable corridors and remotely operated vehicle surveys around selected WTG foundations. Video surveys would be conducted using a towed camera sled or remotely operated vehicle and an additional still image camera. Underwater imagery would be collected in the same years that benthic grab sampling occurs.

1.3.5 Proposed Mitigation, Monitoring, and Reporting Measures

This section outlines the proposed mitigation, monitoring, and reporting measures that are intended to minimize or avoid potential impacts to ESA-listed species.

Mitigation measures committed to by Atlantic Shores through the MMPA process are included as requirements under this BA (**Table 1-10**). As marine mammal requirements included in the final LOA may be more stringent than the mitigation measures committed to by Atlantic Shores in its LOA application, a requirement to follow final LOA conditions that apply to ESA-listed marine mammals is included as a BOEM-proposed measure under this BA (**Table 1-11**) and will also be included as a condition of COP approval.

A full description of all proposed mitigation measures evaluated as part of the Proposed Action, including BOEM-proposed measures and applicant-proposed measures included Atlantic Shores' LOA application, is provided in **Tables 1-10 and 1-11**.

Table 1-10. Proposed Mitigation, Monitoring, and Reporting Measures in Committed to by the Applicant in their MMPA LOA Application, Included in the Proposed Action for Consultation with NMFS under the ESA

No	Measure	Description	Project Phase	Expected Effects
1	PSO and PAM operator training, experience, and responsibilities	• All PSOs and PAM operators will have completed a 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 on similar projects. • Remaining PSOs and PAM operators will have previous experience on similar projects and the ability to work with the relevant software and equipment. • PSO and PAM operator resumes will be provided to NMFS for review and approval prior to the start of activities. • PSOs and PAM operators will complete a Permits and Environmental Compliance Plan training and a two-day training and refresher session with the PSO provider and Project compliance representatives before the anticipated start of Project activities. • PSOs will be employed by a third-party observer provider and will have no tasks other than to conduct observational effort, collect data, and communicate with and instruct relevant vessel crew with regard to the presence of marine mammals and mitigation requirements (including brief alerts regarding maritime hazards). • Situational awareness/common operating picture and coordination: Atlantic Shores will establish a situational awareness network for marine mammal detections through the integration of sighting communication tools such as Mysticetus, Whale Alert, WhaleMap, etc. This network will be monitored daily, and any sighting information will be made available to all project vessels. In addition, field personnel will: monitor the NMFS North Atlantic right whale reporting systems daily; monitor the U.S. Coast Guard VHF Channel 16 throughout the day to receive notifications of any sighting; and monitor any existing real-time acoustic networks.	C	Training of PSOs and PAM operators would minimize potential for adverse effects on marine mammals from vessel interactions or pile driving by increasing effectiveness of mitigation and monitoring measures.
2	Visual monitoring	• No individual PSO will work more than 4 consecutive hours without a 2-hour break or longer than 12 hours during a 24-hour period;	C	These measures ensure that PSOs can effectively monitor for

No	Measure	Description	Project Phase	Expected Effects
		• 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-degree 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 using night-vision goggles with thermal clip-ons, a hand-held spotlight, and/or a mounted thermal camera system; • Activities with larger monitoring zones will use 25 x 150 mm "big eye" binoculars; and • 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.		marine wildlife. Collectively these measures minimize the potential for adverse effects on marine mammals.
3	Acoustic monitoring (WTG and OSS foundation installation only)	• Deployment of PAM system will be outside the perimeter of the shutdown zone (SZ); and • PAM operators will be given adequate breaks and will work no longer than 12 hours per day.	C	The use of PAM better ensures that shutdown zones are free of calling marine mammals before impact pile-driving activities commence.
4	Vessel strike avoidance	Atlantic Shores will implement vessel strike avoidance measures including but not limited to the following except under circumstances when complying with these requirements would put the safety of the vessel or crew at risk or when the vessel is restricted in its ability to maneuver. In addition to the Base Conditions for Vessel Strike Avoidance below, Atlantic Shores will implement a Standard Plan, or an Adaptive Plan as presented below. These three plans are intended to be interchangeable and implemented throughout both the construction and operations phases of the project. Atlantic Shores will submit a final NARW Vessel Strike Avoidance Plan. This plan will be provided to NMFS at least 90 days prior to commencement of vessel use and further details the Adaptive Plan and specific monitoring equipment to be used. The plan will, at a minimum, describe how PAM, in combination with	C, O&M	Training of crew and personnel under the General Operational Measures would minimize the potential for adverse effects on marine mammals by increasing the effectiveness of mitigation and monitoring measures through educational and training materials and avoiding vessel interactions with marine

No	Measure	Description	Project Phase	Expected Effects
		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. General Operational Measures • All personnel working offshore will receive training on marine mammal awareness and vessel strike avoidance measures; • A vessel crew training program will be provided to NMFS for review and approval prior to the start of activities. All vessel crew members will be briefed in the identification of protected species that may occur in the survey area and in regulations and best practices for avoiding vessel collisions. Confirmation of the training and understanding of the requirements will be documented on a training course log sheet. Signing the log sheet will certify that the crew members understand and will comply with the necessary requirements throughout activities offshore; • Vessel personnel will maintain a vigilant watch for marine mammals and slow down or maneuver vessel as appropriate to avoid striking marine mammals; and • When marine mammals are sighted while a vessel is underway, the vessel will take action as necessary to avoid violating the relevant separation distance (e.g., attempt to remain parallel to the animal's course, avoid excessive speed or abrupt changes in direction until the animal has left the area). Operational Separation Distances • Vessels will maintain, to the extent practicable, separation distances of: – Greater than 546 yard (500 meter) distance from any sighted NARW or unidentified large marine mammals – Greater than 109 yards (100 meters) from all other whales; and – Greater than 54 yards (50 meters) from dolphins, porpoises, and seals. Standard Vessel Avoidance Plan • Implement Base Conditions as described above; • **Between November 1st and April 30th:** Vessels greater than		mammals. Operational separation distances would minimize the potential for adverse effects on marine mammals resulting from vessel interactions. The Standard and Adaptive Vessel Avoidance Plans would minimize the potential for ship strikes and impacts to marine mammals. Communication between Project vessels would further reduce potentially adverse effects by alerting vessels to the presence of marine mammals in the area.

No	Measure	Description	Project Phase	Expected Effects
		or equal to 65 feet (19.8 meters) in overall length, excluding CTVs, will operate at 10 knots or less between November 1 and April 30 while transiting to and from the Project Area except while transiting areas which have not been demonstrated by best available science to provide consistent habitat for NARW. Vessels greater than or equal to 65 feet (19.8 meters) in overall length, including CTVs, will operate at 10 knots or less when within any active Seasonal Management Area (SMA); • **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 (transiting or surveying) operating at greater than 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-degree direction of the forward path of the vessel (90 degrees port to 90 degrees 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; and • Visual observers may be third-party observers (i.e., NMFS-approved PSOs) or crew members. <u>Adaptive Vessel Avoidance Plan</u> Atlantic Shores will adhere to the Standard Plan outlined above 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 Atlantic Shores choose not to implement this Adaptive Plan or a component of the Adaptive Plan is offline (e.g., equipment technical issues), Atlantic Shores will default to the Standard Plan (described above). The Adaptive Plan will not apply to vessels greater than or equal to		

No	Measure	Description	Project Phase	Expected Effects
		65 feet (19.8 meters) in length 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 NARW detections are regularly transmitted to a central information portal and disseminated through the situational awareness network; – The transit corridor (i.e., the path a Project vessel will use to transit between the Project Area and the port from which the vessel is operating) and Offshore Project Areas 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 slow-down zone expires when there has been no further visual or acoustic detection in the past 12 hours within the triggered zone; and – 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 at greater than 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-degree direction of the forward path of the vessel (90 degrees port to 90 degrees 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		

No	Measure	Description	Project Phase	Expected Effects
		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 (i.e., an action zone in which a NARW detection has been made within the last 12 hours) within the DMA may trigger a slow down as described above; and • If PAM and/or thermal systems are offline, the Standard Vessel Avoidance Plan measures will apply for the respective zone (where PAM is offline) or vessel (if automated visual systems are offline).		
5	Data recording	• All data will be recorded using industry-standard software, and/or standardized data forms, whether hard copy or electronic; and • Data recorded will include information related to ongoing operations, observation methods and effort, visibility conditions, marine mammal detections (e.g., species, age classification [if known], numbers, behavior), and any mitigation actions requested and enacted.	C, O&M	This mitigation measure would be used to evaluate impacts and potentially lead to additional mitigation measures if required.
6	Reporting	Atlantic Shores will immediately report to appropriate POCs in the following situations: • If a stranded, entangled, injured, or dead marine mammal is observed, the sighting will be reported within 24 hours to the NMFS SAS hotline; • If a protected species is injured or killed as a result of Project activities, the vessel captain or PSO on board will report immediately to NMFS Office of Protected Resources and Greater Atlantic Regional Fisheries Office no later than within 24 hours; and • Any NARW sightings will be reported as soon as feasible and no later than within 24 hours to the NMFS SAS hotline or via the WhaleAlert Application. Data and Final Reports will be prepared using the following protocols: • All vessels will utilize a standardized data entry format; • A database of all sightings and associated details (e.g., distance from vessel, behavior, species, group size/composition) within and outside of the designated SZs,	C, O&M	These monitoring measures would ensure monitoring of mitigation effectiveness and compliance. The data gathered could be used to evaluate impacts and potentially lead to additional mitigation measures, if required.

No	Measure	Description	Project Phase	Expected Effects
		monitoring effort, environmental conditions, and Project-related activity will be provided after field operations and reporting are complete. This database will undergo thorough quality checks and include all variables required by the NMFS-issued Incidental Take Authorization (ITA) and BOEM Lease OCS-A 0499 and will be required for the Final Technical Report due to BOEM and NMFS; • During construction, weekly reports briefly summarizing sightings, detections and activities will be provided to NMFS and BOEM on the immediate Wednesday following a Sunday-Saturday period; • Final reports will follow standardized format for PSO reporting from activities requiring marine mammal mitigation and monitoring; and • An annual report summarizing the prior year's activities will be provided to NMFS and to BOEM on April 1 every calendar year summarizing the prior year's activities.		
7	Visual monitoring for WTG and OSS foundation installation	• There will be six to eight visual PSOs and PAM operators on the impact pile driving vessel and six to eight visual PSOs and PAM operators on any secondary marine mammal monitoring vessel; and • At least two visual PSOs will be on watch on each construction and secondary vessel during pre-start clearance, throughout impact pile driving, and 30 minutes after piling is completed. <u>Daytime Visual Monitoring</u> • PSOs will monitor for 30 minutes before and after each piling event; • Two PSOs will monitor the SZ with the naked eye and reticule binoculars while one PSO periodically scans outside the SZ using the mounted big eye binoculars; and • The secondary vessel, if used, will be positioned and circling at the outer limit of the Large Whale SZ. <u>Daytime Periods of Reduced Visibility</u> • If the monitoring zone is obscured, the two PSOs on watch will continue to monitor the SZ using thermal camera systems and handheld night-vision devices (NVDs), as able; and • All PSOs on duty will be in contact with the on-duty PAM	C	These monitoring measures would not minimize the potential for adverse effects but would ensure the effectiveness of the required mitigation and monitoring measures for marine mammals during impact pile driving.

No	Measure	Description	Project Phase	Expected Effects
		operator who will monitor the PAM systems for acoustic detections of marine mammals that are calling in the area. Nighttime Visual: Construction and Secondary Vessel • Visual PSOs will rotate in pairs: one observing with an NVD and one monitoring the infrared (IR) thermal imaging camera system; and • 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 monitor the required visual zones piling would not occur.		
8	Acoustic monitoring for WTG and OSS foundation installation	• PAM operator will monitor during all pre-start clearance periods, piling, and post-piling monitoring periods (daylight, reduced visibility, and nighttime monitoring); • One 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; and • PAM operator will inform the PSOs on duty of animal detections approaching or within applicable ranges of interest to the pile-driving activity.	C	These monitoring measures would not minimize the potential for adverse effects but would ensure the effectiveness of the required mitigation and monitoring measures for marine mammals during impact pile driving.
9	Shutdown zones for WTG and OSS foundation installation	Mitigation and monitoring zones for Level A harassment are based on modelled, species-specific exposure ranges. The maximum exposure range was chosen for any piling scenario. The Level B monitoring zones, which will be applied to all marine mammal species, are based on the largest acoustic ranges for any piling scenario using the NOAA (2005) data source and modelled by JASCO. The Level A exposure ranges, Level B monitoring zone, mitigation zones, and vessel separation distances for impact pile driving are summarized in the table below. The mitigation zones are subject to modification based on final engineering design. These zones and ranges are based on modeled piling scenarios	C	The establishment of shutdown zones would minimize the potential for adverse effects on marine mammals resulting from impact pile driving.

<table>
<tr><th>No</th><th>Measure</th><th>Description</th><th>Project Phase</th><th>Expected Effects</th></tr>
<tr><td></td><td></td><td>for monopile and jacket pile installation and assume 10 dB broadband noise attenuation. Mitigation zones established for all species, including NARW, will be applied accordingly as depicted in the table below. Monitoring zones for Level B behavioral harassment during the Project may be modified, with NMFS approval, based on measurements of the received sound levels during piling operations.
Mitigation and monitoring zones for Level A harassment assume either one or two monopiles driven per day, and either four pre-piled or post-piled pin piles driven per day. When modeled injury threshold distances differed among these scenarios, the largest for each species group was selected for conservatism. The pre-piling clearance zones for large whales, porpoise, and seals are based upon the maximum Level A exposure zone for each group. The NARW pre-piling clearance zone was established to be equal to the Level B zone to avoid any preventable exposures. The shutdown zones for large whales, NARW, porpoise, and seals are based upon the maximum Level A zone of each group.
<table>
<tr><th>Species Group</th><th>Clearance Zone (m)</th><th>Shutdown Zone (m)</th><th>Level B Monitoring Zone (m)</th></tr>
<tr><td>NARW</td><td>1,900</td><td>1,900</td><td>3,900</td></tr>
<tr><td>Large whales</td><td>1,900</td><td>1,900</td><td>3,900</td></tr>
<tr><td>Delphinids</td><td>1,900</td><td>N/A</td><td>3,900</td></tr>
<tr><td>Harbor porpoise</td><td>1,900</td><td>1,480</td><td>3,900</td></tr>
<tr><td>Seals</td><td>1,900</td><td>320</td><td>3,900</td></tr>
</table></td><td></td><td></td></tr>
<tr><td>10</td><td>Pre-start clearance for WTG and OSS foundation installation</td><td>• Piling may be initiated any time within a 24-hour period;
• Prior to the beginning of each pile driving event, PSOs and PAM operators will monitor for marine mammals for a minimum of 30 minutes and continue at all times during pile driving;
• All clearance zones will be confirmed to be free of marine mammals prior to initiating ramp-up and the large whale clearance zones will be fully visible, and the NARW acoustic zone monitored for at least 30 minutes prior to commencing ramp-up; and</td><td>C</td><td>Pre-start clearance may decrease the potential for impacts on marine mammals during impact pile driving.</td></tr>
</table>

No	Measure	Description	Project Phase	Expected Effects
		• 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 the 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	Ramp up (Soft start) for WTG and OSS foundation installation	• Each monopile installation will begin with a minimum of 20-minute soft-start procedure as technically feasible; • Soft-start procedure will not begin until the clearance zones have been cleared by the visual PSO or PAM operators; and • If a marine mammal is detected within or about to enter the applicable clearance zones, prior to or during the soft-start procedure, pile driving will be delayed until the animal has been observed exiting the clearance zones 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).	C	The establishment of soft-start protocols would minimize the potential for adverse effects and warn animals of the pending impact pile-driving activity in the area and allow them to leave before full hammer power is reached.
12	Shutdowns for WTG and OSS foundation installation	• If a marine mammal is detected entering or within the respective SZs after pile driving has commenced, an immediate shutdown of pile driving will be implemented unless Atlantic Shores 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 SZs are confirmed by PSOs to be clear of marine mammals for the minimum species-specific time periods; • The SZ will be continually monitored by PSOs and PAM during any pauses in pile driving; and • If a marine mammal is sighted within the SZ during a pause in piling, piling will be delayed until the animal(s) has moved outside the SZ and no marine mammals are sighted for a period of 30 minutes.	C	The establishment of shutdown protocols would minimize the potential for adverse effects on marine mammals resulting from impact pile driving.
13	Post-piling monitoring for	PSOs will continue to survey the monitoring zone throughout the	C	This monitoring

No	Measure	Description	Project Phase	Expected Effects
	WTG and OSS foundation installation	duration of pile installation and for a minimum of 30 minutes after piling has been completed.		measure would not minimize adverse effects but would ensure the effectiveness of the required mitigation and monitoring measures for impact pile driving.
14	Noise attenuation for WTG and OSS foundation installation	Atlantic shores will use an NAS for all impact piling events and is committed to achieving 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 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.	C	The reduction in sound levels would reduce the area of underwater noise effects on marine mammals and the prey they feed upon during impact pile driving.
15	Sound measurements for WTG and OSS foundation installation	• Measurements of the installation of at least one WTG and one OSS foundation will be made. If different piled foundation types are selected for the WTGs and/or OSSs between Projects 1 and 2, sound field verification will be conducted for at least one foundation of each piled type. Results of sound field verification will be used to modify SZs, as appropriate; and • For each foundation installation measured, Atlantic Shores will estimate ranges to Level A and Level B harassment isopleths by extrapolating from in-situ measurements at multiple distances from the foundation including at least one measurement location at the most conservative distance for the Exclusion Zone and Monitoring Zone	C	These monitoring measures would not reduce effects but would ensure that the deployed noise reduction technologies and shutdown zones are effective during impact pile driving.
16	Visual monitoring for HRG surveys with sound sources with operating frequencies below 180 kHz	• Four to six PSOs on all 24-hour survey vessels; • Two to three PSOs on all 12-hour survey vessels; and • The PSOs will begin observation of the SZs 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. Daytime Visual Monitoring (period between nautical twilight rise and set for the region)	C, O&M	These monitoring measures would not minimize the potential for adverse effects on marine mammals but would ensure the effectiveness of the required mitigation and monitoring measures

No	Measure	Description	Project Phase	Expected Effects
		• One PSO on watch during all pre-clearance periods and source operation; and • PSOs will use reticule binoculars and the naked eye to scan the monitoring zone for marine mammals. <u>Nighttime and Low Visibility Visual Observations</u> • The lead PSO will determine if conditions warrant implementing reduced visibility protocols; • Two PSOs on watch during all pre-clearance periods and operations; and • Each PSO will use the most appropriate available technology (e.g., IR camera and NVD) and viewing locations to monitor the SZs and maintain vessel separation distances.		for HRG surveys.
17	Shutdown zones for HRG surveys with sound sources with operating frequencies below 180 kHz	• NARW: 547 yards (500 meters) • All other marine mammal species: 109 yards (100 meters) • Certain Delphinus, Lagenorhynchus, Stenella, or Tursiops that are visually detected as voluntarily approaching the vessel or towed equipment: No SZ	C. O&M	The establishment of shutdown zones may decrease the potential for impacts on marine mammals during HRG surveys.
18	Pre-start clearance for HRG surveys with sound sources with operating frequencies below 180 kHz	Pre-start clearance will be conducted during HRG surveys using impulsive sources or non-parametric sub-bottom profilers. • Prior to initiation of equipment ramp-up, PSOs and PAM operators will conduct a 30-minute watch of the clearance zones to monitor for marine mammals; • The clearance zones must be visible using the naked eye or appropriate visual technology during the entire clearance period for operations to start; if the clearance zones are not visible, source operations less than 180 kHz will not commence; and • If a marine mammal is observed within its respective clearance zone during pre-clearance period, ramp-up will not begin until the animal(s) has been observed exiting its respective clearance zone or until an additional time period has elapsed with no further sighting (i.e., 15 minutes for small odontocetes and 30 minutes for all other species).	C, O&M	Pre-clearance may decrease the potential for impacts on marine mammals during HRG surveys.
19	Ramp-up (Soft start) for HRG surveys with sound sources with operating	Ramp-up will be conducted during HRG surveys using impulsive sources or non-parametric sub-bottom profilers. • Ramp-up will not be initiated during periods of inclement	C, O&M	The establishment of soft-start protocols during inclement

No	Measure	Description	Project Phase	Expected Effects
	frequencies below 180 kHz	conditions or if the clearance zones cannot be adequately monitored by the PSOs, using the appropriate visual technology for a 30-minute period; • 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 clearance zone, ramp-up will be delayed; and • Ramp-up will continue once the animal has been observed exiting its respective clearance zone or until an additional time period has elapsed with no further sighting (i.e., 15 minutes for small odontocetes and 30 minutes for all other species).		weather and poor lighting conditions would minimize the potential for adverse effects and warn animals of the pending HRG survey activity in the area, allowing them to leave before full acoustic power is reached.
20	Shutdowns for HRG surveys with sound sources with operating frequencies below 180 kHz	• Shutdown of impulsive, non-parametric HRG survey equipment other than CHIRP SBPs operating at frequencies below 180 kHz is required if a marine mammal is sighted at or within its respective SZ; • 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 SZs; and • 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.	C, O&M	The establishment of shutdown protocols may decrease the potential for impacts on marine mammals during HRG surveys.
21	Visual monitoring for cofferdam installation and removal	• All observations will take place from one of the construction vessels stationed at or near the vibratory piling location; • Two PSOs on duty on the construction vessel; and • PSOs will continue to survey the SZ using visual protocols throughout the installation of each cofferdam sheet pile and for a minimum of 30 minutes after piling has been completed. Daytime Visual Monitoring	C	These monitoring measures would not minimize the potential for adverse effects on marine mammals but would ensure the effectiveness of the

No	Measure	Description	Project Phase	Expected Effects
		• Two PSOs will maintain watch during the pre-start clearance period, throughout the vibratory pile driving, and 30 minutes after piling is completed; • Two PSOs will conduct observations concurrently; and • One observer will monitor the SZ with the naked eye and reticle binoculars; one PSO will monitor in the same way but will periodically scan outside the SZ. Daytime Visual Monitoring during Periods of Low Visibility • One PSO will monitor the SZ with the mounted IR camera while the other maintains visual watch with the naked eye/binoculars.		required mitigation and monitoring measures for vibratory pile driving.
22	Shutdown zones for cofferdam installation and removal	The following shutdown zones will be enacted during vibratory piling if safe and technically feasible to do so: • Large whales (baleen whales and sperm whales): 328 feet (100 meters); • Mid-frequency cetaceans other than sperm whale: 164 feet (50 meters); • Harbor porpoise (high-frequency cetacean): 492 feet (150 meters) • Seals: 197 feet (60 meters)	C	The establishment of shutdown zones would minimize the potential for adverse effects on marine mammals resulting from vibratory pile driving.
23	Pre-start clearance for cofferdam installation and removal	• PSOs will monitor the clearance zone for 30 minutes prior to the start of vibratory pile driving; and • If a marine mammal is observed entering or within the respective clearance zones 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).	C	Pre-clearance to ensure that shutdown zones are free of marine mammals before vibratory pile driving activities can commence would minimize the potential for impacts on marine mammals during vibratory pile driving.
24	Ramp-up (Soft start) for cofferdam installation and removal	Ramp-up (a slow increase in power repeated three times) will be initiated if the clearance zone cannot be adequately monitored (i.e., obscured by fog, inclement weather, poor lighting conditions) for a 30-minute period.	C	The establishment of soft-start protocols during inclement weather and poor lighting conditions would minimize the

No	Measure	Description	Project Phase	Expected Effects
				potential for adverse effects and warn animals of the pending vibratory pile driving in the area, allowing them to leave before full acoustic power is reached.
25	Shutdowns for cofferdam installation and removal	• If a marine mammal is observed entering or within the respective SZs after sheet pile installation has commenced, a shutdown will be implemented; and • SZ 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 SZ and no marine mammals are sighted for a period of 15 minutes (small cetaceans and pinnipeds) or 30 minutes (large cetaceans and deep divers).	C	The establishment of shutdown protocols may decrease the potential for impacts on marine mammals during vibratory pile driving.

C = construction period; O&M = operation and maintenance period; D = decommissioning period

Table 1-11. BOEM-proposed Mitigation, Monitoring, and Reporting Measures Included in the Proposed Action for Consultation with NMFS under the ESA

No	Measure	Description	Project Phase	Expected Effects
1	Incorporate LOA requirements	The measures required by the final MMPA LOA would be incorporated by reference where appropriate into COP approval, and BOEM and/or BSEE would monitor compliance with these measures.	Project Years 1 – 5 (C, O&M)	Incorporation of mitigation measures designed to reduce impacts on marine mammals
2	Vessel strike avoidance for marine mammals and sea turtles	Atlantic Shores must continue to implement vessel strike avoidance measures to include the identified vessel speed restrictions and minimum separation distances for crew transfer vessels agreed to in the Applicant-proposed measures (**Table 1-10**, Measure No. 4).	Project Years 6+ (O&M, D)	Minimizes risk of vessel strikes to marine mammals and sea turtles
3	Marine debris awareness training	The Lessee would ensure that vessel operators, employees, and contractors engaged in offshore activities pursuant to the approved COP complete marine trash and debris awareness training annually. The training consists of two parts: (1) viewing a marine trash and debris training video or slide show (described below); and (2) receiving an	Pre-C, C, O&M, D	Decrease the loss of marine debris which may represent entanglement and/ or ingestions risk

No	Measure	Description	Project Phase	Expected Effects
		explanation from management personnel that emphasizes their commitment to the requirements. The marine trash and debris training videos, training slide packs, and other marine debris related educational material may be obtained at https://www.bsee.gov/debris or by contacting BSEE. The training videos, slides, and related material may be downloaded directly from the website. Operators engaged in marine survey activities would continue to develop and use a marine trash and debris awareness training and certification process that reasonably assures that their employees and contractors are in fact trained. The training process would include the following elements: • Viewing of either a video or slide show by the personnel specified above; • An explanation from management personnel that emphasizes their commitment to the requirements; • Attendance measures (initial and annual); and • Recordkeeping and the availability of records for inspection by DOI. By January 31 of each year, the Lessee would submit to DOI an annual report that describes its marine trash and debris awareness training process and certifies that the training process has been followed for the previous calendar year. The Lessee would send the reports via email to BOEM (at renewable_reporting@boem.gov) and to BSEE (at marinedebris@bsee.gov).		
4	Passive Acoustic Monitoring (PAM) Plan	BOEM and USACE would ensure that Atlantic Shores prepares a PAM Plan that describes all proposed equipment, deployment locations, detection review methodology and other procedures, and protocols related to the proposed uses of PAM for mitigation and long-term monitoring. This plan would be submitted to NMFS and BOEM for review and concurrence at least 120 days prior to the planned start of activities requiring PAM.	C, O&M	Ensure the efficacy of PAM placement for appropriate monitoring
5	Pile Driving Monitoring Plan	BOEM would ensure that Atlantic Shores prepares and submits a *Pile Driving Monitoring Plan* to NMFS for review and concurrence at least 90 days before start of pile driving. The plan would detail all plans and procedures for	C	Ensure adequate monitoring and mitigation is in place during pile driving

No	Measure	Description	Project Phase	Expected Effects
		sound attenuation as well as for monitoring ESA-listed whales and sea turtles during all impact and vibratory pile driving. The plan would also describe how BOEM and Atlantic Shores would determine the number of whales exposed to noise above the Level B harassment threshold during pile driving with the vibratory hammer to install the cofferdam at the sea to shore transition. Atlantic Shores would obtain NMFS' concurrence with this plan prior to starting any pile driving.		
6	PSO coverage	BOEM and USACE would ensure that PSO coverage is sufficient to reliably detect marine mammals and sea turtles at the surface in clearance and shutdown zones to execute any pile driving delays or shutdown requirements during foundation installation. This will include a PSO/PAM team on the construction vessel and two additional PSO vessels each with a visual monitoring team. The following equipment and personnel will be on each associated vessel. Construction Vessel: • 2—visual PSOs on watch; • 2—reticle binoculars (7x or 10x) calibrated for observer height off the water; • 2—"big eye" binoculars (25x or similar) mounted 180° apart if vessel is deemed appropriate to provide a platform in which use of the big eye binoculars would be effective; • 2—handheld or wearable night vision devices with infrared spotlights; • 1—mounted thermal/infrared camera system; • 1—digital single-lens reflex camera equipped with a 300-millimeter lens; • 2—PSO-dedicated VHF radios; • 1—PAM operator on duty; • 1—monitoring station for real-time PAM system; and • 1—data collection software system. Each Additional PSO Vessel (2): • 2—visual PSOs on watch;	C	Ensure adequate monitoring of zones

No	Measure	Description	Project Phase	Expected Effects
		• 2—reticle binoculars (7x or 10x) calibrated for observer • height off the water; • 1—mounted "big eye" binoculars (25x or similar) if vessel is deemed appropriate to provide a platform in which use of the big eye binoculars would be effective; • 1—handheld or wearable night vision device with infrared spotlight; • 1—mounted thermal/IR camera system; • 1—digital single lens reflex camera equipped with a 300-mm lens; • 2—PSO-dedicated VHF radios; and • 1—data collection software system. If, at any point prior to or during construction, the PSO coverage that is included as part of the Proposed Action is determined not to be sufficient to reliably detect ESA-listed whales and sea turtles within the clearance and shutdown zones, additional PSOs and/or platforms would be deployed. Determinations prior to construction would be based on review of the *Pile Driving Monitoring Plan*. Determinations during construction would be based on review of the weekly pile driving reports and other information, as appropriate.		
7	Sound field verification	Applicant proposed measures plus: BOEM and USACE would ensure that if the clearance and/or shutdown zones are expanded due to the results of verification of sound fields from Project activities, PSO coverage is sufficient to reliably monitor the expanded clearance and/or shutdown zones. Additional observers would be deployed on additional platforms for every 1,500 meters that a clearance or shutdown zone is expanded beyond the distances modeled prior to verification.	C	Ensure adequate monitoring of clearance zones
8	Adaptive shutdown zones	BOEM and USACE may consider reductions in the shutdown zones for ESA-listed sei, fin, or sperm whales based upon sound field verification of a minimum of 3 piles. Sound field verification of additional piles may be required based on results of actual measurements.. However, BOEM/USACE would ensure that the shutdown zone for	C	Ensures that shut down zones are sufficiently conservative

No	Measure	Description	Project Phase	Expected Effects
		sei, fin, and sperm whales is not reduced to less than 1,000 m, or 500 m for ESA-listed sea turtles. No reductions in the clearance or shutdown zones for NARWs would be considered regardless of the results of sound field verification of a minimum of three piles.		
9	Monitoring zone for sea turtles	BOEM and USACE would ensure that Atlantic Shores monitors the full extent of the area where noise would exceed the 175 dB rms threshold for ESA-listed sea turtles for the full duration of all pile driving activities and for 30 minutes following the cessation of pile driving activities and record all observations in order to ensure that all take that occurs is documented.	C	Ensures accurate monitoring of sea turtle take
10	Look out for sea turtles and reporting	a. For all vessels operating north of the Virginia/North Carolina border, between June 1 and November 30, Atlantic Shores would have a trained lookout posted on all vessel transits during all phases of the Projects to observe for sea turtles. The trained lookout would communicate any sightings, in real time, to the captain so that the requirements in (e) below can be implemented. b. For all vessels operating south of the Virginia/North Carolina border, year-round, Atlantic Shores would have a trained lookout posted on all vessel transits during all phases of the Projects to observe for sea turtles. The trained lookout would communicate any sightings, in real time, to the captain so that the requirements in (e) below can be implemented. This requirement would be in place year-round for any vessels transiting south of Virginia, as sea turtles are present year-round in those waters. c. The trained lookout would monitor https://seaturtlesightings.org/ prior to each trip and report any observations of sea turtles in the vicinity of the planned transit to all vessel operators/captains and lookouts on duty that day. d. The trained lookout would maintain a vigilant watch and monitor a 500-m Vessel Strike Avoidance Zone at all times to minimize potential vessel strikes of ESA-listed sea turtle species. Alternative monitoring technology (e.g., infrared spotlight in combination with night vision, thermal cameras,	Pre-C, C, O&M, D	Minimizes risk of vessel strikes to sea turtles

No	Measure	Description	Project Phase	Expected Effects
		etc.) would be available to ensure effective watch at night and in any other low visibility conditions. If the trained lookout is a vessel crew member, this would be their designated role and primary responsibility while the vessel is transiting. Any designated crew lookouts would receive training on protected species identification, vessel strike minimization procedures, how and when to communicate with the vessel captain, and reporting requirements. e. If a sea turtle is sighted within 100 m or less of the operating vessel's forward path, the vessel operator would slow down to 4 knots (unless unsafe to do so) and then proceed away from the turtle at a speed of 4 knots or less until there is a separation distance of at least 100 m at which time the vessel may resume normal operations. If a sea turtle is sighted within 50 m of the forward path of the operating vessel, the vessel operator would shift to neutral when safe to do so and then proceed away from the turtle at a speed of 4 knots. The vessel may resume normal operations once it has passed the turtle. f. Vessel captains/operators would avoid transiting through areas of visible jellyfish aggregations or floating sargassum lines or mats. In the event that operational safety prevents avoidance of such areas, vessels would slow to 4 knots while transiting through such areas. g. All vessel crew members would be briefed in the identification of sea turtles and in regulations and best practices for avoiding vessel collisions. Reference materials would be available aboard all Project vessels for identification of sea turtles. The expectation and process for reporting of sea turtles (including live, entangled, and dead individuals) would be clearly communicated and posted in highly visible locations aboard all Project vessels, so that there is an expectation for reporting to the designated vessel contact (such as the lookout or the vessel captain), as well as a communication channel and process for crew members to do so. h. The only exception is when the safety of the vessel or crew necessitates deviation from these requirements on an		

No	Measure	Description	Project Phase	Expected Effects
		emergency basis. If any such incidents occur, they must be reported to NMFS within 24 hours. i. If a vessel is carrying a PSO or trained lookout for the purposes of maintaining watch for NARWs, an additional lookout is not required and this PSO or trained lookout must maintain watch for whales and sea turtles. j. Vessel transits to and from the Wind Farm Area, that require PSOs will maintain a speed commensurate with weather conditions and effectively detecting sea turtles prior to reaching the 100 m avoidance measure.		
11	Vessel strike avoidance for Rice's whale	For vessels operating in the Gulf of Mexico, the Lessee shall ensure that vessel operators and crews associated with the Proposed Action are aware of the presence of Rice's whale in the Gulf of Mexico. Rice's whales are protected under the Endangered Species Act of 1973 and the Marine Mammal Protection Act of 1972. All Project vessels transiting the Gulf of Mexico must comply with the Rice's whale mitigation measures outlined below. If a whale is observed in the Gulf of Mexico and cannot be confirmed to be a species other than a Rice's whale, the vessel operator and crew must assume the whale is a Rice's whale and comply with mitigation requirements accordingly. a. All vessels associated with the Proposed Action must have a least one dedicated visual observer on duty during daylight hours who is responsible for keeping watch for Rice's whales and ensuring compliance with Rice's whale mitigation measures, as detailed below. Visual observers may be third-party observers (i.e., PSOs) or crew members. Visual observers must have sufficient training to distinguish marine mammals from other phenomena and broadly to identify a marine mammal as a Rice's whale, other whale (defined in this context as sperm whales or baleen whales other than Rice's whales), or other marine mammal. b. All Project vessels must maintain a minimum separation distance of 546 yards (500 meters) from Rice's whales. If a Rice's whale is sighted within 546 yards (500 meters) of a vessel, the vessel must slow down, stop their vessel, or	C	Minimize vessel strike risk for Rice's whale

No	Measure	Description	Project Phase	Expected Effects
		alter course, as appropriate and regardless of vessel size, to avoid a vessel strike. All known or suspected collisions with Rice's whales or other whales must be reported immediately by calling 1-877-WHALE-HELP. c. If a Rice's whale (and any other whales that may be Rice's whales) is observed at any time by PSOs or Project personnel, Atlantic Shores, or their contractors, must immediately (if not feasible, as soon as possible and no longer than 24 hours after the sighting) report sighting information to NMFS by calling 1-877-WHALE-HELP. i. If calling the hotline is not possible, sighting reports should be submitted to nmfs.ser.re.sightings@noaa.gov. ii. The sighting report should include the time, date, and location (latitude/longitude) of the sighting, number of whales, animal description/certainty of sighting (provide photos/video if taken), lease area/project name, PSO/personnel name, PSO provider company (if applicable), and contact info. iii. All sighting reports must also be submitted to renewable_reporting@boem.gov and protectedspecies@bsee.gov d. All vessels associated with the Proposed Action must be equipped with a functioning Automatic Identification System (AIS) that is operational and actively transmitting. All static data (e.g., vessel MMSI number, name, vessel type) and voyage related data (e.g., navigational status, static draft, destination) must be entered into AIS accurately. AIS is required to monitor the number of vessels and traffic patterns for analysis and compliance with vessel speed requirements and to make identification of infrastructure easier for non-Project vessels. The Lessee must submit to BOEM a report with the AIS data at the time it submits the certification of compliance required under 30 CFR §585.633(b). Additional Requirements within the 328 to 1,312-Foot (100 to 400 Meter) Isobath Project vessels operating in the 328 to 1,312-foot (100 to 400-meter) isobath within the Gulf of Mexico must comply		

No	Measure	Description	Project Phase	Expected Effects
		with requirements a through d above, as well as the following additional requirements: a. All vessels associated with the Proposed Action are strongly encouraged to minimize transit distance within the 328 to 1,312-foot (100 to 400-meter) isobath. b. All vessels, regardless of size, must observe a 10-knot or less year-round speed restriction at all times when transiting through the 328 to 1,312-foot (100 to 400-meter) isobath. The only exception to the 10-knot vessel speed restriction would be when the safety of the vessel or crew is in doubt or the safety of the life at sea is in question. <u>Additional Requirements within the Rice's Whale Core Distribution Area (CDA)</u> Project vessels operating in the Rice's whale CDA within the Gulf of Mexico must comply with requirements a through d above, as well as the following additional requirements: a. All vessels associated with the Proposed Action should avoid transit in the Rice's whale CDA. b. If transiting within the Rice's whale CDA cannot be avoided, all vessels, regardless of size, must observe a 10-knot or less, year-round speed restriction during daylight hours. The only exception to the 10-knot vessel speed restriction would be when the safety of the vessel or crew is in doubt of the safety of life at sea is in question. c. Vessel transit through the CDA is not permitted at nighttime or in low visibility conditions (e.g., fog, surface winds greater than 11 knots, average wave height greater than 3 feet) except for emergencies when the safety of the vessel or crew is in doubt or the safety of life at sea is in question. d. If an operator deviates from these conditions/protocols, a record of said noncompliance must be generated and include the following information: the lease number; vessel name; automatic identification system (AIS) ID; environmental conditions, including Beaufort scale (wind speed/wave height) and any other relevant weather conditions, including cloud cover, fog, sun glare, and		

No	Measure	Description	Project Phase	Expected Effects
		overall visibility on the horizon; deviations and reasons for exceeding speed restrictions; deviations and reasons for transit through the CDA at nighttime or in low visibility conditions; all interactions with Rice's whales and/or approaches within 546 yards (500 meters). Additionally, all "sighting report(s)" associated with the transit must be appended to the Transit Report. The Lessee must submit the Transit Report(s) to renewable_reporting@boem.gov, protectedspecies@bsee.gov, and nmfs.ser.rw.sightings@noaa.gov within 24 hours of transit through the Rice's whale CDA. The subject of the email should include "Transit through Rice's Whale CDA."		
12	Sampling gear	All sampling gear would be hauled at least once every 30 days, and all gear would be removed from the water and stored on land between survey seasons to minimize risk of entanglement.	All fisheries surveys	Minimizes risk of entanglement
13	Gear identification	To facilitate identification of gear on any entangled animals, all trap/pot gear used in the surveys would be uniquely marked to distinguish it from other commercial or recreational gear. Using yellow and black striped duct tape, place a 3-foot-long mark within 2 fathoms of a buoy. In addition, using black and white paint or duct tape, place 3 additional marks on the top, middle and bottom of the line. These gear marking colors are proposed as they are not gear markings used in other fisheries and are therefore distinct. Any changes in marking would not be made without notification and approval from NMFS.	Pot/trap surveys	Distinguishes survey gear from other commercial or recreational gear
14	Lost survey gear	If any survey gear is lost, all reasonable efforts that do not compromise human safety would be undertaken to recover the gear. All lost gear would be reported to NMFS (nmfs.gar.incidental-take@noaa.gov) within 24 hours of the documented time of missing or lost gear. This report would include information on any markings on the gear and any efforts undertaken or planned to recover the gear.	All fisheries surveys	Promotes recovery of lost gear
15	Survey training	At least one of the survey staff onboard the trawl surveys and ventless trap surveys would have completed NEFOP observer training (within the last 5 years) or other training in	Trawl and ventless trap surveys	Promotes safe handling and release

No	Measure	Description	Project Phase	Expected Effects
		protected species identification and safe handling (inclusive of taking genetic samples from Atlantic sturgeon). Reference materials for identification, disentanglement, safe handling, and genetic sampling procedures would be available on board each survey vessel. BOEM would ensure that Atlantic Shores prepares a training plan that addresses how this requirement would be met and that the plan is submitted to NMFS in advance of any trawl or trap surveys. This requirement is in place for any trips where gear is set or hauled.		of Atlantic sturgeon
16	Sea turtle disentanglement	Vessels deploying fixed gear (e.g., pots/traps) would have adequate disentanglement equipment (i.e., knife and boathook) onboard. Any disentanglement would occur consistent with the Northeast Atlantic Coast STDN Disentanglement Guidelines at https://www.reginfo.gov/public/do/DownloadDocument?objectID=102486501 and the procedures described in "Careful Release Protocols for Sea Turtle Release with Minimal Injury" (NOAA Technical Memorandum 580; https://repository.library.noaa.gov/view/noaa/3773).	Pot/trap surveys	Requires disentanglement of sea turtles caught in gear
17	Sea turtle/Atlantic sturgeon identification and data collection	Any sea turtles or Atlantic sturgeon caught and/or retrieved in any fisheries survey gear would first be identified to species or species group. Each ESA-listed species caught and/or retrieved would then be properly documented using appropriate equipment and data collection forms. Biological data, samples, and tagging would occur as outlined below. Live, uninjured animals should be returned to the water as quickly as possible after completing the required handling and documentation. a. The Sturgeon and Sea Turtle Take Standard Operating Procedures would be followed (https://media.fisheries.noaa.gov/2021-11/Sturgeon%20%26%20Sea%20Turtle%20Take%20SOPs_external_11032021.pdf). b. Survey vessels would have a passive integrated transponder (PIT) tag reader onboard capable of reading 134.2 kHz and 125 kHz encrypted tags (e.g., Biomark GPR Plus Handheld PIT Tag Reader) and this reader be used to	All fisheries surveys	Requires standard data collection and documentation of any sea turtle/ Atlantic sturgeon caught during surveys

No	Measure	Description	Project Phase	Expected Effects
		scan any captured sea turtles and sturgeon for tags. Any recorded tags would be recorded on the take reporting form (see below). c. Genetic samples would be taken from all captured Atlantic sturgeon (alive or dead) to allow for identification of the DPS of origin of captured individuals and tracking of the amount of incidental take. This would be done in accordance with the Procedures for Obtaining Sturgeon Fin Clips (https://media.fisheries.noaa.gov/dam-migration/sturgeon_genetics_sampling_revised_june_2019.pdf). i. Fin clips would be sent to a NMFS-approved laboratory capable of performing genetic analysis and assignment to DPS of origin. To the extent authorized by law, BOEM is responsible for the cost of the genetic analysis. Arrangements would be made for shipping and analysis in advance of submission of any samples; these arrangements would be confirmed in writing to NMFS within 60 days of the receipt of the Project BiOp with ITS. Results of genetic analysis, including assigned DPS of origin would be submitted to NMFS within 6 months of the sample collection. ii. Subsamples of all fin clips and accompanying metadata forms would be held and submitted to a tissue repository (e.g., the Atlantic Coast Sturgeon Tissue Research Repository) on a quarterly basis. The Sturgeon Genetic Sample Submission Form is available for download at: https://media.fisheries.noaa.gov/2021-02/Sturgeon%20Genetic%20Sample%20Submission%20sheet%20for%20S7_v1.1_Form%20to%20Use.xlsx?nullhttps://www.fisheries.noaa.gov/new-england-mid-atlantic/consultations/section-7-take-reporting-programmatics-greater-atlantic. d. All captured sea turtles and Atlantic sturgeon would be documented with required measurements and photographs. The animal's condition and any marks or injuries would be described. This information would be entered as part of the record for each incidental take. A		

No	Measure	Description	Project Phase	Expected Effects
		NMFS Take Report Form would be filled out for each individual sturgeon and sea turtle (download at: https://media.fisheries.noaa.gov/2021-07/Take%20Report%20Form%2007162021.pdf?null) and submitted to NMFS as described in the take notification measure below.		
18	Sea turtle/Atlantic sturgeon handling and resuscitation guidelines	Any sea turtles or Atlantic sturgeon caught and retrieved in gear used in fisheries surveys would be handled and resuscitated (if unresponsive) according to established protocols and whenever at-sea conditions are safe for those handling and resuscitating the animal(s) to do so. Specifically: a. Priority would be given to the handling and resuscitation of any sea turtles or sturgeon that are captured in the gear being used, if conditions at sea are safe to do so. Handling times for these species should be minimized (i.e., kept to 15 minutes or less) to limit the amount of stress placed on the animals. b. All survey vessels would have copies of the sea turtle handling and resuscitation requirements found at 50 CFR 223.206(d)(1) prior to the commencement of any on-water activity (download at: https://media.fisheries.noaa.gov/dam-migration/sea_turtle_handling_and_resuscitation_measures.pdf). These handling and resuscitation procedures would be carried out any time a sea turtle is incidentally captured and brought onboard the vessel during the Proposed Action. c. If any sea turtles that appear injured, sick, or distressed, are caught and retrieved in fisheries survey gear, survey staff would immediately contact the Greater Atlantic Region Marine Animal Hotline at 866-755-6622 for further instructions and guidance on handling the animal, and potential coordination of transfer to a rehabilitation facility. If unable to contact the hotline (e.g., due to distance from shore or lack of ability to communicate via phone), the USCG should be contacted via VHF marine radio on Channel 16. If required, hard-shelled sea turtles (i.e., non-leatherbacks) may be held on board for up to 24 hours	All fisheries surveys	Ensures the safe handling and resuscitation of sea turtles and Atlantic sturgeon following established protocols

No	Measure	Description	Project Phase	Expected Effects
		following handling instructions provided by the Hotline, prior to transfer to a rehabilitation facility. d. Attempts would be made to resuscitate any Atlantic sturgeon that are unresponsive or comatose by providing a running source of water over the gills as described in the Sturgeon Resuscitation Guidelines (https://media.fisheries.noaa.gov/dam-migration/sturgeon_resuscitation_card_06122020_508.pdf). e. Provided that appropriate cold storage facilities are available on the survey vessel, following the report of a dead sea turtle or sturgeon to NMFS, and if NMFS requests, any dead sea turtle or Atlantic sturgeon would be retained on board the survey vessel for transfer to an appropriately permitted partner or facility on shore as safe to do so. f. Any live sea turtles or Atlantic sturgeon caught and retrieved in gear used in any fisheries survey would ultimately be released according to established protocols and whenever at-sea conditions are safe for those releasing the animal(s) to do so.		
19	Take notification	GARFO PRD would be notified as soon as possible of all observed takes of sea turtles, and Atlantic sturgeon occurring as a result of any fisheries survey. Specifically: a. GARFO PRD would be notified within 24 hours of any interaction with a sea turtle or sturgeon (nmfs.gar.incidental-take@noaa.gov). The report would include at a minimum: (1) survey name and applicable information (e.g., vessel name, station number); (2) GPS coordinates describing the location of the interaction (in decimal degrees); (3) gear type involved (e.g., bottom trawl, gillnet, longline); (4) soak time, gear configuration and any other pertinent gear information; (5) time and date of the interaction; and (6) identification of the animal to the species level. Additionally, the e-mail would transmit a copy of the NMFS Take Report Form (download at: https://media.fisheries.noaa.gov/2021-07/Take%20Report%20Form%2007162021.pdf?null) and a	All fisheries surveys	Establishes procedures for immediate reporting of sea turtle/ Atlantic sturgeon take

No	Measure	Description	Project Phase	Expected Effects
		link to or acknowledgement that a clear photograph or video of the animal was taken (multiple photographs are suggested, including at least one photograph of the head scutes). If reporting within 24 hours is not possible due to distance from shore or lack of ability to communicate via phone, fax, or email, reports would be submitted as soon as possible; late reports would be submitted with an explanation for the delay. b. At the end of each survey season, a report would be sent to NMFS that compiles all information on any observations and interactions with ESA-listed species. This report would also contain information on all survey activities that took place during the season including location of gear set, duration of soak/trawl, and total effort. The report on survey activities would be comprehensive of all activities, regardless of whether ESA-listed species were observed.		
20	Monthly/annual reporting requirements	BOEM would ensure that Atlantic Shores implements the following reporting requirements necessary to document the amount or extent of take that occurs during all phases of the Proposed Action: a. All reports would be sent to: nmfs.gar.incidental-take@noaa.gov. b. During the construction phase and for the first year of operations, Atlantic Shores would compile and submit monthly reports that include a summary of all Project activities carried out in the previous month, including vessel transits (number, type of vessel, and route), and piles installed, and all observations of ESA-listed species. Monthly reports are due on the 15th of the month for the previous month. c. Beginning in year 2 of operations, Atlantic Shores would compile and submit annual reports that include a summary of all Project activities carried out in the previous year, including vessel transits (number, type of vessel, and route), repair and maintenance activities, survey activities, and all observations of ESA-listed species. These reports are due by April 1 of each year (i.e., the 2026 report is due by April 1, 2027). Upon mutual agreement of NMFS and	C, O&M	Establishes reporting requirements and timing to document take and operator activities

No	Measure	Description	Project Phase	Expected Effects
		BOEM, the frequency of reports can be changed.		
21	BOEM/NMFS meeting requirements for sea turtle take documentation	To facilitate monitoring of the incidental take exemption for sea turtles, through the first year of operations, BOEM and NMFS would meet twice annually to review sea turtle observation records. These meetings/conference calls would be held in September (to review observations through August of that year) and December (to review observations from September to November) and would use the best available information on sea turtle presence, distribution, and abundance, Project vessel activity, and observations to estimate the total number of sea turtle vessel strikes in the action area that are attributable to Project operations. These meetings would continue on an annual basis following year 1 of operations. Upon mutual agreement of NMFS and BOEM, the frequency of these meetings can be changed.	C, O&M Year 1	
22	Data Collection BA BMPs	BOEM would ensure that all Project Design Criteria and Best Management Practices incorporated in the Atlantic Data Collection consultation for Offshore Wind Activities (June 2021) shall be applied to activities associated with the construction, maintenance and operations of the Atlantic Shores Wind project as applicable.	Pre-C, C, O&M, D	Incorporates previously determined best management practices to reduce the likelihood of take of listed species during surveys, vessel operations, and maintenance in the Atlantic OCS.
23	Alternative Monitoring Plan (AMP) for pile driving	The Lessee must not conduct pile driving operations at any time when lighting or weather conditions (e.g., darkness, rain, fog, sea state) prevent visual monitoring of the full extent of the clearance and shutdown zones. The Lessee must submit an AMP to BOEM and NMFS for review and approval at least 6 months prior to the planned start of pile-driving. This plan may include deploying additional observers, alternative monitoring technologies such as night vision, thermal, and infrared technologies, and use of PAM and must demonstrate the ability and effectiveness to maintain clearance all pre-clearance and shutdown zones during daytime as outlined below in Part 1	C	Establishes requirement for low visibility impact pile driving approval

No	Measure	Description	Project Phase	Expected Effects
		and nighttime as outlined below in Part 2 to BOEM's and NMFS's satisfaction. The AMP must include two stand-alone components as described below: • Part 1 – Daytime when lighting or weather (e.g., fog, rain, sea state) conditions prevent visual monitoring of the full extent of the clearance and shutdown zones. Daytime being defined as one hour after civil sunrise to 1.5 hours before civil sunset. • Part 2 – Nighttime inclusive of weather conditions (e.g., fog, rain, sea state). Nighttime being defined as 1.5 hours before civil sunset to one hour after civil sunrise. If a protected marine mammal or sea turtle is observed entering or found within the shutdown zones after impact pile-driving has commenced, the Lessee would follow the shutdown procedures outlined in Section 1.4.4 of the Protected Species Management and Equipment Specifications Plan. The Lessee would notify BOEM and NMFS of any shutdown occurrence during pile driving operations within 24 hours of the occurrence unless otherwise authorized by BOEM and NMFS. The AMP should include, but is not limited to the following information: • Identification of night vision devices (e.g., mounted thermal/IR camera systems, hand-held or wearable NVDs, IR spotlights), if proposed for use to detect protected marine mammal and sea turtle species. • The AMP must demonstrate (through empirical evidence) the capability of the proposed monitoring methodology to detect marine mammals and sea turtles within the full extent of the established clearance and shutdown zones (i.e., species can be detected at the same distances and with similar confidence) with the same effectiveness as daytime visual monitoring (i.e., same detection probability). Only devices and methods demonstrated as being capable of detecting marine mammals and sea		

No	Measure	Description	Project Phase	Expected Effects
		turtles to the maximum extent of the clearance and shutdown zones will be acceptable. • Evidence and discussion of the efficacy (range and accuracy) of each device proposed for low visibility monitoring must include an assessment of the results of field studies (e.g., Thayer Mahan demonstration), as well as supporting documentation regarding the efficacy of all proposed alternative monitoring methods (e.g., best scientific data available). • Procedures and timeframes for notifying NMFS and BOEM of Atlantic Shores' intent to pursue nighttime pile driving. • Reporting procedures, contacts and timeframes. BOEM may request additional information, when appropriate, to assess the efficacy of the AMP		
24	Periodic underwater surveys, reporting of monofilament and other fishing gear around WTG foundations	The Lessee must monitor indirect impacts associated with charter and recreational fishing gear lost from expected increases in fishing around WTG foundations by surveying at least ten of the WTGs located closest to shore in each Project 1 and Project 2 area of the Atlantic Shores South Lease Area (OCS-A 0499) annually. If Atlantic Shores utilizes piled jacket foundations for WTGs in Project 2, BOEM may increase the number of foundations that must be surveyed in Project 2. Survey design and effort (i.e., the number of WTGs and frequency of reporting) may be modified only upon concurrence by BOEM and BSEE. The Lessee must conduct surveys by remotely operated vehicles, divers, or other means to determine the frequency and locations of marine debris. The Lessee must report the results of the surveys to BOEM (at renewable_reporting@boem.gov) and BSEE (at marinedebris@bsee.gov) in an annual report, submitted by April 30 for the preceding calendar year. Annual reports must be submitted in Microsoft Word format. Photographic and videographic materials must be provided on a portable drive in a lossless format such as TIFF or Motion JPEG 2000. Annual reports must include survey reports that include: the survey date; contact information of the	O&M	Establishes requirement for monitoring and reporting of lost monofilament and other fishing gear around WTGs

No	Measure	Description	Project Phase	Expected Effects
		operator; the location and pile identification number; photographic and/or video documentation of the survey and debris encountered; any animals sighted; and the disposition of any located debris (i.e., removed or left in place). Required data and reports may be archived, analyzed, published, and disseminated by BOEM.		
25	PDC minimize vessel interactions with protected species (from HRG Programmatic)	All vessels associated with survey activities (transiting [i.e., travelling between a port and the survey site] or actively surveying) must comply with the vessel strike avoidance measures (PDC 5) specified in the Project Design Criteria and Best Management Practices for Protected Species Associated with Offshore Wind Data Collection, last revised in November 2021, including the measures below. The only exception is when the safety of the vessel or crew necessitates deviation from these requirements. • If any ESA-listed marine mammal is sighted within 500 m of the forward path of a vessel, the vessel operator must steer a course away from the whale at <10 knots (18.5 km/hr) until the minimum separation distance has been established. Vessels may also shift to idle if feasible. • If any ESA-listed marine mammal is sighted within 200 m of the forward path of a vessel, the vessel operator must reduce speed and shift the engine to neutral. Engines must not be engaged until the whale has moved outside of the vessel's path and beyond 500 meters. If stationary, the vessel must not engage engines until the large whale has moved beyond 500 m. • If a sea turtle or manta ray is sighted at any distance within the operating vessel's forward path, the vessel operator must slow down to 4 knots and steer away (unless unsafe to do so). The vessel may resume normal vessel operations once the vessel has passed the individual.	Pre-C, C, O&M, D	Establishes requirement for vessel strike avoidance measures
26	Operational Sound Field Verification Plan	BOEM would require the Lessee to develop an operational sound field verification plan to determine the operational noises emitted from the Offshore Wind Area. The plan must include measurement procedures and results reporting that meet ISO standard 18406:2017 (Underwater acoustics –	O&M	Establishes requirement for operational noise monitoring

No	Measure	Description	Project Phase	Expected Effects
		Measurement of radiated underwater sound from percussive pile driving). The plan would be reviewed and approved by BOEM and NMFS.		
27	Sound field verification of foundation installation	Atlantic Shores must submit a Sound Field Verification Plan consistent with requirements of the NMFS Biological Opinion. The results of sound field verification must be compared to modeled injury and disturbance isopleths for marine mammals, sea turtles, and Atlantic sturgeon.	C	Verifies that modeled acoustic ranges to recommended sea turtle thresholds were conservative enough to not underestimate the number of marine mammal and sea turtle exposures during foundation installation.
28	Minimum visibility requirement	In order to commence pile driving at foundations, PSOs must be able to visually monitor a 6,244-foot (1,900-meter) radius from their observation points for at least 60 minutes immediately prior to piling commencement. In order to commence pile driving at trenchless installation sites, PSOs must be able to visually monitor a 3,280-foot (1,000-meter) radius from their observation points for at least 30 minutes immediately prior to piling commencement. Acceptable visibility will be determined by the Lead PSO.	C	Ensures adequate monitoring of zones, which would minimize noise-related effects on marine mammals

C = construction period; O&M = operation and maintenance period; D = decommissioning period

2. ENVIRONMENTAL BASELINE

The environmental baseline consists of existing habitat conditions in the action area and listed species use of the action area, considering the past and present impacts of the following:

- All federal, state, or private actions and other human activities that have influenced the condition of the action area
- The anticipated impacts of all proposed federal actions that have already undergone formal or early Section 7 consultation
- The impact of state or private actions that are contemporaneous with the consultation in process (50 CFR 402.02)

Within this section, BOEM presents information on the conditions of the action area and other activities that would occur in the action area to inform consideration of the effects of the Proposed Action.

2.1. PHYSICAL ENVIRONMENT

Atlantic Shores conducted detailed surveys of the action area during COP development, including multi-season geophysical and geotechnical surveys conducted from May 2020 to August 2021 to collect data on water depths, seafloor morphology, seafloor conditions, anthropogenic features, and subsurface conditions and stratigraphy. Those surveys are the most current information available for characterizing baseline physical conditions and are relied upon here and supported by other appropriate sources of information where available.

2.1.1 Seabed and Physical Oceanographic Conditions

2.1.1.1. Seabed Conditions

Atlantic Shores collected G&G survey data throughout the Project area. These data indicate that the seabed in the Lease area and proposed cable routes is generally flat with a very gently to gently dipping seabed between 1 and 3 degrees to the south-southeast (Atlantic Shores 2023a). Seafloor features include sand bedforms and swales (COP Volume II, Appendices II-A1 and II-A6; Atlantic Shores 2023a). Seafloor morphology also includes megaripples, ripples, unconsolidated marine sediment, hummocky seafloor, and irregular seafloor (COP Volume II, Appendix II-A1; Atlantic Shores 2023a). Ripples are the predominant feature in the Atlantic and Monmouth export cable corridors (Atlantic Shores 2023a).

Surficial sediment mapping indicates a predominantly sand seafloor with decreasing grain size to the south throughout the Lease area (MARCO 2020). Sands with less than 5% gravel are predominant in the south portion of the lease area and near the export cable landfall locations (Atlantic Shores 2023a). Gravel, gravel mixes, and gravelly sand predominate in the north and west portions of the Lease Area (Atlantic Shores 2023a).

Within the Lease area, water depths range from 56 to 125 feet (17 to 38 meters) at mean lower low water (MLLW) (**Figure 2-1**) (COP Volume II, Appendix II-A1; Atlantic Shores 2023a). Within the areas surveyed for the export cable corridors, water depths range from less than 0.3 feet (0.1 meters) to 115 feet (35 meters) at MLLW (COP Volume II, Appendix II-A1; Atlantic Shores 2023a).

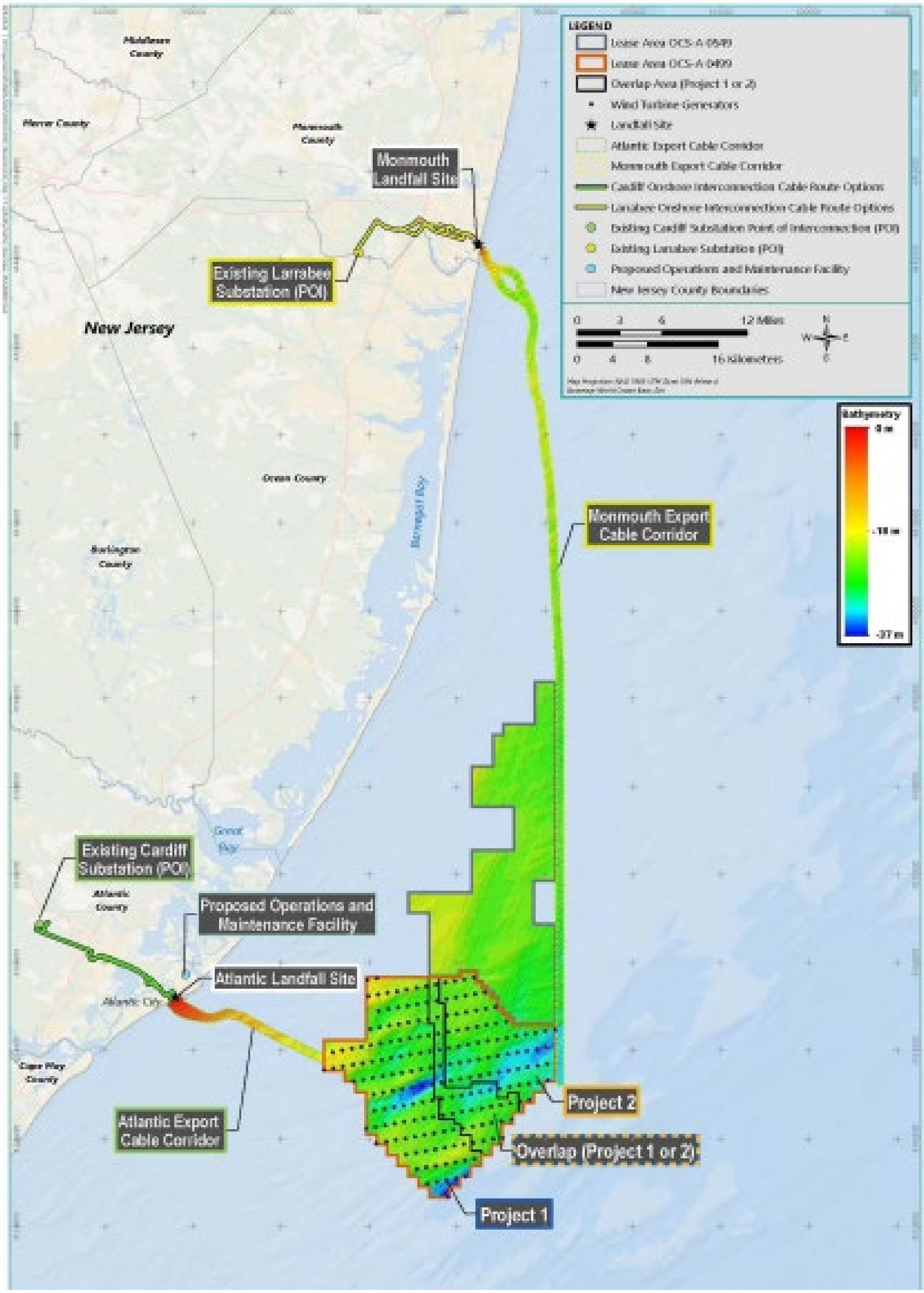

Figure 2-1. Bathymetry in the Project Area

2.1.1.2. Oceanographic Conditions

The Project Area is influenced by the northward flowing Gulf Stream ocean current system and southward flowing cool water from New England (Atlantic Shores 2023a). Average surface flow over the OCS in the Project Area is from 1 to 5 inches per second (2 and 12 centimeters per second). Modeled extreme current speeds for the Mid-Atlantic Bight were up to 1.21 feet per second (0.37 meters per second) (Atlantic Shores 2023a).

Bottom water temperatures in the New Jersey WEA ranged from 35.6 degrees Fahrenheit (°F) to 73.4°F (2 to 23 degrees Celsius [°C]) between 2003 and 2016 (Guida et al. 2017). Seasonal water temperature fluctuations in those years were up to 68°F (20°C) at the surface and 59°F (15°C) at the bottom (Guida et al. 2017). The warmest temperatures occur from July through September at the surface and in September at the bottom (Guida et al. 2017). The coldest temperatures occur in February (Guida et al. 2017).

2.1.1.3. Water Quality

Pollutants in the region generally originate from inshore point (e.g., regulated discharges) and nonpoint (e.g., stormwater runoff) sources. Contaminants originating from offshore sources are limited to discharges from ships. Water quality generally improves with distance from shore.

Water quality measurements were taken in 2010 from 23 indicator locations near the WTA and export cable corridors by the EPA (Atlantic Shores 2023a). These measurements indicate that suspended particle concentrations range from 17.2 to 35.7 milligrams per liter (mg/L) (EPA 2016). Dissolved inorganic nitrogen ranges from 0.002 to 0.97 micrograms per liter (µg/L), and dissolved inorganic phosphorus ranges from 0.007 to 0.284 µg/L. Dissolved oxygen (DO) concentrations range between 2.6 and 9.1 mg/L (EPA 2016). Chlorophyll *a* concentrations vary seasonally and range from 5.44 to 120.37 µg/L.

Based on a water quality assessment conducted in 2016, the New Jersey Department of Environmental Protection (NJDEP) determined that the nearshore waters (within 3 miles from shore) near export cable corridors and landfall sites were unsupportive of general aquatic life use (Atlantic Shores 2023a). All locations except the Monmouth export cable corridor are supportive of recreational use (Atlantic Shores 2023a). Water quality conditions were supportive of shellfish harvesting at the export cable corridors but not the landfall sites.

2.1.2 Electromagnetic Fields

The Atlantic Shores South WTA and export cable corridors would not overlap with any EMF-generating existing infrastructure, though fiberoptic cables (which do not generate EMFs) would be encountered. Two inactive fiberoptic cables transect the planned Atlantic Shores South Project 2 WTA (Atlantic Shores 2023a). One of those inactive cables partially transects the planned Project 1 and Project 2 overlap area (Atlantic Shores 2023a). The planned Monmouth export cable corridor would intersect nine existing fiber optic cables (4 active and 5 inactive) (Atlantic Shores 2023a). The Atlantic export cable corridor would not intersect existing cable infrastructure.

2.1.3 Anthropogenic Conditions

2.1.3.1. Artificial Light

Vessel traffic and safety lighting on marine structures (i.e., buoys and meteorological towers) are the only sources of artificial light in the offshore portion of the action area. Land-based artificial light sources are generally predominant in nearshore areas.

2.1.3.2. Vessel Traffic

The Project Area is between the busy Port of New York and New Jersey and Delaware Bay vessel traffic areas. Heavy vessel traffic transits through the region of the Project Area along the East Coast of the United States (**Figure 2-2**). In addition to commercial vessel traffic, commercial and recreational fishing vessels, as well as other recreational vessels (e.g., sail boats, dive boats, sightseeing boats, pleasure craft), transit the area.

Based on Automatic Information System (AIS) data, vessel traffic in the region is concentrated in the nearshore and harbor areas west of the Lease Area and is also moderately heavy on north-south routes to the east of the Lease Area (**Figure 2-2**). The overall traffic density within the WTA is relatively low (Atlantic Shores 2023a). On average, there are 4,105 vessel tracks in the WTA annually (COP Volume II, Appendix II-S; Atlantic Shores 2023a). Between 2017 and 2019 (i.e., the AIS data period), cargo vessels accounted for 37 percent of vessel traffic within the Lease Area (Atlantic Shores 2023a). On average, 3 unique cargo vessels transited the WTA each day. Tug and barge vessels transit along the coastline relatively closer to shore than other higher speed traffic but within the WTA with some diagonal transits (**Figure 2-2**). Passenger vessels (i.e., passenger ferries and cruise ships) generally travel regular, predetermined routes. Cruise vessels largely transit further offshore transiting through the offshore-most portion of the WTA (**Figure 2-2**). Vessel traffic from cruise vessels also follows routes to and from Atlantic City. Over the AIS data period, an average of less than one (0.3) unique passenger vessels transited the buffered study area daily (Atlantic Shores 2023a). Over the entire AIS data period, 84 passenger vessels transited the Lease Area. AIS and Vessel Monitoring System data show heavy fishing vessel traffic across the Lease Area (**Figure 2-2**) (Atlantic Shores 2023a). Fishing vessels accounted for approximately 11 percent of AIS vessel traffic over the AIS data period (Atlantic Shores 2023a). However, AIS vessel data do not account for all fishing vessels less than 65 feet in length. Fishing vessels less than 65 feet in length accounted for approximately 18 percent of fishing vessels reporting AIS data (COP Volume II, Appendix II-S; Atlantic Shores 2023a).

2.1.4 Underwater Noise

Ambient noise levels in the New York Bight, immediately north of the WTA and export cable corridors, were characterized using passive acoustic monitoring data collected from October 2017 to July 2018 (Estabrook et al. 2019). The study focused on characterizing noise levels within frequency ranges corresponding to the predicted ranges of most sensitive hearing for large whales found in the area (i.e., blue whale, fin whale, humpback whale, NARW, sei whale, and sperm whale), based on their calling frequencies (Estabrook et al. 2019 citing Dunlop et al. 2007; Hatch et al. 2012; Risch et al. 2014; Weirathmueller et al. 2013) and found that the highest noise levels occurred at monitoring locations closest to New York Harbor, where vessel traffic was highest. Noise levels at each of the monitoring sites were relatively consistent throughout the monitoring period and generally ranged from 72 to 124 decibels (dB) referenced to 1 micropascal (re 1 μPa) (Estabrook et al. 2019). Median ambient noise levels were highest in the frequency band assessed for humpback whales (28 to 708 hertz [Hz]), which overlapped the NARW and sei whale frequency bands.

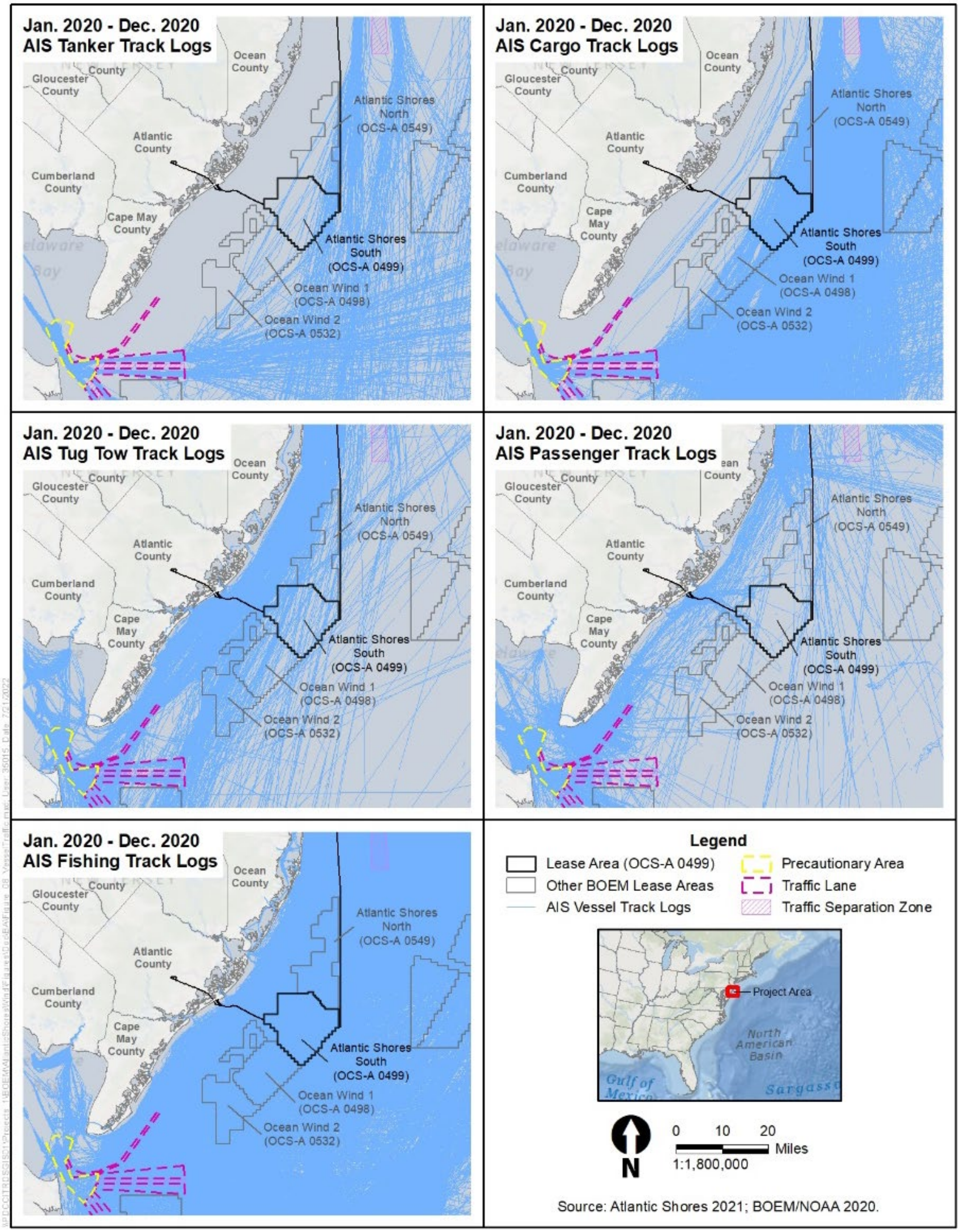

Figure 2-2. Vessel Traffic Tracks through the Action Area

2.2. CLIMATE CHANGE

Climate change is an ongoing and developing phenomenon that has been shown to affect marine ecosystems. Warming sea temperature is a key feature of global climate change caused by atmospheric greenhouse effects from global greenhouse gas emissions including carbon dioxide (CO_2). Warming water temperatures, in combination with sea level rise, could affect ESA-listed species in the action area. Warming and sea level rise could affect these species through increased storm frequency and severity, altered habitat/ecology, changes in prey distribution, altered migration patterns, increased disease incidence, increased erosion and sediment deposition, and development of protective measures (e.g., seawalls and barriers). Increased storm severity or frequency may result in increased energetic costs for marine mammals, particularly for young life stages, reducing individual fitness. Altered habitat/ecology associated with warming has resulted in northward distribution shifts for some prey species (Hayes et al. 2021); marine mammals are altering their behavior and distribution in response to these alterations (Davis et al. 2017, 2020; Hayes et al. 2020, 2021). Warming is also expected to influence the frequency of marine mammal diseases. Warming and sea level rise could lead to changes sea turtle distribution, habitat use, migratory patterns, nesting periods, nestling sex ratios, nesting habitat quality or availability, prey distribution or abundance, and availability of foraging habitat (Fuentes and Abbs 2010; Janzen 1994; Newson et al. 2009; Witt et al. 2010). Northward shifts in fish communities, including demersal finfish and shellfish, have been documented to occur concurrently with rises in sea surface temperature (Gaichas et al. 2015; Hare et al. 2016; Lucey and Nye 2010).

Ocean acidification is another major problem caused by the release of anthropogenic CO_2 into the atmosphere (Doney et al. 2020). The ocean serves as a major sink for anthropogenic CO_2 (Doney et al. 2020). Once deposited in seawater, CO_2 lowers pH levels, increasing its acidity. Ocean acidification may have negative impacts on zooplankton and benthic organisms, especially the many species that have calcareous shells or exoskeletons (e.g., shellfish, copepods) by reducing the growth of these species (PMEL 2020). Ocean acidification may affect ESA-listed marine mammal, sea turtle, and fish species through negative effects on their prey.

Warming and sea level rise, with their associated consequences, and ocean acidification could lead to long-term, high-consequence impacts on ESA-listed species of marine mammals, sea turtles, and fish.

2.3. ESA-LISTED SPECIES AND CRITICAL HABITAT

The best available information on the occurrence and distribution of ESA-listed species in the action area is provided by a combination of visual sighting and acoustic data, technical reports, and academic publications, including:

- Site-specific aerial survey data collected by Atlantic Shores see COP Appendix II-L2 (Atlantic Shores 2023a);
- Data from the Atlantic Marine Assessment Program for Protected Species 2010 to 2019 surveys (NEFSC and SEFSC 2015, 2016, 2018, 2019; Palka et al. 2017);
- Marine mammal stock assessment reports (Hayes et al. 2017, 2018a, 2019, 2020, 2021);
- Ecological baseline studies conducted for the New Jersey Department of Environmental Protection (Geo-Marine 2010);
- Sighting and density data from the Ocean Biodiversity Information System (Roberts et al. 2015, 2016a, 2016b, 2017, 2018, 2020, 2022);
- Aerial and shipboard survey data collected by the Northwest Atlantic Marine Ecoregional Assessment (Greene et al. 2010), the Northeast Fisheries Science Center, and NYSERDA (Normandeau and APEM 2018, 2019a, 2019b, 2019c, 2020);
- Data retrieved from the North Atlantic Right Whale Consortium database (NARWC 2021);

- Data retrieved from the Northeast Ocean Data Portal (NROC 2021);
- The ESA Section 7 Mapper (NOAA 2020); and
- Fisheries data collected by federal and state agencies, including BOEM (Guida et al. 2017), the Northeast Fisheries Science Center, the Northeast Area Monitoring and Assessment Program, and the New Jersey Department of Environmental Protection

Based on this information, 24 ESA-listed species could occur in the action area (**Table 2-1**): seven marine mammal species, five sea turtle species, five fish species, and seven coral species. The West Indian manatee (*Trichechus manatus*) is under jurisdiction of USFWS and will therefore not be addressed in this BA.

BOEM accessed the best available information on the occurrence and distribution of critical habitat to identify critical habitat in the action area. No critical habitat is designated for any ESA-listed species within the Project area. However, designated critical habitat is found within the portion of the action area that includes potential vessel routes to and from ports on the Delaware River and in the Gulf of Mexico, including critical habitat for the New York Bight distinct population segment (DPS) of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*), NARW, the Northwest Atlantic Ocean DPS of loggerhead sea turtle (*Caretta caretta*), and elkhorn (*Acropora palmata*) and staghorn (*A. cervicornis*) corals (**Table 2-1**).

2.3.1 Species and Critical Habitat Considered but Excluded from Further Analysis

Several species that could occur in the action area are either unlikely to occur or their occurrence would be limited to a portion of the action area outside the impact area of most Project activities (i.e., outside the Project area). For species unlikely to occur in the action area, based on the analysis presented below, effects from the Proposed Action are extremely unlikely to occur and are therefore ***discountable***. For species with limited occurrence (i.e., occurrence along vessel transit routes between the Project area and the Gulf of Mexico), the potential for effects from the Proposed Action are considered extremely unlikely to occur. Brief descriptions of each of the species unlikely to occur or expected to have limited occurrence within the action area are provided in Sections 2.3.1.1 through 2.3.1.16. Species that are likely to occur in the Project area are discussed in more detail in Section 3.

As noted in Section 2.3, critical habitat has been designated in the action area for the New York Bight DPS of Atlantic sturgeon, the NARW, the Northwest Atlantic Ocean DPS of loggerhead sea turtle, and elkhorn and staghorn coral. However, these critical habitat units are located in the portion of the action area where Project vessel transits in the Delaware River or to and from the Gulf of Mexico would occur. Therefore, potential impacts to critical habitat would be limited to those associated with vessel traffic. As described in Sections 2.3.1.8 through 2.3.1.10, vessel traffic is not expected to affect any physical and biological features of critical habitat designated in the action area.

Table 2-1. ESA-Listed Species and Critical Habitat in the Action Area

Species	Distinct Population Segment	ESA Status		Critical Habitat Status	Occurrence in Action Area	
		Status	Listing Date		Species	Critical Habitat
Marine Mammals						
Blue whale	NA	Endangered	1970	Not designated	Unlikely[1]	NA
Fin whale	NA	Endangered	1970	Not designated	Likely[1]	NA
North Atlantic right whale	NA	Endangered	1970	Designated	Likely[1]	Yes
Rice's whale	NA	Endangered	2019	Not designated	Limited[1]	NA[2]
Sei whale	NA	Endangered	1970	Not designated	Likely[1]	NA
Sperm whale	NA	Endangered	1970	Not designated	Likely[1]	NA
Sea Turtles						
Green sea turtle	North Atlantic	Threatened	2016	Designated	Likely[3]	No[4]
Hawksbill sea turtle	NA	Endangered	1970	Designated	Limited[3]	No
Kemp's ridley sea turtle	NA	Endangered	1970	Not designated	Likely[3]	NA
Leatherback sea turtle	NA	Endangered	1970	Designated	Likely[3]	No
Loggerhead sea turtle	Northwest Atlantic	Threatened	2011	Designated	Likely[3]	Yes
Fish						
Atlantic salmon	Gulf of Maine	Endangered	2000	Designated	Unlikely[5]	No
Atlantic sturgeon	Gulf of Maine, New York Bight, Chesapeake Bay, Carolina, and South Atlantic	Threatened, Endangered	2012	Designated	Likely[5]	Yes (New York Bight DPS only)
Giant manta ray	NA	Threatened	2018	Not designated	Limited[5]	NA
Gulf sturgeon	NA	Threatened	1991	Designated	Unlikely[5]	No
Nassau grouper	NA	Threatened	2016	Proposed	Unlikely[5]	NA
Oceanic whitetip shark	NA	Threatened	2018	Not designated	Limited[5]	NA
Scalloped hammerhead shark	Central & Southwest Atlantic	Threatened	2014	Not designated	Unlikely[5]	NA
Shortnose sturgeon	NA	Endangered	1967	Not designated	Limited[5]	NA

Species	Distinct Population Segment	ESA Status		Critical Habitat Status	Occurrence in Action Area	
		Status	Listing Date		Species	Critical Habitat
Smalltooth sawfish	U.S.	Endangered	2003	Designated	Unlikely[5]	No
Corals						
Boulder star coral	NA	Threatened	2014	Proposed	Limited	NA
Elkhorn coral	NA	Threatened	2006	Designated	Limited	Yes
Lobed star coral	NA	Threatened	2014	Proposed	Limited	NA
Mountainous star coral	NA	Threatened	2014	Proposed	Limited	NA
Pillar coral	NA	Threatened	2014	Proposed	Limited	NA
Rough cactus coral	NA	Threatened	2014	Proposed	Limited	NA
Staghorn coral	NA	Threatened	2006	Designated	Limited	Yes

NA = Not Applicable.
[1] Sources: NEFSC and SEFSC 2011a, 2011b, 2012, 2014a, 2014b, 2015, 2016, 2018, 2019; Atlantic Shores 2023a; Geo-Marine 2010; Roberts et al. 2015, 2016a, 2016b, 2017, 2018, 2020; Hayes et al. 2017, 2018, 2019, 2020, 2021.
[2] Rulemaking is currently underway to propose critical habitat for Rice's whale in the Gulf of Mexico.
[3] Sources: Greene et al. 2010; Normandeau and APEM 2018, 2019a, 2019b, 2019c, 2020; NARWC 2021.
[4] NMFS plans to propose critical habitat for green sea turtle by the end of June 2023.
[5] Sources: Guida et al. 2017; NOAA 2020b; NROC 2021.

2.3.1.1. Blue Whale

The blue whale (*Balaenoptera musculus*) is listed as endangered throughout its range (USFWS 1970). Blue whale occurrence in the Mid-Atlantic Bight is rare (Atlantic Shores 2023a). This species is expected to occur in deeper waters (at least 328 feet [100 meters]) than those found in the Lease Area (Waring et al. 2011).

Blue whales have been acoustically detected throughout much of the North Atlantic. Most of these detections occurred around the Grand Banks off Newfoundland and west of the British Isles. This species is considered an occasional visitor in U.S. Atlantic waters (Hayes et al. 2020). Therefore, this species is unlikely to occur in the action area.

Given that blue whales are unlikely to occur in the action area, Project vessels are not expected to encounter blue whales. If a Project vessel were to co-occur with a blue whale in the action area, any effects are extremely unlikely to occur. All Project vessels will utilize dedicated, trained lookouts to reduce the risk of vessel collision, will maintain 328-foot (100-meter) separation distances from large whales, and adhere to vessel strike avoidance measures as advised by NMFS. Based on the unexpected co-occurrence of blue whales and Project vessels in the action area and the mitigation measures to avoid vessel strikes, any effects to blue whales are extremely unlikely to occur and therefore ***discountable.*** Therefore, the Proposed Action ***may affect, but not likely to adversely affect*** blue whales.

2.3.1.2. Rice's Whale

Rice's whale (*B. ricei*) is listed as endangered throughout its range (NMFS 2019a). This species was originally classified as the Gulf of Mexico subspecies of Bryde's whale (*B. edeni*) at the time of listing but was reclassified as a distinct species in 2021 (NMFS 2021j). This species is not found within the Project area or within the portion of the action area where vessels transit to and from regional ports (i.e., ports in New Jersey and Virginia).

Rice's whale only occurs in the Gulf of Mexico and has been consistently sighted in the northeastern Gulf of Mexico. They are generally distributed along the continental shelf break between 328 and 1,312 feet (100 and 400 m) depth (NMFS 2022e). Therefore, occurrence of this species would be limited to the portion of the action area where vessel transits to and from ports in the Gulf of Mexico would occur.

Given the absence of this species in the Project area and the limited number of vessel transits through the Gulf of Mexico, it is extremely unlikely that a Project vessel would encounter Rice's whales. If a Project vessel were to co-occur with a Rice's whale in the Gulf of Mexico portion of the action area, any effects are extremely unlikely to occur as all Project vessels will adhere to vessel strike avoidance measures for this species as advised by NMFS (**Table 1-11**), including utilization of dedicated visual observers to reduce the risk of vessel collision, maintenance of specified separation distances, vessel speed restrictions in the 328 to 1,312-foot (100 to 400-meter) isobath (**Figure 2-3**), and avoidance of the Rice's whale Core Distribution Area (**Figure 2-3**). As effects are extremely unlikely to occur, they are ***discountable***. Therefore, the Proposed Action ***may affect, but not likely to adversely affect*** Rice's whale.

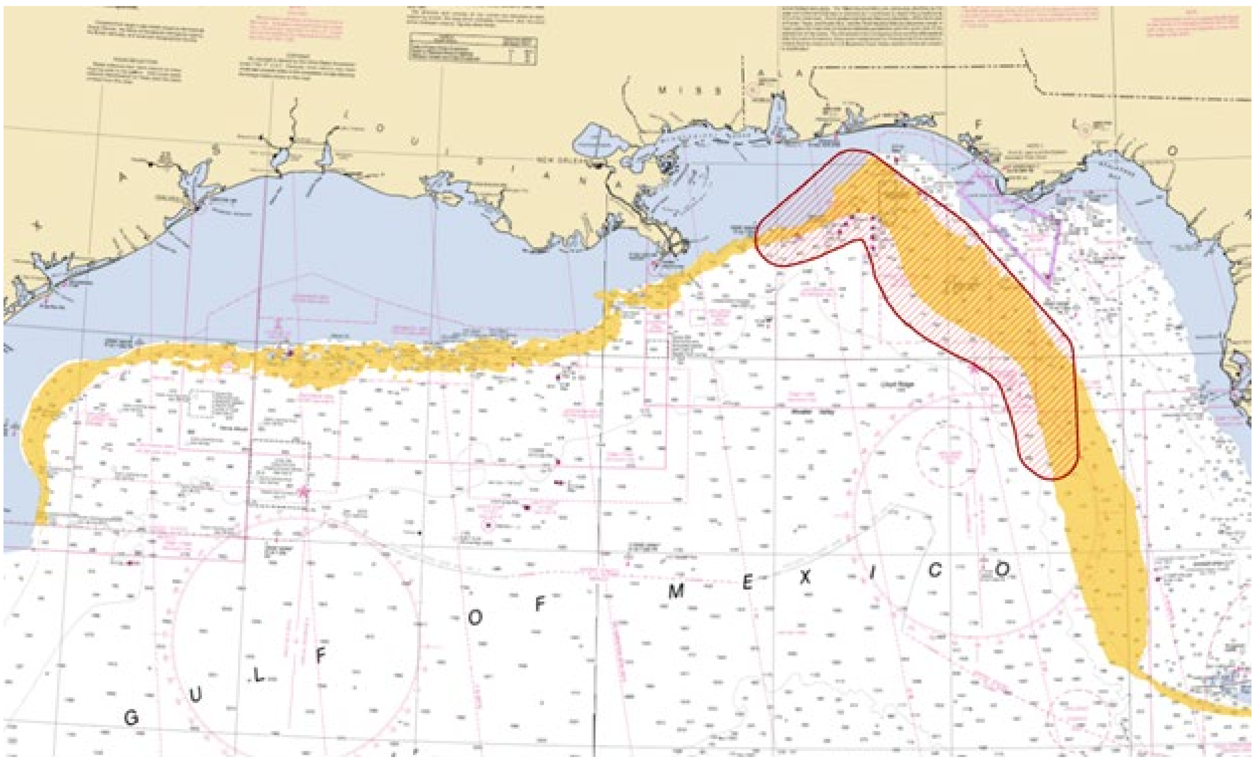

Figure 2-3. Rice's Whale Core Distribution Area (Red Hatched Area) and Extended Habitat between the 328- and 1,312-foot (100- and 400-meter) Isobaths (Yellow Area)

2.3.1.3. Hawksbill Sea Turtle

The hawksbill sea turtle (*Eretmochelys imbricata*) is listed as endangered throughout its range (USFWS 1970). Though hawksbill sea turtles have been documented in OCS waters of the northwest Atlantic Ocean, they are rare in the region (Atlantic Shores 2023a). Therefore, this species is considered unlikely to occur in the Project area or the portion of the action area associated with vessel transits to regional ports.

Hawksbill sea turtles have a circumtropical distribution and usually occur between latitudes 30°N and 30°S in the Atlantic Ocean. Hawksbill sea turtles are widely distributed throughout the Caribbean Sea, off the coasts of Florida and Texas in the continental United States, in the Greater and Lesser Antilles, and along the mainland of Central America south to Brazil and could therefore occur in the portion of the action area associated with vessel transits to and from the Gulf of Mexico. 80his species generally inhabits nearshore foraging grounds and is often associated with coral reefs (NMFS 2022c). Adult hawksbill sea turtles are capable of migrating long distances between nesting beaches and foraging areas. For instance, a female hawksbill sea turtle tagged at Buck Island Reef National Monument in St. Croix was later identified 1,160 miles (1,866 km) away in the Miskito Cays in Nicaragua (NMFS 2022c). Although nesting within the continental United States is typically rare, it can occur along the southeast coast of Florida and the Florida Keys.

Given the limited number of vessel transits to and from the western Gulf of Mexico, Project vessels are not expected to encounter hawksbill sea turtles. If a Project vessel were to co-occur with a hawksbill sea turtle in the action area, any effects from vessels are extremely unlikely to occur as all vessels traveling through the Gulf of Mexico would be required to post a trained lookout to monitor for sea turtles within a 500-meter radius of the vessel and would be required to maintain a 328-foot (100-meter) separation distance from all sea turtles. As vessel strikes are considered extremely unlikely to occur, they are ***discountable***. Therefore, the Proposed Action ***may affect, but not likely to adversely affect*** hawksbill sea turtle.

2.3.1.4. Atlantic Salmon

The Gulf of Maine DPS of Atlantic salmon (*Salmo salar*) is listed as endangered under the ESA (NMFS 2000). Atlantic salmon is an anadromous species that inhabits waters of North America, Iceland, Greenland, Europe, and Russia (NMFS 2022a). In the U.S., wild populations of Atlantic salmon are limited to coastal rivers in Maine. This species is not found in the Project area. Therefore, the Proposed Action is expected to have ***no effect*** on this species.

2.3.1.5. Giant Manta Ray

The giant manta ray (*Manta birostris*) is listed as threatened throughout its range (NMFS 2018d). This highly-migratory species is found in temperate, subtropical, and tropical oceans worldwide, both offshore and in productive coastal areas. Sightings of giant manta rays in the Mid-Atlantic and in New England are rare, though individuals have been documented as far north as New Jersey and Block Island (Gudger 1922; Miller and Klimovich 2017). This species could transit through the Project area but occurrence there or in the portion of the action area associated with vessel transits to regional ports is considered low (Atlantic Shores 2023a). Therefore, this species is considered unlikely to occur in the Project area or the portion of the action area associated with vessel transits to regional ports.

Giant manta rays make seasonal long-distance migrations, aggregate in certain areas and remain resident, or aggregate seasonally (Dewar et al. 2008; Girondot et al. 2015; Graham et al. 2012; Stewart et al. 2016). Giant manta rays occur regularly in the portions of the action area where vessel transits to and from the Gulf of Mexico would occur. The available sightings data indicate that adult and juvenile giant manta rays occur regularly along Florida's east coast (J. Pate, MMF, pers. comm. to M. Miller, NMFS OPR, 2018; H. Webb unpublished data). In the Gulf of Mexico, the Flower Garden Banks National Marine Sanctuary and the surrounding region might represent the first documented nursery habitat for giant manta rays; small age classes have been observed consistently across years at both the population and individual level (Stewart et al. 2018).

Vessel strike has been identified as a threat to giant manta ray (NMFS 2018d). While giant manta rays do not surface to breathe, they can spend considerable time in surface waters while basking and feeding, where they are more susceptible to vessel strikes (McGregor et al. 2019). They show little fear toward vessels, which can also make them extremely vulnerable to vessel strikes, especially from fast-moving recreational vessels (Deakos 2011; C. Horn, NMFS, personal observation). The giant manta ray is frequently observed in nearshore coastal waters and feeding within and around inlets. As vessel traffic is concentrated in and around inlets and nearshore waters, this overlap exposes the giant manta ray in these locations to an increased likelihood of potential vessel strike. Yet, few instances of confirmed or suspected mortalities of giant manta ray attributed to vessel strike injury (e.g., via strandings) have been documented. This lack of documented mortalities could also be the result of other factors that influence carcass detection (i.e., wind, currents, scavenging, decomposition etc.). In addition, manta rays appear to be able to heal from wounds very quickly. While high wound-healing capacity is likely to be beneficial for their long-term survival, the fitness cost of injuries and numerous vessel strikes occurring may be masked (McGregor et al. 2019).

Given the limited number of vessel transits to and from the Gulf of Mexico and the dispersed distribution of giant manta ray in the open ocean habitat where Project vessel transits would occur, effects of the Proposed Action are extremely unlikely to occur and ***discountable***. Therefore, the Proposed Action ***may affect, but not likely to adversely affect*** giant manta rays.

2.3.1.6. Gulf Sturgeon

The Gulf sturgeon (*Acipenser oxyrinchus desotoi*) is listed as threatened throughout its range (USFWS and NOAA 1991). Gulf sturgeon is found from Lake Pontchartrain in Louisiana to the Suwannee River in Florida (NMFS 2023b). This anadromous species spawns in freshwater in the spring and fall, oversummering in freshwater habitats between those seasons. After the fall spawning period, Gulf sturgeon move into estuarine waters to feed. Younger age classes remain in freshwater or estuarine environments year-round. Once Gulf sturgeon reach two to three years of age, they move into marine waters of the Gulf of Mexico during the winter before returning to freshwater in the spring (NMFS 2023b). Gulf sturgeon are generally found in coastal waters from October or November to February or March (Ross et al. 2009). In the marine environment, this species occupies shallow waters (i.e., 10 meters [32.8 feet] or less) (Edwards et al. 2003, 2007; Fox et al. 2002; Ross et al. 2009; Ross et al. 2009 citing Sulak and Clugston 1999). Given this species distribution it would not occur in the Project area or the portion of the action area associated with vessel transits to regional ports.

Gulf sturgeon have the potential to occur in the portion of the action area associated with vessel transits to and from the Gulf of Mexico. However, vessels transiting to and from Corpus Christi, Texas are expected to follow general traffic patterns through the Straits of Florida and across the Gulf of Mexico, offshore of the shallow coastal waters occupied by Gulf sturgeon during their overwintering period. Given the habitat preference and seasonality of Gulf sturgeon in the marine environment, Project vessels are extremely unlikely to encounter Gulf sturgeon, and effects of the Proposed Action are ***discountable***. Therefore, the Proposed Action ***may affect, but not likely to adversely affect*** this species.

2.3.1.7. Nassau Grouper

The Nassau grouper (*Epinephelus striatus*) is listed as threatened throughout its range (NMFS 2016b). This species is found in tropical and subtropical waters of the Caribbean Sea and the western North Atlantic Ocean. In U.S. waters, this species is found in southern Florida, Puerto Rico, and the U.S. Virgin Islands (NMFS 2023c). There has been one confirmed sighting of Nassau grouper in the Gulf of Mexico at Flower Gardens Bank. This species prefers shallow reef habitats but may be found to depths of 130 meters (426 feet) (NMFS 2023c). Given its distribution, Nassau grouper would not occur in the Project area or the portion of the action area associated with vessel transits to regional ports.

Nassau grouper have the potential to occur in the portion of the action area associated with vessel transits to and from the Gulf of Mexico. However, based on its preference for shallow reef habitats, Project vessels are not expected to encounter Nassau grouper. Therefore, the Proposed Action is expected to have ***no effect*** on this species.

2.3.1.8. Oceanic Whitetip Shark

The oceanic whitetip shark (*Carcharhinus longimanus*) is listed as threatened throughout its range (NMFS 2018e). This species is generally found in subtropical and subtropical oceans worldwide, inhabiting deep, offshore waters (NMFS 2022d). In the western Atlantic, oceanic whitetips occur as far north as Maine (NMFS 2016d). This species could transit through the Project area but prefers waters greater than 600 ft (183 m) deep, which is deeper than the Project area. Therefore, this species is considered unlikely to occur in the Project area or the portion of the action area associated with vessel transits to regional ports.

Oceanic whitetip sharks may occur in the portions of the action area associated with vessel transits to and from the Gulf of Mexico. However, this species is not known to spend time at the surface where they would be subject to vessel strike. Further, vessel strikes have not been identified as a threat to the species (NMFS 2016d). Given that Project vessels are not expected to encounter oceanic whitetip shark, the Proposed Action is expected to have ***no effect*** on this species.

2.3.1.9. Scalloped Hammerhead Shark

The Central & Southwest Atlantic DPS of scalloped hammerhead shark (*Sphyrna lewini*) is listed as threatened under the ESA (NMFS 2014d). This DPS is found in waters of the Caribbean Sea, including the U.S. Exclusive Economic Zone off Puerto Rico and the U.S. Virgin Islands. Given this distribution, scalloped hammerhead sharks belonging to the Central & Southwest Atlantic DPS would not occur in the Project area or the portion of the action area associated with vessel transits to regional ports. Though this species has the potential to occur in the portion of the action area associated with vessel transits to and from the Gulf of Mexico, vessels transiting to and from Corpus Christi, Texas are expected to follow general traffic patterns through the Straits of Florida and are not expected to enter the Caribbean Sea. Therefore, Project vessels are not expected to encounter scalloped hammerhead sharks belonging to the Central & Southwest Atlantic DPS and the Proposed Action is expected to have ***no effect*** on this DPS.

2.3.1.10. Smalltooth Sawfish

The U.S. DPS of smalltooth sawfish (*Pristis pectinate*) is listed as endangered (NMFS 2003). This species lives in tropical seas and estuaries of the Atlantic Ocean (NMFS 2023d). In the U.S., smalltooth sawfish are generally found in shallow, coastal waters and lower river reaches along the southwest coast of Florida from Charlotte Harbor through the Everglades and Florida Keys. Given its distribution, this species would not occur in the Project area or the portion of the action area associated with vessel transits to regional ports.

Gulf sturgeon have the potential to occur in the portion of the action area associated with vessel transits to and from the Gulf of Mexico. However, vessels transiting to and from Corpus Christi, Texas are expected to follow general traffic patterns through the Straits of Florida and across the Gulf of Mexico, offshore of the shallow coastal waters occupied by smalltooth sawfish. Given the habitat usage of this species, Project vessels are not expected to encounter smalltooth sawfish. Therefore, the Proposed Action is expected to have ***no effect*** on this species.

2.3.1.11. ESA-Listed Corals

There are seven species of coral found in the waters of Florida and the Gulf of Mexico that are listed as threatened throughout their range: elkhorn coral (NMFS 2006), staghorn coral (NMFS 2006), boulder star coral (*Orbicella franksi*) (NMFS 2014c), lobed star coral (*O. annularis*) (NMFS 2014c), mountainous star coral (*O. faveolata*) (NMFS 2014c), pillar coral (*Dendrogyra cylindrus*) (NMFS 2014c), and rough cactus coral (*Mycetophyllia ferox*) (NMFS 2014c). These corals would not occur in the Project area or the portion of the action area associated with vessel transits to regional ports but may occur in the portion of the action area associated with vessel transits to and from the Gulf of Mexico. As corals are benthic species they would not be vulnerable to vessel strike by Project vessels. Therefore, the Proposed Action is expected to have ***no effect*** on ESA-listed corals.

2.3.1.12. Critical Habitat Designated for Elkhorn and Staghorn Corals

NMFS designated critical habitat for elkhorn and staghorn corals on November 26, 2008 (NMFS 2008), including four specific areas: the Florida area, the Puerto Rico area, the St. John/St. Thomas area, and the St. Croix area. The Florida area encompasses approximately 1,329 square miles (3,442 square kilometers) of marine habitat. The portion of the action area associated with vessel transits to and from the Gulf of Mexico overlaps the Florida area (**Figure 2-4**). The physical and biological feature (PBF) essential to conservation of these species is substrate of suitable quality and availability (i.e., natural consolidated hard substrate or dead coral skeleton that is free from fleshy or turf macroalgae cover and sediment cover) to support successful larval settlement and recruitment, and reattachment and recruitment of fragments. Vessel traffic would not affect this PBF as no substrate-disturbing activities (e.g., anchoring) are expected in this portion of the action area. Additionally, vessels transiting to and from Corpus Christi, Texas are expected to follow general traffic patterns through the Straits of Florida and across the Gulf of Mexico, which would not take them through the critical habitat for elkhorn and staghorn corals. Given the lack of vessel impacts on the PBF identified for conservation of elkhorn and staghorn corals, the Proposed Action is expected to have ***no effect*** on designated habitat for these species, and this critical habitat is excluded from further evaluation in this BA.

2.3.1.13. Critical Habitat Designated for New York Bight DPS of Atlantic Sturgeon

NMFS designated critical habitat for the New York Bight DPS of Atlantic sturgeon on August 17, 2017 (NMFS 2017b). This designation encompassed approximately 340 miles (547 kilometers) of aquatic habitat in rivers in Connecticut, Massachusetts, New York, New Jersey, Pennsylvania, and Delaware, including the lower 85 miles (137 kilometers) of the Delaware River Estuary. The portion of the action area that includes vessel routes to ports on the Delaware River (i.e., Paulsboro Marine Terminal, Repauno Port and Rail Terminal, and New Jersey Wind Port) overlaps Atlantic sturgeon critical habitat in the Delaware River (**Figure 2-5**).

The PBFs in the Delaware River critical habitat unit essential to conservation of the species include:

- PBF 1 – Hard bottom substrate (e.g., rock, cobble, gravel, limestone, boulder, etc.) in low salinity waters (i.e., 0.0 to 0.5 parts per thousand [ppt] range) for settlement of fertilized eggs and refuge, growth, and development of early life stages
- PBF 2 – Aquatic habitat with a gradual downstream salinity gradient of 0.5-30.0 ppt and soft substrate (e.g., sand, mud) downstream of spawning sites for juvenile foraging and physiological development
- PBF 3 – Water with appropriate depths and without physical barriers to passage between the river mouth and spawning sites necessary allow unimpeded movement of adults to and from spawning sites; movement of juvenile Atlantic sturgeon to appropriate salinity zones within the river estuary; and staging, resting, or holding of subadults or spawning condition adults. Water depths in main river channels must also be deep enough (e.g., ≥1.2 meters) to ensure continuous flow in the main channel at all times when any sturgeon life stage would be in the river
- PBF 4 – Water, especially in the bottom meter of the water column, with the temperature, salinity, and oxygen values that, combined, support critical life history functions, including spawning, annual and interannual survival of juvenile and older sturgeon, and larval, juvenile, and subadult growth, development, and recruitment (e.g., 13°C to 26°C [55.4°F to 78.8°F] for spawning habitat and ≤ 30°C [86°F] and 6 mg/L dissolved oxygen for juvenile rearing habitat)

All four of these PBFs occur within critical habitat found in the action area. Vessel traffic would not affect bottom substrate (PBFs 1 and 2), salinity (PBFs 1, 2, and 4), water depth (PBF 3), temperature

(PBF 4), or dissolved oxygen (PBF 4) as no bottom-disturbing (e.g., anchoring) or water quality-affecting activities are expected. Additionally, vessel traffic would not serve as a barrier to passage of Atlantic sturgeon (PBF 3). Given the lack of vessel impacts on PBFs 1, 2, 3, and 4, the Proposed Action is expected to have ***no effect*** on designated habitat for the New York Bight DPS of Atlantic sturgeon, and this critical habitat is excluded from further evaluation in this BA.

2.3.1.14. Critical Habitat Designated for North Atlantic Right Whale

NMFS designated critical habitat for the NARW on January 27, 2016 (NMFS 2016a). This designation included two units: the Gulf of Maine and Georges Bank region (Unit 1) and an area off the southeastern coast of the United States (Unit 2). The portion of the action area that includes potential vessel routes to and from the Gulf of Mexico may overlap Unit 2, which includes waters off the coasts of North Carolina, South Carolina, Georgia, and the Atlantic coast of Florida (**Figure 2-6**).

The PBFs of Unit 2 essential to conservation of the species include:

- Calm sea surface conditions (below 5 on the Beaufort Wind Scale)
- Sea surface temperatures of 44.6 to 62.6°F (7 to 17°C)
- Water depths of 19.7 to 26.2 feet (6 to 8 meters)

Vessel traffic through this portion of the action area would not affect any of these essential PBFs and would not affect the simultaneous co-occurrence of these features in Unit 2 from November through April. Project vessels transiting along the Atlantic coast between North Carolina and Florida could use routes located offshore of the designated critical habitat and would not need to travel through that area. Therefore, the Proposed Action is expected to have ***no effect*** on designated critical habitat for NARW, and this critical habitat is excluded from further evaluation in this BA.

2.3.1.15. Critical Habitat Designated for Northwest Atlantic Ocean DPS of Loggerhead Sea Turtle

NMFS designated critical habitat for the Northwest Atlantic Ocean DPS on August 11, 2014 (NMFS 2014a). This designation included nearshore reproductive habitat, wintering habitat, breeding habitat, constricted migratory corridors, and *Sargassum* habitat in the Atlantic Ocean and Gulf of Mexico (**Figure 2-7**). Vessels transiting routes to and from the Gulf of Mexico would travel through wintering habitat, breeding habitat, migratory habitat, and/or *Sargassum* habitat.

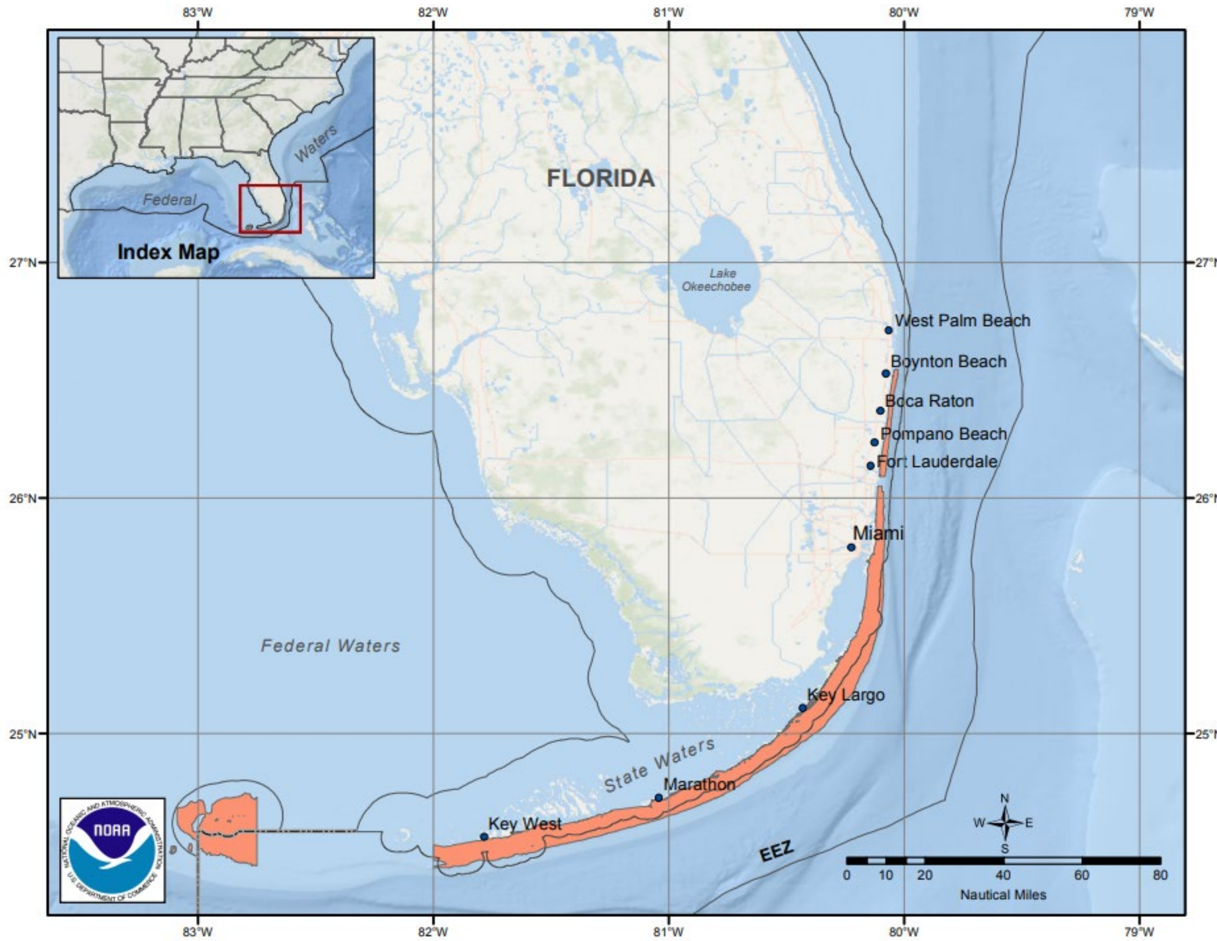

Figure 2-4. Elkhorn and Staghorn Coral Critical Habitat in the Action Area

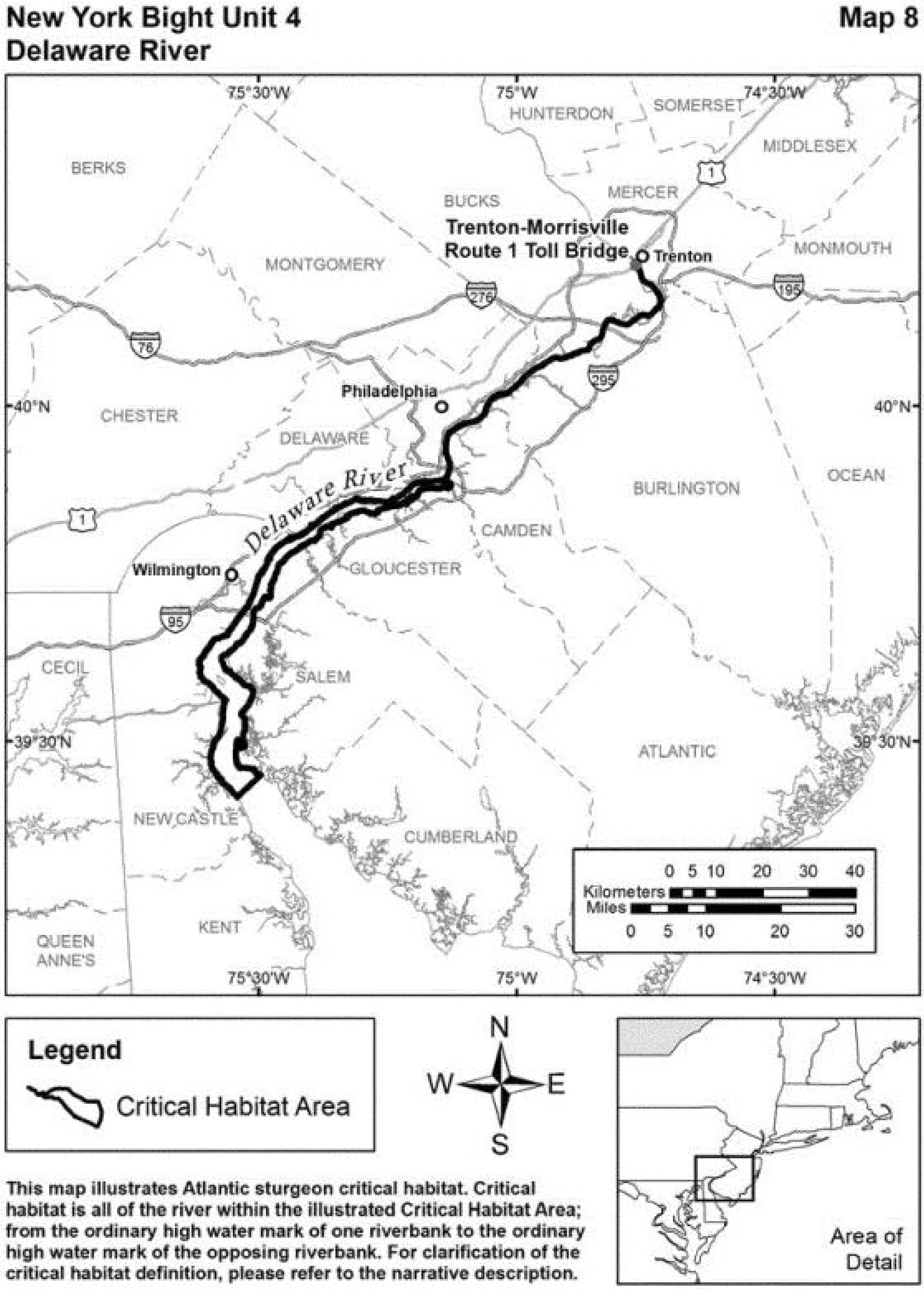

Figure 2-5. Critical Habitat for New York Bight Distinct Population Segment of Atlantic Sturgeon in the Action Area

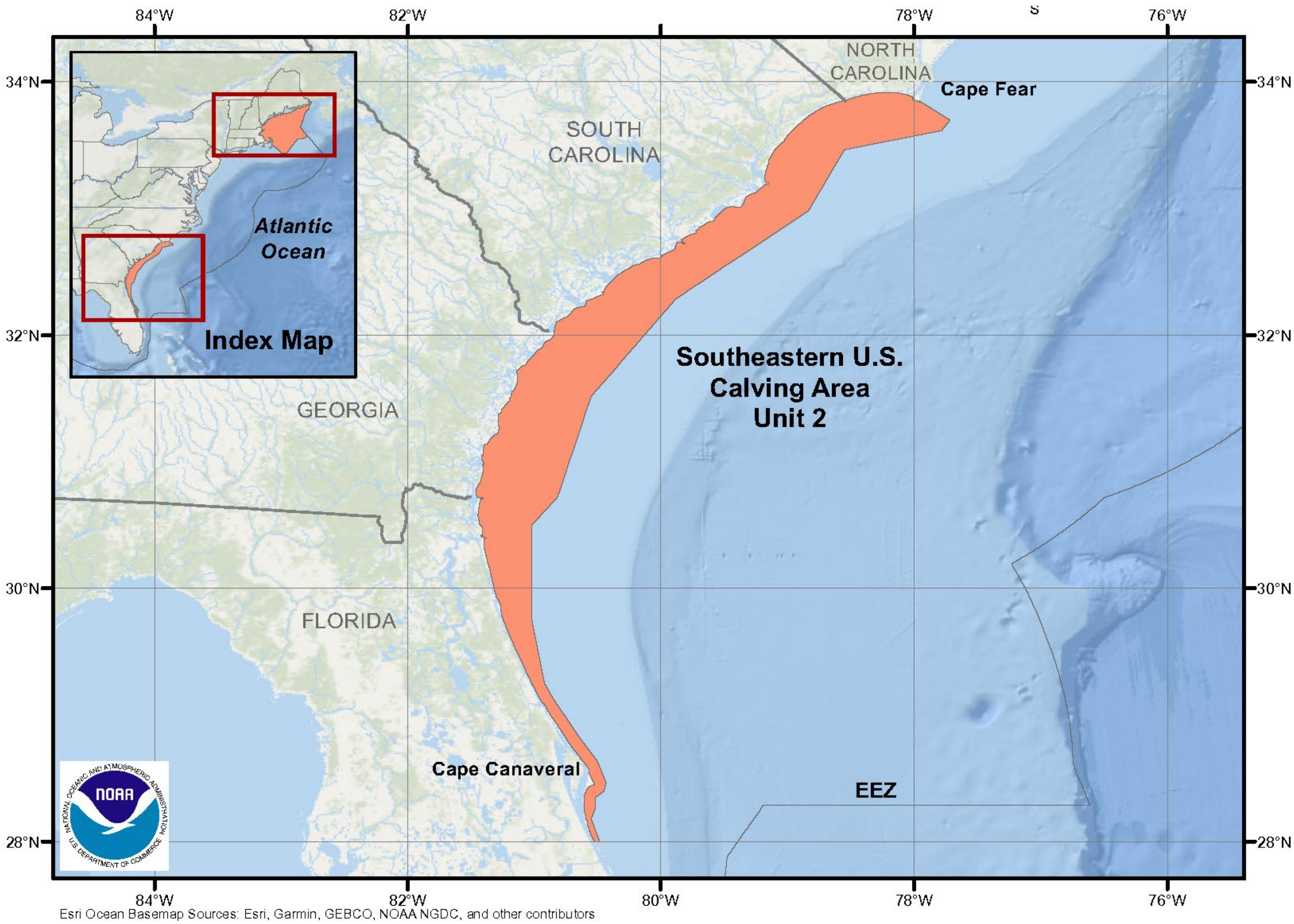

Figure 2-6. North Atlantic Right Whale Critical Habitat in the Action Area

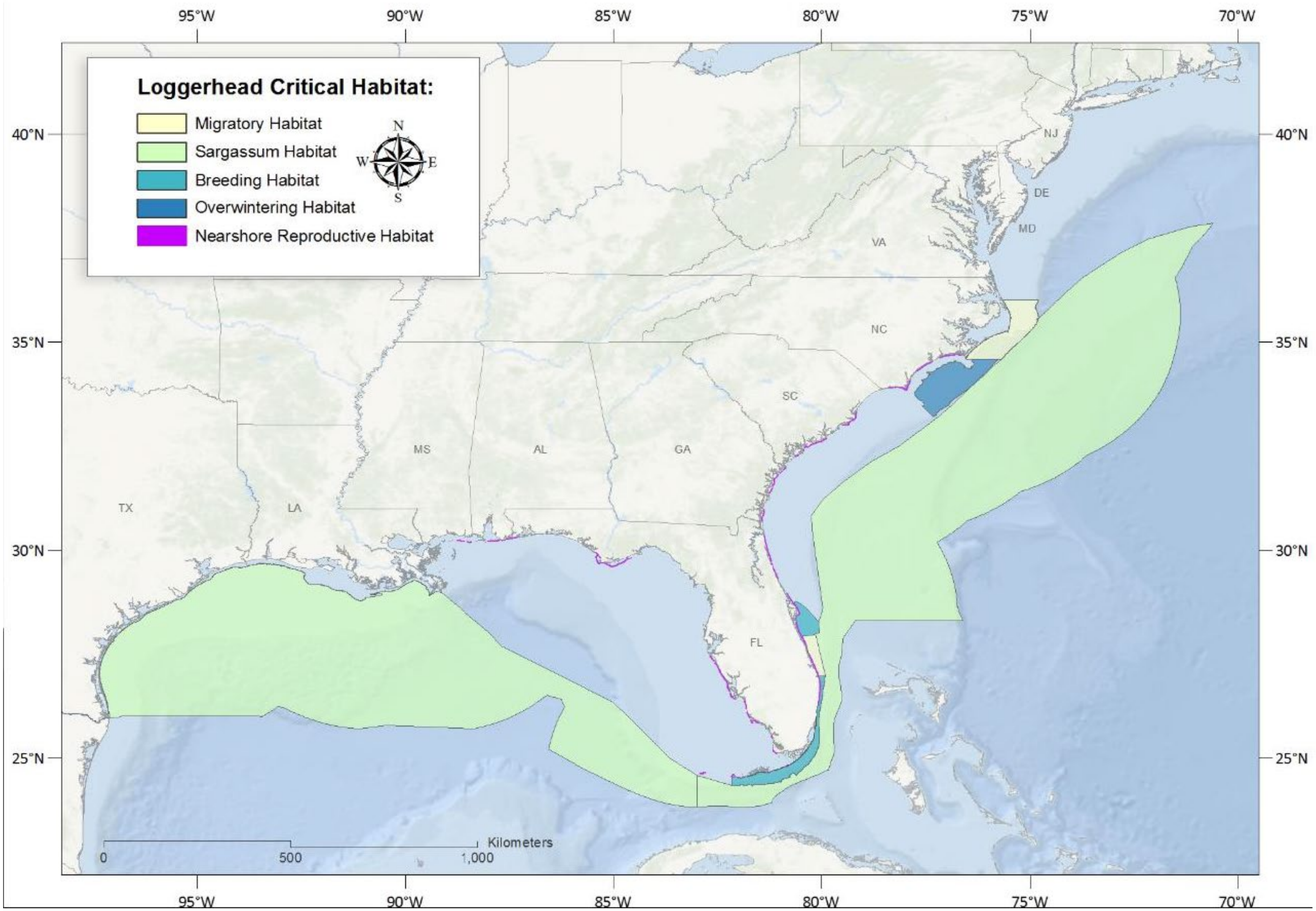

Figure 2-7. Critical Habitat for the Northwest Atlantic Distinct Population Segment of Loggerhead Sea Turtles

Wintering habitat is defined as "warm water habitat south of Cape Hatteras, North Carolina near the western edge of the Gulf Stream used by a high concentration of juveniles and adults during the winter months." Breeding habitat is defined as "sites with high densities of both male and female adult individuals during the breeding season." Constricted migratory habitat is defined as "high use migratory corridors that are constricted… by land on one side and the edge of the continental shelf and Gulf Stream on the other side." *Sargassum* habitat is defined as "developmental and foraging habitat for young loggerheads where surface waters form accumulations of floating material." PBFs for these habitats include:

- Specific water temperatures: greater than 50°F (10°C) from November through April for winter habitat; suitable for optimum *Sargassum* growth for *Sargassum* habitat
- Specific water depths: 65.5 to 328 feet (20 to 100 meters) for winter habitat, greater than 32.8 feet (10 meters) for *Sargassum* habitat
- Specific geographic locations: continental shelf waters in proximity to the western boundary of the Gulf Stream for winter habitat, proximity to primary Florida migratory corridor and Florida nesting grounds for breeding habitat, constricted shelf area that concentrates migratory pathways for migratory habitat, proximity to currents for offshore transport for *Sargassum* habitat
- High densities of males and female turtles (breeding habitat)
- Passage conditions suitable for migration (migratory habitat)
- Convergence zones, downwelling areas, and/or boundary current margins that concentrate floating material (*Sargassum* habitat)
- *Sargassum* concentrations that support adequate cover and prey abundance (*Sargassum* habitat)
- Prey availability (*Sargassum* habitat)

Vessel traffic through this portion of the action area would not affect any of these essential PBFs as vessel traffic would not affect or change water temperatures; affect or change water depths; affect habitat in continental shelf waters in proximity to the western boundary of the Gulf Stream, in proximity to the primary Florida migratory corridor or Florida nesting grounds, or in constricted continental shelf area; affect the density of reproductive male or female loggerheads; affect passage conditions in this area; affect conditions that result in convergence zones, surface-water downwelling areas, the margins of major boundary currents (Gulf Stream), and other locations where there are concentrated components of the *Sargassum* community in water temperatures suitable for the optimal growth of *Sargassum* and inhabitance of loggerheads; affect the concentration of *Sargassum*; or affect the availability of prey within Sargassum. Therefore, the Proposed Action is expected to have ***no effect*** on designated critical habitat for the Northwest Atlantic Ocean DPS of loggerhead sea turtle, and this critical habitat is excluded from further evaluation in this BA.

2.3.2 Species Considered for Further Analysis

Nine ESA-listed species under NMFS jurisdiction are likely to occur in the Project area, the ensonified area, and/or along vessel transit routes to regional ports within the action area and are therefore considered for further analysis: four large whale species (fin whale, NARW, sei whale, and sperm whale), four sea turtle species (green sea turtle [*Chelonia mydas*], Kemp's ridley sea turtle [*Lepidochelys kempii*], leatherback sea turtle [*Dermochelys coriacea*], and loggerhead sea turtle), and one fish species (Atlantic sturgeon). These species and their potential occurrence in the action area are summarized in **Table 2-1**. Information about species occurrence was drawn from several available sources identified in Section 2.3. Additional species-specific sources of information are cited in Section 3 where appropriate. General information about these species, status, threats, use of the action area, and additional information about habitat use that is pertinent to this consultation are described in Section 3.

3. EFFECTS OF THE PROPOSED ACTION

The effects of the Proposed Action, including Scenario 1 and Scenario 2, are analyzed in this section based on the PDE described in Section 1.3. This section also includes an analysis of the effects of the Connected Action. Effects of the Proposed Action and Connected Action include all consequences to ESA-listed species or designated critical habitat caused by the Proposed Action across all phases of the Project, including pre-construction, construction, O&M, and decommissioning or by the Connected Action. This includes consequences of other activities that would not occur but for the Proposed Action that are reasonably certain to occur. Effects are considered relative to the likelihood of species' exposure to each effect and the biological significance of that exposure. Biological significance is evaluated based on the extent and duration of exposure relative to established effects thresholds or relative to baseline conditions described in Section 2. Effects evaluated for the Proposed Action and the Connected Action include impacts from underwater noise, dredging, habitat disturbance, secondary entanglement due to increased presence of recreational fishing, turbidity, vessel traffic, monitoring surveys, electromagnetic fields and heat, air emissions, lighting of structures, and unexpected/unanticipated impacts. Each of these impacts is evaluated separately for ESA-listed marine mammals (Section 3.2), sea turtles (Section 3.3), and fish (Section 3.4).

3.1. DETERMINATION OF EFFECTS

The term "consequences," was introduced to the ESA to replace "direct" and "indirect" effects in 2019. Consequences are a result or effect of an action on ESA species. NMFS uses two criteria to identify the ESA-listed species and designated critical habitat that are ***not likely to be adversely affected*** by the Proposed Action.

The first criterion is exposure, or some reasonable expectation of a co-occurrence, between one or more potential stressors associated with the proposed activities and ESA-listed species or designated critical habitat. If NMFS concludes that an ESA-listed species or designated critical habitat is not likely to be exposed to the proposed activities, they must also conclude that the species or designated critical habitat is ***not likely to be adversely affected*** by those activities.

The second criterion is the probability of a response given exposure. An ESA-listed species or designated critical habitat that co-occurs with a stressor of the action but is not likely to respond to the stressor is also ***not likely to be adversely affected*** by the Proposed Action.

Section 7(a)(2) of the ESA requires federal agencies, in consultation with NMFS, to ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species; or adversely modify or destroy their designated critical habitat.

"Jeopardize the continued existence of" means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of an ESA-listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR §402.02).

"Destruction or adverse modification" means a direct or indirect alteration that appreciably diminishes the value of critical habitat for the conservation of an ESA-listed species as a whole (50 CFR §402.02).

Based on an analysis of potential consequences, we provide a determination for each species and designated critical habitat. One of the following three determinations, as defined by the ESA, has been applied for listed species and critical habitat that have potential to be affected by the Project: No effect; may affect, but not likely to adversely affect; may affect, likely to adversely affect.

The probability of an effect on a species or designated critical habitat is a function of exposure intensity and susceptibility of a species to a stressor's effects (i.e., probability of response).

A ***No effect*** determination indicates that the proposed Project would have no impacts, positive or negative, on species or designated critical habitat. Generally, this means that the species or critical habitat would not be exposed to the proposed Project and its environmental consequences.

A ***may affect, but not likely to adversely affect*** determination would be given if the Project's effects are wholly beneficial, insignificant, or discountable.

1. *Beneficial* effects have an immediate positive effect without any adverse effects to the species or habitat.
2. *Insignificant* effects relate to the size or severity of the impact and include those effects that are undetectable, not measurable, or so minor that they cannot be meaningfully evaluated. Insignificant is the appropriate effect conclusion when plausible effects are going to happen but will not rise to the level of constituting an adverse effect.
3. *Discountable*[4] effects are those that are extremely unlikely to occur. For an effect to be discountable, there must be a plausible adverse effect (i.e., a credible effect that could result from the action and that would be an adverse effect if it did impact a listed species), but it is extremely unlikely to occur (USFWS and NMFS 1998).

A *may affect, likely to adversely affect* determination occurs when the proposed Project may result in any adverse effect on a species or its designated critical habitat. In the event that the Project may have beneficial effects on listed species or critical habitat, but is also likely to cause some adverse effects, then the proposed Project ***may affect, likely to adversely affect***, the listed species.

Table 3-1 provides the effects determinations for each ESA-listed species analyzed in this assessment by stressor. Section 3.2 provides a description of the existing conditions for ESA-listed marine mammal species considered for further analysis, accompanied by the detailed effects assessment for each stressor on these ESA-listed marine mammals. Section 3.3 describes existing conditions for ESA-listed sea turtles considered for further analysis and provides the detailed effects assessment for each stressor on each of these ESA-listed sea turtles. Lastly, Section 3.4 details existing conditions for ESA-listed marine fish considered for further analysis and provides the detailed effects assessment for each stressor on these ESA-listed marine fish.

[4] When the terms "discountable" or "discountable effects" appear in this document, they refer to potential effects that are found to support a "not likely to adversely affect" conclusion because they are extremely unlikely to occur. The use of these terms should not be interpreted as having any meaning inconsistent with the ESA regulatory definition of "effects of the action."

Table 3-1 Effects Determinations by Stressor

	Stressor	Marine Mammals				Sea Turtles				Marine Fish	
		Fin Whale	North Atlantic Right Whale	Sei Whale	Sperm Whale	Green Sea Turtle (North Atlantic DPS)	Kemp's Ridley Sea Turtle	Leatherback Sea Turtle	Loggerhead Sea Turtle (Northwest Atlantic DPS)	Atlantic Sturgeon	Shortnose Sturgeon
Underwater Noise	Impact Pile-Driving	LAA	LAA	LAA for PTS NLAA for BD	NLAA	NLAA for PTS LAA for BD	LAA	LAA	LAA	NLAA	No Effect
Underwater Noise	Vibratory Pile-Driving	No Effect for PTS LAA for BD	No Effect for PTS LAA for BD	No Effect for PTS LAA for BD	No Effect for PTS LAA for BD	NLAA	NLAA	NLAA	NLAA	NLAA	No Effect
Underwater Noise	HRG Surveys	No Effect for PTS NLAA for BD	No Effect for PTS NLAA for BD	No Effect for PTS NLAA for BD	No Effect for PTS NLAA for BD	NLAA	NLAA	NLAA	NLAA	NLAA	No Effect
Underwater Noise	Cable Laying	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	No Effect
Underwater Noise	Dredging	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	No Effect
Underwater Noise	Vessels	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
Underwater Noise	Aircraft	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	No Effect
Underwater Noise	WTGs	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	No Effect
Dredging		No Effect	No Effect	No Effect	No Effect	NLAA	NLAA	NLAA	NLAA	NLAA	No Effect
Habitat Disturbance		NLAA	NLAA	NLAA	NLAA	No Effect	NLAA	NLAA	No Effect	NLAA	No Effect
Secondary Entanglement from Increased Recreational Fishing Due to Reef Effect		NLAA	NLAA	NLAA	NLAA	NLAA	LAA	LAA	LAA	NLAA	No Effect

Stressor	Marine Mammals				Sea Turtles				Marine Fish	
	Fin Whale	North Atlantic Right Whale	Sei Whale	Sperm Whale	Green Sea Turtle (North Atlantic DPS)	Kemp's Ridley Sea Turtle	Leatherback Sea Turtle	Loggerhead Sea Turtle (Northwest Atlantic DPS)	Atlantic Sturgeon	Shortnose Sturgeon
Turbidity	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	No Effect
Vessel Traffic	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	LAA	LAA
Monitoring Surveys	NLAA	NLAA	NLAA	NLAA	NLAA for all except for trawl surveys which are LAA for capture/minor injury	NLAA for all except for trawl surveys which are LAA for capture/minor injury	NLAA for all except for trawl surveys which are LAA for capture/minor injury	NLAA for all except for trawl surveys which are LAA for capture/minor injury	NLAA for all except for trawl surveys which are LAA for capture/minor injury	No Effect
EMF	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	No Effect
Air Emissions	No Effect	No Effect	No Effect	No Effect	No Effect	No Effect	No Effect	No Effect	No Effect	No Effect
Lighting/ Marking of Structures	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	No Effect
Unanticipated Events	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
Overall Effects Determination	**LAA**	**LAA**	**LAA**	**LAA**	**LAA**	**LAA**	**LAA**	**LAA**	**LAA**	**LAA**

BD = behavioral disturbance; DPS = distinct population segment; EMF = electromagnetic field; HRG = high-resolution geophysical; LAA = likely to adversely affect; NLAA = not likely to adversely affect; TTS = temporary threshold shift; PTS = permanent threshold shift; TBD = to be determined following additional analysis; WTG = wind turbine generator

3.2. MARINE MAMMALS

Following is a description of the existing conditions for each species of ESA-listed marine mammal in the action area considered for further analysis in this BA, accompanied by the detailed effects assessment for each stressor on ESA-listed marine mammals.

The fin whale and NARW, both listed as endangered, are likely to occur in the Project area. Sei whale and sperm whale are likely to occur in the ensonified area.

3.2.1 Fin Whale

3.2.1.1. Description and Life History

The fin whale is the second-largest species of whale, reaching a maximum weight of 40 to 80 tons (36 to 73 metric tons) and a maximum length of 75 to 85 feet (23 to 26 meters) (NMFS 2021d). This species reaches physical maturity at 25 years of age. Age of sexual maturity varies between sexes; males reach sexual maturity at 6 to 10 years of age, and females mature between the age of 7 and 12 years. The gestation period for fin whales is 11 to 12 months, and females give birth in tropical and subtropical areas in midwinter (NMFS 2021d).

Fin whales are mysticetes (i.e., baleen whales) and forage using lunge or skim feeding. This species feeds during summer and fasts during the winter migration (NMFS 2021d). Primary prey species include krill, squid, herring, sand lance, and copepods (Kenney and Vigness-Raposa 2010).

For the purposes of evaluating underwater noise impacts, marine mammals have been organized into groups based on their hearing physiology and sensitivity (NMFS 2018a). All mysticetes, including fin whales, are classified as low-frequency cetaceans. This hearing group has a generalized hearing range of 7 Hz to 35 kilohertz (kHz).

3.2.1.2. Status and Population Trend

The fin whale was listed as endangered in 1970, as part of a pre-cursor to the ESA (USFWS 1970). The status of this species was most recently reviewed as part of its 5-year status review in 2019, and NMFS (2019b) determined that the species should be downlisted from endangered to threatened. However, no rulemaking has been proposed to reclassify the species under the ESA. Fin whales found in the action area belong to the Western North Atlantic stock. The best abundance estimate for the Western North Atlantic stock is 6,802 individuals (Hayes et al. 2022). There are currently insufficient data to determine a population trend for this species.

Threats to fin whales include vessel strikes, entanglement, anthropogenic noise, and climate change. This species is likely the second most vulnerable species to vessel strikes following NARW (NMFS 2021d). In a study evaluating historic and recent vessel strike reports, fin whales were involved in collisions the most frequently of the 11 large species evaluated (Laist et al. 2001). Though entanglement can result in injury or mortality in this species, fin whales may be less susceptible to entanglement than other large whale species (Glass et al. 2010; Nelson et al. 2007).

3.2.1.3. Distribution and Habitat Use

Fin whales inhabit deep, offshore waters of every major ocean and are most common in temperate to polar latitudes (NMFS 2021d). In the U.S. Atlantic, fin whales are common in shelf waters north of Cape Hatteras, North Carolina and are found in this region year-round (Edwards et al. 2015; Hayes et al. 2020). This species most commonly occupies waters along the 328-foot (100-meter) isobath but may be found in both shallower and deeper waters (Kenney and Winn 1986). Fin whale migratory patterns are complex. Most individuals in the North Atlantic migrate between summer feeding grounds in the Arctic in the

Labrador/Newfoundland region and winter breeding and calving areas in the tropics around the West Indies (NMFS 2021d).

Fin whales occur regularly in the action area year-round. Aerial surveys have documented the species in the action area in all seasons (Atlantic Shores 2023a). Fin whale sightings are more common during winter and summer in the New Jersey (Atlantic Shores 2023a). Average monthly densities within a 3.9-km buffer of the Project Area ranged from 0.028 animal per 100 square kilometers (animals/100 square kilometers [km^2]) in August to 0.178 animal/100 km^2 in January (**Table 3-2**) (Application for Marine Mammal Protection Act (MMPA) Rulemaking and Letter of Authorization; Atlantic Shores 2023b).

3.2.2 North Atlantic Right Whale

3.2.2.1. Description and Life History

The NARW is a large mysticete that can reach lengths up to 52 feet (16 meters) and weights up to 70 tons (64 metric tons) (NMFS 2021h). This species may live to 70 years of age or more. Female NARWs reach sexual maturity at approximately age 10 and have a calf every three to four years, though in recent years the time span between calvings has increased to six to ten years (NMFS 2021h). The gestation period is approximately one year, and calves are born in the coastal waters of South Carolina, Georgia, and Florida.

NARWs feed throughout the water column and may skim feed through dense patches of prey at the surface (NMFS 2021h). This species feeds primarily on copepods belonging to the *Calanus* and *Pseudocalanus* genera (McKinstry et al. 2013).

As noted in Section 3.2.1, marine mammals are organized into groups based on their hearing physiology and sensitivity (NMFS 2018a). All mysticetes, including NARWs, are classified as low-frequency cetaceans. This hearing group has a generalized hearing range of 7 Hz to 35 kHz.

3.2.2.2. Status and Population Trend

The NARW was listed as endangered in 1970, as part of a pre-cursor to the ESA (USFWS 1970). The status of this species was most recently reviewed during 2012 as part of the species' 5-year status review, and its endangered status remains unchanged (NMFS 2012b). NARWs found in the Project area belong to the Western North Atlantic stock. The most recent stock assessment for NARW was conducted in 2022. The best abundance estimate for the Western North Atlantic stock is 338 individuals (NMFS 2023a). The species is considered critically endangered, and the Western North Atlantic stock experienced a decline in abundance between 2011 and 2020 with an overall decline of 29.7 percent.

Threats to NARW include vessel strikes, entanglement, anthropogenic noise, and climate change. NARW has been undergoing an unusual mortality event since 2017, attributed to vessel strikes and entanglement in fisheries gear (NMFS 2021a). Vessel strike and entanglement are leading causes of death in this species (Kite-Powell et al. 2007; Knowlton et al. 2012). From 2002 to 2006, NARW was subject to the highest proportion of vessel strikes and entanglements of any species evaluated (Glass et al. 2010). As this species spends a relatively high proportion of time at the surface and is a slow swimmer, NARW are particularly vulnerable to vessel strike, and most strikes are fatal to this species (Jensen and Silber 2004). Seventy-two percent of NARWs show evidence of past entanglements (Johnson et al. 2005), and entanglement may be limiting population recovery (Knowlton et al. 2012).

3.2.2.3. Distribution and Habitat Use

NARW is found primarily in coastal waters, though the species also occurs in deep, offshore waters (NMFS 2021h). In the U.S. Atlantic, NARW range extends from Florida to Maine. This species exhibits strong migratory patterns between high-latitude summer feeding grounds in New England and Canada and low-latitude winter calving and breeding grounds in shallow, coastal waters off South Carolina, Georgia, and northern Florida. However, some individuals may migrate along the Mid-Atlantic coast throughout the calving season (Krzystan et al. 2018).

As noted in Section 2.3.1, there is designated critical habitat for NARW within the action area. There is also a Seasonal Management Area for NARW and a biologically important area for NARW migration within the action area (**Figure 3-1**). The Seasonal Management Area is in effect from November through April; during this period, vessels 65 feet (19.8 meters) or longer cannot exceed 10 knots during transit.

NARW could be found in the Project area throughout the year. Aerial surveys documented NARW offshore of the New Jersey in all seasons except summer (Atlantic Shores 2023a). NARW has been acoustically detected in waters off New Jersey and New York during all months of the year (Estabrook et al. 2019; Whitt et al. 2013). Average monthly densities within a 3.9-km buffer of the Project Area ranged from 0.001 animal/100 km^2 in July and August to 0.074 animal/100 km^2 in March (**Table 3-2**) (Application for Marine Mammal Protection Act (MMPA) Rulemaking and Letter of Authorization; Atlantic Shores 2023b).

3.2.3 Sei Whale

3.2.3.1. Description and Life History

The sei whale is a large baleen whale, reaching a maximum weight of 50 tons (45 metric tons) and a maximum length of 40 to 60 feet (12 to 18 meters) (NMFS 2022f). This species reaches sexual maturity at 6 to 12 years of age. The gestation period for sei whales is 11 to 13 months, and females give birth every 2 to 3 winters at subtropical latitudes (NMFS 2022f).

Sei whales forage by gulping or skimming. This species prefers to feed at dawn (NMFS 2022f). Primary prey species include plankton, small schooling fish, and cephalopods.

As noted in Section 3.2.1, marine mammals are organized into groups based on their hearing physiology and sensitivity (NMFS 2018a). All mysticetes, including sei whales, are classified as low-frequency cetaceans. This hearing group has a generalized hearing range of 7 Hz to 35 kHz.

3.2.3.2. Status and Population Trend

The sei whale is listed as endangered throughout its range (USFWS 1970). The status of this species was most recently reviewed as part of its 5-year status review in 2021, and its endangered status remains unchanged (NMFS 2021k). Sei whales found in the action area belong to the Nova Scotia stock. The best abundance estimate for the Nova Scotia stock is 6,292 individuals (Hayes et al. 2022). A trend analysis has not been conducted for this species due to low statistical power.

Threats to sei whales include vessel strikes, entanglement, anthropogenic noise, and climate change. Entanglement is one of the primary threats to sei whales and could lead to reduced reproductive success or mortality (NMFS 2022d).

3.2.3.3. Distribution and Habitat Use

Sei whale is found throughout subtropical, temperate, and subpolar waters throughout the globe (NMFS 2022d). This species typically occurs in deep, offshore waters. Sei whale distribution is unpredictable, but this species is commonly found in the Gulf of Maine and on Georges and Stellwagen Banks in the summer (NMFS 2022d).

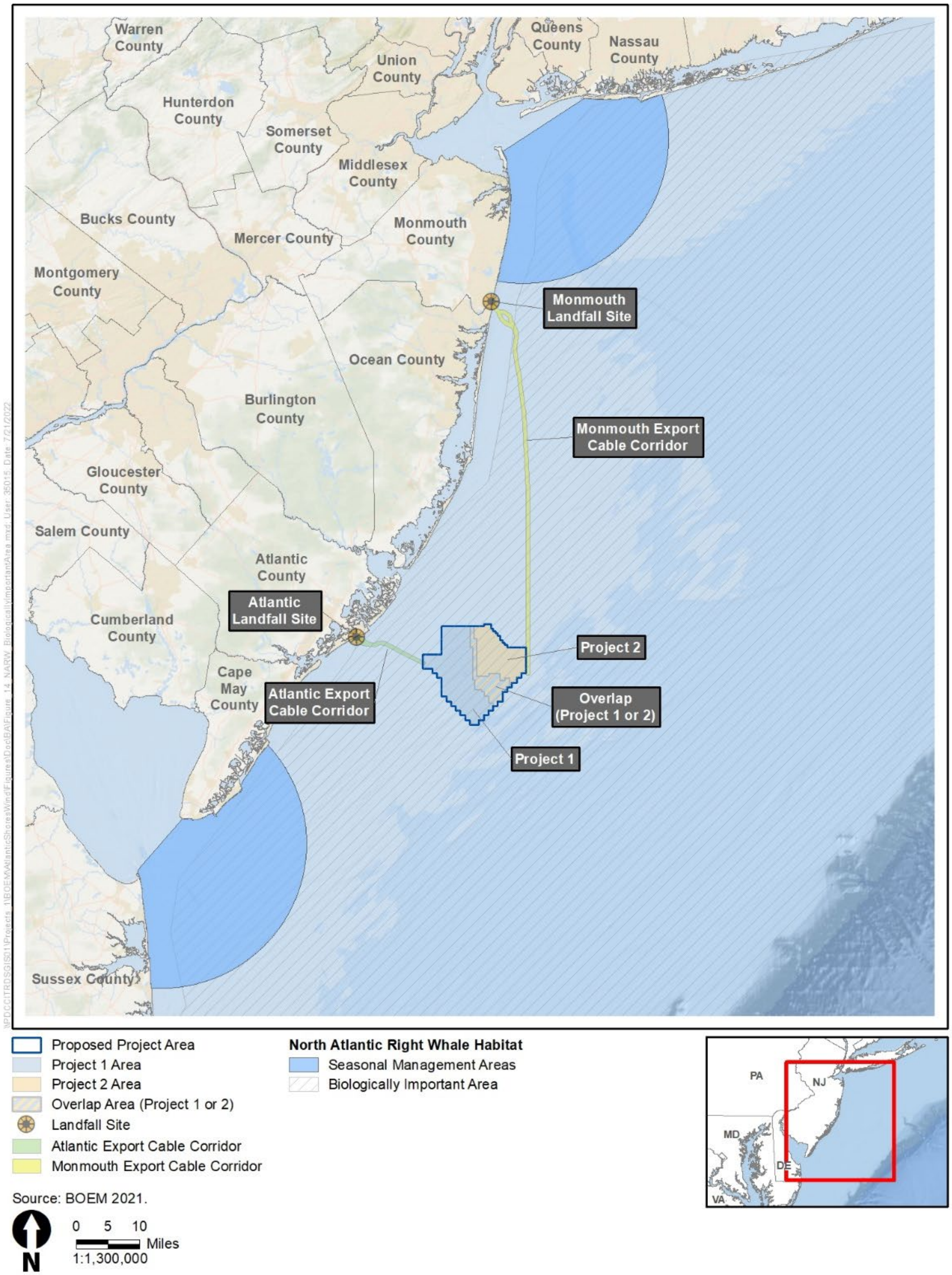

Figure 3-1. Seasonal Management Area and Biologically Important Area for North Atlantic Right Whales in the Action Area

Sei whales are uncommon in the Mid-Atlantic Bight and no sightings have been documented in New Jersey State waters (Atlantic Shores 2023a). Passive acoustic monitoring equipment in New York waters have detected sei whales from the fall through the spring, though the calls were not localized to New York waters (WHOI 2018; WCS Ocean Giants 2020). This species is generally expected to occur around the continental shelf edge beyond the Lease Area (Hayes et al. 2021 citing Mitchell 1975). Therefore, the occurrence would largely be limited to the ensonified portion of the action area. Average monthly densities within a 3.9-km buffer of the Project Area ranged from 0.001 animal/100 km^2 in July and August to 0.074 animal/100 km^2 in April (**Table 3-2**) (Application for Marine Mammal Protection Act (MMPA) Rulemaking and Letter of Authorization; Atlantic Shores 2023b).

3.2.4 Sperm Whale

3.2.4.1. Description and Life History

The sperm whale is the largest odontocete, reaching lengths of 40 to 52 feet (12 to 16 meters) and weighing 15 to 45 tons (14 to 41 metric tons) (NMFS 2022g). Age of sexual maturity varies between sexes. Males reach sexual maturity at 10 to 20 years of age but generally do not participate in breeding until they are in their late twenties. Females mature at approximately the age of 9. The gestation period for sperm whales is 14 to 16 months, and females give birth every 5 to 7 years (NMFS 2022g).

Sperm whales are predatory specialists known for hunting prey in deep water. The species is among the deepest diving of all marine mammals. Foraging dives often reach depths of 2,000 feet (610 meters) and last for up to 45 minutes, though the species is capable of dives to 10,000 feet (3,048 meters) for over 60 minutes (NMFS 2022g). Their diet includes squid, sharks, skates, and deep-water fish.

As noted in Section 3.2.1, marine mammals are organized into groups based on their hearing physiology and sensitivity (NMFS 2018a). Sperm whales are classified as mid-frequency cetaceans (MFC). This hearing group has a generalized hearing range of 150 Hz to 160 kHz.

3.2.4.2. Status and Population Trend

The sperm whale is listed as endangered throughout its range (USFWS 1970). The status of this species was most recently reviewed as part of its 5-year status review in 2015, and its endangered status remains unchanged (NMFS 2015b). Sperm whales found in the action area belong to the North Atlantic stock. The most recent abundance estimate for the North Atlantic stock is 4,349 (Hayes et al. 2020). A trend analysis has not been conducted for this species due to low statistical power.

Threats to sperm whales include vessel strikes, entanglement, anthropogenic noise, marine debris, climate change, and oil spills and contaminants. Though few vessel strikes of sperm whales have been documented, their extended surface time between deep dives makes them more vulnerable to vessel strikes (NMFS 2022e). Sperm whales are known to depredate (i.e., remove fish) longline gear, and this interactive behavior with fishing gear increases their risk of entanglement (NMFS 2022e).

3.2.4.3. Distribution and Habitat Use

Sperm whales have a cosmopolitan distribution, occurring in all the world's oceans (NMFS 2022e). Compared to other large whales (i.e., mysticetes), sperm whale migrations are relatively unpredictable and poorly understood. In some populations, females remain in tropical waters with their young year-round while males undergo long migrations to higher latitudes (NMFS 2022e).

This species was not observed in New Jersey waters during Ecological Baseline studies conducted by Geo-Marine (2010) but is a known seasonal visitor (Atlantic Shores 2023a). Water depths in the Lease Area are too shallow for sperm whales. This species is expected to occur year-round in deeper waters near the shelf break (Tetra Tech and Smultea Sciences 2018; Tetra Tech and LGL 2019, 2020). Therefore, occurrence of this species would be limited to the portion of the action area associated with vessel transits to and from the Gulf of Mexico. Average monthly densities within a 3.9-km buffer of the Project Area ranged from 0.000 animals/100 km^2 in August through October to 0.010 animal/100 km^2 in May (**Table 3-2**) (Application for Marine Mammal Protection Act (MMPA) Rulemaking and Letter of Authorization; Atlantic Shores 2022).

Table 3-2. Monthly Marine Mammal Densities within 3.9 km of the Project Area with Annual Average

Species	Density (animals/100 km^2)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg
Fin whale	0.178	0.123	0.098	0.099	0.088	0.075	0.047	0.028	0.029	0.031	0.038	0.141	0.081
NARW	0.069	0.074	0.062	0.046	0.010	0.003	0.001	0.001	0.002	0.004	0.010	0.042	0.027
Sei whale	0.026	0.016	0.034	0.074	0.027	0.006	0.001	0.001	0.002	0.008	0.026	0.042	0.022
Sperm whale	0.004	0.002	0.001	0.007	0.010	0.005	0.003	0.000	0.000	0.000	0.003	0.004	0.003

Sources: Roberts et al. 2016a, 2016b, 2022

3.2.5 Effects Analysis for Marine Mammals

3.2.5.1. Definition of Take, Harm, and Harass

Section 3 of the ESA defines take as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct. Harm, as defined by regulation (50 CFR §222.102), includes acts that actually kill or injure wildlife and acts that may cause significant habitat modification or degradation that actually kill or injure fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering.

NMFS has not defined “harass” under the ESA by regulation. However, on October 21, 2016, NMFS issued interim guidance on the term “harass,” defining it as to “create the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering” (NMFS 2016c). For this consultation, we rely on this definition of “harass” when assessing effects to all ESA-listed species.

For marine mammal species, prior to the issuance of the October 21, 2016, guidance, consultations that involved NMFS Permits and Conservation Division’s authorization under the MMPA relied on the MMPA definition of harassment. Under the MMPA, harassment is defined as any act of pursuit, torment, or annoyance that:

1. *has the potential to injure a marine mammal or marine mammal stock in the wild (Level A Harassment); or*
2. *has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering (Level B Harassment). Under NMFS regulation, Level B harassment does not include an act that has the potential to injure a marine mammal or marine mammal stock in the wild.*

NMFS October 21, 2016, guidance states that the “interim ESA harass interpretation does not specifically equate to MMPA Level A or Level B harassment but shares some similarities with both levels in the use of the terms ‘injury/injure’ and a focus on a disruption of behavior patterns. NMFS has not defined ‘injure’ for purposes of interpreting Level A and Level B harassment but in practice has applied a physical test for Level A harassment” (NMFS 2016c). In this assessment, available data and models that provide estimates of MMPA Level B harassment have been used in estimating the number of instances of behavioral disturbance of ESA-listed marine mammals, whereas available data and models that provide estimates of MMPA Level A harassment have been considered for our analysis to be instances of harm and/or injury (i.e., permanent threshold shift [PTS]) under the ESA, depending on the nature of the effects.

Level B harassment as applied in this consultation may involve a wide range of behavioral responses, including, but not limited to, avoidance, changes in calling or dive patterns, or disruption of feeding, migrating, or reproductive behaviors.

3.2.5.2. Underwater Noise

Cetaceans (i.e., mysticetes and odontocetes) rely heavily on sound for essential biological functions, including communication, mating, foraging, predator avoidance, and navigation (Madsen et al. 2006; Weilgart 2007). Anthropogenic underwater noise may have adverse impacts on marine mammals if the sound frequencies produced by the noise sources overlap with marine mammals' hearing ranges (NSF and USGS 2011). If such overlap occurs, underwater noise can result in behavioral and/or physiological effects, potentially interfering with essential biological functions (Southall et al. 2007).

High levels of underwater noise have the potential to result in take of ESA-listed species in the action area. The Proposed Action would generate temporary noise during the construction phase due to impact pile driving, vibratory pile driving, HRG surveys, cable laying, and vessels. The Proposed Action would also generate long-term noise during the O&M phase due to vessel and aircraft traffic, which would be intermittent, and operation of WTGs. The extent and severity of effects from Project-generated underwater noise is dependent on the timing of activities relative to species occurrence, the type of noise impact, and species-specific sensitivity. To support the underwater noise assessment for the Project, the Applicant conducted Project-specific underwater noise modeling for the following Project activities: impact pile driving, vibratory pile driving, and HRG surveys. This subsection provides an overview of underwater noise, auditory criteria used to evaluate impacts on marine mammals, and an assessment or each noise source associated with the Proposed Action. The assessment of underwater noise in this BA uses modeling and take calculations (Level A and Level B harassment as per the MMPA) presented in Atlantic Shores' application for an LOA (Atlantic Shores 2022, 2023b). Following the assessment of these noise sources, a summary of overall underwater noise effects to ESA-listed marine mammal species is provided.

Overview of Underwater Noise

Underwater noise can be described through a source-path-receiver model. An acoustic source emits sound energy that radiates outward and travels through the water and the seafloor as pressure waves; pressure is the most relevant component of sound to marine mammals. The sound level decreases with increasing distance from the acoustic source as the sound pressure waves spread out under the influence of the surrounding environment. The amount by which the sound levels decrease between a source and receiver (e.g., a whale) is called transmission loss (Richardson et al. 1995). The amount of transmission loss that occurs depends on the distance between the source and the receiver, the frequency of the sound, properties of the water column, and properties of the seafloor layers. Underwater sound levels are expressed in dB, which is a logarithmic ratio relative to a fixed reference pressure of 1 micropascal (μPa).

Sound travels faster and farther in water (approximately 4,921 feet [1,500 meters] per second) than it does in air (approximately 1,148 feet [350 meters] per second). The efficiency of underwater sound propagation allows marine mammals to use underwater sound for essential biological functions, as described above. Anthropogenic (i.e., human-introduced) noise has gained recognition as a potential stressor for marine mammals because of their reliance on underwater hearing for maintenance of these critical biological functions (Ketten 1998; Richardson et al. 1995). Underwater noise generated by human activities can often be detected by marine mammals many kilometers from the source. Potential acoustic effects of anthropogenic underwater noise on marine mammals include mortality, non-auditory injury, permanent or temporary hearing loss, behavioral changes, and acoustic masking, with the severity of the effect increasing with decreasing distance from the sound source. All the above impacts have the potential to induce stress on marine animals in their receiving environment (Erbe 2013; OSPAR Commission 2009).

For auditory effects, underwater noise is less likely to disturb or injure an animal if it occurs at frequencies at which the animal cannot hear well. The importance of sound components at particular frequencies can be scaled by frequency weighting relative to an animal's sensitivity to those frequencies (Nedwell and Turnpenny 1998; Nedwell et al. 2007). Regulatory thresholds used for the purpose of predicting the extent of potential noise impacts on marine mammal hearing (i.e., permanent threshold shift [PTS]/temporary threshold shift [TTS]), described in the following subsection, and subsequent management of these impacts have recently been revised to account for the duration of exposure, incorporate new hearing and TTS data, and account for the differences in hearing acuity in various marine mammal species (Finneran 2016; NMFS 2018b).

In the current regulatory context, anthropogenic sound sources are categorized as either impulsive or non-impulsive, and either continuous or intermittent, based on their differing potential to affect marine species (NMFS 2018a). Specifically, when it comes to potential damage to marine mammal hearing, sounds are classified as either impulsive or non-impulsive, and when considering the potential to affect behavior or acoustic masking, sounds are classified as either continuous or intermittent.

Impulsive noises are characterized as having (ANSI S1.13-2005; Finneran 2016):

- Broadband frequency content;
- Fast rise-times and rapid decay times;
- Short durations (i.e., less than1 second); and
- High peak sound pressures.

Characterization of non-impulsive noises is less clear. Characteristics of non-impulsive sound sources may include:

- Variable in spectral composition (i.e., broadband, narrowband, or tonal);
- Longer rise-time/decay times and total durations compared to an impulsive sound; and
- Continuous (e.g., vessel engine radiated noise), or intermittent (e.g., echosounder pulses).

Potential adverse auditory effects to marine mammals from Project-generated underwater noise includes permanent threshold shift (PTS), temporary threshold shift (TTS), behavioral disruption, and masking. A summary of the reports used to evaluate underwater noise effects in the BA are provided below:

- Atlantic Shores South Acoustic Exposure Modeling. Weirathmueller, M. J., E. T. Küsel, K. E. Zammit, S. G. Dufault, K. E. Limpert, and D. G. Zeddies. 2023. Document 02272, Version 2.0. Technical Report by JASCO Applied Sciences. Dated 14 April 2023.
- Cofferdam Installation and Removal Memorandum. JASCO Applied Sciences Inc. 2022. Distance to regulatory thresholds and exposure estimation for vibratory pile driving of sheet piles. Prepared for Atlantic Shores Offshore Wind, LLC, Dated 20 May 2022.
- High-Resolution Geophysical Surveys Take Estimate Memorandum. EDR. 2022. Take Estimates from High-Resolution Geophysical Surveys for the Letter of Authorization. Prepared for Atlantic Shores Offshore Wind. LLC, Dated May 11, 2022.

For sound sources or for species where no Project-specific modeling was completed, information available in the literature regarding source levels was used to develop the effects analysis.

The sections below provide an overview of the available information on marine mammal hearing, the thresholds applied, the results of the underwater noise modeling conducted, and the impact consequences for each potential underwater noise generating activity for the Project.

Auditory Criteria for Marine Mammals

Assessment of the potential effects of underwater noise on marine mammals requires acoustic thresholds against which received sound levels can be compared. Auditory thresholds from underwater noise are expressed using three common metrics: root-mean-square sound pressure level (SPL or L_{rms}) and peak sound pressure level (L_{pk}), both measured in dB re 1 μPa, and sound exposure level (SEL), a measure of energy in decibels relative to 1 micropascal squared second (dB re 1 $\mu Pa^2 s$). L_{pk} is an instantaneous value, whereas SEL (L_E) is the total noise energy over a given time period or event. As such, the SEL accumulated over 24 hours, ($L_{E,24h}$) is appropriate when assessing effects to marine mammals from cumulative exposure to multiple pulses or durations of exposure. L_{rms} is a root mean squared (rms) average over a period of time and is equal to the SEL divided (linearly) by the time period of exposure. Therefore, if the time period is 1 second, the values of the SEL and the L_{rms} are equal.

For marine mammals, established acoustic criteria for hearing injury and behavioral disturbance recognized by NMFS have been updated in terms of auditory injury thresholds (NMFS 2018b). The revised auditory injury thresholds apply dual criteria based on L_{pk} and SEL accumulated over 24 hours (L_{E24hr}) and are based on updated frequency weighting functions for five marine mammal hearing groups described by NMFS 2018b, Southall et al. (2007), and Finneran and Jenkins (2012) as summarized in **Table 3-3**. Behavioral disturbance thresholds for marine mammals are based on L_{rms} of 160 dB re 1 μPa for non-explosive, impulsive or intermittent sounds and 120 dB re 1 μPa for continuous sounds for all marine mammal species (NOAA 2005). It is worth noting that non-impulsive HRG survey equipment that have signals that sweep through a range of frequencies (i.e., CHIRPs) were assessed against the 160 dB re 1 μPa threshold. Although these disturbance thresholds remain current (in the sense that they have not been formally superseded by newer directives), they are not frequency weighted to account for different hearing abilities by the five marine mammal hearing groups.

Table 3-3 Marine Mammal Hearing Groups

Hearing Groups	Taxonomic Group	Generalized Hearing Range[1]
Low-frequency cetaceans (LFC)	Baleen whales (e.g., humpback whale, blue whale)	7 Hz to 35 kHz
Mid-frequency cetaceans (MFC)	Most dolphin species, beaked whales, sperm whale	150 Hz to 160 kHz

dB = decibels; Hz = hertz; kHz = kilohertz
Sources: Finneran and Jenkins 2012; NMFS 2018b; Southall et al. 2007
[1]The generalized hearing range is for all species within a group. Individual hearing may vary. Generalized hearing range based on ~65 dB threshold from normalized composite audiogram, with the exception of lower limits for LFC (Southall et al. 2007)

The potential for underwater noise exposures to result in adverse impacts on a marine animal depends on the received sound level, the frequency content of the sound relative to the hearing ability of the animal, the duration, and the level of natural background noise. Potential effects range from subtle changes in behavior at low received levels to strong disturbance effects or potential injury at high received levels.

Sound reaching the receiver with ample duration and SPL can result in a loss of hearing sensitivity in marine animals termed a noise-induced threshold shift. This may consist of temporary threshold shift (TTS) or permanent threshold shift (PTS). TTS is a relatively short-term, reversible loss of hearing following exposure (Southall et al. 2007; Le Prell 2012), often resulting from cellular fatigue and metabolic changes (Saunders et al. 1985; Yost 2000). While experiencing TTS, the hearing threshold rises, and subsequent sounds must be louder to be detected. PTS is an irreversible loss of hearing (permanent damage; not fully recoverable) following exposure and commonly results from inner ear hair cell loss or structural damage to auditory tissues (Saunders et al. 1985; Henderson et al. 2008). PTS has been demonstrated in harbor seals (Kastak et al. 2008; Reichmuth et al. 2019). TTS has been demonstrated in some odontocete and pinniped species in response to exposure to impulsive and non-impulsive noise sources in a laboratory setting (a full review is provided in Finneran et al. 2017; NOAA 2013; Southall et al. 2007). Prolonged or repeated exposures without recovery time to sound levels sufficient to induce TTS can lead to PTS (Southall et al. 2007).

Table 3-4 outlines the acoustic thresholds for onset of acoustic impacts (PTS, TTS, and/or behavioral disruption) for marine mammals for both impulsive and non-impulsive noise sources. Impulsive noise sources for the Project include impact pile driving, and some HRG equipment. Non-impulsive noise sources associated with the Project include vibratory pile driving associated with installation and removal of the cofferdam, some HRG equipment, vessel activities, and dredging.

Table 3-4. Acoustic Injury (PTS and TTS) and Behavioral Disturbance Thresholds for ESA-listed Cetaceans

Hearing Group	Effect	Impulsive Source			Non-Impulsive Source	
		Unweighted L_{pk} (dB re 1 μPa)	Weighted $L_{E,24h}$ (dB re 1 μPa²s)	Unweighted L_{rms} (dB re 1 μPa)	Weighted $L_{E,24h}$ (dB re 1 μPa²s)	Unweighted L_{rms} (dB re 1 μPa)
LFC	PTS	219	183	-	199	-
	TTS	213	168	-	179	-
	BD	-	-	160	-	120
MFC	PTS	230	185	-	198	-
	TTS	224	170	-	178	-
	BD	-	-	160	-	120

BD = behavioral disturbance; dB re 1 μPa = decibels relative to 1 micropascal; dB re 1 μPa²s = decibels relative to 1 micropascal squared second; $L_{E,24hr}$ = sound exposure level accumulated over 24 hours; L_{pk} = instantaneous peak sound pressure level; L_{rms} = root mean square sound pressure level; LFC = low-frequency cetacean; MFC = mid-frequency cetacean; PTS = permanent threshold shift; TTS = temporary threshold shift
Source: NMFS 2018a, 2022d
Note: Values presented for SEL ($L_{E,24h}$) use a 24-hour cumulative analysis unless stated otherwise.

Marine mammals show varying levels of disturbance in response to underwater noise sources. Observed behavioral responses include displacement and avoidance, decreases in vocal activity, and habituation. Behavioral responses can consist of disruption in foraging patterns, increases in physiological stress, and reduced breeding opportunities, among other responses. To better understand and categorize the potential effects of behavioral responses, Southall et al. (2007) developed a behavioral response severity scale of low, moderate, or high (Finneran et al. 2017; Southall et al. 2007). This scale was recently updated in Southall et al. (2021). The revised report updated the single severity response criteria defined in Southall et al. (2007) into three parallel severity tracks that score behavioral responses from 0 to 9. The three severity tracks are (1) survival, (2) reproduction, and (3) foraging. This approach is acknowledged as being relevant to vital rates, defining behaviors that may affect individual fitness, which may ultimately affect population parameters. It is noted that not all the responses within a given category need to be observed but that a score is assigned for a severity category if any of the responses in that category are displayed. To be conservative, the highest (or most severe) score is to be assigned for instances when several responses are observed from different categories. In addition, the authors acknowledge that it is no longer appropriate to relate “simple all-or-nothing thresholds” to specific received sound levels and behavioral responses across broad taxonomic groupings and sound types due to the high degree of variability within and between species and noise types. The new criteria also move away from distinguishing noise impacts from impulsive vs. non-impulsive sound types into considering the specific type of noise (e.g., pile driving, seismic, vessels, etc.).

For the purposes of this BA, the NMFS behavioral thresholds along with the updated Southall et al. (2021) severity scale and information available in the literature will be used to assess the potential effects and consequences of behavioral effects from underwater noise on marine mammals.

Auditory masking occurs when sound signals used by marine mammals overlap in time, space, and frequency with another sound source (Richardson et al. 1995). Masking can reduce communication space, limit the detection of relevant biological cues, and reduce communication or echolocation effectiveness. A growing body of literature is focused on improving the framework for assessing the potential for masking of animal communication by anthropogenic noise and understanding the resulting effects. More research is needed to understand the process of masking, the risk of masking by anthropogenic activities such as sonar emissions, the ecological significance of masking, and what anti-masking strategies are used by marine animals and their degree of effectiveness before masking can be incorporated into regulation strategies or mitigation approaches (Erbe et al. 2016). For the current assessment, masking was considered possible if the frequency of the sound source overlaps with the hearing range of the marine mammal (**Table 3-3**).

Assessment of Effects

Impact Pile Driving

The intense, impulsive noise (i.e., noise with rapid changes in sound pressure) associated with impact pile driving can cause behavioral and physiological effects in marine mammals. Potential behavioral effects of pile-driving noise include avoidance and displacement (Dähne et al. 2013; Lindeboom et al. 2011; Russell et al. 2016; Scheidat et al. 2011). Potential physiological effects include temporary threshold shift (TTS) or permanent threshold shift (PTS) in an animal's hearing ability. Literature indicates that marine mammals would avoid disturbing levels of noise. Avoidance of impulsive noise sources has been observed in odontocetes (Hatakeyama et al. 1994; Watkins et al. 1993) and mysticetes (Johnson 2002; McCauley et al. 1998; Richardson et al. 1986, 1999). Avoidance of pile driving noise has been well documented in harbor porpoise (e.g., Benhemma-Le Gall et al. 2021; Brandt et al. 2011; Dähne et al. 2013; Scheidat et al. 2011) and has also been observed in harbor seal (Russell et al. 2016). However, individual responses to pile-driving noise are unpredictable and likely context specific. Behavioral effects and most physiological effects (e.g., stress responses and TTS) are expected to be short term and localized, although some sounds may be detected by marine mammals at a distance greater than 62 miles (100 km). Given that pile driving would occur on the OCS, marine mammals would be able to escape from disturbing levels of noise. Any disruptions to foraging or other normal behaviors would be short term, and increased energy expenditures associated with this displacement are expected to be small. PTS could permanently limit an individual's ability to locate prey, detect predators, navigate, or find mates and could therefore have long-term effects on individual fitness.

Impact pile driving would occur during construction to install WTG foundations and potentially OSS and met tower foundations (Section 1.3.1). Based on the anticipated construction schedules, concurrent pile driving for the Ocean Wind 1 offshore wind project, the nearest project to Atlantic Shores South, is not anticipated during construction of the Proposed Action (BOEM 2022b). Concurrent impact pile driving is possible at Empire Wind 2 during the fourth quarter of 2026 through the fourth quarter of 2027 (BOEM 2022a). However, Empire Wind 2 is located approximately 80 miles to the northwest of the Lease Area.

The severity of underwater noise effects associated with impact pile driving is dependent on the received sound level (i.e., the sound level to which the organism is exposed), which is a function of the sound level generated by the noise source, the distance between the source and the organism, the acoustic properties of the water and seabed in between the source and the organism, and the duration of sound exposure.

Modeling Approach

Underwater sound propagation and animal movement modeling for impact pile driving for the Proposed Action was conducted in support of the COP (COP Volume II, Appendix II-L; Atlantic Shores 2023a). The sound propagation modeling used the GRLWEAP 2010 wave equation model (Pile Dynamics 2010) to estimate forcing functions for each pile type, and these functions were used as inputs to JASCO's impact pile driving source model to estimate acoustic source characteristics. JASCO's Marine Operations Noise Model and Full Wave Range Dependent Acoustic Model were used to estimate sound fields generated during impact pile driving. Sound propagation modeling was conducted at two representative locations within the Lease Area and included hypothetical broadband attenuation levels (0, 6, 10, and 15 dB) to account for utilization of noise abatement technology. Two seasonal conditions (summer and winter) were evaluated for use in modeling, and summer conditions (i.e., sound speed profile) were selected as they provided the most realistic sound propagation environment for impact pile driving. The summer conditions were considered representative for the months of May through October. The results of sound propagation modeling were used to estimate ranges to acoustic thresholds and were used as inputs for animal movement modeling. Animal movement modeling was conducted using JASCO's JASMINE model. The results of animal movement modeling were used to estimate exposure ranges ($ER_{95\%}$). This range represents the radius of a circle around a pile-driving noise source that encloses the closest point of approach for 95 percent of simulated animals (animats) exposed above relevant thresholds. $ER_{95\%}$ for each species are the distances outside of which an exposure is unlikely to occur for animals of that species and is based on animal movement modeling rather than a static animal at a specified distance for the entire duration of pile driving. $ER_{95\%}$ distances are species-specific rather than categorized only by hearing group because they incorporate species-specific biological parameters such as movement habits and species distribution.

For Scenario 1 under the Proposed Action, impact pile driving of 201 monopile foundations (200 WTGs across Projects 1 and 2 and 1 met tower for Project 1) and 96 pin piles for jacket foundations (4 large OSSs across Projects 1 and 2 with 24 pin piles each) was modeled. Two construction schedules were modeled for Scenario 1, a two-year schedule that assumes only one monopile is installed per day and a one-year schedule that assumes up to two monopiles are installed per day. Both schedules assume four pin piles are installed per day. The schedules used for the exposure estimates presented in the BA are provided in **Table 3-5**.

For Scenario 2 under the Proposed Action, impact pile driving of 112 monopile foundations (111 WTGs for Project 1 and 1 met tower for Project 1) and 454 pin piles for jacket foundations (89 WTGs for Project 2 with 4 pin piles each and 4 large OSSs across Projects 1 and 2 with 24 pin piles each) was modeled. Only one construction schedule was modeled for Scenario 2, a two-year schedule that assumes one monopile is installed per day and four pin piles are installed per day. While this modeling captured the greatest potential impact associated with installation of OSS foundations for both Scenarios, the overall greatest potential impact associated with impact pile driving was not captured as the met tower foundation was only modeled as a monopile. A jacket foundation for the met tower is within the PDE and would be expected to have a greater impact. However, the reduction in impact due to modeling a single foundation as a monopile rather than jacket foundation is expected to be minimal.

Atlantic Shores has committed to using a noise mitigation system (also termed noise abatement system) during installation of WTG and OSS foundations that achieves 10 dB of noise attenuation (**Table 1-10**). The noise mitigation system would be a single bubble curtain paired with an additional sound attenuation device or a double big bubble curtain. Bellmann et al. (2020) found three noise abatement systems to have proven effectiveness and to be offshore suitable: 1) the near-to-pile noise abatement systems – noise mitigation screen (IHC-NMS); 2) the near-to-pile hydro sound damper (HSD); and 3) for a far-from-pile noise abatement system, the single and double big bubble curtain (BBC and DBBC). With the IHC-NMS or the BBC, noise reductions of approximately 15 to 17 dB in depths of 82 to 131 feet (25 to 40 meters) could be achieved. The HSD system, independent of the water depth, demonstrated noise reductions of 10 dB with an optimum system design. The achieved broadband noise reduction with a BBC or DBBC was dependent on the technical-constructive system configuration. Based on Bellmann et al. (2020), the noise mitigation system performance of 10 dB broadband attenuation assumed for the Project is considered achievable with currently available technologies for pile-driving activities. The modeling incorporated the use of the 10-dB-per-hammer-strike noise attenuation for the predicted received sound fields used to estimate potential marine mammal exposures.

Table 3-5. Construction Schedules, Presented as Pile Driving Days, Utilized for Estimating Marine Mammal Exposures to Impact Pile Driving Noise

Month	Scenario 1[1]				Scenario 2			
	Year 1		Year 2		Year 1		Year 2	
	WTG Monopile[2]	OSS Jacket	WTG Monopile	OSS Jacket	WTG Monopile[2]	OSS Jacket	WTG Jacket	OSS Jacket
May	8	0	5	0	8	0	5	0
June	20	6	15	6	20	6	15	6
July	25	0	20	0	25	0	20	0
August	19	6	18	6	19	6	18	6
September	18	0	14	0	18	0	14	0
October	16	0	13	0	16	0	13	0
November	5	0	4	0	5	0	4	0
December	1	0	0	0	1	0	0	0
Total Piling Days	112	12	89	12	112	12	89	12
Total Piles	112	48	89	48	112	48	356	48
Total Foundations	112	2	89	2	112	2	89	2

Source: COP Volume II, Appendix II-L, Tables G-3 and G-4; Atlantic Shores 2023a
[1] The two-year construction schedule was used for Scenario 1 as it resulted in a higher number of exposures than the one-year construction schedule.
[2] Includes one monopile foundation for the met tower for Project 1.
Notes: Monopiles are 15 meters in diameter and are installed at a rate of one per day. Pin piles for the jacket foundations are 5 meters in diameter and are installed at a rate of four per day.

Modeling Results – Acoustic and Exposure Ranges (PTS and Behavioral Effects)

To estimate radial distances (i.e., acoustic ranges and exposure ranges) to PTS thresholds for impact pile driving, NMFS (2018a) hearing-group-specific, dual-metric thresholds for impulsive noise were used (**Table 3-4**). Most ESA-listed marine mammals evaluated in this BA (i.e., fin whales, NARWs, and sei whales) belong to the low-frequency cetacean (LFC) group. Sperm whales belong to the mid-frequency cetacean (MFC) group. The sound exposure level threshold resulted in the largest acoustic ranges. For installation of 49-foot (15-meter) monopiles[5] (with a single monopile installed each day) and 16-foot (5-meter) pin piles (with four pin piles installed each day)[6] with 10 dB of sound attenuation, acoustic ranges ($R_{95\%}$) estimated from sound propagation modeling indicate that LFC that remain within 3.03 miles (4.87

[5] Assumed installation with a Menck MHU 4400S hammer, a total of 15,387 strikes with a strike rate of 30 strikes per minute.
[6] Assumed installation with a IHC S-2500 hammer, a total of 6,750 strikes with a strike rate of 30 strikes per minute.

kilometers) and 4.08 miles (6.57 kilometers) of monopile and pin pile driving, respectively, could experience PTS (**Table 3-6**). MFC that remain within 98 feet (30 meters) of monopiles or 660 feet (200 meters) of pin piles during impact pile driving could experience PTS.

Table 3-6. Estimated Acoustic Ranges to Per-Pile Sound Exposure Level PTS Threshold for Marine Mammals with 10 dB of Attenuation

Hearing Group	49-ft (15-m) Monopiles[1]	39-ft (12-m) Monopiles[1]	16-ft (5-m) Pin Piles[2]
LFC	3.03 mi (4.87 km)	2.79 mi (4.49 km)	4.08 mi (6.57 km)
MFC	98 ft (30 m)	131 ft (40 m)	656 ft (200 m)

ft = foot; km = kilometer; m = meter; mi = mile
Source: COP Volume II, Appendix II-L, Version 2.0, April 2023, Tables F-89 through F-92; Atlantic Shores 2023a.
[1] For one monopile driven per day
[2] For four pin piles driven per day
Note: Acoustic ranges presented in the table are for summer conditions as these ranges were used for exposure estimates given the seasonal pile driving restriction.

Modeled PTS exposure ranges, which take anticipated marine mammal movements into account (as described above) for fin and sei whales were estimated at 2.32 miles (3.74 kilometers) for monopile installation and 1.96 miles (3.16 kilometers) for pin pile installation with 10 dB of sound attenuation (**Tables 3-7 and 3-8**). PTS exposure ranges for NARWs were estimated at 2.27 miles (3.65 kilometers) for monopile installation and 1.96 miles (3.16 kilometers) for pin pile installation. Based on the results of animal movement modeling, with 10 dB of noise attenuation, PTS effects to MFC (sperm whales) are not anticipated (i.e., exposure ranges were 0 miles [0 kilometers]). Exposure ranges assuming installation of two monopiles per day, which resulted in the greatest impact (i.e., number of exposures) on sea turtles, are presented in **Table 3-9**.

To estimate exposure ranges to behavioral thresholds, NMFS' impulsive noise threshold for Level B harassment under the MMPA was used (**Table 3-4**). For installation of 49-foot (15-meter) monopiles and 16-foot (5-meter) pin piles with 10 dB of noise attenuation, fin or sei whales within 2.32 miles (3.74 kilometers) and 1.96 miles (3.16 kilometers) of monopile and pin pile driving, respectively, could experience behavioral effects (**Tables 3-7 and 3-8**). NARWs that come within 2.27 miles (3.65 kilometers) of monopiles or 1.96 miles (3.16 kilometers) of pin piles during impact pile driving could experience behavioral effects. Based on the animal movement modeling and application of the noise mitigation system, PTS effects to MFC (sperm whales) are not anticipated (i.e., exposure ranges were 0 miles [0 kilometers]).

Atlantic Shores has also stated that pile driving could be initiated at any time during a 24-hour period if there is an approved nighttime piling plan. If there is no approved plan, pile driving during nighttime hours could occur if unforeseen circumstances prevent the completion of pile driving during daylight hours and it is necessary to continue piling during the night to protect the asset integrity or safety (see BOEM-proposed measure #21 in **Table 1-11**). Therefore, in addition to PAM, the Applicant is proposing to use other visual monitoring techniques that would be implemented during nighttime installation or during periods of daytime low visibility. These include thermal or infrared cameras, night vision devices, and infrared spotlights. The efficacy of these other monitoring devices is relatively unknown. If Atlantic Shores requests to conduct nighttime pile driving, BOEM will require Atlantic Shores to develop an Alternative Monitoring Plan for pile driving (see BOEM-proposed measure #21 in **Table 1-11**) that incorporates devices that meet or exceed the standards currently being used to monitor the full extent of the established shutdown and clearance zones with the same efficiency as daytime monitoring (e.g., mounted thermal/infrared camera systems, hand-held or wearable night vision devices, infrared spotlights) to detect protected marine mammal and sea turtle species.

The plan will be reviewed and approved by NMFS and BOEM. If the plan does not sufficiently address the concerns and demonstrate the efficacy of the technology for the Alternative Monitoring Plan for Nighttime Pile Driving, then nighttime impact pile driving would not occur. Specifically, no new piles could be initiated after dark if BOEM and NMFS do not approve the nighttime monitoring plan and the technology proposed.

Table 3-7. Marine Mammal Maximum $ER_{95\%}$ Exposure Ranges for Monopiles with 10 dB Attenuation

Species	49-ft (15-m)			39-ft (12-m)		
	PTS		BD	PTS		BD
	L_{pk}	$L_{E,\ 24hr}$	L_{rms}	L_{pk}	$L_{E,\ 24hr}$	L_{rms}
Fin whale	0.00 mi (0.00 km)	1.12 mi (1.81 km)	2.32 mi (3.73 km)	0.00 mi (0.00 km)	0.68 mi (1.09 km)	2.19 mi (3.52 km)
NARW	< 0.01 mi (< 0.01 km)	0.45 mi (0.72 km)	2.27 mi (3.65 km)	0.00 mi (0.00 km)	0.35 mi (0.56 km)	2.24 mi (3.60 km)
Sei whale	0.00 mi (0.00 km)	1.12 mi (1.81 km)	2.32 mi (3.73 km)	0.00 mi (0.00 km)	0.68 mi (1.09 km)	2.19 mi (3.52 km)
Sperm whale	0.00 mi (0.00 km)	0.00 mi (0.00 km)	0.00 mi (0.00 km)	0.00 mi (0.00 km)	0.00 mi (0.00 km)	0.00 mi (0.00 km)

BD = behavioral disturbance; dB = decibel; ft = foot; km = kilometer; m = meter; mi = mile; PTS = permanent threshold shift
Source: Application for Marine Mammal Protection Act (MMPA) Rulemaking and Letter of Authorization, August 2022, Table 20; Atlantic Shores 2022; COP Volume II, Appendix II-L, Version 2.0, April 2023, Table G-33.
Note: Exposure ranges presented in the table are based on installation of one monopile per day under summer conditions as these ranges were used for exposure estimates. Seasonal pile driving restrictions would limit the chance of exposure during winter conditions.

Table 3-8. Marine Mammal Maximum $ER_{95\%}$ Exposure Ranges for 16-foot (5-meter) Pin Piles with 10 dB Attenuation

Species	PTS		BD
	L_{pk}	$L_{E,\ 24hr}$	L_{rms}
Fin whale	0.00 mi (0.00 km)	1.18 mi (1.90 km)	1.96 mi (3.16 km)
NARW	0.00 mi (0.00 km)	0.66 mi (1.06 km)	1.96 mi (3.16 km)
Sei whale	0.00 mi (0.00 km)	1.18 mi (1.90 km)	1.96 mi (3.16 km)
Sperm whale	0.00 mi (0.00 km)	0.00 mi (0.00 km)	0.00 mi (0.00 km)

BD = behavioral disturbance; dB = decibel; km = kilometer; mi = mile; PTS = permanent threshold shift
Source: Application for Marine Mammal Protection Act (MMPA) Rulemaking and Letter of Authorization, August 2022, Tables 22 and 23; Atlantic Shores 2022.
Note: Exposure ranges presented in the table are based on installation of four pin piles per day under summer conditions as these acoustic ranges were used for exposure estimates given the seasonal pile driving restriction.

Table 3-9. Marine Mammal Maximum $ER_{95\%}$ Exposure Ranges for Installation of Two Monopiles per Day with 10 dB Attenuation

Species	49-ft (15-m)			39-ft (12-m)		
	PTS		BD	PTS		BD
	L_{pk}	$L_{E, 24hr}$	L_{rms}	L_{pk}	$L_{E, 24hr}$	L_{rms}
Fin whale	0.00 mi (0.00 km)	1.14 mi (1.83 km)	2.32 mi (3.74 km)	0.00 mi (0.00 km)	0.81 mi (1.30 km)	2.25 mi (3.62 km)
NARW	0.00 mi (0.00 km)	0.45 mi (0.72 km)	2.24 mi (3.61 km)	0.00 mi (0.00 km)	0.21 mi (0.33 km)	2.16 mi (3.48 km)
Sei whale	0.00 mi (0.00 km)	1.14 mi (1.83 km)	2.32 mi (3.74 km)	0.00 mi (0.00 km)	0.81 mi (1.30 km)	2.25 mi (3.62 km)
Sperm whale	0.00 mi (0.00 km)	0.00 mi (0.00 km)	0.00 mi (0.00 km)	0.00 mi (0.00 km)	0.00 mi (0.00 km)	0.00 mi (0.00 km)

BD = behavioral disturbance; dB = decibel; ft = foot; km = kilometer; m = meter; mi = mile; PTS = permanent threshold shift
Source: Application for Marine Mammal Protection Act (MMPA) Rulemaking and Letter of Authorization, August 2022, Table 21; Atlantic Shores 2022; COP Volume II, Appendix II-L, Version 2.0, April 2023, Table G-34.

Effects of Exposure to Noise Above the PTS Thresholds

Modeling indicates that under Scenario 1 up to six fin whales, one NARW, and one sei whale may be exposed to underwater noise levels above PTS thresholds from impact pile-driving noise (**Table 3-10**). Under Scenario 2, up to seven fin whales, one NARW, and one sei whale may be exposed to underwater noise levels above PTS thresholds. As these exposure estimates relied solely on the summer sound speed profile, which was considered representative for May through October, they may be slightly underestimated given that cooler temperatures in the winter months (i.e., November and December) would be expected to result in larger exposure ranges. However, the difference between the summer and winter sound speed profiles is minimal, and any differences in exposure estimates from using the summer sound speed profile in the two winter months would be negligible, particularly given that only 10 out of 205 foundations (5 percent) would be installed in November and December. Additionally, a conservative approach was taken to modeling by utilizing the construction scenario (i.e., foundation selection and installation schedule) that resulted in the greatest number of PTS exposures, and exposure estimates were generally rounded up to the nearest integer. Based on the conservative modeling approach and the minimal difference between the sound speed profiles for summer and winter, estimation of November and December exposures using the winter sound speed profile would not result in a change in the impact determination for impact pile driving noise presented in this section. Exposure estimates assuming installation of two monopiles per day, which resulted in the greatest impact (i.e., number of exposures) on sea turtles, are presented in **Table 3-11**.

One PTS exposure was modeled for NARW during foundation installation under either Scenario 1 or Scenario 2 (Atlantic Shores 2023b). However, no Level A take is requested for NARWs because the potential for PTS exposures for NARW can be reduced to zero given the mitigation measures outlined in **Tables 1-10 and 1-11**. Specifically, the following measures will be used to ensure no NARW PTS exposures:

- The clearance zone for NARW will be established to be equal to the behavioral disturbance zone to avoid any preventable exposures. Up to seven PSOs will perform visual monitoring during the pre-start clearance period: three PSOs monitoring from the pile driving vessel and two PSOs monitoring from each of up to two support vessels. These support vessels are anticipated to run north to south transects of 2.5 miles (4 kilometers) approximately 2.5 miles (4 kilometers) east and west of the pile driving vessel;
- A ramp-up procedure will be implemented;

- Two PSOs aboard the pile driving vessel will visually monitor the shutdown zone with the naked eye and reticle binoculars while a third scans outside the shutdown zone with big eye binoculars. These PSOs would be supplemented by two PSOs on each of up to two support vessels, alternating between the naked eye, reticle binoculars, and big eye binoculars;
- A real-time PAM system will be designed and deployed to supplement visual monitoring;
- A minimum visibility range of 6,244 feet (1,900 meters) will be maintained during all foundation installations, and no piling will commence if this visibility range is not met; and

Shutdown procedures will be implemented if a NARW is detected entering or within the shutdown zone established for that species after pile driving has commenced, and pile driving will only be re-initiated after the shutdown zone has been clear for 30 minutes.

No sperm whales are expected to experience PTS under either Scenario. Sperm whales' generalized hearing frequency range is higher than the other ESA-listed marine mammals likely to occur in the area ensonified by impact pile driving, resulting in smaller radial distances to effects thresholds, and sperm whale densities are low in and around the Lease Area given their preference for deeper waters near the shelf break. As previously noted, modeling captured the near-greatest impact for impact pile driving noise under Scenarios 1 and 2 by assuming four large OSSs with jacket foundations across Projects 1 and 2. The difference in exposures between installation of a single met tower with a monopile foundation, which was modeled, compared to a single met tower with a piled jacket foundation, which would have the greatest impact, would be minimal.

Table 3-10. Estimated Number of Marine Mammals Exposed to Impact Pile Driving Noise[1] with 10 dB of Noise Attenuation based on Modeling Results

Species	Scenario 1			Scenario 2		
	PTS		BD	PTS		BD
	L_{pk}	$L_{E, 24hr}$	L_{rms}	L_{pk}	$L_{E, 24hr}$	L_{rms}
Fin whale	0	6	15	0	7	18
NARW	0[2]	0[3]	3	0[2]	0[4]	3
Sei whale	0	1	2	0	1	3
Sperm whale	0	0	0	0	0	0

BD = behavioral disturbance; dB = decibels; PTS = permanent threshold shift

Source: COP Volume II, Appendix II-L, Tables 15 and 16; Atlantic Shores 2023a.

[1] Exposure estimates are based on installation of one monopile per day or four pin piles per day.

[2] 0.01 PTS exposures were estimated for this species, but due to mitigation measures proposed by the Applicant, no PTS exposures (Level A takes) are expected, and no Level A takes have been requested for this species.

[3] 0.25 PTS exposures were estimated for this species, but due to mitigation measures proposed by the Applicant, no PTS exposures (Level A takes) are expected, and no Level A takes have been requested for this species.

[4] 0.39 PTS exposures were estimated for this species, but due to mitigation measures proposed by the Applicant, no PTS exposures (Level A takes) are expected, and no Level A takes have been requested for this species.

Table 3-11. Estimated Number of Marine Mammals Exposed to Impact Pile Driving Noise with 10 dB of Noise Attenuation based on Modeling Results for Two Monopiles Driven Per Day

Species	Scenario 1		
	PTS		BD
	L_{pk}	$L_{E,\ 24hr}$	L_{rms}
Fin whale	0	5	14
NARW	0	0	2
Sei whale	0	1	2
Sperm whale	0	0	0

BD = behavioral disturbance; dB = decibels; PTS = permanent threshold shift

Source: COP Volume II, Appendix II-L, Table 17; Atlantic Shores 2023a.

The Applicant-proposed mitigation for impact pile driving (**Table 1-10**) includes pre-clearance and shutdown zones. The pre-clearance zones and shutdown zones are based on the maximum PTS exposure ranges modeled for each species. The Applicant-proposed mitigation for WTG and OSS foundation installation also includes ramp-up procedures that would occur over a 20-minute period and shutdown procedures that would be enacted if a marine mammal is detected entering or within the shutdown zone after pile driving is commenced. Shutdown procedures include an immediate shutdown of pile driving unless such a shutdown is not feasible due to imminent risk of injury or loss of life to an individual; in such a case, hammer energy would be reduced. Following shutdown procedures, the shutdown zone would be continuously monitored by PSOs, and pile driving would not resume until the shutdown zones have been clear of marine mammals for at least 30 minutes. In addition to visual monitoring by PSOs, real-time passive acoustic monitoring as described **Table 1-10** will be used to assist in detections during daytime, low visibility, and nighttime conditions.

PTS Effects Summary

The potential for PTS for all whales considered is minimized by the implementation of pre-clearance procedures, clearance and shutdown zones, and ramp-up and shutdown procedures proposed by the Applicant, as described above. The proposed implementation of pre-clearance procedures (**Table 1-10**), which requires that impact pile driving can only commence when the clearance zones are fully visible to PSOs allows a high marine mammal detection capability, and enables a high rate of success in implementing these zones to avoid PTS. However, exposures leading to PTS for some species are still possible. As the clearance and shutdown zones are based on the maximum PTS zones modeled for each taxon, the potential for PTS effects is reduced. Ramp-ups could be effective in deterring marine mammals from impact pile-driving activities prior to exposure resulting in PTS. However, few empirical studies have been conducted that test how effective ramp-up procedures are for moving marine mammals, particularly baleen whales, beyond acoustic injury ranges. Studies on ramp-ups of deep penetration seismic surveys (i.e., airgun arrays) have shown mixed results for efficacy and seem to be highly contextual (Dunlop et al. 2016; Barkaszi et al. 2012; Barkaszi and Kelly 2019). Given the mixed results in the limited empirical studies, the efficacy of deterring ESA-listed whales through pile driving ramp-up procedures is unknown, but ramp-up procedures will be used. Therefore, in the effects analysis for impact pile driving under the Proposed Action, ramp-up procedures are assumed to reduce risk of PTS exposure but are not considered to be fully effective, particularly at further distances where noise accumulation leading to PTS may still occur.

Therefore, the effects of exposure to impact pile driving noise resulting in sound levels that exceed PTS thresholds ***may affect, likely to adversely affect*** up to five fin whales and one sei whale. As described above, these individuals may experience permanent limitations in their ability to detect predators or find mates, which could have long-term effects on their individual fitness.

These combined mitigation measures, however, do optimize the opportunity for visual PSOs and PAM operators to detect NARWs around the foundation installation activities. These measures would help reduce the amount of time an animal is receiving acoustic energy above the PTS onset thresholds, which lowers the risk of PTS being realized. With full implementation of these mitigation measures, the potential for PTS exposure to NARW is considered extremely unlikely to occur and ***discountable***. No PTS exposures were modeled for sperm whales; PTS exposures for sperm whales are extremely unlikely to occur and are, therefore, considered ***discountable***. Therefore, the effects of noise exposure above PTS thresholds resulting from pile driving during foundation installation ***may affect, but not likely to adversely affect*** NARWs and sperm whales.

Effects of Exposure to Noise Above the Behavioral Disturbance Threshold

Considering foundation installation pile driving activities, under Scenario 1 (**Table 3-10**) up to 15 fin whales, 3 NARWs, and 2 sei whales could be exposed to noise levels that meet or exceed the behavioral threshold during the Proposed Action. Under Scenario 2, up to 18 fin whales, 3 NARWs, and 3 sei whales could be exposed to noise that meets or exceeds the behavioral threshold (**Table 3-10**). Although behavioral thresholds may be reached or exceeded, species reactions and the consequences of these reactions are relatively unknown. This is due to the lack of species-specific studies that outline the behavioral responses of ESA-listed marine mammal species likely to be present in the ensonified area to impact pile-driving activities. Some avoidance and displacement of LFCs has been documented during seismic exploration, which may be used as a proxy to determine the potential behavioral reactions of LFC to other impulsive activities such as impact pile driving. However, recent reports assessing the severity of behavioral reactions to underwater noise sources indicate that applying behavioral responses across broad sound categories (e.g., impulsive noise sources) can lead to significant errors in predicting effects (Southall et al. 2021). Hearing group-specific analyses are presented below.

Low-frequency Cetaceans (LFC)

Behavioral effects are more difficult to mitigate and are, therefore, still considered likely to occur for activities such as impact pile driving with large acoustic disturbance areas. The most commonly reported behavioral effect of pile-driving activity on marine mammals has been short-term avoidance or displacement from the pile-driving site, although studies that examine the behavioral responses of baleen whales to pile driving are absent from the literature. Since there are no studies that have directly examined the behavioral responses of baleen whales to pile-driving, studies using other impulsive sound sources such as seismic airguns serve as the best available proxies. With seismic airguns, the distance at which responses occur depends on many factors, including the size of the airgun, which determines the source level, as well as the hearing sensitivity, behavioral state, and life stage of the animal (Southall et al. 2021). Malme et al. (1986) observed that gray whales exposed to sound pressure levels of approximately 173 dB re 1 μPa, had a 50 percent probability of stopping feeding and leaving the area. Some whales ceased to feed but remained in the area at received sound pressure levels of 163 dB re 1 μPa. Overall, individual gray whale responses were highly variable. Other studies have documented baleen whales initiating avoidance behaviors to full-scale seismic surveys at distances as short as 1.8 miles (3 kilometers) (Johnson 2002; McCauley et al. 1998; Richardson et al. 1986) and as far as 12 miles (20 kilometers) (Richardson et al. 1999). Bowhead whales have exhibited other behavioral changes, including reduced surface intervals and dive durations, at received SPLs between 125 and 133 dB re 1 μPa (Malme et al. 1988). Bowhead whales have also shown increased calling rates as airgun pulse energies increase from their lowest detectable levels. The increase in rates then leveled off at a received cumulative SEL around 94 dB re 1 $\mu Pa^2 s$ and decreased once the 10-minute cumulative SEL exceeded 127 dB re 1 $\mu Pa^2 s$ (Blackwell et al. 2013). A more recent study by Dunlop et al. (2017) compared the migratory behavior of humpback whales exposed to a 3,130-cubic inch airgun array with those that were not exposed. There was no gross change in behavior observed, including respiration rates, although whales exposed to the seismic survey made a slower progression southward along their migratory route compared to the control group.

This was largely seen in female-calf groups, suggesting there may be differences in vulnerability to underwater sound based on life stage (Dunlop et al. 2017). The researchers produced a dose-response model which suggested behavioral change was most likely to occur within 2 miles (4 kilometers) of the seismic survey vessel at SELs greater than 135 dB re 1 μPa^2 s (Dunlop et al. 2017).

Though the Lease Area, where impact pile driving will occur, does not overlap with any critical habitat (Section 2.3.1, *Species and Critical Habitat Considered but Excluded from Further Analysis*), it does overlap with a Biologically Important Area for migrating NARWs. Timing of migrations includes a northward migration from winter calving grounds to summer feeding grounds during March to April and a southward migration back to winter calving grounds during October and November. During this migration period, adults may be accompanied by calves and periodically feed and rest along their migration route (Hayes et al. 2022). Fin and sei whales generally prefer the deeper waters of the continental slope and more often can be found in waters greater than295 feet (90 meters) deep (Hain et al. 1985; Hayes et al. 2022; Waring et al. 2011). Based on the literature previously identified, behavioral responses of LFCs to impact pile driving could include ceasing feeding and avoiding the ensonified area. To limit potential effects to NARWs, impact pile driving will not occur between January 1 and April 30 (which is accounted for the in the modeled exposure estimates), avoiding the times of year when NARWs are present in higher densities. If animals are exposed to underwater noise above behavioral thresholds, it could result in displacement of individuals from a localized area around a pile (maximum of 2.32 miles [3.74 kilometers] for installation of monopiles; **Table 3-7**). However, this displacement would be temporary for the duration of activity, which would be a maximum of 16 hours per 24-hour period for impact pile driving of four pin piles per day. NARWs, and any other LFCs, would be expected to resume their previous behavior after an unknown period of time following the cessation of active pile driving. In addition, the behavioral disturbance area would not be expected to impede the migration of NARWs to critical habitats located to the north and south of the Project area as animals would still be able to pass along coastal areas and areas offshore of the Lease Area.

Acoustic masking can occur if the frequencies of the activity overlap with the communication frequencies used by marine mammals. Modeling results show that dominant frequencies of impact pile-driving noise under the Proposed Action will be concentrated below 1 kHz (Atlantic Shores 2023b), indicating that impact pile driving dominant frequencies overlap with the range of best hearing sensitivity for LFCs (**Table 3-3**). Additionally, low frequency sound can propagate greater distances than higher frequencies, meaning masking from impact pile driving may occur over larger distances than masking due to higher frequency noise. There is evidence that some marine mammals can compensate for the effects of acoustic masking by changing their calling rates (Blackwell et al. 2013; Cerchio et al. 2014; Di Iorio and Clark 2010), increasing call amplitude (Holt et al. 2009; Scheifele et al. 2005), or shifting the dominant frequencies of their calls (Lesage et al. 1999; Parks et al. 2007b). When effects of masking cannot be compensated for, increasing noise could affect the ability to locate and communicate with other individuals. NARWs appear to be particularly sensitive to the effects of masking as a result of underwater noise and have faced significant reductions in their communication space due to anthropogenic noise. For example, calling NARWs in the Stellwagen Bank National Marine Sanctuary were exposed to noise levels greater than 120 dB re 1 µPa for 20 percent of their peak feeding month and were estimated to have lost 63 to 67 percent of their communication space (Hatch et al. 2012). Reduced communication space caused by anthropogenic noise could potentially contribute to the population fragmentation and dispersal of the critically endangered NARW (Brakes and Dall 2016; Hatch et al. 2012;). However, given that pile-driving would occur intermittently, and would occur up to 16 hours per day under the Proposed Action, it is unlikely that complete auditory masking would occur.

Mid-frequency Cetaceans (MFC)

MFCs also show varying levels of sensitivity to mid-frequency impulsive noise sources (i.e., impact pile driving), with observed responses ranging from displacement (Maybaum 1993) to avoidance behavior

(Hatakeyama et al. 1994; Watkins et al. 1993;), decreased vocal activity, and disruption in foraging patterns (Goldbogen et al. 2013). Würsig et al. (2000) studied the response of Indo-Pacific humpback dolphins to impact pile driving in the seabed in water depths of 20 to 26 feet (6 to 8 meters). No overt behavioral changes were observed in response to the pile-driving activities, but the animals' speed of travel increased. Some dolphins remained in the vicinity while others temporarily abandoned the area. Once pile-driving ceased, dolphin abundance and behavioral activities returned to pre-pile-driving levels. In a study conducted during wind farm construction in Cromarty Firth, Scotland, the effect of impact and vibratory pile driving on the vocal presence of both bottlenose dolphins and harbor porpoises was compared both in and outside the Cromarty Firth area (Graham et al. 2017). The researchers found a similar level of response of both species to both impact and vibratory piling, likely due to the similarly low received SELs from the two approaches, which were measured at 129 dB re 1 μPa^2 s for one second of vibratory driving and 133 dB re 1 μPa^2 s for a single strike of impact driving, both at 2,664 feet (812 meters) from the pile. Generally, there were no statistically significant responses attributable to either type of pile driving activity, including the presence/absence of a species or the duration over which individuals were encountered, with the exception of encounter duration for bottlenose dolphins on days with impact pile driving. The duration of bottlenose dolphin acoustic encounters decreased by an average of approximately 4 minutes at sites within the Cromarty Firth (closest to pile-driving activity) in comparison to areas outside the Cromarty Firth (Graham et al. 2017). The authors hypothesized that the lack of a strong response was because the received levels were very low in this particularly shallow environment, despite similar size piles and hammer energy to other studies.

Sperm whales are rarely seen in shallower waters of the OCS (i.e., less than 1,000 feet [305 meters] deep) and frequent the continental slope in water depths greater than 2,000 feet (609 meters) (NMFS 2010). They prefer deeper waters to hunt for squid and are generally found in the Mid-Atlantic Bight during the spring. Near the Lease Area, the density of sperm whales is expected to be low (**Table 3-2**). Based on the available literature, behavioral responses of sperm whales to impact pile driving could include ceasing feeding and avoiding the ensonified area. However, no behavioral exposures of sperm whales are expected (**Table 3-10**).

As previously outlined for LFCs, modeling results indicate that dominant frequencies of impact pile-driving noise under the Proposed Action will be concentrated below 1 kHz (Atlantic Shores 2023b). Though this does overlap with the frequency range of sperm whale hearing (**Table 3-3**) and echolocation clicks, it is not within their peak sensitivity range. Therefore, the effects of masking would be less severe for MFC as they are better attuned to noise outside the dominant frequency range of impact pile driving. Therefore, impact piling noise would not impede their ability to echolocate prey or navigate. Additionally, given that pile driving occurs intermittently, and would occur up to 16 hours a day under the Proposed Action, it is unlikely that complete auditory masking would occur.

Behavioral Effects Summary

Based on the mitigation and monitoring measures included in the Proposed Action (**Tables 1-10 and 1-11**) and the temporary, intermittent nature of impact pile driving noise under the Proposed Action, the potential for exposure of these ESA-listed marine mammal species to noise levels leading to behavioral disruption would be reduced to the level of the individual animal and would not be expected to have population-level effects. Neither the ramp-up mitigation measure committed to by Atlantic Shores nor animal aversion (i.e., moving away from the source), which is the anticipated reaction to the ramp up procedures, were accounted for in the exposure estimates. Therefore, the behavioral exposure estimates should be considered a conservative estimate. As discussed above, up to 15 fin whales, 3 NARWs, and 2 sei whales may be exposed to noise above the behavioral threshold under Scenario 1 (**Table 3-10**). Under Scenario 2, up to 18 fin whales, 3 NARWs, and 3 sei whales may be exposed to noise above the behavioral threshold. Due to the large behavioral disturbance exposure range, behavioral exposures for these species cannot be completely avoided with mitigation.

Fin whales are expected to utilize the Project area year-round and have been seen in the Project area with mixed aggregations of feeding humpbacks and with the presence of known prey species, suggested that fin whales may forage in the Project area (GeoMarine 2010); therefore, behavioral changes resulting from disturbance have the potential to interrupt critical functions (i.e., foraging). NARW uses the Project area as a migratory corridor (Section 3.2.2.3) and can be present year-round. The migratory corridor is considered a Biologically Important Area; as such, behavioral disturbance in this area for a critically endangered species may result in affecting critical functions (i.e., migration). The interruption of critical functions may have energetic consequences for individual marine mammals. Therefore, the behavioral disturbance resulting from impact pile driving cannot be discounted.

Sei whales are most likely to occur in deeper waters offshore of the Project area. Although these species may occur year-round in the Project area, their use of the Project area is likely ancillary to deeper water habitats. It is unlikely that any behavioral reactions to noise exposures above the behavioral thresholds would interrupt critical functions for these species and therefore would not meet the definition of harassment under the ESA. As the behavioral reactions are not expected to significantly disrupt normal behavior patterns, any effects would be too small to be meaningfully measured, detected, or evaluated and, therefore, ***insignificant***.

As discussed above, no sperm whales are expected to be exposed to noise levels exceeding the behavioral threshold. Therefore, behavioral effects associated with impact pile driving are extremely unlikely occur and would be ***discountable***.

Given the effects assessment above, the effects of exposure to impact pile driving noise resulting in sound levels that exceed the behavioral disturbance threshold ***may affect, likely to adversely affect*** fin whales and NARWs; and ***may affect but not likely to adversely affect*** sei and sperm whales.

Vibratory Pile Driving

Vibratory pile driving generates continuous, non-impulsive underwater noise with lower source levels than impact pile driving. In a study of vibratory and impact pile driving noise associated with sheet pile installation, vibratory pile driving maximum peak sound levels were less than 185dB re 1 µPa, sound exposure levels (accumulated over two seconds) were below 188 dB re 1 μPa^2 s at distances of 5 to 23 feet (1.5 to 7 meters) (Hart Crowser and Illingworth and Rodkin 2009). Comparatively, impact hammer maximum peak sound levels reached 195 dB re 1 µPa at 16 feet (5 meters) (Hart Crowser and Illingworth and Rodkin 2009). Noise impacts from non-impulsive noise sources are generally less severe compared to impacts from impulsive noise sources, but physiological effects may still occur in proximity to the noise source if source levels are sufficiently high and/or if animals remain in the vicinity and are exposed to those levels for a sufficient duration.

Vibratory pile driving for Scenario 1 or Scenario 2 under the Proposed Action would occur over approximately sixteen days during construction to install and remove temporary cofferdams at the exit point of HDD for each of the export cable landfalls and would not occur between Memorial Day and Labor Day.

Modeling Approach

To support Atlantic Shores' LOA application (Atlantic Shores 2022, 2023b), underwater sound propagation modeling for vibratory pile driving was conducted for marine mammals. JASCO's Marine Operations Noise Model was used to estimate sound fields generated during vibratory pile driving. Sound propagation modeling was conducted at one representative location for each landing site (Monmouth and Atlantic). Exposures were then estimated based on the acoustic ranges calculated during sound propagation modeling, maximum monthly species density between September and May (**Table 3-12**), and an assumed 8 days of installation and 8 days of removal for the cofferdams at each of the two landfall sites.

Table 3-12. Maximum Monthly Marine Mammal Densities (September through May, animals/100 km^2) at each of the Cable Landing Sites

Species	Monmouth	Atlantic
Fin whale	0.117	0.052
NARW	0.035	0.092
Sei whale	0.046	0.018
Sperm whale	0.008	0.002

Source: Roberts et al. 2016a, 2016b, 2017, 2018, 2021a, 2021b

Modeling Results – Acoustic Ranges (PTS and Behavioral Effects)

To estimate ranges to PTS and behavioral thresholds for vibratory pile driving, NMFS (2018) hearing-group-specific PTS thresholds (Level A under the MMPA) for non-impulsive noise and NMFS' non-impulsive noise threshold for PTS (Level A under the MMPA) of 199 dB and behavioral disruption (Level B harassment under the MMPA) were used For vibratory pile driving without noise mitigation, LFC that remain within less than 230 feet (70 meters) of vibratory pile driving for the entire duration of a pile driving event may experience PTS (**Table 3-13**). MFC are not expected to experience PTS from vibratory pile driving (i.e., acoustic range was 0 miles [0 kilometers]). Marine mammals within 8.1 miles (12.96 kilometers) may experience behavioral disturbance.

Table 3-13. Maximum Acoustic Ranges (kilometers) to PTS and Behavioral Disturbance Thresholds for Marine Mammals for Vibratory Pile Driving of Temporary Cofferdams

Functional Hearing Group	PTS $L_{E,\ 24h}$	Behavioral Disturbance L_{rms}
LFC	0.07	12.96
MFC	0.00	12.96

Source: Atlantic Shores Offshore Wind Application for Marine Mammal Protection Act (MMPA) Rulemaking and Letter of Authorization, Appendix D, Table 5; Atlantic Shores 2022.

Effects of Exposure to Noise Above the PTS Thresholds

Given the short ranges to injury thresholds and relatively shallow waters in which vibratory pile driving would occur, ESA-listed marine mammals are unlikely to be exposed to noise levels that would result in PTS (**Table 3-13**). Modeling results indicate that less than 0.01 fin whale, NARW, and sei whale may be exposed to noise levels exceeding the PTS threshold. These exposure estimates do not account for mitigation measures that would be in place during vibratory pile driving (**Table 1-10**), including establishment of shutdown zones (328 feet [100 meters]), use of PSOs to monitor during pre-clearance and vibratory hammer operational periods, use of soft start, and implementation of shutdowns. These estimates also assume that the animals remain stationary. However, no individuals are expected to remain within the acoustic range for the PTS threshold (i.e., 230 feet [70 meters]) for the duration of a vibratory pile driving event. Based on the anticipated mitigation measures, expected movement of individual animals, and the near-zero exposure estimates, no PTS exposures are expected for fin whale, NARW, or sei whale. No PTS exposures (i.e., Level A takes under the MMPA) were requested for these species in the Applicant's LOA Application. Modeling results indicated that no sperm whales are expected to be exposed to noise levels exceeding the PTS threshold. As no PTS exposures are anticipated, there would be ***no effect*** on fin whales, NARWs, sei whales, or sperm whales.

Effects of Exposure to Noise Above the Behavioral Disturbance Threshold

Considering vibratory pile driving, up to 5 fin whales, 3 NARWs, and 2 sei whales may be exposed to noise levels that exceed behavioral thresholds under either Scenario 1 or Scenario 2 (**Table 3-14**). Vibratory pile driving is only expected to occur over a 16-day period at the two landfall sites. Behavioral effects are considered possible and may extend out to 8.1 miles (12.96 kilometers) from the landfall sites. Modeling results indicate that 0.3 sperm whale may be exposed to noise levels that exceed the behavioral threshold. However, sperm whales are generally rare in nearshore areas. Therefore, exposure to underwater noise above behavioral thresholds from vibratory pile driving is considered extremely unlikely to occur and ***discountable*** for this species.

Table 3-14. Exposure Estimates (number of individuals) for the Behavioral Disturbance Threshold for Marine Mammals for Vibratory Pile Driving of Temporary Cofferdams for Scenario 1 or Scenario 2

Species	Behavioral Disturbance
Fin whale	5
NARW	3
Sei whale	2
Sperm whale	0[1]

Source: Atlantic Shores Offshore Wind Application for Marine Mammal Protection Act (MMPA) Rulemaking and Letter of Authorization, Appendix D, Tables 7 and 8; Atlantic Shores 2022.
[1]Value rounded down from an estimated 0.3 sperm whales exposed. Given this species' preference for deeper offshore waters, exposure to vibratory pile driving noise levels that exceed the behavioral disturbance threshold is extremely unlikely to occur.

Low-frequency Cetaceans (LFC)

As discussed above, up to 5 fin whales, 3 NARWs, and 2 sei whales could be exposed to underwater noise above behavioral thresholds from vibratory pile driving. Due to lower densities of marine mammals in the nearshore areas of the cofferdam installation and removal, the transitory nature of marine mammals, and the very short duration of vibratory pile driving, these estimates are likely conservative. The nearshore areas where vibratory pile driving will occur overlaps with a biologically important area for migrating NARWs. Timing of migrations includes a northward migration from winter calving grounds to summer feeding grounds during March to April and a southward migration back to the calving grounds during November to December. During this migration period adults may be accompanied by calves and periodically feed and rest along their migration route (Hayes et al. 2020). Fin whales are present in the area year-round; however, they generally prefer waters greater than 295 feet (90 meters) in depth (Hayes et al. 2020). There is limited information regarding the potential behavioral reactions of LFCs to vibratory pile driving. Potential effects may include avoidance and ceasing feeding activities, as with impact pile driving activities. If animals are exposed to underwater noise above behavioral thresholds, the noise could result in displacement of mother and calf pairs from a localized area (i.e., up to 8.1 miles [12.96 kilometers] from shore). However, this displacement would be temporary for the duration of activity, which would be for a maximum of 16 days. LFCs would be expected to resume pre-construction activities following the installation/removal period. In addition, the behavioral disturbance area (8.1 miles [12.96 kilometers] from shore) would not impede the migration of NARWs to critical habitats located to the north and south of the Project Area as animals would still be able to pass along offshore areas. The energetic consequences of any avoidance behavior and potential delay in resting or foraging are not expected affect any individual's ability to successfully obtain enough food to maintain their health or impact the ability of any individual to make seasonal migrations or participate in breeding or calving.

Mid-frequency Cetaceans (MFC)

As stated above, sperm whales are generally rare in nearshore areas. Therefore, exposure to underwater noise above behavioral thresholds from vibratory pile driving in nearshores areas is considered extremely unlikely to occur and ***discountable*** for this species.

Behavioral Effects Summary

Based on the mitigation and monitoring measures presented and discussed (**Table 1-10**), the potential for exposure of these ESA-listed marine mammals to noise levels leading to behavioral disturbance would be reduced to the level of the individual animal and would not be expected to have population-level effects. However, as discussed above, up to 5 fin whales, 3 NARWs, and 2 sei whales may be exposed to noise above behavioral thresholds (**Table 3-14**). Therefore, the effects of noise exposure from Project vibratory pile driving leading to behavioral disruption ***may affect, likely to adversely affect*** fin whales, NARWs, and sei whales. As the potential for exposure to vibratory pile driving noise that exceeds the behavioral disturbance threshold for sperm whales is ***discountable***, the effects of exposure to vibratory pile driving noise resulting in sound levels that exceed the behavioral disturbance threshold ***may affect, but not likely to adversely affect*** sperm whales.

Underwater Noise Effects of the Connected Action

For the Connected Action, steel sheet piles and anchor piles would be installed during repair and reinforcement of the existing bulkhead. Sheet piles will be installed entirely using a vibratory hammer. Impacts would be reduced by using installation methods including HDD, jack-and-bore, and pipe jacking (Atlantic Shores 2023a). Noise impacts associated with port modifications would be lower than pile driving impacts associated with impact and vibratory pile driving for construction of the offshore portions of the Proposed Action. ESA-listed marine mammals are not expected to occur within the area affected by pile driving for port modifications. Therefore, there would be ***no effect*** on fin whales, NARWs, sei whales, or sperm whales.

High Resolution Geophysical Surveys

G&G surveys for the Proposed Action under Scenario 1 or Scenario 2 would occur prior to installation of offshore cables and during the O&M phase of the Project (Sections 1.3.1 and 1.3.2). Such surveys can generate high-intensity, impulsive noise that has the potential to result in physiological or behavioral effects in aquatic organisms. G&G surveys for the Proposed Action include HRG surveys. Compared to other G&G survey equipment, HRG survey equipment produces less-intense noise and operates in smaller areas. HRG survey noise may affect marine mammals through stress, disturbance, and behavioral responses. No PTS exposures are expected for any ESA-listed cetacean species during HRG surveys. Thus, there would be ***no effect,*** and PTS exposures are not discussed further.

HRG survey equipment with operating frequencies below 180 kHz (i.e., that may be audible to marine mammals) that may be used for the Proposed Action includes sparkers, chirps, or Innomar parametric sub-bottom profilers. Operational parameters for this equipment are provided in **Table 3-15**. These operational parameters were used as inputs to NMFS' Optional User spreadsheet tool to calculate the distance to the behavioral disturbance threshold for impulsive noise sources (i.e., SPL = 160 dB re 1 µPa). The acoustic ranges associated with each representative equipment type were estimated with the tool (**Table 3-16**).

Table 3-15. Operational Parameters for Potential Project HRG Equipment

HRG Survey Equipment	Representative Type	Operating Frequencies (kHz)	Operational Source Level (dB re 1 µPa-m)	Beamwidth (degrees)	Typical Pulse Duration (ms)	Pulse Repetition Rate (Hz)
Sparker	Applied Acoustics Dura-Spark 240	0.01 to 1.9	203	180	3.4	2
	Geo Marine Geo-Source	0.2 to 5	195	180	7.2	0.41
Chirp	Edgetech 2000-DSS	2 to 16	195	24	6.3	10
	Edgetech 216	2 to 16	179	17, 20, or 24	10	10
	Edgetech 424	4 to 24	180	71	4	2
	Edgetech 512i	0.7 to 12	179	80	9	8
	Pangeosubsea Sub-Bottom Imager	4 to 12.5	190	120	4.5	44
Innomar	Innomar SES-2000 Medium-100 Parametric	85 to 115	241	2	2	40
	Innomar Deep-36 Parametric	30 to 42	245	1.5	0.15 to 5	40

Source: Atlantic Shores Offshore Wind Application for Marine Mammal Protection Act (MMPA) Rulemaking and Letter of Authorization, Appendix C, Table 1; Atlantic Shores 2022.

The largest acoustic range was used as the radius to determine the zone of influence, which was in turn used to estimate behavioral disturbance exposures based upon maximum monthly marine mammal densities (**Table 3-17**) and assumptions of 60 days of survey operation and a survey distance of 34 miles (55 kilometers) per day. Using this approach, behavioral disturbance exposures were estimated over the 5-year survey period (**Table 3-18**).

Table 3-16. Acoustic Ranges to the Behavioral Disturbance Threshold for Representative HRG Survey Equipment

HRG Survey Equipment	Representative Type	Distance to Behavioral Threshold (m)
Sparker	Applied Acoustics Dura-Spark 240	141
	Geo Marine Geo-Source	56
Chirp	Edgetech 2000-DSS	56
	Edgetech 216	9
	Edgetech 424	10
	Edgetech 512i	9
	Pangeosubsea Sub-Bottom Imager	2

Source: Atlantic Shores Offshore Wind Application for Marine Mammal Protection Act (MMPA) Rulemaking and Letter of Authorization, Appendix C, Table 2; Atlantic Shores 2022.

Table 3-17. Maximum Monthly Marine Mammal Densities (animals/100 square kilometers) used to Estimate Exposures for HRG Surveys

Species	Density
Fin whale	0.114
NARW	0.056
Sei whale	0.031
Sperm whale	0.005

Source: Atlantic Shores Offshore Wind Updates to the Application for Marine Mammal Protection Act (MMPA) Rulemaking and Letter of Authorization, Appendix C, Table 4; Atlantic Shores 2023b.

Table 3-18. Estimated Exposures to HRG Survey Noise above the Behavioral Disturbance Threshold for Scenario 1 or Scenario 2

Species	Annual Exposures	Total Exposures
Fin whale	2	10
NARW	1	5
Sei whale	1	5
Sperm whale	1	5

Source: Atlantic Shores Offshore Wind Updates to the Application for Marine Mammal Protection Act (MMPA) Rulemaking and Letter of Authorization, Appendix C, Table 4; Atlantic Shores 2023b.

Exposure estimates indicate that up to 2 fin whales, 1 NARW, 1 sei whale, and 1 sperm whale may be exposed to noise levels exceeding the behavioral threshold annually **(Table 3-18**) under either Scenario 1 or Scenario 2. As described in **Table 1-10**, the Project's LOA application includes mitigation measures for HRG survey activities when operating equipment that produces sound within marine mammals' hearing range (i.e., less than 180 kHz). These measures require the use of PSOs to monitor and enforce clearance and shut down zones (1,640 feet [500 meters]) around HRG survey activities, utilization of ramp-up procedures prior to commencement of survey activities, shutdown protocols, and requirements for each PSO to be equipped with night-vision and/or infrared technology for use during low visibility conditions. These mitigations, which were not addressed in exposure estimates, further minimizing risk of injury. These measures would further minimize the likelihood of marine mammal injury. Any behavioral impacts (e.g., temporary avoidance or displacement) on individual ESA-listed marine mammals associated with G&G surveys for the Proposed Action would be temporary and are not expected to result in stock or population-level effects.

Based on the mitigation measures presented and discussed (**Table 1-10**) the potential for exposure of these ESA-listed species to noise levels leading to behavioral disruption would be reduced at the level of the individual animal and would not be expected to have population-level effects. As mentioned above, up to 2 fin whales, 1 NARW, 1 sei whale, and 1 sperm whale, (based on modeling) may be exposed to noise above behavioral thresholds (**Table 3-18**) annually. However, given the various mitigation measures proposed in Section 1.3.5 and the interim definition of harassment under the ESA for take, no behavioral disruption leading to significant behavioral change is expected based on these numbers and is therefore ***insignificant***. Therefore, the effects of exposure to noise from Project HRG surveys resulting in sound levels that exceed the behavioral disturbance threshold ***may affect, but not likely to adversely affect*** fin whales, NARWs, sei whales, and sperm whales.

Cable Laying

Noise-producing activities associated with cable laying during construction under either Scenario 1 or Scenario 2 include trenching, jet plowing, backfilling, and installation of cable protection. As described in Section 1.3.1, cable lay and burial may utilize jet trenching, plowing/jet plowing, mechanical trenching, or a barge-towed plow. The majority of cable installation would be performed with jet trenching or jet plowing. Mechanical trenching and barge-towed plowing is only expected in limited areas.

There is limited information regarding underwater noise generated by cable-laying and burial activities in the literature. Johansson and Andersson (2012) recorded underwater noise levels generated during a comparable operation involving pipelaying and a fleet of nine vessels. Mean noise levels of 130.5 dB re 1 µPa were measured at 0.9 mi (1.5 km) from the source. Reported noise levels generated during a jet trenching operation provided a source level estimate of 178 dB re 1 µPa-m (Nedwell et al. 2003). As the cable-laying vessel and equipment would be continually moving, the ensonified area would also move. Given the mobile nature of the ensonified area, a given location would not be ensonified for more than a few hours.

Given the source level reported for jet trenching, cable laying noise associated with the Proposed Action is not expected to exceed PTS thresholds for marine mammals (**Table 3-4**). However, the behavioral disturbance threshold (i.e., 120 dB re 1 µPa) may be exceeded. Though sound levels may exceed the behavioral disturbance threshold, cable laying noise is not expected to interrupt or impede critical behaviors for marine mammals (e.g., foraging, migrating). Sound levels generated during cable laying are not expected to be sufficient to cause marine mammals to abandon foraging activity, but exposed individuals may forage less efficiently due to increased energy spent on vigilance behaviors (NMFS 2015a). Decreased foraging efficiency could have short-term metabolic effects resulting in physiological stress, but these effects would dissipate once the prey distribution no longer overlaps the mobile ensonified area. Behavioral disturbance due to cable laying noise is not expected to impede cetacean migration as animals would still be able to migrate around the behavioral disturbance zone. Given that all of the ESA-listed cetaceans are highly mobile, these species are expected to move away from any noise source that may result in behavioral disturbance. Marine mammals are expected to resume normal activities once the cable laying has stopped or the animal has moved outside of the ensonified area.

Expected acoustic frequencies emitted during cable laying are more likely to overlap with the hearing range of LFC than with MFC. However, masking of communications from both hearing groups is possible. Any masking effects would be temporary and transient due to the mobile nature of the activity.

The energetic consequences of any behavioral responses or masking effects associated with cable laying noise under the Proposed Action are not expected to affect any individual marine mammal's ability to successfully forage, complete seasonal migrations, or participate in breeding or calving.

PTS is not expected from cable laying noise and there would therefore be ***no effect*** on fin whales, NARWs, sei whales, or sperm whales**.** Behavioral disturbance resulting from the noise associated with cable laying activities may occur. However, vessel separation requirements included in the mitigation measures for the Proposed Action (**Table 1-10**) would reduce the potential for exposure to sound levels above the behavioral disturbance threshold.

Given vessel separation requirements, the temporary/transient nature of effects, and marine mammals' ability to avoid disturbing levels of noise, the potential for ESA-listed cetaceans to be exposed to underwater noise exceeding behavioral disruption thresholds from cable laying operations would not rise to the level of take under the ESA and is considered ***insignificant***. Therefore, the effects of exposure to noise exposure from Project cable laying operations resulting in sound levels that exceed the behavioral disturbance threshold ***may affect, but not likely to adversely affect*** fin whales, NARWs, sei whales, and sperm whales.

Dredging Noise

Under Scenario 1 or Scenario 2 of the Proposed Action, dredging may be required for seabed preparation prior to foundation installation, sand bedform clearing prior to cable installation, and excavation of the offshore HDD entrance/exit near the cable landing sites. Project dredging may utilize a trailing suction hopper dredge, a cutterhead dredge, and/or a backhoe dredge.

Trailing suction hopper dredges and cutterhead dredges use suction to remove sediment from the seabed. The sound produced by hydraulic dredging results from the combination of sounds generated by the impact and abrasion of the sediment passing through the draghead, suction pipe, and pump. The frequency of the sounds produced by hydraulic suction dredging ranges from approximately 1 to 2 kilohertz, with reported source levels of 172 to 190 dB re 1 µPa at 3.3 feet (1 meter) (McQueen et al. 2019; Robinson et al. 2011; Todd et al. 2015). Robinson et al. (2011) noted that the level of broadband noise generated by suction dredging is dependent on the aggregate type being extracted, with coarse gravel generating higher noise levels than sand. Noise produced by mechanical dredges (e.g., a backhoe dredge) is emitted from winches and derrick movement, bucket contact with the substrate, digging into substrate, and emptying of material into a barge or scow (Dickerson et al. 2001). Reported sound levels of mechanical dredges range from 107 to 124 dB re 1 µPa L_{rms} at 505 feet (154 meters) from the source with peak frequencies of 162.8 Hz (Dickerson et al. 2001; McQueen et al. 2019). Maximum levels occurred when the dredge bucket made contact with the channel bottom in mixed coarse sand or gravel (Dickerson et al. 2001; McQueen et al. 2019).

Based on the available source level information presented above, dredging by hydraulic or mechanical dredges is unlikely to PTS thresholds for marine mammals. Therefore, there would be ***no effect*** on fin whales, NARWs, sei whales, or sperm whales.

Based on the available source level information for dredging equipment expected to be used for the Proposed Action, behavioral thresholds for marine mammals could be exceeded. Behavioral responses of marine mammals to dredging activities have included avoidance in bowhead whales, gray whales, minke whales, and gray seals (Anderwald et al. 2013; Bryant et al. 1984; Richardson et al. 1990). Diederichs et al. (2010) found short-term avoidance of dredging activities by harbor porpoises near breeding and calving areas in the North Sea. Pirotta et al. (2013) found that, despite a documented tolerance of high vessel presence, as well as high availability of food, bottlenose dolphins spent less time in the area during periods of dredging. The study also showed that with increasing intensity in the activity, bottlenose dolphins avoided the area for longer durations, with one instance of avoidance lasting as long as five weeks (Pirotta et al. 2013). The energetic consequences of any avoidance behavior and potential delay in resting or foraging are not expected affect any individual's ability to successfully obtain enough food to maintain their health or impact the ability of any individual to make seasonal migrations or participate in breeding or calving. Therefore, any effects would be too small to be meaningfully measured, detected, or evaluated and, thus, ***insignificant***. Therefore, the effects of exposure to dredging noise resulting in sound levels that exceed the behavioral disturbance threshold ***may affect, but not likely to adversely affect*** fin whales, NARWs, sei whales, and sperm whales**.**

Vessel Noise

The Proposed Action includes the use of vessels during construction, O&M, and decommissioning, as described in Section 1.3 and **Tables 1-7 through 1-9**. No difference in vessel utilization is anticipated between Scenario 1 and Scenario 2 under the Proposed Action. Vessels generate non-impulsive noise that could affect aquatic species. SPL source levels for large vessels range from 177 to 188 dB re 1 µPa-m with most of their energy below 1 kHz and peaks in the 20–100 Hz range (McKenna et al. 2017).

Vessel noise overlaps with the hearing range of marine mammals and may cause behavioral responses, stress responses, and masking (Erbe et al. 2018, 2019; Nowacek et al. 2007; Southall et al. 2007). Based on the low frequencies produced by vessel noise and the relatively large propagation distances associated with low-frequency sound, LFC, including fin whales, NARWs, and sei whales, are at the greatest risk of impacts associated with vessel noise. Potential behavioral responses to vessel noise include startle responses, behavioral changes, and avoidance. In NARW, vessel noise is known to increase stress hormone levels, which may contribute to suppressed immunity and reduced reproductive rates and fecundity (Hatch et al. 2012; Rolland et al. 2012). Masking may interfere with detection of prey and predators and reduce communication distances. Modeling results indicate that vessel noise has the potential to substantially reduce communication distances for NARWs (Hatch et al. 2012).

Vessel activity associated with the Proposed Action is expected to cause repeated, intermittent impacts on ESA-listed marine mammals resulting from short-term, localized behavioral responses, including changes in acoustic behavior, startle responses (e.g., diving), changes in surfacing intervals, or avoidance (Southall et al. 2021). These responses would dissipate once the vessel or individual leaves the area and are expected to be infrequent given the low density of ESA-listed marine mammals in the action area (**Table 3-2**). Any behavioral effects in response to vessel noise are not expected to be biologically significant (Navy 2018). Therefore, no stock or population-level effects on ESA-listed species would be expected.

Project vessels are not expected to generate noise that exceeds PTS thresholds for marine mammals, and there would be ***no effect*** on fin whales, NARWs, sei whales, or sperm whales**.** Vessel noise has the potential to cause behavioral disturbance or masking. Vessel separation requirements included in the mitigation measures for the Proposed Action (**Table 1-10**) would reduce the potential for exposure to sound levels above the behavioral disturbance threshold. Given vessel separation requirements and marine mammals' ability to avoid disturbing levels of noise, the potential for ESA-listed cetaceans to be exposed to vessel noise exceeding behavioral disruption thresholds would not rise to the level of take under the ESA and is, therefore, considered ***insignificant***. Therefore, the effects of exposure to vessel noise resulting in sound levels that exceed the behavioral disturbance threshold ***may affect, but not likely to adversely affect*** fin whales, NARWs, sei whales, and sperm whales.

Aircraft

Helicopters may be used to support construction or O&M of the Proposed Action under either Scenario 1 or Scenario 2. Though helicopters produce in-air noise, a small portion of the produced sound can be transmitted through the water surface and propagate in the aquatic environment. Underwater sound produced by helicopters is generally low frequency (less than 500 Hz) and non-impulsive with sound levels at or below 160 dB re 1 µPa (Richardson et al. 1995). Underwater helicopter noise has the potential to elicit behavioral responses in aquatic species (Efroymson et al. 2000; Patenaude et al. 2002; Richardson et al. 1995).

When traveling at relatively low altitude, helicopter noise that propagates underwater has the potential to elicit short-term behavioral responses in marine mammals, including altered dive patterns, percussive behaviors (i.e., breaching or tail slapping), and disturbance at haul-out sites (Efroymson et al. 2000; Patenaude et al. 2002). Helicopters transiting to and from the action area are expected to fly at sufficiently high altitudes to avoid behavioral effects on marine mammals, with the exception of WTG inspections, take-off, and landing. Additionally, Project aircraft would comply with current approach regulations for NARWs. Current regulations (50 CFR 222.32) prohibit aircraft from approaching within 1,500 feet (457 meters) of NARWs. Any behavioral responses elicited during low-altitude flight would be temporary, dissipating once the aircraft leave the area, and are not expected to be biologically significant.

Given the anticipated altitude of Project aircraft flights and the implementation of NARW approach regulations, exposure to noises above PTS and behavioral disturbance thresholds for all ESA-listed marine mammal species is considered extremely unlikely to occur and ***discountable***. Therefore, exposure to aircraft noise resulting in sound levels that exceed PTS or behavioral disturbance thresholds, ***may affect, but not likely to adversely affect*** fin whales, NARWs, sei whales, or sperm whales.

Wind Turbine Generators

WTGs operating during the O&M phase of the Proposed Action, under either Scenario 1 or Scenario 2, would generate continuous non-impulsive, underwater noise. Monitoring data in the literature are limited to smaller, geared wind turbines (less than 6.15 MW). The relatively low noise levels produced by these WTGs are expected to decrease to ambient levels within a relatively short distance from the turbine foundations (Dow Piniak et al. 2012b; Elliott et al. 2019; Kraus et al. 2016; Thomsen et al. 2015). At Block Island Wind Farm, turbine noise reached ambient noise levels within 164 feet (50 meters) of the turbine foundations (Miller and Potty 2017). Monitoring data indicate that noise levels increase with higher wind speeds, which lead to higher ambient noise levels due to higher wave action (Kraus et al. 2016; Tougaard et al. 2009).

Available data on large direct-drive turbines as proposed for this Project are sparse. Direct-drive turbine design eliminates the gears of a conventional wind turbine, which increases the speed at which the generator spins. Direct-drive generators are larger generators that produce the same amount of power at slower rotational speeds. Only one study of direct-drive turbines presented in Elliott et al. (2019) was available in the literature. The study measured SPLs of 114 to 121 dB re 1 μPa at 164.0 feet (50 meters) for a 6 MW direct-drive turbine.

Based on measurements from WTGs 6.15 MW and smaller, Stöber and Thomsen (2021) estimated that operational noise from larger (10 MW WTG), current-generation WTGs would generate higher source levels (177 dB re 1 μPa-m) than the smaller WTGs measured in earlier research. Additionally, Stöber and Thomsen (2021) estimate that a shift from gear-driven wind turbines to direct drive turbines would decrease sound levels by 10 dB, resulting in a range to the 120 dB re 1 μPa behavioral threshold of 0.9 mile (1.4 kilometer). Using the least-squares fits from Tougaard et al. (2020), SPLs from 15 MW turbines, which may be utilized for U.S. offshore wind farms, in 20 m/s, gale-force wind would be expected to fall below the same behavioral threshold within approximately 910 feet (277 meters). In lighter winds (approximately 20 knots [10 meters per second], a “fresh breeze” on the Beaufort scale), the predicted range to threshold would be only approximately 525 feet (160 meters). Both models were based on small turbines, adding uncertainty to the modeling results. Stöber and Thomsen (2021) use only the loudest measurements from each study cited. While this is reasonable practice for most sound source studies, sound from an operating WTG can be expected to correlate with wind speed and therefore with higher environmental noise. Scaling the loudest sound measurements linearly with turbine power, as the study did, will scale environmental noise up along with it and can be expected to overestimate sound levels from larger turbines. This is especially concerning as no correlation coefficient was provided to assess the goodness of fit. Tougaard et al. (2020) take wind speed into account for each of the measurements in their fit and scale the level with WTG power using a logarithmic measurement. Because of these factors, range estimates based on Tougaard et al. (2020) are considered more relevant to this assessment.

Based on the currently available data for turbines 6 MW and smaller, and modeling information presented above, underwater noise from WTG operations from offshore wind activities is unlikely to cause PTS in marine mammals. However, underwater noise from WTG operations could exceed behavioral thresholds and cause masking of communications. More acoustic research is warranted to characterize source levels originating from large direct-drive turbines and to what distance behavioral and masking effects are likely.

Jansen and de Jong (2016) and Tougaard et al. (2009) concluded that marine mammals would be able to detect operational noise within a few thousand feet of 2 MW WTGs, but the effects would have no significant impacts on individual survival, population viability, distribution, or behavior. Lucke et al. (2007) exposed harbor porpoise to simulated noise from operational wind turbines and found masking effects at 128 dB re 1 µPa in the frequencies 700, 1,000, and 2,000 Hz. This suggests the potential for a reduction in effective communication space within the wind farm environment for marine mammals that communicate primarily in frequency bands below 2,000 Hz. Any such effects would likely be dependent on hearing sensitivity of the individual and the ability to adapt to low-intensity changes in the noise environment.

Project WTGs are not likely to generate noise that exceeds PTS thresholds for marine mammals. Therefore, exposure to noise levels above PTS thresholds from WTG operations is considered extremely unlikely to occur and ***discountable***. Therefore, the effects of exposure to WTG noise resulting in sound levels that exceed PTS thresholds ***may affect, but not likely to adversely affect*** fin whales, NARWs, sei whales, and sperm whales.

These species may be exposed to noise above the behavioral thresholds during WTG operations, particularly during high wind events when WTGs generate higher levels of noise. However, during high wind events ambient underwater noise levels are also elevated, potentially reducing the impact of WTG operational noise as high ambient noise conditions would be expected to decrease the distance from the WTG at which operational noise levels fall below ambient noise levels. Given marine mammals' ability to avoid harmful noises, any behavioral effects resulting from exposure to underwater noise exceeding behavioral disturbance thresholds from WTG operations would be ***insignificant***. Therefore, the effects of exposure to WTG noise resulting in sound levels that exceed the behavioral disturbance threshold ***may affect, but not likely to adversely affect*** fin whales, NARWs, sei whales, and sperm whales.

Summary of Underwater Noise Effects

Noise generated from Project activities include impulsive (e.g., impact pile driving, some HRG surveys) and non-impulsive sources (e.g., vibratory pile diving, some HRG surveys, vessels, turbine operations). Of those activities, only impact pile driving could cause PTS effects on marine mammals. All noise sources have the potential to cause behavioral disturbance effects through behavioral modification, as well as masking and other non-lethal effects in certain species. The mitigation measures outlined in **Tables 1-10 and 1-11** are expected to be effective in limiting the potential for PTS effects in most marine mammal species; however, the potential for some PTS and behavioral effects remain. **Table 3-19** summarizes the number of ESA-listed marine mammals potentially exposed to underwater noises above PTS and behavioral thresholds for all underwater noise sources.

Table 3-19 Estimated Number of ESA-listed Marine Mammals Exposed to Sound Levels above PTS and Behavioral Thresholds

Hearing Group	Species	Scenario 1		Scenario 2	
		PTS Exposures	BD Exposures	PTS Exposures	BD Exposures
Impact Pile Driving for Foundation Installation (10 dB noise mitigation)					
LFC	Fin whale	6	15	7	18
	NARW	0	3	0	3
	Sei whale	1	2	1	3
MFC	Sperm whale	0	0	0	0
Vibratory Pile Driving for Cofferdam Installation (0 dB noise mitigation)					
LFC	Fin whale	0	5	0	5
	NARW	0	3	0	3
	Sei whale	0	2	0	2
MFC	Sperm whale	0	0	0	0
HRG Surveys (5-Year Total) (0 dB noise mitigation)					
LFC	Fin whale	0	10	0	10
	NARW	0	5	0	5
	Sei whale	0	5	0	5
MFC	Sperm whale	0	5	0	5

BD = behavioral disturbance; dB = decibels; HRG = high-resolution geophysical; LFC = low-frequency cetacean; MFC = mid-frequency cetacean; NARW = North Atlantic right whale; OSS = offshore substation; PTS = permanent threshold shift; WTG = wind turbine generator
Source: Atlantic Shores 2023b.

Noise associated with vibratory pile driving, HRG surveys, dredging, cable laying, Project vessels, Project aircraft, or WTG operation for the Proposed Action are not expected to result in injury (i.e., PTS) of ESA-listed marine mammals based on the source levels. Impact pile driving has the potential to cause PTS in ESA-listed marine mammals. The mitigation measures described in Section 1.3.5 (**Tables 1-10 and 1-11**) and summarized in this section are expected to minimize injury risk for these species, but the risk cannot be discounted for fin and sei whales. Noise generated by impact pile driving, vibratory pile driving, HRG surveys, cable laying, dredging, Project vessels, Project aircraft, and WTG operation could all result in behavioral effects on ESA-listed marine mammals. Behavioral effects associated with construction activities (i.e., impact pile driving, vibratory pile driving, HRG surveys, cable laying, and dredging) would be temporary but could occur over relatively large distances for some noise sources. Any behavioral effects associated with Project vessel or Project helicopter noise would also be temporary and are expected to be ***discountable*** (for Project aircraft) or ***insignificant*** (for Project vessels). Behavioral effects associated with WTG operation are expected to be ***insignificant***.

Effects on Prey Organisms

ESA-listed marine mammals in the Offshore Wind Area feed on a variety of invertebrates and fish as described in Sections 3.2.1, 3.2.2, 3.2.3, and 3.2.4.

The susceptibility of invertebrates to human-made sounds is unclear, and there is currently insufficient scientific basis to establish biological effects thresholds (Finneran et al. 2016). The available research on the topic is limited and relatively recent (Carroll et al. 2016; Edmonds et al. 2016; Hawkins and Popper 2014; Pine et al. 2012; Weilgart 2018). This research indicates that invertebrate sound sensitivity is restricted to particle motion, the effect of which dissipates rapidly such that any effects are localized (Edmonds et al. 2016). In particular, it is unlikely that Project activities would measurably affect the invertebrate forage base of NARWs and sei whales, who feed primarily on invertebrate zooplankton.

Impact pile driving may temporarily reduce the abundance of fish in proximity to the activity. Physiological injury, TTS, and behavioral effects could occur to small fish. Project activities could temporarily reduce the abundance of fish for fin whales in proximity to the activity. Sperm whales feed primarily in the deep waters off the continental slope and are extremely unlikely to be affected by reduction in prey items in the shallower waters of the Lease Area. With the implementation of ramp-ups, the potential for injury to fishes are minimized. Ramp-up would facilitate a gradual increase of energy to allow marine life to leave the area prior to the start of operations at full energy that could result in injury and may be effective in deterring prey fish from certain Project activities (e.g., impact pile driving) prior to exposure resulting in injury. The potential for injury to fish is also minimized by using a noise mitigation system during all impact pile driving operations. Although fish within may be injured within proximity to the impact pile driving activity, resulting effects on marine mammals would be localized and short-term and would not alter the natural variability of prey species. For example, capelin is a primary forage species targeted by fin whales when they are available in abundance. Capelin and other marine forage fish like herring, anchovies, and sardines have short lifespans and variable recruitment rates. Species with this type of reproductive strategy commonly display rapid and dramatic changes in abundance from year to year in response to environmental variability (Leggett and Frank 1990; Shikon et al. 2019; Sinclair 1988) and shifts in distribution in response to changing climatic conditions (Carscadden et al. 2013). As a result, fin whales would likely move to other areas to forage on fish in response to any loss or avoidance of the Project area by these species. Sperm whales are wide-ranging, adaptive predators and feed primarily in the deep waters off the continental slope. Sperm whales only occasionally prey on the types of organisms likely to occur in the Lease Area (Leatherwood et al. 1988; Pauly et al. 1998) and are extremely unlikely to be affected by reduction in prey items in the shallower waters of the Offshore Wind Area.

The effects on ESA-listed cetaceans due to reductions in prey items from underwater noise generated by the Project would be so small that they could not be measured, detected, or evaluated and are therefore ***insignificant***. Therefore, impacts from underwater noise sources due to the Proposed Action ***may affect, but not likely to adversely affect*** prey organisms of fin whales, NARWs, sei whales, and sperm whales.

3.2.5.3. Dredging Effects on Marine Mammals

Under Scenario 1 or Scenario 2 of the Proposed Action, dredging may be required for seabed preparation prior to installation of met tower or OSS foundations, as described in Section 1.3.1. Seabed preparation is most likely to be required if gravity foundations are selected for the met tower and/or OSSs. Seabed preparation is not anticipated for piled or suction bucket foundations, which have been proposed for WTGs. If dredging is needed, utilization of a trailing suction hopper dredge is anticipated. Dredging may also be required for sand bedform clearing prior to cable installation. If such dredging is required, it would be completed using a trailing suction hopper dredge, a cutterhead dredge, and/or a backhoe dredge. Atlantic Shores estimates that up to 20 percent of export cable routes, 20 percent of interlink cable routes, and 10 percent of inter-array cable routes may require sand bedform clearing. Finally, a backhoe dredge may be required to complete excavation of the offshore HDD entrance/exit near the cable landing sites.

The maximum impact installation under either Scenario 1 or Scenario 2 would be installation of a met tower with a suction bucket jacket foundation and four large OSSs with suction bucket jacket foundations. If seabed preparation is required for all WTG, OSS, and met tower foundations, a 368.75-acre (1.49-square kilometer) area would be dredged for seabed preparation under Scenario 1, and a 339.95-acre (1.38-square kilometer) area would be dredged for seabed preparation under Scenario 2 (**Table 1-5**). The minimum impact installation, in terms of dredging, under either Scenario would be installation of a met tower and 10 small OSSs with piled jacket foundations, resulting in a 345.56-acre (1.40-square kilometer) dredged area for seabed preparation under Scenario 1 and a 302.82-acre (1.23-square kilometer) area of dredged area for seabed preparation under Scenario 2 (assuming that all foundations require seabed preparation). Including seabed preparation for foundation installation, sand bedform clearing for cable installation (1,794.09 acres [7.26 square kilometers], **Table 1-6**), and backhoe dredging for the HDD pit (0.24 acres [less than 0.01 square kilometers], **Table 1-6**), a 2,162.96-acre (8.75-square kilometer) area or a 2,134.17-acre (8.58-square kilometer) area would be dredged for the maximum impact installation under Scenario 1 or Scenario 2, respectively (**Table 1-6**). For the minimum impact installation, a 2,139.78-acre (8.66-square kilometer) or a 2,097.03-acre (8.49-square kilometer) area would be dredged under Scenario 1 or Scenario 2, respectively.

Noise impacts to marine mammals from dredging is discussed in Section 3.2.5.2. The size of ESA-listed whales compared to the dredging equipment and the fact that a whale would have to be on the seafloor or in the water column directly below the dredge indicates that physical interactions between a hydraulic or mechanical dredge and ESA-listed whales are extremely unlikely to occur and therefore ***discountable***. Therefore, dredging leading to physical interactions ***may affect, but not likely to adversely affect*** fin whales, NARWs, sei whales, or sperm whales.

Dredging would result in localized increases in total suspended sediment (TSS) concentrations. Effects of increased TSS concentrations are assessed in Section 3.2.5.6. Dredging would also temporarily disturb the benthic community in the dredged area. As no ESA-listed marine mammals that occur in the Project area are benthic feeders, temporary impacts on the benthic community associated with dredging would be expected to have ***no effect*** on fin whales, NARWs, sei whales, or sperm whales.

Dredging Effects of the Connected Action

The Connected Action would include hydraulic cutterhead or mechanical dredging. Dredging would result in localized increases in total suspended sediment (TSS) concentrations. Elevated TSS concentrations associated with cutterhead dredging could reach 550.0 mg/L and would occur within a radius of up to 1,640 feet (500 meters). Elevated TSS concentrations associated with mechanical dredging could reach 445.0 mg/L (NMFS 2020c citing USACE 2001) and would occur within a radius of up to 2,400 feet (732 meters) (NMFS 2020c citing Burton 1993; NMFS 2020c citing USACE 2015a). Dredging activities may also result in indirect effects through effects on benthic prey species. Dredging effects associated with the Connected Action would be localized to the waters around the O&M facility. ESA-listed marine mammals are not expected to occur within the affected area. Therefore, dredging associated with port modifications would have ***no effect*** on fin whales, NARWs, sei whales, or sperm whales.

3.2.5.4. Habitat Disturbance

Activities included in the Proposed Action would result in habitat disturbance or modifications that may cause impacts to benthic and water column habitat. Anticipated habitat disturbance or alterations may result from physical disturbance of sediment, the presence of structures, changes in oceanographic and hydrologic conditions, conversion of soft-bottom habitat to hard-bottom habitat, and the reef effect. Following the assessment of these potential sources of habitat disturbance/modification, a summary of overall effects to ESA-listed marine mammal species due to habitat disturbance is provided.

Displacement from Physical Disturbance of Sediment

As described in Sections 1.3.1 geotechnical surveys would be conducted during the pre-construction phase of the Proposed Action under either Scenario 1 or Scenario 2. Geotechnical surveys (e.g., benthic grabs) may cause benthic disturbance as a result of physical seafloor sampling. Geotechnical surveys would be conducted at specific WTG locations. Activities required prior to cable installation, including boulder clearance and a pre-lay grapnel run, and vessel anchoring during construction and decommissioning would also result in benthic disturbance. Project dredging would also result in physical disturbance of sediment, but this activity was evaluated in Section 3.2.5.3.

Each individual geotechnical sampling event would disturb a 10.8 to 107.6-square foot (1 to 10-square meter) area of seabed (BOEM 2014). Assuming all 200 WTG locations require geotechnical sampling (a maximum impact assumption), an area of up to 0.5 acres (2,000 square meters) would be disturbed. Any material moved during boulder clearance and the pre-lay grapnel run would be placed adjacent to the cable corridor. Boulder relocation may disturb approximately 226.5 acres (0.9 square kilometer) of benthic habitat, and the pre-lay grapnel run may disturb approximately 869.7 acres (3.5 square kilometers). Vessel anchoring for the Proposed Action may temporarily disturb approximately 262 acres (1 square kilometer) of benthic habitat. Between the two activities up to 1,386.6 acres (5.6 square kilometers) of benthic habitat may be disturbed under either Scenario 1 or Scenario 2. None of these activities are expected to result in permanent habitat loss or conversion in the action area.

Physical disturbance of sediment associated with the Proposed Action may temporarily displace benthic prey species. However, impacts on benthic prey associated with geotechnical surveys, boulder relocation, a pre-lay grapnel run, and anchoring for the Proposed Action would be expected to have ***no effect*** on fin whales, NARWs, sei whales, or sperm whales, which do not forage on benthic prey species.

Behavioral Changes due to the Presence of Structures

The presence of structures associated with the Proposed Action could result in avoidance and displacement of marine mammals or behavioral disruption. However, it is difficult to separate out any behavioral reactions of marine mammals due to the physical presence of WTGs from behavioral reactions due to the underwater noise the structures may emit. The effects of WTG noise on ESA-listed marine mammals are assessed in Section 3.2.5.2. The installation method having the greatest impact for either Scenario 1 or Scenario 2 is the installation of 200 WTGs, 1 met tower, and 10 small OSSs (i.e., the greatest number of structures possible under the Proposed Action). The installation method having the least amount of impact for either Scenario 1 or Scenario 2 is installation of 200 WTGs, 1 met tower, and 4 large OSS (i.e., the smallest number of structures possible under the Proposed Action).

Displacement of marine mammals could potentially move them into areas with lower habitat value or with higher risk of vessel collision or fisheries interactions. Fisheries interactions are likely to have demographic effects on marine mammal species. Entanglement is a significant threat for NARW. Seventy-two percent of NARWs show evidence of past entanglements (Johnson et al. 2005), and entanglement in fishing gear is a leading cause of death for this species and may be limiting population recovery (Knowlton et al. 2012). Entanglement may also be a significant cause of death for other mysticete species (Read et al. 2006).

Disruption of normal behaviors could also occur due to the presence WTGs. Although spacing between the structures (at least 0.6 nautical miles [1.1 kilometers]) would be sufficient to allow marine mammals to utilize habitat between and around structures, information about large whale responses to offshore wind structures is lacking. Monitoring at Block Island Wind Farm, composed of five turbines with piled jacket foundations, and the Coastal Virginia Offshore Wind pilot project, composed of two turbines with monopile foundations, have not produced data with observable changes in marine mammal movement (NMFS 2021c). Studies in the United Kingdom have focused on harbor porpoises, a species particularly sensitive to underwater noises (Southall et al. 2007). Harbor porpoise behavior and abundance were not affected by O&M of the Horns Rev offshore wind project in the North Sea as evidenced by acoustic activity (Tougaard et al. 2006). The Horns Rev project is closer in size to the Proposed Action at 80 foundations; however, spacing is closer together (0.27 nautical miles [0.5 kilometer] compared to a minimum of 0.6 nautical miles [1.1 kilometers]). Nysted, a 72-turbine offshore wind farm in the Baltic Sea, recorded significant decreases in acoustic activity of harbor porpoise during construction and immediately post-construction, but activity slowly increased over 10 years during operations, though not fully to pre-construction levels (Teilmann and Carstensen 2012). The Nysted turbines are also spaced more closely than the Project, from 0.3 to 0.5 nautical miles (0.5 to 0.9 kilometer).

Though behavioral effects on ESA-listed marine mammals due to the presence of structures warrants further study, available evidence does not indicate that the Proposed Action would result in observable changes in marine mammal movements or result in long-term displacement from the Lease Area. Therefore, the presence of Project structures on the OCS leading to behavioral changes ***may affect, but not likely to adversely affect*** fin whales, NARWs, sei whales, and sperm whales.

Changes in Oceanographic and Hydrological Conditions due to the Presence of Structures

The presence of structures (i.e., WTGs, met tower, and OSSs) during operation of the Proposed Action may cause a variety of long-term hydrodynamic effects during O&M, which could impact prey species of ESA-listed whales. The maximum impact installation for either Scenario 1 or Scenario 2 is installation of 200 WTGs, 1 met tower, and 10 small OSSs (i.e., the greatest number of structures possible under the Proposed Action). The minimum impact installation for either Scenario 1 or Scenario 2 is installation of 200 WTGs, 1 met tower, and 4 large OSS (i.e., the smallest number of structures possible under the Proposed Action).

Atmospheric wakes, characterized by reduced downstream mean wind speed and turbulence along with wind speed deficit, are documented with the presence of vertical structures. Magnitude of atmospheric wakes can change relative to instantaneous velocity anomalies. In general, lower impacts of atmospheric wakes are observed in areas of low wind speeds.

Several hydrodynamic processes have been identified to exhibit changes from vertical structures:

- Advection and Ekman transport are directly correlated with shear wind stress at the sea surface boundary. Vertical profiles presented by Christiansen et al. (2022) exhibit reduced mixing rates over the entire water column. As for the horizontal velocity, the deficits in mixing are more pronounced in deep waters than in well-mixed, shallow waters, which is likely favored by the influence of the bottom mixed layer in shallow depths. In both cases, the strongest deficits occur near the pycnocline depth.
- Additional mixing downstream has been documented from Kármán vortices and turbulent wakes due to the pile structures of wind turbines (Carpenter et al. 2016; Grashorn and Stanev 2016; Schultze et al. 2020).
- Up-dwelling and down-dwelling dipoles under contact of constant wind directions affecting average surface elevation of waters have been documented as the result of offshore wind farms (Brostörm 2008; Ludewig 2015; Paskyabi and Fer 2012). Mean surface variability between 1 and 10 percent has been reported.
- With sufficient salinity stratification, vertical flow of colder/saltier water to the surface occurs in lower sea surface level dipoles and warmer/less saline water travels to deeper waters in elevated sea surface heights (Christiansen et al. 2022; Ludewig 2015;). This observation also suggested impacts on seasonal stratification, as documented by Christiansen et al. (2022). However, the magnitude of salinity and temperature changes with respect to vertical structures is small compared to the long-term and interannual variability of temperature and salinity.

The potential hydrodynamic effects due the presence of vertical structures in the water column identified above affect nutrient cycling and could influence the distribution and abundance of fish and planktonic prey resources throughout O&M (van Berkel et al. 2020). Several studies have modeled and theorized potential impacts, but overall science is limited as to what environmental effects will accompany the hydrologic changes brought about by a large turbine installation at the proposed spacing in an environment such as the U.S. OCS.

Potential effects of hydrodynamic changes in prey aggregations are specific to listed species, such as fin whale, NARW, and sei whale, that feed on plankton, whose movement is largely controlled by water flow, as opposed to other listed species (e.g., sperm whales) that eat fish, cephalopods, and crustaceans, which are either more stationary on the seafloor or are more able to move independent of typical ocean currents. Hydrodynamic effects may directly affect planktonic prey distribution through physical processes. Aggregations of plankton, which provide a dense food source for fin whales, NARWs, and sei whales to efficiently feed upon, are concentrated by physical and oceanographic features; increased mixing due to the presence of structures may disperse aggregations and may decrease efficient foraging opportunities.

Hydrodynamic effects may also indirectly affect planktonic prey through effects on primary productivity. Increased localized mixing, which may deepen the thermocline, could impact seasonal stratification, which could affect primary productivity and therefore prey presence or distribution (Carpenter et al. 2016; Chen et al. 2018; English et al. 2017; Kellison and Sedberry 1998; Lentz 2017; Matte and Waldhauer 1984). However, increased primary productivity may not lead to increases in planktonic prey species, as the increased productivity may be consumed by filter feeders colonizing the structures (Slavik et al. 2019).

The degree of effect on planktonic prey species was not hypothesized to be significant due to the effects to hydrodynamics, which would be limited to an area within a few hundred meters of individual turbines (Miles et al. 2017; Schultze et al. 2020). As a result, any effects from the changes in oceanographic and hydrological conditions due to presence of structures would be so small that they could not be measured, detected, or evaluated and are therefore ***insignificant***. Therefore, changes in oceanographic and hydrologic conditions due to the presence of Project structures on the OCS leading to effects on planktonic prey ***may affect, but not likely to adversely affect*** fin whales, NARWs, and sei whales. Given that sperm whales do not feed on planktonic prey, changes in oceanographic and hydrologic conditions due to the presence of Project structures on the OCS are expected to have ***no effect*** on this species.

Conversion of Soft-Bottom Habitat to Hard-Bottom Habitat

Installation of WTGs, OSSs, and submarine cables and associated scour and cable protection during construction of the Proposed Action would result in habitat conversion and loss. Some soft-bottom habitat would be lost, and some soft-bottom and pelagic habitat would be converted to hard-bottom and hard, vertical habitat, respectively. This habitat loss and conversion would persist through the O&M phase and into decommissioning until the structure is removed.

As previously noted, under the Proposed Action monopile and/or piled jacket foundations have been selected WTGs for Scenario 1 and Scenario 2. However, several foundation types are still being considered for the OSSs. The maximum impact installation for conversion of soft-bottom habitat for either Scenario would be four large OSSs with suction bucket jackets. The minimum impact installation for either Scenario would be ten small OSSs with piled jackets. The number of foundations by type for the WTGs and OSSs for each Scenario are summarized in **Table 3-20** in terms of the least and greatest impacts associated with the area of benthic habitat occupied by each foundation. The installation of up to 200 WTGs with monopile foundations for Scenario 1 under the Proposed Action would result in the loss of up to 261 acres (1.06 square kilometers) of soft-bottom habitat in the WTG foundation footprints (**Table 3-21**). The installation of 105 to 136 WTGs with monopile foundations and 64 to 95 WTGs with jacket foundations for Scenario 2 under the Proposed Action with would result in the loss of 203 to 222 acres (square kilometers) of soft-bottom habitat in the WTG foundation footprints. The installation of 10 small OSSs with jacket foundations under either Scenario would result in the loss of 7 acres (0.03 square kilometers) of soft-bottom habitat in the OSS foundation footprints (**Table 3-21**). The installation of 4 large OSSs with suction bucket jacket foundations under either Scenario would result in the loss of 26 acres (0.011 square kilometers) of soft-bottom habitat in the OSS foundation footprints (**Table 3-21**). For either Scenario of the Proposed Action, the installation of cable protection for the export cables would result in the conversion of 345 acres (1.4 square kilometers) of soft-bottom habitat to hard-bottom habitat. No cable protection is anticipated for the interarray cables. In total, Scenario 1 under the Proposed Action would result in the loss or conversion of 613 to 632 acres of soft-bottom habitat (**Table 3-21**). For Scenario 2 under the Proposed Action, 555 to 593 acres of soft-bottom habitat would be lost or converted.

Table 3-20. Number of Foundations by Type Associated with the Least and Greatest Impact for Habitat Conversion Effects

Foundations	Scenario 1		Scenario 2	
	Minimum Impact	Maximum Impact	Minimum Impact	Maximum Impact
WTG monopile foundations	200	200	105	136
WTG jacket foundations	0	0	95	64
Small OSS jacket foundations	10	0	10	0
Large OSS suction bucket jacket foundations	0	4	0	4

Table 3-21. Habitat Loss or Conversion (acres) Associated with the Minimum and Maximum Footprint for each Scenario

Project Component	Scenario 1		Scenario 2	
	Minimum Impact	Maximum Impact	Minimum Impact	Maximum Impact
WTG foundations with scour protection	261	261	203	222
OSS foundations with scour protection	7	26	7	26
Cable protection	345	345	345	345
TOTAL	**613**	**632**	**555**	**593**

The loss or conversion of soft-bottom habitat in the action area could reduce foraging habitat or prey availability for species that consume benthic prey species. This habitat loss/conversion could have long term effects if it resulted in changes in the use of the area by ESA-listed species or the availability, abundance, or distribution of forage species. The only forage fish species that is expected to be affected by these habitat alterations would be sand lance. As sand lance are strongly associated with sandy substrate, and the Project would result in a loss of such soft-bottom habitat, there would be a reduction in availability of habitat for sand lance that theoretically could result in a localized reduction in the abundance of sand lance in the Project area. Even in a worst-case scenario assuming that the reduction in the abundance of sand lance in the Project area is directly proportional to the amount of soft substrate lost, it would be expected to be an unmeasurable reduction in sand lance available as forage for fin and sei whales in the action area. Given this small, localized reduction in sand lance and the fact that sand lance is only one of many species that fin and sei whales may feed on in the action area, any effects from the conversion of soft-bottom habitat to hard-bottom habitat are expected to be so small that they could not be measured, detected, or evaluated and would be ***insignificant***. Therefore, loss or conversion of soft-bottom habitat leading to effects on benthic prey ***may affect, but not likely to adversely affect*** fin whales or sei whales. As NARWs and sperm whales do not forage in soft-bottom habitats, conversion of soft-bottom habitat to hard-bottom habitat is expected to have ***no effect*** on NARWs and sperm whales.

Concentration of Prey Species due to the Reef Effect

Though the installation of WTGs and OSSs for the Proposed Action would result in the loss of soft-bottom habitat (analyzed above), it would also result in the conversion of open-water habitat to hard, vertical habitat, which would attract and aggregate prey species through the artificial reef effect (Causon and Gill 2018; Taormina et al. 2018). The greatest impact for concentration of prey species under either Scenario would result from the installation with the greatest amount of habitat conversion, identified above: four large OSSs with suction bucket jacket foundations. The least impact under either Scenario would be the installation of 10 small OSSs with piled jacket foundations. The aggregation of prey at artificial reefs could result in increased foraging opportunities for some marine mammal species, attracting them to the structures (Degraer et al. 2020; Pezy et al. 2018; Raoux et al. 2017; Wang et al. 2019). Russell et al. (2014) found clear evidence that seals were attracted to a European wind farm, apparently attracted by the abundant concentrations of prey created by the artificial reef effect. The artificial reef effect created by these structures forms biological hotspots that could support species range shifts and expansions and changes in biological community structure resulting from a changing climate (Degraer et al. 2020; Methratta and Dardick 2019; Raoux et al. 2017, 2019). There are currently no large-scale offshore renewable energy projects within the geographic analysis area for marine mammals from which to assess the potential for artificial reef effects. However, in the case of a smaller-scale project (i.e., 15 WTGs for South Fork Wind Farm, it was not expected that the reef effect would result in an increase in species preyed on by NARWs, fin whales, or sei whales; sperm whales are not expected to forage in the shallow waters of the offshore wind lease areas located on the Outer Continental Shelf (NMFS 2021c). Although reef effects may aggregate fish species and potentially attract increased predators, they are not anticipated to have any measurable effect on ESA-listed marine mammals. Based on the available information, it is expected that there may be an increase in the abundance of schooling fish that fin or sei whales may prey on but that this increase would be so small that the effects to fin or sei whales cannot be meaningfully measured, evaluated, or detected. Because it is not expected that sperm whales would forage in the Project area (due to the shallow depths), it is not expected that any impacts to the forage base for sperm whales would occur. The potential beneficial, yet not measurable, increase in aggregation of prey species of the fin and sei whale due to the reef effect would be removed following decommissioning. As a result, any effects from the concentration of prey species due to the reef effect would be so small that they could not be measured, detected, or evaluated and are therefore ***insignificant***. Therefore, concentration of prey species due to the reef effect associated with structures in the water ***may affect, but not likely to adversely affect*** fin whales or sei whales. Based on NARW diet and preferred foraging habitats of sperm whales, there would be ***no effect*** on these species.

Summary of Habitat Disturbance Effects

Displacement from physical disturbance of sediment associated with geotechnical surveys and anchoring would have ***no effect*** on ESA-listed marine mammals based on the small scale of disturbance and the affected foraging habitat, which is not utilized by these species. The physical presence of WTGs in the Lease Area could directly affect ESA-listed marine mammals through avoidance, displacement, or behavioral disruption. The presence of structures could also cause changes in oceanographic and hydrologic conditions, which may affect planktonic prey for some ESA-listed marine mammals. Any behavioral disruption or hydrodynamic changes are not expected to be significant for ESA-listed marine mammals. Habitat conversion and loss associated with WTGs, OSSs, scour protection, and cable protection is not expected to result in measurable changes in foraging opportunities for ESA-listed marine mammals.

As described above, any effects from habitat disturbance on marine mammals are expected to be ***insignificant***. Therefore, the effects of habitat disturbance associated with the Proposed Action ***may affect, but not likely to adversely affect*** fin whales, NARWs, sei whales, and sperm whales**.**

3.2.5.5. Secondary Entanglement due to an Increased Presence of Recreational Fishing in Response to Reef Effect

Aggregation of species at WTG and OSS foundations may result in increased recreational fishing activity in the vicinity of the structures. The presence of offshore structures associated with the Proposed Action could also displace commercial or recreational fishing vessels to areas outside of the Lease Area or potentially lead to a shift in gear types due to displacement. Though not anticipated, if displacement leads to an overall shift from mobile to fixed gear types, there could be an increased number of vertical lines in the water, increasing the risk of interactions between ESA-listed species and fixed fishing gear. Fisheries interactions are likely to have demographic effects on marine mammal species.

As noted in Section 3.2.2, entanglement in fishing gear has been identified as one of the leading causes of mortality in NARWs and may be a limiting factor in the species' recovery (Knowlton et al. 2012). Johnson et al. (2005) reports that 72 percent of NARWs show evidence of past entanglements. Additionally, recent literature indicates that the proportion of NARW mortality attributed to fishing gear entanglement is likely higher than previously estimated from recovered carcasses (Pace 2021). Entanglement may also be responsible for high mortality rates in other large whale species (Read et al. 2006).

The greatest and least impact installations for secondary entanglement are defined by the minimum and maximum amount of conversion to hard-bottom habitat (see **Table 3-20**), as greater amounts of hard bottom are expected to attract greater amounts of reef fish which in turn attract recreational anglers. An increase in recreational fishing activity increases the risk of marine mammals becoming entangled in lost fishing gear (e.g., monofilament line), which could result in injury or mortality due to infection, starvation, or drowning (Moore and van der Hoop 2012). Abandoned or lost fishing gear may become tangled with foundations. And could cause harm to marine mammals and other wildlife. However, debris tangled with WTG foundations may still pose a hazard to marine mammals. Any effects from secondary entanglement due to an increased presence of recreational fishing in response to reef effect would be so small that they could not be measured, detected, or evaluated and are therefore ***insignificant***. Therefore, the effects of secondary entanglement due to an increased presence of recreational fishing in response to the reef effect from Project structures ***may affect, but not likely to adversely affect*** fin whales, NARWs, sei whales, or sperm whales**.**

3.2.5.6. Turbidity

Construction activities for the Proposed Action would include pile driving for foundation installation, cable-laying activities for installation of inter-array and export cables, and dredging for seabed preparation, sandform clearing, and HDD pits, as described in Section 3.2.5.3. These activities would disturb bottom sediment, resulting in short-term increases in turbidity in the action area. The maximum and minimum impact installations are defined by those installations with the most and the least dredging anticipated, as described in Section 3.2.5.3. The greatest increases in turbidity would be expected to occur from installation of a met tower with a gravity foundation and four large OSSs with gravity foundations under either Scenario 1 or Scenario 2.

Using available information collected from a project in the Hudson River, pile driving activities are expected to produce TSS concentrations of approximately 5.0 to 10.0 mg/L above background levels within approximately 300 feet (91 meters) of the pile being driven (NMFS 2020c citing FHWA 2012). The increases in suspended sediment associated with pile driving would be localized to the vicinity of the pile being driven.

During cable installation, jet plowing is expected to produce maximum TSS concentrations of approximately 235.0 mg/L at 65 feet (20 meters) from the jet plow, with concentrations decreasing to 43.0 mg/L within 656 feet (200 meters) (NMFS 2020c citing ESS Group 2008). Sediment transport analysis conducted for the Project predicted that the sediment plumes at above ambient concentrations (≥ 10 mg/L) would extend between 1.1 and 1.8 miles (1.7 and 2.9 kilometers) from cable routes or WTG area (COP Volume II, Appendix II-J3; Atlantic Shores 2023a). Sediment plumes associated with cable installation would dissipate to ambient levels within two to four hours, and fully dissipate within six hours. The increases in suspended sediment associated with cable emplacement and maintenance would be localized to the cable corridors.

Modeling results of cutterhead dredging indicate that TSS concentrations above background levels would be present throughout the bottom 6 feet (1.8 meters) of the water column for a distance of approximately 1,000 feet (305 meters) (NMFS 2020c citing USACE 1983). Elevated suspended sediment levels are expected to be present only within a 984 to 1,640 feet (300 to 500 meters) radius of the cutterhead dredge (NMFS 2020c citing USACE 1983; NMFS 2020c citing Hayes et al. 2000; NMFS 2020c citing LaSalle 1990). TSS concentrations associated with cutterhead dredge sediment plumes typically range from 11.5 to 282.0 mg/L with the highest levels (550.0 mg/L) detected adjacent to the cutterhead dredge and concentrations decreasing with greater distance from the dredge (NMFS 2020c citing USACE 2005, 2010, 2015b; NMFS 2020c citing Nightingale and Simenstad 2001). Elevated TSS concentrations associated with mechanical dredging could reach 445.0 mg/L (NMFS 2020c citing USACE 2001) and would occur within a radius of up to 2,400 feet (732 meters) (NMFS 2020c citing Burton 1993; NMFS 2020c citing USACE 2015a). Elevated TSS concentrations associated with hopper dredging could reach 475.0 mg/L (NMFS 2020c citing Anchor Environmental 2003) and would occur within a radius of up to 3,937 feet (1,200 meters) (Wilber and Clarke 2001). The increases in suspended sediment associated with dredging would be localized to the area around the activity.

As described in Johnson (2018), NMFS has determined that elevated TSS could result in effects on ESA-listed whale species under specific circumstances (e.g., high TSS levels over long periods during dredging operations). In general, marine mammals are not subject to impact mechanisms that injure fish (e.g., gill clogging, smothering of eggs and larvae), so injury-level effects are unlikely. Behavioral impacts, including avoidance or changes in behavior, increased stress, and temporary loss of foraging opportunity, could occur but only at high TSS levels (Johnson 2018). Todd et al. (2015) postulated that dredging and related turbidity impacts could affect the prey base for marine mammals, but the significance of those effects would be highly dependent on site-specific factors and movement of the marine mammals to avoid the action. Given the small-scale and short-term changes in turbidity due to Project construction and decommissioning, activities that increase turbidity (e.g., inter-array and export cable installation and vessel anchoring) are not likely to have measurable effects on ESA-listed whales.

Data are not available regarding whale avoidance of localized turbidity plumes; however, Todd et al. (2015) suggest that since marine mammals often live in turbid waters, significant impacts from turbidity are not likely. If elevated turbidity caused any behavioral responses such as avoiding the turbidity zone or changes in foraging behavior, such behaviors would be temporary, and any negative impacts would be short term and temporary. Cronin et al. (2017) suggest that NARWs may use vision to find copepod aggregations, particularly if they locate prey concentrations by looking upward. However, Fasick et al. (2017) indicate that NARWs certainly must rely on other sensory systems (e.g., vibrissae on the snout) to detect dense patches of prey in very dim light (e.g., at depths greater than 525 feet [160 meters] or at night). If turbidity from Project activities caused foraging whales to leave the area, there would be an energetic cost of swimming out of the turbid area. However, whales could resume foraging behavior once they were outside of the turbidity zone. Recent studies indicate that whales are likely able to forage in low visibility conditions, and thus could continue to feed in the elevated turbidity (Todd et al. 2015).

Increased turbidity effects during construction and decommissioning could impact the prey species of marine mammals. Studies of the effects of turbid water on fish suggest that concentrations of suspended solids can reach thousands of milligrams per liter before an acute reaction is expected (Wilber and Clarke 2001). However, as mentioned previously, sedimentation effects would be temporary and localized, with regions returning to previous levels soon after the activity ceases.

North Atlantic right whales feed almost exclusively on copepods. Of the different kinds of copepods, NARWs feed especially on late-stage *Calanus finmarchicus*, a large calanoid copepod (Baumgartner et al. 2007), as well as *Pseudocalanus* spp. and *Centropages* spp. (Pace and Merrick 2008). Because a

NARW's mass is 10 or 11 orders of magnitude larger than that of its prey, this species is very specialized and restricted in their habitat requirements—they must locate and exploit feeding areas where copepods are concentrated into high-density patches (Pace and Merrick 2008).

Copepods exhibit diel vertical migration; that is, they migrate downward out of the euphotic zone at dawn, presumably to avoid being eaten by visual predators, and they migrate upward into surface waters at dusk to graze on phytoplankton at night (Baumgartner and Fratantoni 2008; Baumgartner et al. 2011). Baumgartner et al. (2011) conclude that there is considerable variability in this behavior and that it may be related to stratification and presence of phytoplankton prey with some copepods in the Gulf of Maine remaining at the surface and some remaining at depth. Because copepods even at depth are not in contact with the substrate, no burial or loss of copepods is anticipated during turbidity-generating activities. No scientific literature could be identified that evaluated the effects on marine copepods resulting from exposure to TSS. Based on what is known about effects of TSS on other aquatic life, it is possible that high concentrations of TSS could negatively affect copepods. However, given that 1) the expected TSS levels are below those that are expected to result in effects to even the most sensitive species evaluated; 2) the sediment plume would be transient and temporary (i.e., persisting in any one area for no more than 3 hours); 3) elevated TSS is limited to the bottom 9.8 feet (3 meters) of the water column; and 4) elevated TSS plumes would occupy only a small portion of the Project area at any given time, any effects related to copepod availability, distribution, or abundance on foraging whales would be so small that they could not be meaningfully evaluated, measured, or detected.

Fin whales in the North Atlantic eat pelagic crustaceans (mainly euphausiids or krill) and schooling fish such as capelin, herring, and sand lance (NMFS 2010a). Fin whales feed by lunging into schools of prey with their mouth open, gulping large amounts of food and water. A fin whale eats up to 4,000 pounds (1,814 kilograms) of food every day during the summer months.

An average sei whale eats about 2,000 pounds (907 kilograms) of food per day. They can dive 5 to 20 minutes to feed on plankton (including copepods and krill), small schooling fish, and cephalopods (including squid) by both gulping and skimming.

Anticipated TSS levels for the Project are below the levels expected to result in the mortality of fish that are preyed upon by fin or sei whales. In general, fish can tolerate at least short-term exposure to high levels of TSS. Wilber and Clarke (2001) reviewed available information on the effects of exposure of estuarine fish and shellfish to suspended sediment. In an assessment of available information on sublethal effects to non-salmonids, they report that the lowest observed concentration-duration combination eliciting a sublethal response in white perch (*Morone americana*) was 650 mg/L for 5 days, which increased blood hematocrit (Wilber and Clarke 2001 citing Sherk et al. 1974).

Regarding lethal effects, Atlantic silversides (*Menidia menidia*) and white perch were among the estuarine fish with the most sensitive lethal responses to suspended sediment exposures, exhibiting 10 percent mortality at sediment concentrations less than 1,000 mg/L for durations of 1 and 2 days, respectively (Wilber and Clarke 2001). Forage fish in the action area would be exposed to maximum TSS concentration-duration combinations far less than those demonstrated to result in sublethal or lethal effects of the most sensitive non-salmonids for which information is available. Based on this, no mortality of any forage fish is expected; therefore, no reduction in fish as prey for fin or sei whales is anticipated.

Sperm whales hunt for food during deep dives, with feeding occurring at depths of 1,640 to 3,281 feet (500 to 1,000 meters) (NMFS 2010b). Deepwater squid make up the majority of their diet (NMFS 2010b). Given the shallow depths of the Project area where sedimentation would occur, it is extremely unlikely that any sperm whales would be foraging in the area affected by sedimentation and extremely unlikely that any potential sperm whale prey would be affected by sedimentation.

Any effects from increased turbidity levels associated with construction activities on marine mammals or their prey would be so small that they could not be measured, detected, or evaluated and are therefore ***insignificant***. Therefore, the effects of increased turbidity levels from Project construction activities ***may affect, but not likely to adversely affect*** fin whales, NARWS, sei whales, and sperm whales.

In the vicinity of the planned O&M Facility in Atlantic City, NJ and the cable landfall sites, runoff from shoreside construction for the Proposed Action has the potential to result in localized effects on water quality due to increased turbidity. Turbidity effects associated with shoreside construction would be lower than turbidity effects associated with dredging, and measures would be in place to minimize water quality impacts associated with shoreside construction. Effects of shoreside construction associated with the Proposed Action would be localized to the waters around the O&M facility. ESA-listed marine mammals are not expected to occur within the affected area. Therefore, shoreside construction is expected to have ***no effect*** on fin whales, NARWs, sei whales, or sperm whales.

Turbidity Effects of the Connected Action

The Connected Action would include hydraulic cutterhead or mechanical dredging. Dredging would result in localized increases in total suspended sediment (TSS) concentrations. Elevated TSS concentrations associated with cutterhead dredging could reach 550.0 mg/L and would occur within a radius of up to 1,640 feet (500 meters). Elevated TSS concentrations associated with mechanical dredging could reach 445.0 mg/L (NMFS 2020c citing USACE 2001) and would occur within a radius of up to 2,400 feet (732 meters) (NMFS 2020c citing Burton 1993; NMFS 2020c citing USACE 2015a). Dredging activities may also result in temporary decreases in benthic prey species for other species, but not marine mammals. Dredging effects associated with the Connected Action would be localized to the waters around the O&M facility. ESA-listed marine mammals are not expected to occur within the affected area and would therefore not be foraging in these habitats. Given that no turbidity effects on whales or their prey are expected to occur, as described above, dredging associated with the Connected Action would have ***no effect*** on fin whales, NARWs, sei whales, or sperm whales.

3.2.5.7. Vessel Traffic

As detailed in Section 1.3, a variety of vessels would be used to construct, operate, and decommission the Proposed Action (**Table 1-7**). Maximum estimates for the number of vessels required for a single construction activity range from 2 vessels for installation of scour protection to up to 16 vessels for OSS installation. During export cable installation, up to six vessels may be operating simultaneously for that construction activity. In the unlikely event that all construction activities for Project 1 and Project 2, including HRG surveys, foundation installation, scour protection installation, WTG installation, OSS installation, inter-array cable installation, export cable installation, and fuel bunkering, were to occur simultaneously, up to 51 vessels could be operating at a given time. There are no anticipated differences in vessel traffic between Scenario 1 and Scenario 2 under the Proposed Action, and foundation selection for the met tower and OSSs is not expected to affect required vessel trips. Vessel trip information for each anticipated port, divided by Project phase, is provided in **Table 1-9**. Vessel trip information for each vessel type associated with foundation installation is provided in **Table 3-22**. Vessel traffic associated with the Proposed Action could affect ESA-listed species through vessel strikes. In addition to increased risk of vessel strike, vessels produce underwater noise, which was evaluated in Section 3.2.5.2. Vessels would also produce artificial lighting, which is addressed in Section 3.2.5.11, and air emissions, which are addressed in Section 3.2.5.10. Unanticipated discharges of fuel, fluids, hazardous material, trash, or debris from Project vessels are addressed in Section 3.2.5.12.

Table 3-22. Maximum Number of Round Trips for Each Construction Vessel Type during Foundation Installation for the Proposed Action

Vessel	WTG Foundation Installation	Met Tower Foundation Installation	OSS Foundation Installation
Jack-up Vessel	18	0	3
Bubble Curtain Support Tug	18	0	3
Barge 1	55	1	8
Barge 2	55	1	8
Towing Tug 1	55	1	8
Towing Tug 2	55	1	8
Additional Tug	55	1	0
CTV	186	1	17
Fall Pipe Vessel	88	0	0
Dredger	6	0	0

Notes: Vessel trip estimates cover all foundation types within the PDE for the Proposed Action. Up to 10 vessels would be operating simultaneously in the Project area for foundation installation for each structure (i.e., WTGs, met tower, or OSSs). There are no anticipated differences in vessel traffic between Scenario 1 and Scenario 2 under the Proposed Action

Over the three-year construction period, an estimated 1,745 total vessel round trips are expected to occur between the Lease Area and ports in New Jersey, Virginia, and Texas, with the majority of those trips occurring between the New Jersey Wind Port and the Lease Area (**Table 1-9**), resulting in an annual average of approximately 582 vessel round trips (1,164 one-way vessel trips). Compared to existing vessel traffic in the Lease Area (i.e., 4,105 vessel tracks annually, Section 2.1.3.2), construction vessel traffic represents a 28 percent increase in traffic in the Lease Area (**Table 3-23**). Seventy two percent of construction vessel trips would be between the Lease Area and the New Jersey Wind Port, 18 percent would be between the Lease Area and Atlantic City, New Jersey, and 7 percent of trips would be between the Lease Area and Paulsboro, New Jersey. Repauno, New Jersey, Portsmouth, Virginia, and Corpus Christi, Texas are each expected to receive 20 trips (approximately 1 percent of total construction vessel traffic) from Project vessels.

During the O&M phase, an estimated 1,861 vessel round trips (3,722 one-way trips) are expected to occur annually between the Lease Area and ports in New Jersey and Virginia, with the majority of those trips occurring between the O&M facility in Atlantic City and the Lease Area (**Table 1-9**). This level of vessel traffic represents a 91 percent increase in traffic compared to existing vessel traffic in the Lease Area (**Table 3-23**). During this phase, 98 percent of annual vessel trips would be between the Lease Area and Atlantic City, 2 percent would be between the Lease Area and the New Jersey Wind Port, and the remaining vessel traffic would be split approximately evenly between ports in Paulsboro, Repauno, and Portsmouth. Vessel traffic during decommissioning is expected to be similar to the construction phase.

While Project vessel traffic would result in a measurable or substantial increase in vessel traffic in the Lease Area, traffic in the Lease Area is relatively low compared to the surrounding areas (Section 2.1.3.2). The action area includes waters transited by vessels entering the Port of New York and New Jersey and the Delaware River, which is home to multiple major ports. The USCG's Port Access Route Study for the Seacoast of New Jersey (NJPARS) provides information on baseline vessel traffic in the waters surrounding the Lease Area. The study area for the waters encompassed by the NJPARS extends along the coast of Maryland, Delaware, and New Jersey from approximately 20 nautical miles south of the Delaware-Maryland border to slightly south of the entrance to New York Bay, including the Lease Area. AIS data indicated that there were 74,352 annual transits (i.e., one-way trips) through the NJPARS study area in 2019. The NJPARS study concluded that vessel traffic through the study area was largely associated with commercial fishing. Compared to annual traffic in the NJPARS study area, annual traffic during construction of the Project would represent an approximately 2 percent increase in vessel traffic (**Table 3-23**). Annual traffic during the O&M phase would represent an approximately 5 percent increase in vessel traffic (**Table 3-23**).

Table 3-23. Annual Existing One-Way Transits and Anticipated One-Way Transits (with Percent Increase) Associated with the Proposed Action

Area	Existing Transits	Project Transits – Construction	Project Transits – O&M
Lease Area	4,105	1,163 (28%)	3,722 (91%)
NJPARS Study Area	74,352	1,163 (2%)	3,722 (5%)

The Proposed Action would result in increased risk of vessel strike for marine mammals as a result of Project vessel traffic during the construction, O&M, and decommissioning phases of the Project. Vessel strikes are a significant concern for mysticetes, including fin whales, NARWs, which are relatively slow swimmers (van der Hoop et al. 2017), and sei whales. Vessel strikes are relatively common for cetaceans (Kraus et al. 2005) and are a known or suspected cause of the three active unusual mortality events in the Atlantic Ocean for cetaceans (humpback whale, minke whale, and NARW). Vessel strikes are a primary cause of death for NARW (Kite-Powell et al. 2007) and have a greater effect on the NARW population compared to other mysticete species given its small population size and low reproductive rate (Hayes et al. 2022 citing Corkeron et al. 2018). Almost all sizes and classes of vessels have been involved in collisions with marine mammals around the world, including large container ships, ferries, cruise ships, military vessels, recreational vessels, commercial fishing boats, whale-watch vessels, research vessels and even jet skis (Dolman et al. 2006). Marine mammals are expected to be most vulnerable to vessel strikes when within the vessel's draft and Not detectable by visual observers (e.g., animal below the surface or poor visibility conditions such as bad weather or low light), and probability of vessel strike increases with increasing vessel speed (Pace and Silber 2005; Vanderlaan and Taggart 2007). NARWs are at highest risk for vessel strike when vessels travel in excess of 10 knots (Vanderlaan and Taggart 2007); serious injury to cetaceans due to vessel collision rarely occurs when vessels travel below 10 knots (Laist et al. 2001). Average vessel speeds for Project vessels aside from CTVs are expected to be below 10 knots (**Table 1-8**), reducing the risk of vessel interactions between ESA-listed marine mammals and most Project vessels.

Atlantic Shores has proposed measures to avoid, minimize, and mitigate impacts associated with vessel traffic, including vessel speed restrictions (MAR-01, MAR-04, SEA-01) and collision avoidance measures. These collision avoidance measures include maintaining separation distances for marine mammals (MAR-04), reporting as part of the Mandatory Ship Reporting System for NARWs (MAR-05), checking for active Dynamic Management Areas or Slow Zones daily (MAR-05), reporting NARW sightings to the North Atlantic Right Whale Sighting Advisory System (MAR-03), implementing crew member training on vessel strike avoidance measures (MAR-03), and using a dedicated lookout to reduce collision risk (MAR-03). Additional measures to address vessel strike are included in the Project's LOA application and are proposed by BOEM in this BA (Section 1.3.5, **Tables 1-10 and 1-11**). These measures include, but are not limited to:

- Between November 1 and April 30, vessels greater than or equal to 65 feet (19.8 meters) in overall length, excluding CTVs, would operate at 10 knots (5.1 m/s) or less while transiting to and from the Project area except while transiting areas which have not been demonstrated by best available science to provide consistent habitat for NARW.[7] Vessels greater than or equal to 65 feet (19.8 meters) in

[7] These areas will be identified using the best available science prior to construction. These areas may include any areas outside NARW range that may be transited by Project vessels (e.g., the Gulf of Mexico).

overall length, including CTVs regardless of size, would operate at 10 knots (5.1 meters per second) or less when within any active SMA. All CTVs operating at greater than 10 knots (5.1 meters per second) would 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-degree direction of the forward path of the vessel (90 degrees port to 90 degrees starboard). Visual observers must be equipped with alternative monitoring technology for periods of low visibility (e.g., darkness, rain, and fog). 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

- Between May 1 and October 31, all underway vessels (transiting or surveying) operating at greater than 10 knots (5.1 meters per second) would 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-degree direction of the forward path of the vessel (90 degrees port to 90 degrees starboard). Visual observers must be equipped with alternative monitoring technology for periods of low visibility (e.g., darkness, rain, and fog). 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
- Vessels of all sizes would operate at 10 knots (5.1 meters per second) or less in any Dynamic Management Areas

The anticipated vessel operations combined with the mitigation measures described above and provided in **Table 1-10** would minimize collision risk during construction. As described above, a 10-knot speed restriction for vessels greater than or equal to 65 feet (19.8 meters) in length would be in effect between November 1 and April 30. Though this speed restriction would not apply to CTVs, a dedicated visual observer would be utilized to monitor for marine mammals when these vessels are traveling in excess of 10 knots. Between May 1 and October 31, all underway vessels operating at greater than 10 knots would have a dedicated visual observer on duty at all times to monitor for marine mammals. All Project vessels, regardless of size, would operate at 10 knots or less in any active Seasonal Management Area or Dynamic Management Area. Additionally, PAM networks would be used to check the vessel transit corridor for NARWs year-round to allow for vessel speed restrictions prior to NARWs being sighted. Because vessel strikes are not anticipated given the relatively low number of vessel trips and the monitoring and mitigation activities required to avoid encountering marine mammals, this BA concludes that vessel strikes are unlikely to occur.

Atlantic Shores has estimated that there would be daily trips of CTVs during O&M, originating from the Atlantic City O&M facility. Specifications for the vessels that would be used for during the O&M phase are described in **Table 1-8**. While the CTVs' lack of in-water hull reduces the likelihood of a subsurface collision, marine mammals resting or breathing on the surface could be affected by these vessels. Additionally, the high speed of the vessels allows less reaction time for both the marine mammal and for the vessel operator conducting a maneuver to avoid the marine mammal. Based on the density of ESA-listed marine mammals in the Project area and an expected of 1,861 trips per year over the operational life of the Project, there are periods of time where there is a moderate risk of encountering an ESA-listed marine mammal (Roberts et al. 2017, 2018, 2021b). The mitigation measures to avoid vessel strike implemented for construction would also apply to O&M vessels. These measures include speed restrictions of 10 knots or less for vessels greater than 65 feet (19.8 meters) in length from November 1 to April 30 and a dedicated visual observer on duty on CTVs when operating above 10 knots during this period; a dedicated visual observer on duty at all times to monitor for marine mammals on all vessels operating above 10 knots from May 1 to October 31; and vessel speed restrictions of 10 knots or less for all vessels regardless of size in any active Seasonal Management Area of Dynamic Management Area. Further mitigation and monitoring measures for the Project are outlined in **Tables 1-10 and 1-11**.

Based on the density of marine mammals in the Project area and expected vessel trips (**Table 1-9**), there is a low to moderate risk of encountering an ESA-listed marine mammal over the life of the Project (Roberts et al. 2017, 2018, 2021b). The operating parameters (**Table 1-8**), combined with the mitigation measures proposed by Atlantic Shores and required by BOEM (see **Tables 1-10 and 1-11** for all vessel strike avoidance measures), would minimize collision risk with Project vessels. Vessel strikes are not anticipated when monitoring and mitigation activities are effectively designed and implemented, as outlined; thus, the potential for vessel strikes to fin whales, NARWs, sei whales, or sperm whales is ***discountable***. Therefore, the effects of vessel strikes from Project vessel activities leading to injury or mortality ***may affect, but not likely to adversely affect*** fin whales, NARWs, sei whales, or sperm whales.

3.2.5.8. Monitoring Surveys

As described in Section 1.3.4, biological monitoring studies for the Proposed Action include otter trawl surveys, trap surveys, hydraulic clam dredge surveys, grab sampling, and underwater imagery. Many of the potential impacts to ESA-listed marine mammal species arising from monitoring surveys are related to underwater vessel noise and increased vessel traffic. These stressors are evaluated in Sections 3.2.5.2 and 3.2.5.7, respectively. Additionally, some of these biological monitoring efforts (i.e., trawl, trap, and dredge surveys) have the potential to result in capture or entanglement of ESA-listed species or effects on prey or habitat for ESA-listed species.

Trawl Survey

Large whale species, including fin whale, NARW, sei whale, and sperm whale, have the speed and maneuverability to avoid oncoming mobile gear (NMFS 2021b) (e.g., trawls or dredges). The slow speed of mobile gear and the short tow times for the proposed trawl surveys further reduce the potential for entanglement or other interactions with mobile gear, and observations during mobile gear use have shown that capture or entanglement of large whales is extremely rare and extremely unlikely to occur (NMFS 2021b). In its opinion on the Continued Prosecution of Fisheries and Ecosystem Research Conducted and Funded by the Northeast Fisheries Science Center and the Issuance of a Letter of Authorization under the Marine Mammal Protection Act for the Incidental Take of Marine Mammals pursuant to those Research Activities, which includes the Northeast Area Assessment and Monitoring Program (NEAMAP), NMFS concluded that impacts to fin whales, NARWs, sei whales, and sperm whales, if any, as a result of trawl gear use would be expected to be discountable (NMFS 2021b). The sampling gear used to conduct trawl surveys for fisheries monitoring would be the same as that used by NEAMAP, and the sampling procedures are modeled after the NEAMAP bottom trawl survey. Based on the analysis above, the potential for entanglement of ESA-listed cetaceans in bottom trawl equipment is considered extremely unlikely to occur and is ***discountable***.

Trap Survey

Ventless traps have the potential to result in adverse impacts to marine mammals due to entanglement in lines and floats, and entanglement is a significant threat for NARW (see Section 3.2.2.2). Ventless trap surveys for the Proposed Action would utilize groundlines, ropeless gear, and biodegradable components to reduce entanglement risk whenever feasible. If ropeless gear cannot be used, the maximum number of vertical lines in the water would be 12. Based on the intended use of ropeless gear and the limited number of buoy lines if ropeless gear cannot be utilized, entanglement in gear would be extremely unlikely to occur and ***discountable***. Hydraulic Clam Dredge Survey

As noted above, large whale species have the speed and maneuverability to avoid oncoming mobile gear (NMFS 2021b). Observations during mobile gear use have shown that capture or entanglement of large whales is extremely rare and unlikely (NMFS 2021b). The slow speed of mobile gear and the very short tow times for the proposed dredge surveys further reduce the potential for entanglement or other interactions with mobile gear.

Based on the anticipated survey methods and proposed measures to reduce entanglement risk for the trap surveys, impacts of fisheries and habitat surveys and monitoring on ESA-listed marine mammals are expected to be extremely unlikely to occur and ***discountable***. Therefore, monitoring surveys associated with the Proposed Action leading to entanglement ***may affect, but not likely to adversely affect*** fin whales, NARWs, sei whales, and sperm whales.

Prey and Habitat Effects

After descending through the water column, trawl gear operates for the demersal otter trawl survey would operate on or very near the bottom. NARWs feed on copepods, which are expected to pass through trawl gear used for the Project and would not be affected by turbidity created by the gear. Sperm whales feed on deep water species that do not occur in the survey area. Fin and sei whales consume prey species that have potential to be removed by trawl gear. However, the Northeast Fisheries Science Center surveys are estimated to remove a negligible few hundred tons of prey fish per year total compared to the overall fish consumption of fin and sei whales (NMFS 2021b). Trawl survey effort for the Proposed Action is expected to be a small fraction of the total effort for the NEAMAP surveys. Therefore, effects from the proposed trawl survey activities on the availability of prey of ESA-listed cetaceans are expected to be so small that they cannot be meaningfully measured, evaluated, or detected and are, therefore, ***insignificant***.

The proposed trap surveys would not have any effects on the availability of prey for fin whales, NARWs, sei whales, or sperm whales. NARWs feed on copepods, which are very small organisms that will pass through trap gear rather than being captured in it. Fin whales and sei whales feed on plankton and small schooling fish. The size of the trap gear is too large to capture any fish that may be prey for these species. Sperm whales feed on deep water species that do not overlap with the study area where trap surveys would occur. Therefore, the proposed trap surveys are expected to have no effect on the availability of prey of ESA-listed cetaceans.

After descending through the water column, clam dredges operate on or in the seabed. Prey species for fin whales, NARWs, and sei whales are not susceptible to capture in this gear. Sperm whales feed on deep water species that do not overlap with the study area where clam dredge surveys would occur. Therefore, the proposed clam dredge surveys are expected to have no effect on the availability of prey of ESA-listed cetaceans.

Though prey species of some ESA-listed marine mammals (i.e., forage fish prey for fin and sei whales, see Sections 3.2.1, 3.2.2, 3.2.3, and 3.2.4) may be subject to capture in the trawl surveys proposed for the Project, the effects of reduced prey availability are expected to be so small that they cannot be meaningfully measured, evaluated, or detected and are, therefore, ***insignificant***. ESA-listed marine mammal species do not utilize benthic habitats which may be disturbed during monitoring efforts. Given the potential insignificant prey effects, fisheries and habitat surveys and monitoring leading to effects on prey and/or habitat ***may affect, but not likely to adversely affect*** fin and sei whales. Monitoring surveys are expected to have ***no effect*** on the prey and/or habitat of NARWs and sperm whales.

3.2.5.9. Electromagnetic Fields and Heat

The Proposed Action, either Scenario 1 or Scenario 2, would include installation of up to 342 miles (550 kilometers) of export cables, 37 miles (60 kilometers) of interlink cables, and 584 miles (990 kilometers) of interarray cables, increasing the production of EMF and heat in the action area. EMF and heat effects would be reduced by cable burial to an appropriate depth and the use of shielding, if necessary.

Marine mammals are capable of detecting magnetic field gradients of 0.1 percent of the Earth's magnetic field (i.e., approximately 0.05 microtesla) (Kirschvink 1990). Based on this sensitivity, marine mammals are likely very sensitive to minor changes in magnetic fields (Walker et al. 2003) and may react to local variation in geomagnetic fields associated with cable EMFs. These variations could result in short-term effects on swimming direction or migration detours (Gill et al. 2005). However, no EMF impacts on marine mammals associated with underwater cables have been documented. Atlantic Shores would bury cables to a minimum depth of 5 to 6.6 feet (1.5 to 2.0 meters) wherever possible. In areas where sufficient cable burial is not feasible, surface cable protection (e.g., rock placement, concrete mattresses, rock bags, grout-filled bags, half-shell pipes) would be utilized. Cable burial and surface protection, where necessary, would minimize EMF exposure for ESA-listed marine mammals. Any potential impacts on ESA-listed marine mammals from EMF associated with the Proposed Action are expected to be too small to be measured and would therefore be ***insignificant***, and effects of EMF and heat ***may affect, but not likely to adversely affect*** fin whales, NARWs, sei whales, and sperm whales.

3.2.5.10. Air Emissions

Air emissions would be generated during the construction, O&M, and decommissioning phases of the Proposed Action, including both Scenario 1 and Scenario 2. Emissions would primarily be generated by Project vessels and the installation equipment on board Project vessels. Atlantic Shores has conducted an air emissions inventory for the Proposed Action, provided in Appendix II-C of the COP (Atlantic Shores 2023a).

Operation of Project vessels during construction would result in short-term increases in Project-related air emissions. During O&M, operation of Project vessels would result in long-term increases in emissions related to the Proposed Action. However, estimated air emissions from O&M activities would generally be lower than emissions generated during construction activities and are not expected to have a significant effect on regional air quality. Air emissions during decommissioning are expected to be similar or less than emissions estimated for construction activities. Atlantic Shores has proposed measures to avoid and minimize air emissions effects, including the use of low-sulfur fuels, the use of vessels that meet Best Available Control Technology and Lowest Achievable Emission Rate requirements, and minimization of engine idling time. Operation of WTG installation equipment during Project construction would result in short-term increases in air emissions during construction of the Proposed Action. Atlantic Shores has proposed measures to avoid and minimize air emissions effects, including the use of low-sulfur fuels and minimization of engine idling time. Air pollutant concentrations associated with the Proposed Action are not expected to exceed National Ambient Air Quality Standards or New Jersey Ambient Air Quality Standards. Therefore, BOEM anticipates that air quality impacts from Project emissions would be minor.

The effects of air pollution on marine mammals are not well-studied, and air emissions are not a stressor of concern for marine mammal species (BOEM 2019a). Given that long-term effects on regional air quality are expected to be insignificant and that the net benefits of replacing fossil-fuel burning power plants with offshore wind farms are expected to improve air quality, the air emissions produced by Project vessels are expected to have ***no effect*** on fin whales, NARWs, sei whales, or sperm whales.

3.2.5.11. Lighting of Structures and Vessels

Vessels and offshore structures associated with future offshore wind activity would have deck and safety lighting, producing artificial light during the construction, O&M, and decommissioning phases of the Proposed Action. Offshore structures would have yellow flashing navigational lighting and red flashing FAA hazard lights, in accordance with BOEM's (2021c) lighting and marking guidelines. Following these guidelines, direct lighting would be avoided, and indirect lighting of the water surface would be minimized to the greatest extent practicable.

Lighting of Project structures or on Project vessels is not expected to have direct effects on marine mammals. However, artificial light may affect the distribution of zooplankton in the water column (Orr et al. 2013) and has the potential to aggregate and alter community composition of fish and invertebrates

(McConnell et al. 2010; Davies et al. 2016). A change in prey species distribution could affect ESA-listed marine mammals. Fin whales, NARWs, and sei whales are thought to feed at night (Víkingsson 1997; Baumgartner et al. 2003; Baumgartner and Fratantoni 2008; Guilpin et al. 2019). Sperm whales also forage at night but are expected to feed in deeper waters outside the Project area.

While the effects of artificial lighting on marine mammals themselves are largely unknown, impacts are anticipated to be negligible if appropriate design techniques and uses are employed. Atlantic Shores would light WTGs and OSSs in compliance with FAA and USCG standards and BOEM best practices (VIS-04), which include red wavelength-emitting diode obstruction lighting; lighting that flashes 30 flashes per minute; and directional shielding of aeronautical obstruction lights to prevent visibility below the horizontal plane. Atlantic Shores has additionally proposed to consider use of an ADLS to minimize the time that FAA-required lighting is illuminated on the offshore structures associated with the Proposed Action (BIR-05, BAT-03, VIS-05). The employed mitigation measures are expected to reduce short- and long-term artificial light so that the effects to marine mammals and their prey are likely so small that they cannot be meaningfully measured, detected, or evaluated. Therefore, effects of lighting of vessels and offshore structures associated with the Proposed Action on ESA-listed marine mammals would be ***insignificant***, and the lighting of structures and vessels ***may affect, but not likely to adversely affect*** fin whales, NARWs, sei whales, and sperm whales**.**

3.2.5.12. Unexpected/Unanticipated Events

Unexpected or unanticipated events with the potential to affect ESA-listed species could occur during the construction, O&M, or decommissioning phases of the Proposed Action. Such events would include vessel collisions or allisions, severe weather events resulting in equipment failure, oil spills, or encounters with unexploded ordinance.

Vessel collisions or allisions may result in oil spills. Such events are considered unlikely given the lighting requirements for Project vessels and offshore structures, vessel speed restrictions, proposed spacing of Project structures, inclusion of Project structures on navigational charts, and Notices to Mariners issued by the U.S. Coast Guard. Therefore, effects on ESA-listed species due to vessel collisions or allisions are extremely unlikely to occur and therefore ***discountable***.

The Lease Area may be affected by extratropical storms, which are common in the area between October and April, or hurricanes. The high winds associated with these events have the potential to result in the failure of WTGs. However, the WTGs will be designed to withstand site-specific weather conditions, including winter storms, hurricanes, and tropical storms. The WTGs will be suitable for sites with wind speeds of up to 127.5 miles per hour (57 meters per second) and gusts of up to 178.5 miles per hour (79.8 meters per second). Therefore, such a failure is highly unlikely and effects on ESA-listed species associated with WTG failure are extremely unlikely to occur and therefore ***discountable***.

Vessel traffic associated with the Proposed Action would increase the risk of accidental releases of fuels, fluids, and hazardous materials (Section 3.2.4.7). There would also be a low risk of leaks of fuel, fluid, or hazardous materials from any of the 200 WTGs anticipated for the Project. The total volume of WTG fuels, fluids, and hazardous materials associated with the Proposed Action was not estimated for Atlantic Shores, but a leak of such fluids is expected to be unlikely (Atlantic Shores 2023a). Project vessels are expected to adhere to USCG regulations for the prevention and control of oil spills (Atlantic Shores 2023a). BOEM has modeled the risk of spills associated with WTGs and determined that, at maximum, a release of 129,000 gallons is likely to occur no more frequently than once every 1,000 years and a release of 2,000 gallons or less is likely to occur every 50 to 100 years (Bejarano et al. 2013).

Effects of oil spills from vessels was addressed in Section 3.2.5.7. Effects of oil spills from WTGs or OSSs would be similar. Atlantic Shores has developed an OSRP (COP Volume II, Appendix II-C; Atlantic Shores 2023a) with measures to avoid accidental releases and a protocol to respond to such a release if one occurs. Given the low likelihood of occurrence, effects of oil spills on ESA-listed marine mammals are extremely unlikely to occur and therefore ***discountable***.

As described in Section 1.3.1, the export cable route would be surveyed for unexploded ordinance (UXO) prior to cable installation. A study of munitions and explosives of concern has been conducted and an associated hazard assessment has been provided to BOEM under confidential cover as part of the COP (see Volume II, Appendix II-A). This study indicated that the likelihood of encountering munitions and explosives of concern during construction of the Proposed Action is low. In the event that UXO are found during construction, Atlantic Shores would implement a mitigation strategy to avoid UXO. At this time, no UXO detonation is planned. Given that UXO encounters or responses are extremely unlikely, effects on ESA-listed species are extremely unlikely to occur and therefore ***discountable***.

Given that effects of vessel collisions or allisions, severe weather events resulting in equipment failure, oil spills, or encounters with UXO are ***discountable***, effects of unexpected/unanticipated events that may occur during construction, O&M, and decommissioning of the Project ***may affect, but not likely to adversely affect*** fin whales, NARWs, sei whales, and sperm whales.

3.3. SEA TURTLES

Following is a description of the existing conditions for ESA-listed sea turtles in the action area considered for further analysis in this BA, accompanied by the detailed effects assessment for each stressor on ESA-listed sea turtles.

Four ESA-listed species of sea turtle are likely to occur in the Project area: green sea turtle, Kemp's ridley sea turtle, leatherback sea turtle, and loggerhead sea turtle. The North Atlantic DPS of green sea turtles and Northwest Atlantic DPS of loggerhead sea turtles are listed as threatened, and Kemp's ridley and leatherback sea turtles are listed as endangered.

3.3.1 North Atlantic DPS of Green Sea Turtle

3.3.1.1. Description and Life History

The green sea turtle is the largest hard-shelled sea turtle, reaching a maximum weight of 350 pounds (150 kilograms) and having a carapace length of up to 3.3 feet (1 meter) (NMFS 2021e). Green sea turtles generally reach sexual maturity between the age of 25 and 35. Female green sea turtles nest every two to five years while males breed annually (NMFS 2021e). In the U.S., breeding occurs in late spring and early summer, and nesting occurs in the Southeast between June and September, peaking in June and July (USNRC 2010 citing NOAA 2010; NMFS 2021e). During the nesting season, females come ashore to nest approximately every two weeks with clutch sizes of approximately 100 eggs (NMFS 2021e). Hatchlings emerge after approximately two months and swim to offshore, pelagic habitats. Young green sea turtles remain in these pelagic habitats for five to seven years before returning to coastal habitats as juveniles (NMFS 2021e).

During their pelagic phase, green sea turtles are omnivorous, foraging in drift communities. Once juveniles return to coastal habitats, they become benthic foragers. As benthic foragers, this species is primarily herbivorous, consuming mostly algae and seagrasses, though sponges and other invertebrates may also contribute to their diet (NMFS 2021e).

The hearing range of sea turtles is limited to low frequencies, typically below 1,600 Hz. The hearing range for green sea turtles is from 50 to 1,600 Hz, with peak sensitivity between 200 and 400 Hz (Dow Piniak et al. 2012a).

3.3.1.2. Status and Population Trend

Green sea turtles were originally listed under the ESA in 1978. In 2016, the species was divided into eleven DPSs. Green sea turtles found in the Project area most likely belong to the North Atlantic DPS, which is listed as threatened (NMFS and USFWS 2016). The status of this DPS was most recently reviewed as part of the 2016 DPS determination and ESA listing. There is no population estimate for the North Atlantic DPS of green sea turtles. However, female nester abundance for this DPS is estimated at 167,234 (Seminoff et al. 2015). All major nesting populations in this DPS have shown long-term increases in abundance (Seminoff et al. 2015).

Green sea turtles found along vessel transit routes to and from the Gulf of Mexico may belong to the South Atlantic DPS, which is listed as threatened (NMFS and USFWS 2016). The status of this DPS was most recently reviewed as part of the 2016 DPS determination and ESA listing. There is no population estimate for this DPS. Female nester abundance is estimated at 63,332; however, the South Atlantic is data poor, and this abundance estimate does not include data for many nesting sites (only 37 of 51 sites), including some relatively large rookeries (Seminoff et al. 2015). Nesting populations at most primary nesting sites with sufficient data are stable or increasing (Seminoff et al. 2015).

All sea turtle species in the action area, including green sea turtles, are subject to regional, pre-existing threats, including habitat loss or degradation, fisheries bycatch and entanglement in fishing gear, vessel strikes, predation and harvest, disease, and climate change. Coastal development, artificial lighting, beach armoring, erosion, sand extraction, vehicle traffic, and sea level rise associated with climate change adversely affect nesting habitat (NMFS and USFWS 2015a). Anthropogenic activities, including boating and dredging, degrade seagrass beds, which are used as foraging habitat by this species. Incidental bycatch in commercial and artisanal fisheries, including gill net, trawl, and dredge fisheries, is a major threat to the North Atlantic DPS of green sea turtles (NMFS and USFWS 2015a). This species is vulnerable to fibropapillomatosis, a chronic disease that often leads to death (NMFS and USFWS 2015a citing Van Houtan et al. 2014). Green sea turtles are also subject to cold stunning, a hypothermic reaction due to exposure to prolonged cold-water temperatures. This phenomenon occurs regularly at foraging locations throughout U.S. waters and leads to mortality in juveniles and adults (NMFS and USFWS 2015a).

3.3.1.3. Distribution and Habitat Use

Green sea turtles inhabit tropical and subtropical waters around the globe. In the U.S., green sea turtles occur from Texas to Maine, as well as the Caribbean (NMFS 2021e). Hatchling and early juvenile sea turtles inhabit open waters of the Atlantic Ocean. Late juveniles and adults are typically found in nearshore waters of shallow coastal habitats (NMFS 2021e). Seasonal distribution is governed by water temperatures (NMFS 2018b). As temperatures warm in the spring, sea turtles migrate into mid-Atlantic waters. This seasonal movement is reversed as water temperatures cool in the fall and sea turtles migrate to warm waters further south. In the mid-Atlantic, juvenile and adult green sea turtles regularly occur in shallow, estuarine waters to forage between May and November (NMFS 2019c).

Green sea turtles have the potential to occur in the action area year-round. This species is uncommon but occurs seasonally in the Project area (Atlantic Shores 2023a). Compared to other sea turtle species, green sea turtles have been sighted in the vicinity of the Project area in relatively low numbers. Seasonal densities of this species were derived from NYSERDA annual aerial survey reports (Normandeau and APEM 2018, 2019a, 2019b, 2019c, 2020). These reports provided data from a three-year series of seasonal aerial surveys conducted along specific line transects off Long Island, New York. Detailed information on sea turtle density derivations is provided in COP Appendix II-L (Atlantic Shores 2023a). Green sea turtles have a seasonal density of 0.038 animals per km^2 during the summer and seasonal densities of 0.000 animals per km^2 during the rest of the year (**Table 3-24**).

3.3.2 Kemp's Ridley Sea Turtle

3.3.2.1. Description and Life History

The Kemp's ridley sea turtle is a hard-shelled turtle and the smallest of all sea turtle species. The species reaches a maximum weight of 100 pounds (45 kilograms) and grows to 2.3 feet (0.7 meters) in length (NMFS 2020b). Kemp's ridley sea turtles reach sexual maturity at approximately 13 years of age. This species exhibits synchronized nesting behavior, coming ashore during daylight hours in large groups called arribadas. Females nest every one to three years and will lay two to three clutches over the course of the nesting season from May to July. Average clutch size is 100 eggs (NMFS 2020b). Hatchlings emerge after 1.5 to 2 months and enter the ocean, traveling to deep, offshore habitats where they will drift in *Sargassum* for one to two years. After completing their oceanic phase, juvenile Kemp's ridley sea turtles move to nearshore waters to mature (NMFS 2020b).

In their oceanic phase, early life stage Kemp's ridley sea turtles are omnivorous, foraging on floating plants and animals near the surface. Once they recruit to nearshore waters, juveniles and adults consume primarily crabs; mollusks, shrimp, fish, and vegetation also contribute to their diet (Ernst et al. 1994; NMFS 2020b). This species is also known to scavenge on dead fish and discarded bycatch (NMFS 2020b).

The hearing range of sea turtles is limited to low frequencies, typically below 1,600 Hz. The Kemp's ridley hearing range extends from 100 to 500 Hz, with peak sensitivity between 100 and 200 Hz (Bartol and Ketten 2006).

3.3.2.2. Status and Population Trend

The Kemp's ridley sea turtle is one of the least abundant sea turtle species in the world. This species was listed as endangered in 1970, as part of a pre-cursor to the ESA (USFWS 1970). The status of this species was most recently assessed for its 5-year status review completed in 2015,[8] and its endangered status remained unchanged (NMFS and USFWS 2015b). In 2012, the population of individuals age-two and up was estimated at 248,307 turtles (NMFS and USFWS 2015b citing Gallaway et al. 2013). Based on hatchling releases in 2011 and 2012, Galloway et al. (2013, as cited in NMFS and USFWS 2015b) postulated that the total population size, including turtles younger than two years of age, could exceed 1,000,000. However, the number of nests recorded in 2012 was the highest of any year in the monitoring period, and the number of nests declined by almost 50% between 2012 and 2014. Therefore, the current population may be significantly lower than the population estimate from 2012 (NMFS and USFWS 2015b). The status review also included an updated age-based model to evaluate trends in the Kemp's ridley population. Results of the model indicated that the population is not recovering and suggested there is a persistent reduction in survival and/or recruitment to the nesting population (NMFS and USFWS 2015b citing Heppell et al. 2005).

All sea turtle species in the action area, including Kemp's ridley sea turtles, are subject to regional, pre-existing threats, including habitat loss or degradation, fisheries bycatch and entanglement in fishing gear, vessel strikes, predation and harvest, disease, and climate change. This species has the highest fisheries interaction rate of any sea turtle species in the Atlantic and Gulf of Mexico (NMFS and USFWS 2015b citing Finkbeiner et al. 2011). Kemp's ridley continue to be captured and killed at high rates in the Gulf of Mexico shrimp fishery despite mitigation measures (NMFS and USFWS 2015b citing NMFS 2014). Kemp's ridley sea turtles are vulnerable to fibropapillomatosis, but disease frequency is low in this species (NMFS and USFWS 2015b). This species is also susceptible to cold stunning.

[8] Another 5-year status review was initiated in June 2021, but this review has not been completed.

3.3.2.3. Distribution and Habitat Use

Kemp's ridley sea turtles primarily inhabit the Gulf of Mexico, though large juveniles and adults travel along the U.S. Atlantic coast. Early life stage sea turtles inhabit open waters of the Atlantic Ocean. Late juvenile and adult Kemp's ridley sea turtles occupy nearshore habitats in subtropical to warm temperate waters, including sounds, bays, estuaries, tidal passes, shipping channels, and beachfront waters. As noted for green sea turtles, seasonal distribution is governed by water temperatures (NMFS 2018b). As temperatures warm in the spring, sea turtles migrate into mid-Atlantic waters. This seasonal movement is reversed as water temperatures cool in the fall and sea turtles to warm waters further south. In the mid-Atlantic, juvenile Kemp's ridley sea turtles regularly occur in shallow, estuarine waters to forage between May and November (NMFS 2019c).

Kemp's ridley sea turtles could occur in the action area year-round. They occur offshore of New Jersey during the summer and fall (Atlantic Shores 2023a). Seasonal densities of this species were derived from NYSERDA annual aerial survey reports (Normandeau and APEM 2018, 2019a, 2019b, 2019c, 2020). These reports provided data from a three-year series of seasonal aerial surveys conducted along specific line transects off Long Island, New York. Detailed information on sea turtle density derivations is provided in COP Appendix II-L (Atlantic Shores 2023a). Kemp's ridley sea turtles are most abundant in the Project area during summer (0.991 animals per km^2) and less abundant during other seasons (**Table 3-24**).

3.3.3 Leatherback Sea Turtle

3.3.3.1. Description and Life History

The leatherback sea turtle is the largest sea turtle species and the only one lacking a hard shell. They can grow to 5.5 feet (1.7 meters) in length and weigh up to 2,200 pounds (998 kilograms) (NMFS 2021f). This species reaches sexual maturity between 9 and 29 years of age. The inter-nesting period for leatherback sea turtles is two to three years. In the United States, the nesting season extends from March to July. In a single nesting season, females will lay an average of five to seven clutches of eggs with an average clutch size of 100 eggs (NMFS and USFWS 2020a citing Eckert et al. 2015; NMFS 2021f). Hatchlings emerge from the nest after approximately two months and disperse into offshore habitats (NMFS and USFWS 2020a). Unlike other sea turtle species, juvenile leatherback sea turtles do not undergo an ontogenetic shift in distribution to shallower habitats and continue to use mid-ocean and continental shelf habitats (NMFS and USFWS 2020a), though older life stages may occur in nearshore waters (NMFS and USFWS 1992).

Leatherback sea turtles often forage in upwelling areas (NMFS and USFWS 2020a citing Saba 2013), though they are known to utilize a variety of habitats for feeding (NMFS and USFWS 2020a citing Robinson and Paladino 2015). Unlike other sea turtle species, leatherbacks have tooth-like cups and sharp jaws, along with backward-pointing spines in their mouth and throat, all adaptations for their unique diet. This species consumes gelatinous prey almost exclusively from the post-hatchling to adult life stage (NMFS 2021f; NMFS and USFWS 2020a citing Salmon et al. 2004).

The hearing range of sea turtles is limited to low frequencies, typically below 1,600 Hz. The leatherback sea turtle's hearing range extends from approximately 50 to 1,200 Hz, with peak sensitivity between 100 and 400 Hz (Dow Piniak et al. 2012b).

3.3.3.2. Status and Population Trend

Similar to Kemp's ridley sea turtle, the leatherback sea turtle was listed as endangered in 1970, as part of a pre-cursor to the ESA. In 2017, NMFS recognized that the Northwest Atlantic subpopulation of leatherback sea turtles may constitute a DPS and began a status review for the species (NMFS and USFWS 2017). The status review indicated that seven subpopulations, including the Northwest Atlantic, meet the criteria for listing as DPS. However, as all seven DPS would be considered endangered and the species is currently listed as endangered throughout its range, NMFS and the USFWS determined that the listing of individual DPSs was not warranted (NMFS and USFWS 2020b). Abundance of leatherback sea turtle was most recently evaluated in the 2020 review undertaken to determine whether to list separate DPSs of leatherbacks under the ESA. Among subpopulations of leatherback sea turtle, abundance estimates for nesting females range from less than 100 to nearly 10,000 (NMFS and USFWS 2020a). Recent data indicate that the abundance of nesting leatherback females has declined rapidly in several subpopulations. In the Northwest Atlantic, the abundance of nesting females is currently estimated at 20,569. This population is currently exhibiting an overall decreasing trend in annual nesting activity (NMFS and USFWS 2020a).

This species is subject to regional, pre-existing threats, including habitat loss or degradation, fisheries bycatch and entanglement in fishing gear, vessel strikes, predation and harvest, disease, and climate change. Most leatherback nesting beaches have been severely degraded by anthropogenic activities, including coastal development, beach erosion, placement of erosion control and stabilization structures, and artificial lighting (NMFS and USFWS 2020a). Fisheries bycatch is considered the primary threat to Northwest Atlantic leatherback sea turtles (NMFS and USFWS 2020a).

3.3.3.3. Distribution and Habitat Use

Leatherback sea turtles are found in the Atlantic, Pacific, and Indian Oceans (NMFS 2021f). This species can be found throughout the western North Atlantic Ocean as far north as Nova Scotia, Newfoundland, and Labrador (Ernst et al. 1994). While early life stages prefer oceanic waters, adult leatherback sea turtles are generally found in mid-ocean, continental shelf, and nearshore waters (NMFS and USFWS 1992). This species displays a marked migration pattern, entering the mid-Atlantic in spring and remaining through the summer months (Shoop and Kenney 1992).

Leatherback sea turtles could occur in the action area throughout the year. Seasonal densities of this species were derived from NYSERDA annual aerial survey reports (Normandeau and APEM 2018, 2019a, 2019b, 2019c, 2020) and are provided in **Table 3-24**. These reports provided data from a three-year series of seasonal aerial surveys conducted along specific line transects off Long Island, New York. Detailed information on sea turtle density derivations is provided in COP Appendix II-L (Atlantic Shores 2023a). Leatherback sea turtles are most abundant in the Project area during summer (0.331 animals per km^2) and fall (0.789 animals per km^2).

3.3.4 Northwest Atlantic DPS of Loggerhead Sea Turtle

3.3.4.1. Description and Life History

The loggerhead sea turtle is a large, hard-shelled sea turtle that can reach 3 feet (1 meter) in carapace length and weigh up to 250 pounds (113 kilograms) (NMFS 2021g). Adults reach sexual maturity at approximately 35 years of age. This species nests every 2 to 3 years on ocean beaches. Nesting occurs in the southeastern United States between April and September, peaking in June and July (Hopkins and Richardson 1984; Dodd 1988). During the nesting season, females will lay two to three clutches of eggs, with each clutch containing 35 to 180 eggs. After approximately 1.5 to 2 months, hatchlings emerge from the nests (Hopkins and Richardson 1984). Hatchlings travel offshore and remain in the open ocean until they return to coastal and continental shelf waters as juveniles. Loggerheads continue to use the same coastal and oceanic waters through adulthood.

Juvenile loggerheads are pelagic and benthic foragers, consuming a variety of prey, including crabs, mollusks, jellyfish, and plants (NMFS and USFWS 2008). Once they reach the subadult life stage and spend more time in coastal areas, loggerhead sea turtles forage in hard bottom habitats, feeding on mollusks, decapod crustaceans, and other benthic invertebrates (NMFS and USFWS 2008).

The hearing range of sea turtles is limited to low frequencies, typically below 1,600 Hz. The loggerhead sea turtle's hearing range extends from approximately 50 to 100 Hz up to 800 to 1,120 Hz (Martin et al. 2012).

3.3.4.2. Status and Population Trend

Loggerhead sea turtle is the most abundant sea turtle species in U.S. waters. Loggerheads found in the action area belong to the Northwest Atlantic DPS. This DPS was listed as threatened in 2011 (NMFS and USFWS 2011). The status of the Northwest Atlantic DPS of loggerhead sea turtles was last assessed as part of the 2011 ESA listing. The most recent population estimate for the Northwest Atlantic continental shelf, calculated in 2010, is 588,000 juvenile and adult loggerhead sea turtles (NEFSC and SEFSC 2011). The 2011 status review included a review of previous nesting analyses, that included data through 2007, And more recent data. Considering previous nesting data with more recent data, the nesting trend for this DPS from 1989 to 2010 was slightly negative. However, the rate of decline was not significantly different from zero (NMFS and USFWS 2011). Though nesting experienced a low in 2007, there was a substantial increase in 2008, and nesting in 2010 was the highest observed since 2000. The recovery units for the Northwest Atlantic DPS have shown no trend or an increasing trend in nest abundance; however, these recovery units have not met their recovery criteria for annual increases in nest abundance (Bolten et al. 2019).

All sea turtle species in the action area, including loggerhead sea turtles, are subject to regional, pre-existing threats, including habitat loss or degradation, fisheries bycatch and entanglement in fishing gear, vessel strikes, predation and harvest, disease, and climate change. Coastal development, artificial lighting, and erosion control structures negatively affect nesting habitat and pose a significant threat to the persistence of the Northwest Atlantic DPS of loggerhead sea turtles (NMFS and USFWS 2010). Fisheries bycatch, particularly in gillnet, trawl, and longline fisheries, is also a significant threat to this DPS. Vessel strikes have become more common for loggerhead sea turtles. Stranded sea turtles with vessel strike injuries increased from approximately 10 percent in the 1980s to a high of 20.5 percent in 2004 (NMFS and USFWS 2010). Though this species is vulnerable to fibropapillomatosis, prevalence is low in loggerheads. Loggerhead sea turtles are also vulnerable to cold stunning, but cold stunning is not a major source of mortality for this species (NMFS and USFWS 2010).

3.3.4.3. Distribution and Habitat Use

Loggerhead sea turtles inhabit nearshore and offshore habitats throughout the world (Dodd 1988). This species occurs throughout the Northwest Atlantic as far north as Newfoundland (NMFS 2021g). As with other sea turtle species, hatchling and early juveniles inhabit open waters of the Atlantic Ocean. As they mature, juveniles move from open water habitats into near-shore coastal areas where they forage and mature into adults. As noted for green and Kemp's ridley sea turtles, seasonal distribution of loggerheads is governed by water temperatures (NMFS 2018b). As temperatures warm in the spring, sea turtles migrate into mid-Atlantic waters. This seasonal movement is reversed as water temperatures cool in the fall and sea turtles migrate to warm waters further south. In the mid-Atlantic, juvenile and adult loggerhead sea turtles, regularly occur in shallow, estuarine waters to forage between May and November (NMFS 2019c).

As noted in Section 2.3, there is designated critical habitat for loggerhead sea turtles within the action area. However, this designated critical habitat is outside the Project area and overlaps with the potential vessel routes to and from the Gulf of Mexico.

Loggerhead sea turtles are the most abundant sea turtle species in the Project area and have the potential to occur there year-round. Density estimates for sea turtles in the Project Area are limited. Seasonal densities of this species were derived from NYSERDA annual aerial survey reports (Normandeau and APEM 2018, 2019a, 2019b, 2019c, 2020) and are provided in **Table 3-24**. These reports provided data from a three-year series of seasonal aerial surveys conducted along specific line transects off Long Island, New York. Though the surveys were conducted outside the Project Area, they provide the most recent sea turtle density estimates within the New York Bight, and densities are not expected to vary significantly across the New York Bight. Therefore, density estimates from the NYSERDA aerial surveys is considered representative of the Project Area and provides the best available scientific information to evaluate effects on these species. Detailed information on sea turtle density derivations is provided in COP Appendix II-L (Atlantic Shores 2023a). Loggerhead sea turtles are most abundant in the Project area during the summer (26.799 animals per km^2), but only occur in very low abundance the rest of the year.

Table 3-24. Seasonal Sea Turtle Densities in the Project Area

Species[1]	Seasonal Density (animals/100 km^2)			
	Spring	Summer	Fall	Winter
Green sea turtle	0.000	0.038	0.000	0.000
Kemp's ridley sea turtle	0.050	0.991	0.190	0.000
Leatherback sea turtle	0.000	0.331	0.789	0.000
Loggerhead sea turtle	0.254	26.799	0.190	0.025

Sources: Normandeau and APEM 2018, 2019a, 2019b, 2019c, 2020
[1] The NYSERDA aerial survey reports included two multi-species categories: loggerhead/Kemp's ridley and unidentified. Turtle counts within these two categories were distributed among the potential species with a weighting that reflected counts for turtles that were identified to species

3.3.5 Effects Analysis for Sea Turtles

3.3.5.1. Underwater Noise

Potential adverse effects to sea turtles from Project-generated underwater noise includes PTS, TTS, and behavioral disruption. The sections below provide an overview of the available information on sea turtle hearing, the thresholds applied, the results of the underwater noise modeling conducted, and the impact consequences for each potential underwater noise generating activity for the Project.

Auditory Criteria for Sea Turtles

Sea turtle auditory perception is thought to occur through a combination of both bone and water conduction rather than air conduction (Lenhardt 1982; Lenhardt and Harkins 1983). Detailed descriptions of sea turtle ear anatomy are found in Ridgway et al. (1969), Lenhardt et al. (1985), and Bartol and Musick (2003). Sea turtles do not have external ears, but the middle ear is well adapted as a peripheral component of a bone conduction system. The thick tympanum is disadvantageous as an aerial receptor but enhances low-frequency bone conduction hearing (Bartol and Musick 2003; Bartol et al. 1999; Lenhardt et al. 1985). A layer of subtympanal fat emerging from the middle ear is fused to the tympanum (Ketten and Bartol 2006; Bartol 2004, 2008). This arrangement enables sea turtles to hear low-frequency sounds while underwater. Vibrations can also be conducted through the bones of the carapace to reach the middle ear. Based on studies of semi-aquatic turtles, Christensen-Dalsgaard et al. (2012) speculated that the sea turtle ear may not be specialized for bone conduction, but rather that sound-induced pulsations may drive the tympanic disc if the middle ear cavity is air-filled.

The limited data available on sea turtle hearing abilities are summarized In **Table 3-25**. The frequency range of best hearing sensitivity of sea turtles ranges from ~100 to 700 Hz; however, there is some sensitivity to frequencies as low as 50 Hz, and possibly as low as 30 Hz (Ridgway et al. 1969).

There is limited data on the ability of sea turtles to hear or be affected by underwater noise that would be generated by the Project. Thresholds outlined for auditory and non-auditory effects to sea turtles have been developed by using fish as surrogates (Finneran et al. 2017; Popper et al. 2014).

Table 3-25 Hearing Capabilities of Sea Turtles

Species	Hearing Range (Hertz)	Highest Sensitivity (Hertz)	Source
Green	60 – 1,000	300 – 500	Ridgway et al. 1969
	100 – 800	600 – 700 (juveniles) 200 – 400 (subadults)	Bartol and Ketten 2006; Ketten and Bartol 2006
	50 – 1,600	50 – 400	Piniak et al. 2012a, 2016
Loggerhead	250 – 1,000	250	Bartol et al. 1999
	50 – 1,100	100 – 400	Martin et al. 2012; Lavender et al. 2014
Kemp's ridley	100 – 500	100 – 200	Bartol and Ketten 2006; Ketten and Bartol 2006
Leatherback	50 – 1,200	100 – 400	Piniak et al. 2012b

Tables 3-26 and 3-27 outline the acoustic thresholds used in the assessment of the onset of PTS, TTS, and/or behavioral disruptions, respectively, for sea turtles. Behavioral criteria for impact and vibratory pile driving were developed by the U.S. Navy in consultation with NMFS and were based on exposure to air gun noise presented in McCauley et al. (2000) (Finneran et al. 2017). Impact pile driving produces repetitive, impulsive sounds, and air gun shots are the most similar source type that has been studied extensively. In addition, the working group that prepared the American National Standards Institute Sound Exposure Guidelines provides quantitative descriptors of sea turtle behavioral responses to pile driving (Popper et al. 2014). The received SPL at which sea turtles are expected to actively avoid air gun exposures, 175 dB re 1 µPa is also expected to be the received sound level at which sea turtles would actively avoid exposure to impact pile driving (impulsive) and vibratory pile driving (non-impulsive) activities (Finneran et al. 2017).

As outlined above for marine mammals, auditory masking occurs when sound signals used by sea turtles (e.g., predator vocalizations and environmental cues) overlaps in time and frequency with another sound source (e.g., pile driving). Popper et al. (2014) concluded that continuous noise that is detectable by sea turtles can mask signal detection. As with behavioral effects, the consequences of masking to sea turtle fitness are unknown. The frequency range of best hearing sensitivity estimated for sea turtles is estimated at 100 to 700 Hz. Masking is therefore more likely to occur with sound sources that have dominant low frequency spectrums such as vessel activities, vibratory pile driving, and WTG operations. These activities also have high-duty cycles (e.g., are continuous) and, therefore, have a higher chance of occurring during, and therefore impacting, sea turtle signal reception.

Table 3-26 Acoustic Impact Thresholds[1] for Sea Turtles – Impulsive Sources

PTS		TTS		Behavioral[2]
$L_{p,\,pk}$ Unweighted	$L_{E,24h}$ Weighted	$L_{p,\,pk}$ Unweighted	$L_{E,\,24h}$ Weighted	L_{rms} Unweighted
232	204	226	189	175

$L_{E,24h}$ = cumulative sound exposure level; $L_{p,\,pk}$ = peak sound pressure level; L_{rms} = root mean squared sound pressure level; PTS = permanent threshold shift; TTS = temporary threshold shift
Source: Finneran et al. 2017
Notes: Peak sound pressure level ($L_{p,0\text{-}pk}$) and L_{rms} have reference values of 1 μPa, and weighted sound exposure level accumulated over 24 hours ($L_{E,24h}$) has a reference value of 1 $\mu Pa^2 s$. The note "Unweighted" is included to indicate $L_{pk,0\text{-}pk}$ and L_{rms} are flat weighted or unweighted within the generalized hearing range of sea turtles (i.e., below 2 kHz). The "Weighted" note associated with cumulative sound exposure level thresholds indicates use of the designated sea turtle weighting function.
[1] Dual metric injury (i.e., PTS and TTS) thresholds for impulsive sounds: Use whichever threshold results in the largest isopleth for calculating PTS onset. If a non-impulsive sound has the potential of exceeding the peak sound pressure level thresholds associated with impulsive sounds, these thresholds are recommended for consideration.
[2] Behavioral threshold applies to both impulsive and non-impulsive sources as currently, there are not enough data to derive separate thresholds for different source types.

Table 3-27 Acoustic Impact Thresholds[1] for Sea Turtles – Non-Impulsive Sources

PTS	TTS	Behavioral[2]
$L_{E,\,24h}$ Weighted	$L_{E,24h}$ Weighted	L_{rms} Unweighted
220	200	175

$L_{E,24h}$ = cumulative sound exposure level; L_{rms} = root mean squared sound pressure level; PTS = permanent threshold shift; TTS = temporary threshold shift
Source: Finneran et al. 2017
Notes: L_{rms} has a reference value of 1 μPa, and weighted sound exposure level accumulated over 24 hours ($L_{E,\,24h}$) has a reference value of 1 μPa^2 s. The note "unweighted" is included to indicate L_{rms} is flat weighted or unweighted within the generalized hearing range of sea turtles (i.e., below 2 kHz). The "Weighted" note associated with cumulative sound exposure level thresholds indicates use of the designated sea turtle weighting function.
[1] If a non-impulsive sound has the potential of exceeding the peak sound pressure level thresholds associated with impulsive sounds, these thresholds are recommended for consideration.
[2] Behavioral disturbance threshold applies to both impulsive and non-impulsive sources as, there are not enough data to derive separate thresholds for different source types.

Assessment of Effects

Impact Pile Driving

Impact pile driving would occur during construction to install WTG, met tower, and OSS foundations (Section 1.3.1). Impact pile driving generates intense, impulsive underwater noise that may result in physiological or behavioral effects in aquatic species.

Pile driving noise can cause behavioral or physiological effects in sea turtles. Potential behavioral effects of pile driving noise include altered dive patterns, short-term disturbance, startle responses, and short-term displacement (NSF and USGS 2011; Samuel et al. 2005). Potential physiological effects include temporary stress response and, close to the pile-driving activity, TTS or PTS. Behavioral effects and most physiological effects are expected to be of short duration and localized to the ensonified area. Any disruptions to foraging or other normal behaviors would be temporary and increased energy expenditures associated with this displacement are expected to be small. PTS could permanently limit an individual's ability to locate prey and detect predators and could therefore have long-term effects on individual fitness.

The severity of the effect is dependent on the received sound level (i.e., the sound level to which the organism is exposed), which is a function of the sound level generated by the noise source, the distance between the source and the organism, and the duration of sound exposure.

Modeling Approach

Underwater sound propagation modeling and animal movement modeling for impact pile driving with 10 dB of noise attenuation was conducted in support of the COP (COP Volume II, Appendix II-L; Atlantic Shores 2023a). As described in Section 3.2.5.2, monopile and/or piled jacket foundations have been selected for WTGs for Scenario 1 or Scenario 2 under the Proposed Action, but several foundation types are still being considered for the met tower and OSSs. As previously noted, modeling captured the near-greatest impact for impact pile driving noise under Scenarios 1 and 2 by assuming four large OSSs with jacket foundations across Projects 1 and 2. The greatest impact for impact pile driving would occur if the met tower for Project 1 utilized a jacket foundation rather than a monopile foundation, as was modeled. The least impact would occur under each Scenario if the met tower and OSSs utilized non-piled foundations. Details regarding the modeling are presented in Section 3.2.5.2.

Modeling Results – Exposure Ranges (PTS and Behavioral Effects)

To estimate radial distances (i.e., exposure ranges) to injury and behavioral thresholds for impact pile driving, peak sound pressure levels and frequency-weighted accumulated SELs for the onset of PTS in sea turtles from Finneran et al. (2017) and behavioral response thresholds from McCauley et al. (2000) were used (**Table 3-26**). For 49-foot (15-meter) monopiles with 10 dB of noise attenuation due to noise mitigation technology, which is the level of attenuation generally achievable by a single noise attenuation system (Bellman et al. 2020), the PTS exposure range for most sea turtles is 131 feet (40 meters); the PTS exposure range for green sea turtles is 0.14 miles (0.22 kilometers) (**Table 3-28**). For 16-foot (5-meter) pin piles, PTS exposure ranges are 131 feet (40 meters) or less (**Table 3-29**). With 10 dB of noise attenuation due to noise-mitigation technology, sea turtles could experience sound levels at behavioral thresholds within 0.87 miles (1.34 kilometers) and 0.45 miles (0.72 kilometers) of monopile and pin pile driving, respectively. Species-specific exposure ranges are provided in **Tables 3-28 and 3-29**. Exposure ranges assuming installation of one monopile per day, which resulted in the greatest impact (i.e., number of exposures) on marine mammals, are presented in **Table 3-30**.

Table 3-28. Sea Turtle $ER_{95\%}$ Exposure Ranges for Monopiles with 10 dB Attenuation

Species	49-foot (15-meter)[1]			39-foot (12-meter)[1]		
	PTS		BD	PTS.		BD
	L_{pk}	$L_{E,\ 24hr}$	L_{rms}	L_{pk}	$L_{E,\ 24hr}$	L_{rms}
Green	--	0.14 mi (0.22 km)	0.87 mi (1.34 km)	--	0.06 mi (0.09 km)	0.85 mi (1.36 km)
Kemp's ridley	--	0.02 mi (0.04 km)	0.80 mi (1.28 km)	--	0.02 mi (0.03 km)	0.76 mi (1.23 km)
Leatherback	--	0.02 mi (0.04 km)	0.80 mi (1.28 km)	--	0.02 mi (0.03 km)	0.71 mi (1.14 km)
Loggerhead	--	--	0.68 mi (1.10 km)	--	--	0.63 mi (1.01 km)

PTS = Permanent Threshold Shift; BD = behavioral disturbance; dB = decibel; mi = mile
Source: COP Volume II, Appendix II-L, Tables 39 and G-36; Atlantic Shores 2023a.
[1] Based on driving two monopiles per day

Table 3-29. Sea Turtle $ER_{95\%}$ Exposure Ranges for 16-foot (5-meter) Pin Piles

Species	10 dB Attenuation		
	PTS		BD
	L_{pk}	$L_{E,\ 24hr}$	L_{rms}
Green	0.00 mi (0.00 km)	0.02 mi (0.04 km)	0.45 mi (0.72 km)
Kemp's ridley	0.00 mi (0.00 km)	0.02 mi (0.03 km)	0.45 mi (0.72 km)
Leatherback	0.00 mi (0.00 km)	0.01 mi (0.01 km)	0.40 mi (0.64 km)
Loggerhead	0.00 mi (0.00 km)	0.00 mi (0.00 km)	0.36 mi (0.58 km)

PTS = Permanent Threshold Shift; BD = Behavioral Disturbance; dB = decibel; mi = mile; km = kilometer.
Source: COP Volume II, Appendix II-L, Table 41; Atlantic Shores 2023a.
Note: Exposure ranges presented in the table are based on installation of four pin piles per day.

Table 3-30. Sea Turtle $ER_{95\%}$ Exposure Ranges for Installation of One Monopile per Day with 10 dB Attenuation

Species	49-foot (15-meter)			39-foot (12-meter)		
	PTS		BD	PTS.		BD
	L_{pk}	$L_{E,\ 24hr}$	L_{rms}	L_{pk}	$L_{E,\ 24hr}$	L_{rms}
Green	--	0.11 mi (0.18 km)	0.87 mi (1.40 km)	--	0.04 mi (0.07 km)	0.83 mi (1.34 km)
Kemp's ridley	--	0.01 mi (0.02 km)	0.81 mi (1.31 km)	--	0.01 mi (0.02 km)	0.77 mi (1.24 km)
Leatherback	--	0.01 mi (0.02 km)	0.75 mi (1.21 km)	--	0.01 mi (0.02 km)	0.57 mi (0.92 km)
Loggerhead	--	--	0.71 mi (1.15 km)	--	--	0.58 mi (0.94 km)

PTS = Permanent Threshold Shift; BD = behavioral disturbance; dB = decibel; mi = mile
Source: COP Volume II, Appendix II-L, Tables 38 and G-35; Atlantic Shores 2023a.

Effects of Exposure to Noise above the PTS Thresholds

Sea turtle noise exposure estimates utilize the results of hydroacoustic and animal movement modeling in combination with animal densities in the waters in and around the Lease Area (**Table 3-24**), and anticipated construction schedules (**Table 3-31).** Exposure estimates were modeled with 10 dB sound attenuation, as discussed above.

Under Scenario 1 of the Proposed Action, modeling estimated up to 1 green sea turtle, 3 Kemp's ridley sea turtles, 2 leatherback sea turtles, and 15 loggerhead sea turtles would be exposed to sound levels exceeding PTS thresholds with 10 dB of sound attenuation (**Table 3-32**). Under Scenario 2 of the Proposed Action, up to an estimated 1 green sea turtle, 2 Kemp's ridley sea turtles, 1 leatherback sea turtle, and 5 loggerhead sea turtles would be exposed to sound levels exceeding PTS thresholds (**Table 3-32**). Exposure estimates assuming installation of one monopile per day, which resulted in the greatest impact (i.e., number of exposures) on marine mammals, are presented in **Table 3-33**.

Table 3-31. Construction Schedules, Presented as Pile Driving Days, Utilized for Estimating Sea Turtle Exposures to Impact Pile Driving Noise

Month	Scenario 1[1]			Scenario 2			
	Year 1			Year 1		Year 2	
	WTG Monopile[2]		OSS Jacket	WTG Monopile[2]	OSS Jacket	WTG Jacket	OSS Jacket
	1 pile/day	2 piles/day					
May	9	3	0	8	0	5	0
June	8	16	6	20	6	15	6
July	10	15	6	25	0	20	0
August	0	25	6	19	6	18	6
September	1	12	6	18	0	14	0
October	13	6	0	16	0	13	0
November	3	1	0	5	0	4	0
December	1	0	0	1	0	0	0
Total Piling Days	45	78	24	112	12	89	12
Total Piles	45	156	96	112	48	356	48
Total Foundations	45	156	4	112	2	89	2

Source: COP Volume II, Appendix II-L, Tables 3 and G-4; Atlantic Shores 2023a
[1]The one-year construction schedule was used for Scenario 1 as it resulted in a higher number of exposures than the two-year construction schedule.
[2]Includes one monopile foundation for the met tower for Project 1.
Notes: Monopiles are 15 meters in diameter and are installed at a rate of one per day under Scenario 2. Pin piles for the jacket foundations are 5 meters in diameter and are installed at a rate of four per day.

Table 3-32. Estimated Number of Sea Turtles Exposed to Impact Pile Driving Noise with 10 dB of Noise Attenuation based on Modeling Results

Species	Scenario 1[1]			Scenario 2		
	PTS		BD	PTS		BD
	L_{pk}	$L_{E,\ 24hr}$	L_{rms}	L_{pk}	$L_{E,\ 24hr}$	L_{rms}
Green	0	1	2	0	1	2
Kemp's ridley	0	3	51	0	2	42
Leatherback	0	2	24	0	1	22
Loggerhead	0	15	915	0	5	788

Beh. = Behavior; dB = decibels; Inj. = Injury
Source: COP Volume II, Appendix II-L, Tables 20 and 21; Atlantic Shores 2023a.
[1] Estimates based on installation of two monopiles per day.

Table 3-33. Estimated Number of Sea Turtles Exposed to Impact Pile Driving Noise with 10 dB of Noise Attenuation based on Modeling Results for One Monopile Installed per Day

Species	Scenario 1		
	PTS		BD
	L_{pk}	$L_{E,\ 24hr}$	L_{rms}
Green	0	1	2
Kemp's ridley	0	2	48
Leatherback	0	1	25
Loggerhead	0	10	816

Beh. = Behavior; dB = decibels; Inj. = Injury
Source: COP Volume II, Appendix II-L, Table 19; Atlantic Shores 2023a.

Modeled exposures leading to PTS are expected to be less than 0.2 for green sea turtles (rounded up to a whole animal in **Table 3-32**) for impact pile driving activities; thus, the potential for PTS is considered extremely unlikely to occur and is ***discountable***. Therefore, the effects of exposure to impact pile driving noise resulting in sound levels that exceed the PTS threshold ***may affect, but not likely to adversely affect*** green sea turtles.

Atlantic Shores has proposed measures to avoid, minimize, and mitigate impacts of pile driving noise on sea turtles, including utilization of protected species observers to monitor and enforce appropriate monitoring and exclusion zones (SEA-03, SEA-05), nighttime and low visibility measures utilizing night vision devices such as night vision binoculars and/or infrared cameras (SEA-04), use of soft-start procedures (SEA-06), and noise-reducing technologies (SEA-06). BOEM is also requiring the use of PSOs and monitoring zones for sea turtles (**Table 1-10**). The potential for PTS is minimized by the implementation of monitoring and exclusion zones for impact pile driving operations that would facilitate a delay of pile driving if sea turtles were observed approaching or within areas that could be ensonified above sound levels that could result in PTS. The PTS exposure ranges are very small, 131 feet (40 meters) or less, and would therefore be easily monitored by a PSO. Given these very small ranges, the nighttime and low visibility visual monitoring measures for sea turtles would likely be effective. In addition, soft starts could be effective in deterring turtles from impact pile driving activities prior to exposure resulting in PTS. The potential for PTS is also minimized by using a noise mitigation system during all impact pile driving operations, which was included in the modeling assumptions. The proposed requirement that impact pile driving can only commence when the monitoring zones are fully visible to PSOs allows a greater chance for detecting sea turtles, and increases the effectiveness in implementation of these zones to avoid PTS. However, exposures leading to PTS cannot be discounted, especially if nighttime pile driving does occur. Therefore, the effects of noise exposure from Project impact pile driving leading to PTS ***may affect, likely to adversely affect*** Kemp's ridley, leatherback, and loggerhead sea turtles.

Effects of Exposure to Noise above the Behavioral Disturbance Threshold

Modeling results indicate that up to an estimated 2 green sea turtles, 51 Kemp's ridley sea turtles, 24 leatherback sea turtles, and 915 loggerhead sea turtles would be exposed to sound levels exceeding behavioral thresholds under Scenario 1 (**Table 3-32**). Up to an estimated 2 green sea turtles, 42 Kemp's ridley sea turtles, 22 leatherback sea turtles, and 788 loggerhead sea turtles would be exposed to sound levels exceeding behavioral thresholds under Scenario 2. As modeling of the TTS threshold was not conducted, BOEM conservatively assumes that all sea turtles that experience behavioral disturbance may have the potential to also experience TTS. It is also reasonable to assume that the thresholds for TTS onset are lower than those for PTS onset, but higher than behavioral disturbance onset. However, relatively little is known about the onset of TTS in sea turtles. As there have been no studies done on TTS in sea turtles, fishes were used as a surrogate to develop TTS thresholds (Finneran et al. 2017). The rationale for using fishes as surrogate comes from Popper et al. (2014) that indicated the functioning of the basilar papilla in the turtle ear is dissimilar to the functioning of the cochlea in mammals. Some experimental studies of freshwater turtles indicate threshold shifts up to 40 dB re 1 µPa may be experienced; however, turtle hearing returned to initial sensitivities following a recovery period of 20 minutes to several days (WHOI 2022). Until more studies improve the understanding of TTS in sea turtles, ranges to TTS thresholds and TTS exposures should be considered qualitative; and mitigation measures designed to reduce PTS exposures described above should also contribute to reducing the risk of the TTS exposures.

The mitigation and monitoring measures described above for PTS and the animal's ability to avoid areas of loud construction noise are expected to decrease the potential exposure of these ESA-listed species to underwater noise above behavioral disturbance thresholds. However, the possibility still exists and cannot be discounted. Therefore, the effects of exposure to impact pile driving noise resulting in sound levels that exceed behavioral disturbance or TTS thresholds ***may affect, likely to adversely affect*** green, Kemp's ridley, leatherback, and loggerhead sea turtles.

Vibratory Pile Driving

Vibratory pile driving under Scenario 1 or Scenario 2 would occur over approximately sixteen days during construction to install and remove temporary cofferdams at the exit point of HDD for each of the export cable landfalls and would not occur between Memorial Day and Labor Day. Vibratory pile driving generates non-impulsive underwater noise with lower source levels than impact pile driving. Noise impacts from non-impulsive noise sources are generally less severe compared to impacts from impulsive noise sources, but physiological effects may still occur in proximity to the noise source if source levels are sufficiently high and/or if animals remain in the vicinity and are exposed to those levels for a sufficient duration. To support Atlantic Shores' LOA application, underwater sound propagation modeling for vibratory pile driving was conducted for marine mammals at the Monmouth and Atlantic cable landing sites and assumed 8 days of installation and 8 days of removal for the cofferdams at each of the two landfall sites (see Section 3.2.5.2 for a description of modeling for vibratory pile driving).

Effects of Exposure to Noise Above the PTS and Behavioral Disturbance Thresholds

In a study of vibratory and impact pile driving noise associated with sheet pile installation, vibratory pile driving maximum peak sound levels were less than 185 dB re 1 µPa, and sound exposure levels (accumulated over two seconds) were below 188 dB re 1 μPa^2 s at distances of 5 to 23 feet (1.5 to 7 meters) (Hart Crowser and Illingworth and Rodkin 2009). Comparatively, impact hammer maximum peak sound levels reached 195 dB re 1 µPa at 16 feet (5 meters). Due to the relatively lower exposure levels and short duration, vibratory hammer installation noise is unlikely to result in greater noise impacts than impact hammer pile driving described in the previous subsection.

Based on the typical sound levels reported by Hart Crowser and Illingworth and Rodkin (2009) for vibratory pile driving (L_E < 190 dB), vibratory pile driving noise is extremely unlikely to exceed PTS thresholds for sea turtles (**Table 3-27**). Sound measurements by Illingworth and Rodkin (2017) were used to model sound propagation of vibratory pile driving for marine mammals (Section 3.2.5.2). The maximum root mean squared sound pressure level (L_{rms}) for vibratory pile driving recorded in the study was 170 dB re 1 µPa at 32.8 feet (10 meters) from the source, which is below the recommended behavioral threshold for sea turtles (**Table 3-27**). Therefore, it is extremely unlikely that sea turtles would be exposed to sound levels exceeding their recommended behavioral threshold during vibratory pile driving for the Proposed Action. Additionally, vibratory pile driving would be of relatively short duration (i.e., 32 days) and would occur outside of the summer months when sea turtle densities would be highest in the ensonified areas. Given that vibratory pile driving noise is extremely unlikely to exceed PTS or behavioral criteria for sea turtles, the risk of PTS or behavioral disturbance associated with vibratory pile driving noise for the Proposed Action is ***discountable***; thus, the effects of exposure to vibratory pile driving noise resulting in sound levels that exceed PTS or behavioral disturbance thresholds ***may affect, but not likely to adversely affect*** green, Kemp's ridley, leatherback, and loggerhead sea turtles.

The Connected Action would include the installation steel sheet piles using a vibratory hammer. Noise impacts associated with port modifications would be lower than pile driving impacts associated with vibratory pile driving for the Proposed Action. Vibratory pile driving for the Connected Action may produce sound pressure levels that exceed the behavioral threshold for sea turtles (**Table 3-27**) over a short distance from the pile driving. Given the small distances to behavioral thresholds and unlikely sea turtle presence in the vicinity of the O&M facility, impacts from pile driving noise on ESA-listed sea turtles would be extremely unlikely to occur and are therefore ***discountable***. Thus, the effects of noise exposure from vibratory pile driving associated with the Connected Action leading to behavioral disturbance ***may affect, but not likely to adversely affect*** green, Kemp's ridley, leatherback, and loggerhead sea turtles.

High Resolution Geophysical Surveys

G&G surveys for Scenario 1 or Scenario 2 under the Proposed Action would occur prior to installation of offshore cables and during the O&M phase of the Project (Section 1.3). Such surveys can generate high-intensity, impulsive noise that has the potential to result in physiological[9] or behavioral effects in aquatic organisms. G&G surveys for the Proposed Action include HRG surveys, which produce less-intense noise and operate in smaller areas compared to other G&G survey equipment.

G&G survey noise has the potential to affect sea turtles through auditory injuries, stress, disturbance, and behavioral responses. TTS or PTS could occur if sea turtles are close to survey activities. However, TTS and PTS are considered unlikely, as sea turtles are expected to avoid disturbing levels of noise associated with survey activities and survey vessels would travel quickly (NSF and USGS 2011). BOEM-proposed mitigation measures for HRG surveys include compliance with Project Design Criteria and Best Management Practices incorporated in the Atlantic Data Collection consultation for Offshore Wind Activities (**Table 1-11**). Given that sea turtles are expected to avoid disturbing levels of noise, the speed of the survey vessels, mitigation measures for the Proposed Action, and the lower noise levels and smaller operational scales of HRG survey equipment, G&G surveys associated with the Proposed Action are extremely unlikely to result in injury of any ESA-listed sea turtles in the action area; thus, risk of PTS associated with HRG surveys for the Proposed Action is ***discountable***. Therefore, the effects of exposure to HRG survey noise resulting in sound levels that exceed the PTS threshold ***may affect, but not likely to adversely affect*** green, Kemp's ridley, leatherback, and loggerhead sea turtles.

As the source level assumed for HRG surveys (**Table 3-16**) could exceed the behavioral thresholds for sea turtles (**Table 3-27**) behavioral disturbance is considered possible. However, the effects of HRG surveys are transient and would dissipate as the vessel move away from the receiver (e.g., turtle). With the application of monitoring measures and the transient nature of the effect, the potential for behavioral exposure to ESA-listed turtles is considered extremely unlikely to occur and is ***discountable***. Therefore, the effects of exposure to HRG survey noise resulting in sound levels that exceed the behavioral disturbance threshold ***may affect, but not likely to adversely affect*** green, Kemp's ridley, leatherback and loggerhead sea turtles.

Cable Laying

Noise-producing activities associated with cable laying during construction under either Scenario 1 or Scenario 2 includes trenching, plowing, backfilling, and installation of cable protection. As the cable-

[9] G&G surveys with the potential to result in physiological effects are generally associated with oil and gas exploration.

laying vessel and equipment would be continually moving, the ensonified area would also move. Given the mobile nature of the ensonified area, a given location would not be ensonified for more than a few hours.

As described in Section 3.2.5.2, there is limited information regarding underwater noise generated by cable-laying and burial activities in the literature. Reported source noise levels generated during cable laying activities (e.g., jet trenching) range up to 178 dB re 1 µPa-m (Nedwell et al. 2003). As the cable-laying vessel and equipment would be continually moving, the ensonified area would also move. Given the mobile nature of the ensonified area, a given location would not be ensonified for more than a few hours.

Based on reported source levels for cable laying and burial, sea turtles are extremely unlikely to be exposed to noise above PTS thresholds from cable laying. Thus, exposure to sound exceeding PTS thresholds for sea turtles is extremely unlikely to occur and is ***discountable***. Therefore, the effects of exposure to cable-laying noise resulting in sound levels that exceed the PTS threshold ***may affect, but not likely to adversely affect*** green, Kemp's ridley, leatherback, and loggerhead sea turtles. Cable-laying noise levels could exceed the disturbance threshold for sea turtles (**Table 3-27**). Therefore, behavioral effects are considered possible but would be temporary with effects dissipating once the activity has ceased or individual has left the area. Should an exposure to sound levels exceeding the behavioral threshold occur, the potential effects would be brief (e.g., a sea turtle may approach the noisy area and divert away from it), and any effects to this brief exposure would be so small that they could not be measured, detected, or evaluated and are therefore ***insignificant***. Therefore, the effects of exposure to cable-laying noise resulting in sound levels that exceed the behavioral disturbance threshold ***may affect, but not likely to adversely affect*** green, Kemp's ridley, leatherback and loggerhead sea turtles.

Dredging Noise

Under Scenario 1 or Scenario 2 of the Proposed Action, dredging may be required for seabed preparation prior to foundation installation, sand bedform clearing prior to cable installation, and excavation of the offshore HDD entrance/exit near the cable landing sites. Project dredging may utilize a trailing suction hopper dredge, a cutterhead dredge, and/or a backhoe dredge.

Hydraulic trailing suction hopper dredging and cutterhead dredging involve the use of suction to remove sediment from the seabed. The sound produced by hydraulic dredging results from the combination of sounds generated by the impact and abrasion of the sediment passing through the draghead, suction pipe, and pump. The frequency of the sounds produced by hydraulic suction dredging ranges from approximately 1 to 2 kilohertz, with reported source levels of 172 to 190 dB re 1 µPa-m (McQueen et al. 2019; Robinson et al. 2011; Todd et al. 2015). Robinson et al. (2011) noted that the level of broadband noise generated by suction dredging is dependent on the aggregate type being extracted, with coarse gravel generating higher noise levels than sand. Mechanical dredging refers to grabs used to remove seafloor material. Noise produced by mechanical dredges is emitted from winches and derrick movement, bucket contact with the substrate, digging into substrate, and emptying of material into a barge or scow (Dickerson et al. 2001). Reported sound levels of mechanical dredges range from 107 to 124 dB re 1 µPa at 505 feet (154 meters) from the source with peak frequencies of 162.8 Hz (Dickerson et al. 2001; McQueen et al. 2019). Maximum levels occurred when the dredge bucket made contact with the channel bottom in mixed coarse sand or gravel (Dickerson et al. 2001; McQueen et al. 2019).

Based on the available source level information presented above, dredging by hydraulic or mechanical dredges is unlikely to exceed PTS thresholds for sea turtles. Exposure to noises above PTS thresholds from Project dredging for all sea turtles is extremely unlikely to occur and is ***discountable***. Therefore, the effects of exposure to dredging noise resulting in sound levels that exceed the PTS threshold ***may affect, but not likely to adversely affect*** green, Kemp's ridley, leatherback, and loggerhead sea turtles.

As outlined above, there is very little information regarding the behavioral responses of sea turtles to underwater noise. Behavioral responses to vessel noise include avoidance behavior but only at very close range (32 feet [10 meters] (Hazel et al. 2007). Popper et al. (2014) suggests that in response to continuous sounds, sea turtles have a high risk for behavioral disturbance in the near field (e.g., tens of meters), moderate risk in the intermediate field (hundreds of meters) and low risk in the far field (thousands of meters). Behavioral effects on sea turtles due to dredging noise are considered possible but would be temporary with effects dissipating once the activity has ceased or the individual has left the area. Should an exposure occur, the potential effects would be brief (e.g., a sea turtle may approach the noisy area and divert away from it), and any effects to this brief exposure would be so small that they could not be meaningfully measured, detected, or evaluated and are therefore ***insignificant***. Therefore, the effects of exposure to dredging noise resulting in sound levels that exceed the behavioral disturbance threshold ***may affect, but not likely to adversely affect*** green, Kemp's ridley, leatherback, and loggerhead sea turtles.

Vessel Noise

The Proposed Action includes the use of vessels during construction, O&M, and decommissioning, as described in Section 1.3. No difference in vessel utilization is anticipated between Scenario 1 and Scenario 2 under the Proposed Action. Vessels generate non-impulsive noise that could affect aquatic species. Source levels for large vessels range from 177 to 188 dB re 1 µPa-m L_{rms} with most of their energy below 1 kHz and peaks in the 20–100 Hz range (McKenna et al. 2017). Smaller support vessels typically produce source levels ranging from 150 to 180 dB re 1 µPa-m L_{rms} (Kipple 2002; Kipple and Gabriele 2003). Vessel noise overlaps with the hearing range of sea turtles, but it is unlikely that received levels of underwater noise from vessel activities would exceed the PTS threshold for sea turtles (**Table 3-27**). Therefore, the potential for ESA-listed sea turtles to be exposed to noise above PTS thresholds is considered extremely unlikely to occur and is ***discountable***. Thus, the effects of exposure to vessel noise resulting in sound levels that exceed the PTS threshold ***may affect, but not likely to adversely affect*** green, Kemp's ridley, leatherback, and loggerhead sea turtles.

Based on vessel source levels, Project vessels may elicit behavioral responses, including startle responses and changes in diving patterns, or a temporary stress response (NSF and USGS 2011; Samuel et al. 2005). Vessel noise associated with the Proposed Action could cause repeated, intermittent impacts on sea turtles resulting from short-term, localized behavioral responses which are expected to dissipate once the vessel leaves the area. With the implementation of vessel separation distances outlined in **Table 1-11** (164 feet [50 meters] for sea turtles), potential behavioral effects would be reduced. In addition, the BOEM-proposed measures to reduce vessel strikes on sea turtles, which include slowing to 4 knots (2 meters per second) when a sea turtle sighted within 328 feet (100 meters) of the forward path of the vessel and avoiding transiting through areas of visible jellyfish aggregations or floating sargassum, will further reduce the potential for behavioral disturbance effects. Based on the proposed mitigation measures, sea turtles are expected to have a low probability of exposure to underwater noises above behavioral thresholds from vessel operations. Should an exposure occur, the potential effects would be brief, and any effects to this brief exposure would be so small that they could not be measured, detected, or evaluated and would therefore be ***insignificant***. Therefore, the effects of exposure to vessel noise resulting in sound levels that exceed the behavioral disturbance threshold ***may affect, but not likely to adversely affect*** green, Kemp's ridley, leatherback, and loggerhead sea turtles.

Aircraft

Helicopters may be used to support construction or O&M of the Proposed Action. Though helicopters produce in-air noise, a small portion of the produced sound can be transmitted through the water surface and propagate in the aquatic environment. Underwater sound produced by helicopters is generally low frequency (less than 500 Hz) and non-impulsive with sound levels at or below 160 dB re 1 µPa (Richardson et al. 1995). Given that underwater sound levels associated with helicopter overflights is below the behavioral threshold for sea turtles (**Table 3-27**), exposure to noises above PTS and behavioral thresholds from Project aircraft for all ESA-listed sea turtles is extremely unlikely to occur and is ***discountable***. Therefore, the effects of exposure to aircraft noise resulting in sound levels that exceed PTS or behavioral disturbance thresholds ***may affect, but not likely to adversely affect*** green, Kemp's ridley, leatherback, and loggerhead sea turtles.

Wind Turbine Generators

WTGs operating during the O&M phase of the Proposed Action, under either Scenario 1 or Scenario 2, would generate non-impulsive, underwater noise. Monitoring data in the literature are limited to smaller, geared wind turbines (less than 6.15 MW). The relatively low noise levels produced by these WTGs are expected to decrease to ambient levels within a relatively short distance from the turbine foundations (Dow Piniak et al. 2012b; Elliott et al. 2019; Kraus et al. 2016; Thomsen et al. 2015). At Block Island Wind Farm, turbine noise reached ambient noise levels within 164 feet (50 meters) of the turbine foundations (Miller and Potty 2017). Monitoring data indicate that noise levels increase with higher wind speeds, which lead to higher ambient noise levels due to higher wave action (Kraus et al. 2016; Tougaard et al. 2009).

Available data on large direct-drive turbines, as proposed for this Project, are sparse. Direct-drive turbine design eliminates the gears of a conventional wind turbine, which increases the speed at which the generator spins. Direct-drive generators are larger generators that produce the same amount of power at slower rotational speeds. Only one study of direct-drive turbines presented in Elliott et al. (2019) was available in the literature. The study measured SPLs of 114 to 121 dB re 1 µPa at 164.0 feet (50 meters) for a 6 MW direct-drive turbine.

Based on measurements from WTGs 6.15 MW and smaller, Stöber and Thomsen (2021) estimated that operational noise from larger (10 MW WTG), current-generation WTGs would generate higher source levels (177 dB re 1 µPa-m) than the smaller WTG measured in earlier research. Additionally, Stöber and Thomsen (2021) estimate that a shift from gear-driven wind turbines to direct drive turbines would decrease sound levels by 10 dB, resulting in a range to the 120 dB re 1 µPa behavioral threshold of 0.9 mile (1.4 kilometer). Using the least-squares fits from Tougaard et al. (2020), SPLs from 11.5 MW turbines (in 20 m/s, gale-force wind) would be expected to fall below the same behavioral threshold within approximately 910 feet (277 meters). In lighter winds (approximately 20 knots [10 meters per second], a "fresh breeze" on the Beaufort scale), the predicted range to threshold would be only approximately 525 feet (160 meters). Both models were based on small turbines, adding uncertainty to the modeling results. Stöber and Thomsen (2021) use only the loudest measurements from each study cited. While this is reasonable practice for most sound source studies, sound from an operating WTG can be expected to correlate with wind speed and therefore with higher environmental noise. Scaling the loudest sound measurements linearly with turbine power, as the study did, will scale environmental noise up along with it and can be expected to overestimate sound levels from larger turbines. This is especially concerning as no correlation coefficient was provided to assess the goodness of fit. Tougaard et al. (2020) take wind speed into account for each of the measurements in their fit and scale the level with WTG power using a logarithmic measurement. Because of these factors, range estimates based on Tougaard et al. (2020) are considered more relevant to this assessment.

Based on the sound levels presented above, maximum noise levels anticipated from operating WTGs would below recommended PTS thresholds (**Table 3-27**) for sea turtles. Therefore, the potential for ESA-listed sea turtles to be exposed to noise above PTS thresholds is considered extremely unlikely to occur and is ***discountable***. Therefore, effects of exposure to WTG noise resulting in sound levels that exceed the PTS threshold ***may affect, but not likely to adversely affect*** green, Kemp's ridley, leatherback, and loggerhead sea turtles.

Based on the available sound levels and modeling information presented above, underwater noise from WTG operations could exceed the behavioral threshold for sea turtles (**Table 3-27**). However, more acoustic research is warranted to characterize source levels originating from large direct-drive turbines, the potential for those turbines to cause behavioral effects, and to what distance behavioral effects are likely. Given sea turtles' anticipated ability to avoid disturbing levels of noise, and the relatively rapid attenuation of WTG noise (Kraus et al. 2016; Thomsen et al. 2015), the potential for ESA-listed sea turtles to be exposed to underwater noise exceeding behavioral thresholds from WTG operations would not rise to the level of take under the ESA and is therefore considered ***insignificant***. Therefore, the effects of exposure to WTG noise resulting in sound levels that exceed the behavioral disturbance threshold ***may affect, but not likely to adversely affect*** green, Kemp's ridley, leatherback, and loggerhead sea turtles.

Summary of Underwater Noise Effects

Noise associated with impact pile driving has the potential to cause PTS in ESA-listed sea turtles. Though the mitigation measures described in Section 1.3.5 (**Tables 1-10 and 1-11**) and summarized in this section would reduce the risk of sea turtle exposures to sounds exceeding the recommended PTS threshold, such exposures may still occur for Kemp's ridley, leatherback, and loggerhead sea turtles. Therefore, the effects of exposure to impact pile driving noise resulting in sound levels that exceed the PTS threshold ***may affect, likely to adversely affect*** Kemp's, ridley, leatherback, and loggerhead sea turtles. As no exposures to sounds exceeding the PTS threshold are expected for green sea turtle, the effects of exposure to impact pile driving noise resulting in sound levels that exceed the PTS threshold ***may affect, but not likely to adversely affect*** this sea turtle species.

Noise associated with vibratory pile driving, HRG surveys, cable laying, dredging, vessels, aircraft, and WTG operation for the Proposed Action are not expected to result in injury of ESA-listed sea turtles based on the source levels. Therefore, the risk of injury associated with these noise sources leading to PTS is either ***insignificant*** or ***discountable***.

Noise levels associated with impact pile driving, vibratory pile driving, HRG surveys, cable laying, dredging, vessels, aircraft, and WTG operation could all result in behavioral effects on ESA-listed sea turtles. These effects would be temporary but could occur beyond a localized area for impact pile driving. As behavioral exposures are expected to occur for ESA-listed sea turtle species, the effects of exposure to impact pile driving noise resulting in sound levels that exceed the behavioral disturbance threshold ***may affect, likely to adversely affect*** green, Kemp's ridley, leatherback, and loggerhead sea turtles. Any behavioral effects associated with other noise sources associated with the Proposed Action would be ***insignificant***. Therefore, the effects of exposure to vibratory pile driving, HRG survey, cable-laying, dredging, vessel, aircraft, and WTG noise resulting in sound levels that exceed PTS or behavioral disturbance thresholds ***may affect, but not likely to adversely affect*** green, Kemp's ridley, leatherback, and loggerhead turtles**.**

Effects on Prey Organisms

The ESA-listed sea turtles assessed in this BA feed on a variety of prey items, including invertebrates like crabs, jellyfish, and mollusks and fish (Section 3.3.1, 3.3.2, 3.3.3, and 3.3.4). As discussed above in Section 3.2.5.2, invertebrate sound sensitivity is restricted to particle motion, and affects are expected to dissipate rapidly such that any effects are highly localized from the noise source (Edmonds et al. 2016). This indicates that the invertebrate forage base for turtles is unlikely to be measurably affected by underwater noise resulting from the Project activities.

Impact pile driving may temporarily reduce the abundance of forage fish in proximity to the activity. However, impacts to these species are unlikely to result in an effect on the survival and fitness of sea turtles based on the minimal contribution of fish to their overall diet and the ability of turtles to adjust their diet to exploit other types of prey resources when available. The effects to turtles due to reduction in prey items from underwater noise generated by the Project would be so small that they could not be meaningfully measured, detected, or evaluated and are ***insignificant***. Therefore, impacts from underwater noise sources due to the Proposed Action ***may affect, but not likely to adversely affect*** prey organisms for green, Kemp's ridley, leatherback, and loggerhead sea turtles.

3.3.5.2. Dredging Effects on Sea Turtles

Under Scenario 1 or Scenario 2 of the Proposed Action, dredging may be required for seabed preparation prior to installation of met tower or OSS foundations, sand bedform clearing prior to cable installation, and excavation of HDD pits near the cable landing site, as described in Section 1.3.1. Dredging equipment that may be used for these activities includes trailing suction hopper dredge, cutterhead dredge, and backhoe dredge.

As identified in Section 3.2.5.3, the greatest impact under either Scenario 1 or Scenario 2 would be installation of a met tower with a suction bucket jacket foundation and four large OSSs with suction bucket jacket foundations, assuming seabed preparation is required for all foundations. The least impact, in terms of dredging, under either Scenario would be installation of a met tower and ten small OSSs with piled jacket foundations, assuming seabed preparation is required for all foundations. Including seabed preparation for foundation installation (368.75 acres [1.49 square kilometers] under Scenario 1 or 339.95 acres [1.38-square kilometers] under Scenario 2), sand bedform clearing for cable installation (1,794.09 acres [7.26 square kilometers]), and backhoe dredging for the HDD pit (0.12 acres [less than 0.01 square kilometers), the greatest impact would be a 2,162.96-acre (8.75-square kilometer) area or a 2,134.17-acre (8.58-square kilometer) dredge area under Scenario 1 or Scenario 2, respectively (**Table 1-6**); the least impact would be a 2,139.78-acre (8.66-square kilometer) or a 2,097.03-acre (8.49-square kilometer) dredge area under Scenario 1 or Scenario 2, respectively. Up to approximately 5.3 million cubic yards of material may be removed under Scenario 1 (approximately 1.1 million cubic yards for seabed preparation and 4.2 million cubic yards for sand bedform clearing), and up to approximately 5.2 million cubic yards of material may be removed under Scenario 2 (approximately 1.0 million cubic yards for seabed preparation and 4.2 million cubic yards for sand bedform clearing).

Dredging would result in localized increases in TSS concentrations that would be temporary, and conditions would return to baseline in time. Effects of increased TSS concentrations on sea turtles are assessed in Section 3.2.5.5. Dredging activities may also result in direct effects through physical interactions (i.e., entrainment, impingement, or capture) between the dredge and aquatic species and indirect effects through effects on benthic prey species.

Sea turtles have been known to become entrained in trailing suction hopper dredges or trapped beneath the draghead as it moves across the seabed. Direct impacts, especially for entrainment, typically result in severe injury or mortality (Dickerson et al. 2004; USACE 2020). Sea turtles may be crushed during placement of the draghead on the seafloor, impinged if unable to escape the draghead suction and become stuck, or entrained if sucked through the draghead. Of the three direct impacts, entrainment most often results in mortality. About 69 projects have recorded sea turtle takes within channels in New Jersey, Delaware, and Virginia, and there have likely been numerous other instances not officially recorded (Ramirez et al. 2017). However, the risk of interactions between hopper dredges and individual sea turtles is expected to be lower in the open ocean areas where Project dredging may occur compared to nearshore navigational channels where sea turtles are more concentrated in a constrained operating environment (Michel et al. 2013; USACE 2020). During swimming and surfacing, sea turtles are highly unlikely to interact with the draghead. These species are most vulnerable when foraging or resting on the seafloor. Sea turtles are generally not known to be vulnerable to entrainment in cutterhead dredges given the small size of their intake and relatively low intake velocity (NMFS 2018b). Mechanical dredging, including the use of a clamshell dredge, is not expected to capture, injure, or kill sea turtles (USACE 2020).

As there are no known large aggregation areas or foraging areas where turtles would be expected to spend large amounts of time stationary on the bottom where they would be vulnerable to physical interactions with hopper dredging equipment, the risk of interactions with hopper dredging associated with the Proposed Action is low. As noted above, there is low risk of interactions between cutterhead or mechanical dredges and sea turtles. Since there is a low risk of interactions with dredging equipment proposed for the Project, physical interactions with the dredge associated with the Proposed Action are considered extremely unlikely to occur and ***discountable***. Therefore, effects of physical interactions due to Project dredging leading to injury or mortality ***may affect, but not likely to adversely affect*** green, Kemp's ridley, leatherback, and loggerhead sea turtles.

Dredging could result in short-term reductions in foraging habitat or short-term effects on prey availability for some sea turtle species (i.e., Kemp's ridley sea turtles which forage in the soft bottom habitats where dredging for the Proposed Action would occur). Dredging for the Proposed Action would not occur in areas with significant submerged aquatic vegetation (Atlantic Shores 2023a), which is used as foraging habitat for green sea turtles. Benthic communities would be expected to recover within one year of disturbance (NMFS 2017a). Though habitat disturbance and modification associated with dredging for the Proposed Action may result in reductions in foraging habitat availability or prey availability for Kemp's ridley sea turtles, these reductions would be short-term, and there would be no changes in benthic community composition. Given the small size of the area where dredging will occur relative to available foraging habitat in the action area and the short duration of dredging, the reduction in benthic prey availability would be small, temporary, and localized. Based on this analysis, we expect any impact of the reduction in prey availability for Kemp's ridley sea turtles due to dredging to be so small that it cannot be meaningfully measured, evaluated, or detected and, thus, ***insignificant***. Therefore, effects of Project dredging leading to reductions in foraging habitat or prey availability ***may affect, but not likely to adversely affect*** Kemp's ridley sea turtles. Most ESA-listed sea turtles that occur in the Project area do not forage in soft bottom habitats. Therefore, Project dredging leading to temporary impacts on the benthic habitat and benthic prey availability would be expected to have ***no effect*** on green, leatherback, or loggerhead sea turtles.

Dredging *Effects of the Connected Action*

Dredging for the Connected Action, which would be conducted with a hydraulic cutterhead dredge or mechanical dredge, may also result in physical interactions and short-term reductions in benthic habitat availability and prey availability for some aquatic species.

As noted above, sea turtles are generally not known to be vulnerable to physical interactions with cutterhead or mechanical dredges (NMFS 2018b; USACE 2020). Therefore, physical interactions due to dredging for the Connected Action is expected to have ***no effect*** on green, Kemp's ridley, leatherback, and loggerhead sea turtles.

Dredging for the Connected Action may increase water depths to -14 feet NAVD88, which is not expected to have a significant impact on benthic community composition. Dredging in the vicinity of the proposed O&M facility is not expected to alter the sediment composition compared to the existing substrate in the dredge area because the area is an existing harbor, which is subject to maintenance dredging. Given there would be no change in sediment composition, changes in benthic community composition would not be expected. Sea turtle foraging in the affected area is extremely unlikely, and the affected area would be very small relative to available foraging habitat for sea turtles. Therefore, any effects on sea turtles due to habitat disturbance and modification associated with dredging for port modifications would be ***discountable***. Therefore, temporary impacts on the benthic habitat and benthic prey availability associated with dredging for the Connected Action ***may affect, but not likely to adversely affect*** green, Kemp's ridley, leatherback, or loggerhead sea turtles.

3.3.5.3. Habitat Disturbance

Activities included in the Proposed Action would result in habitat disturbance or modifications that may cause impacts to benthic and water column habitat. Anticipated habitat disturbance or alterations may result from physical disturbance of sediment, changes in oceanographic and hydrologic conditions, conversion of soft-bottom habitat to hard-bottom habitat, and the reef effect. Following the assessment of these potential sources of habitat disturbance, a summary of overall effects to ESA-listed sea turtle species is provided.

Displacement from Physical Disturbance of Sediment

As described in Sections 1.3.1, geotechnical surveys would be conducted during the pre-construction phase of the Proposed Action under either Scenario. Geotechnical surveys may cause benthic disturbance as a result of physical seafloor sampling at specific WTG locations. Boulder relocation, a pre-lay grapnel run, and anchoring of Project vessels would also result in physical disturbance of the sediment. As identified in Section 3.2.5.4, the greatest impact of geotechnical surveys, boulder relocation, a pre-lay grapnel run, and anchoring under either Scenario would be 1,386.6 acres (5.6 square miles) of benthic habitat disturbance.

Benthic disturbance associated with the Proposed Action has the potential to reduce foraging habitat or prey availability for ESA-listed sea turtle species that forage in soft bottom habitats (i.e., Kemp's ridley sea turtle). These effects would be localized and short-term. Recolonization and recovery of prey species is expected to occur within 2 to 4 years (Van Dalfsen and Essink 2001) but could occur in as little time as 100 days (Dernie et al. 2003). Given the small size of individual disturbed areas and expected occurrence of similar, undisturbed benthic communities in the adjacent seabed, recolonization may occur relatively quickly following geotechnical surveys. Based on the short-term and localized nature of effects and the availability of similar foraging habitat throughout the action area, effects of benthic habitat disturbance associated with geotechnical surveys, boulder relocation, a pre-lay grapnel run, and anchoring for the Proposed Action would be too small to be meaningfully measured, evaluated, or detected and, thus, ***insignificant*** for Kemp's ridley sea turtle. Therefore, impacts on benthic prey associated with geotechnical surveys, boulder relocation, a pre-lay grapnel run, and anchoring for the Proposed Action ***may affect, but not likely to adversely affect*** Kemp's ridley sea turtles. Impacts on benthic prey due to geotechnical surveys, boulder relocation, a pre-lay grapnel run, and anchoring are expected to have ***no effect*** on green, leatherback, or loggerhead sea turtles.

Changes in Oceanographic and Hydrological Conditions due to the Presence of Structures

The presence of WTGs during operation of the Proposed Action may cause a variety of long-term hydrodynamic effects during O&M. A detailed description of the potential long-term, O&M effects of the presence of structures on oceanic conditions is presented in Section 3.2.5.4.

As identified in Section 3.2.5.4, the greatest oceanographic and hydrological impact for either Scenario 1 or Scenario 2 would be installation of 200 WTGs, 1 met tower, and 10 small OSSs (i.e., the greatest number of structures possible under the Proposed Action). The least impact for either Scenario 1 or Scenario 2 would be installation of 200 WTGs, 1 met tower, and 4 large OSS (i.e., the smallest number of structures possible under the Proposed Action).

Green, Kemp's ridley, and loggerhead sea turtles consume prey that are not directly affected by physical oceanographic features such as currents and upwelling. Therefore, any changes in oceanographic and hydrological conditions due to presence of structures are expected to have ***no effect*** on these species. Leatherback sea turtles consume planktonic prey that is not able to move independently of normal ocean currents. The hydrologic alterations within a smaller wind installation (i.e., 15 WTGs for South Fork Wind Farm) were anticipated to result in an increase in or aggregation of leatherback sea turtle prey, but the effect was deemed likely to be so small that it cannot be meaningfully measured, evaluated, or detected and are, therefore, ***insignificant*** (NMFS 2021c). Therefore, changes in oceanographic and hydrologic conditions due to the presence of Project structures on the OCS leading to effects on planktonic prey ***may affect, but not likely to adversely affect*** leatherback sea turtles.

Conversion of Soft-Bottom Habitat to Hard-Bottom Habitat

Installation of WTGs, OSSs, and submarine cables, and associated scour and cable protection, during construction would result in habitat conversion and loss. As described in Section 2.1.1.1, the benthic substrate is the Project area is composed predominantly of sand (i.e., soft bottom habitat). Some soft-bottom habitat would be lost due to construction and installation of the Project, and some soft-bottom and pelagic habitat would be converted to hard-bottom and hard, vertical habitat, respectively. This habitat loss and conversion would persist through the O&M phase and into decommissioning until the structure is removed. Surveys from the Project area did not identify any significant areas of submerged aquatic vegetation (Atlantic Shores 2023b). Therefore, the Proposed Action is not expected to result in conversion of submerged aquatic vegetation beds to hard-bottom habitat.

As identified in Section 3.2.5.4, the greatest habitat conversion impact for either Scenario would be four large OSSs with suction bucket jackets. The least impact for either Scenario would be ten small OSSs with piled jackets (**Table 3-20**). Scenario 1 under the Proposed Action would result in the loss or conversion of 613 to 632 acres of soft-bottom habitat (**Table 3-21**). For Scenario 2 under the Proposed Action, 555 to 593 acres of soft-bottom habitat would be lost or converted.

The loss of soft-bottom habitat in the action area could potentially affect Kemp’s ridley sea turtles, which forage in a variety of habitats including sandy or muddy bottoms (NMFS and USFWS 2015). Though loss of soft-bottom habitat would represent a loss in potential foraging habitat for this species, the habitat loss would be small relative to similar soft-bottom habitat available in the action area. Therefore, the impact of loss of soft-bottom habitat on Kemp’s ridley sea turtles would be too small to be meaningfully measured, evaluated, or detected and, thus, ***insignificant***. As other ESA-listed sea turtles do not utilize soft bottom habitats, loss of soft bottom habitat associated with the presence of Project structures is expected to have ***no effect*** on green, leatherback, and loggerhead sea turtles. Therefore, the presence of structures leading to loss of soft bottom habitat ***may affect, but not likely to adversely affect*** Kemp’s ridley sea turtles.

Concentration of Prey Species due to the Reef Effect

The installation of WTGs and OSSs would result in the conversion of soft-bottom and open-water habitat to hard-bottom and vertical habitat, respectively, which would attract and aggregate prey species through the artificial reef effect (Causon and Gill 2018; Taormina et al. 2018). As identified in Section 3.2.5.4, the greatest impact for concentration of prey species under either Scenario would result from the installation of four large OSSs with suction bucket jacket foundations. The least impact under either Scenario would be the installation of 10 small OSSs with piled jacket foundations.

Aggregation of prey species at WTG and OSS foundations may benefit some ESA-listed sea turtle species due to prey aggregation, which may result in increased foraging opportunities for these species, attracting them to the structures (Degraer et al. 2020). In the Gulf of Mexico, green, Kemp’s ridley, leatherback, and loggerhead sea turtles have been documented in the presence of offshore oil and gas platforms (Gitschlag and Herczeg 1994; Gitschlag and Renauld 1989; Hastings et al. 1976; Rosman et al. 1987), indicating that sea turtles are likely to use habitat created by in-water structures to forage. Kemp’s ridley and loggerhead sea turtles forage on hard substrate and consume prey species (i.e., crabs) expected to benefit from the reef effect. Though leatherback sea turtles are pelagic foragers and unlikely to forage on the structures themselves, their prey base (i.e., gelatinous species) may benefit from the artificial reef effect. Artificial structures provide settlement habitat for jellyfish polyps, which may contribute to jellyfish blooms

(Duarte et al. 2013). However, given the small size of the area affected and any potential resulting increase in available forage, impacts on Kemp's ridley, leatherback and loggerhead sea turtles would be too small to be meaningfully measured, detected, or evaluated and, thus, would be **insignificant**. Therefore, the presence of structures leading to concentrations of prey ***may affect, but not likely to adversely affect*** Kemp's ridley, leatherback, and loggerhead sea turtles. As green sea turtles forage on vegetation, which would not be affected by the reef effect, concentration of prey species is expected to have ***no effect*** on this species.

Summary of Habitat Disturbance Effects

Habitat disturbance associated with physical disturbance of sediment would be short-term and localized to a small area. Therefore, associated impacts on Kemp's ridley sea turtle, which forages in soft bottom habitats, would be ***insignificant***. Habitat conversion and loss associated with WTGs, OSSs, scour protection, and cable protection may reduce foraging habitat for Kemp's ridley sea turtles, but given the relatively small area of habitat loss, its impact would be ***insignificant***. Other ESA-listed sea turtles do not use soft-bottom habitat and would therefore not be affected by sediment disturbance or habitat conversion. Changes in oceanographic and hydrological conditions may affect prey species for leatherback sea turtles, but the impact of these changes is expected to be ***insignificant***. Such changes are expected to have no effect on prey species and forage items for green, Kemp's ridley, and loggerhead sea turtles. The presence of structures leading to concentration of prey through the reef effect may lead to a localized increase in prey resources for Kemp's ridley, leatherback, and loggerhead sea turtles. However, the impact of this increase would be ***insignificant***. No effects on green sea turtle forage items are expected. Given the insignificant impacts anticipated, the effects of habitat disturbance from the proposed action ***may affect, but not likely to adversely affect*** green, Kemp's ridley, leatherback, and loggerhead sea turtles.

3.3.5.4. Secondary Entanglement due to an Increased Presence of Recreational Fishing in Response to Reef Effect

The aggregation of prey species described in Section 3.3.5.3 may also result in increased recreational fishing activity in the vicinity of the WTGs and OSSs. An increase in recreational fishing activity increases the risk of sea turtles becoming entangled in or ingesting lost fishing gear, which could result in injury or death. Specifically, entanglement and hooking can cause abrasions, loss of limbs, or increased drag resulting in reduced swimming efficiency and decreased ability to forage or avoid predators (Berreiros and Raykov 2014; Gregory 2009; Vegter et al. 2014). Between 2016 and 2018, 186 sea turtles were observed to have been hooked or entangled by recreational fishing gear. If there is an increase in recreational fishing in the Project area, it is likely that this will represent a shift in fishing effort from areas outside the wind farm area to within the wind farm area, though an increase in overall effort cannot be discounted. Given vessel safety concerns regarding being too close to foundations and other vessels, the likelihood of recreational fishermen aggregating around the same turbine foundation at the same time is low. Leatherback and loggerhead sea turtles, which forage in pelagic habitats, are more likely to be exposed to recreational fishing lines in the pelagic Lease Area. However, Kemp's ridley sea turtles may forage on the hard substrate associated with scour protection and may be exposed to any recreational fishing gear that reaches the benthic environment. Green sea turtles, which forage on benthic vegetation that does not occur in the Lease Area, are less likely to be exposed to recreational fishing lines around Project structures.

The presence of offshore structures associated with the Proposed Action could displace commercial or recreational fishing vessels to areas outside of the Lease Area or potentially lead to a shift in gear types due to displacement. Assuming fishing vessels are displaced to adjacent areas, risk of interaction with fishing vessels would not be greater than current risk. If displacement leads to an overall shift from mobile to fixed gear types, there could be an increased number of vertical lines in the water, increasing the risk of interactions between ESA-listed sea turtles and fixed fishing gear.

Given the low exposure risk for green sea turtles, entanglement in recreational fishing gear around Project structures is extremely unlikely to occur and, thus, ***discountable***. Therefore, secondary entanglement due to increased recreational fishing associated with Project structures ***may affect, but not likely to adversely affect*** green sea turtles. The risk of secondary entanglement cannot be discounted for the other ESA-listed sea turtles. Therefore, potential secondary entanglement due to increased recreational fishing associated with Project structures ***may affect, likely to adversely affect*** Kemp's ridley, leatherback, and loggerhead sea turtles.

3.3.5.5. Turbidity

Construction activities for the Proposed Action would include pile driving for foundation installation, cable-laying activities for installation of inter-array and export cables, and dredging for seabed preparation, sandform clearing, and HDD pits. These activities would disturb bottom sediment, resulting in short-term increases in turbidity in the action area. The greatest impact under either Scenario, as identified in Section 3.2.5.6, would result from installation of a met tower with a gravity foundation and four large OSSs with gravity foundations. The least impact under either Scenario would be the installation of a met tower and OSSs with piled or suction bucket foundations.

As described in Section 3.2.5.6, pile driving activities are expected to produce TSS concentrations of approximately 5.0 to 10.0 mg/L above background levels within approximately 300 feet (91 meters) of the pile being driven (NMFS 2020c citing FHWA 2012). Cable installation activities are expected to produce maximum TSS concentrations of approximately 235.0 mg/L at 65 feet (20 meters) (NMFS 2020c citing ESS Group 2008). Sediment transport analysis conducted for the Project predicted that the sediment plumes at above ambient concentrations (≥ 10 mg/L) would extend between 1.1 and 1.8 miles (1.7 and 2.9 kilometers) from cable routes or the Lease Area but would dissipate to ambient levels within two to four hours (COP Volume II, Appendix II-J3; Atlantic Shores 2023a).

TSS concentrations associated with cutterhead dredge sediment plumes typically range from 11.5 to 282.0 mg/L with the highest levels (550.0 mg/L) detected adjacent to the cutterhead dredge (NMFS 2020c citing USACE 2005, 2010, 2015b; NMFS 2020c citing Nightingale and Simenstad 2001), and elevated suspended sediment levels are expected to be present only within a 984 to 1,640 feet (300 to 500 meters) radius (NMFS 2020c citing USACE 1983; NMFS 2020c citing Hayes et al. 2000; NMFS 2020c citing LaSalle 1990). Elevated TSS concentrations associated with mechanical dredging could reach 445.0 mg/L (NMFS 2020c citing USACE 2001) and would occur within a radius of up to 2,400 feet (732 meters) (NMFS 2020c citing Burton 1993; NMFS 2020c citing USACE 2015a). Elevated TSS concentrations associated with hopper dredging could reach 475.0 mg/L (NMFS 2020c citing Anchor Environmental 2003) and would occur within a radius of up to 3,937 feet (1,200 meters) (NMFS 2020c citing Wilber and Clarke 2001).

As sea turtles may occur within portions of the action area affected by pile driving, cable laying, and dredging, increased turbidity associated with Project activities could potentially affect these species. There are no data to indicate suspended sediment has physiological effects on sea turtles. However, elevated suspended sediment may cause sea turtles to alter their normal movements and behaviors as sea turtles would be expected to avoid the area of elevated suspended sediment. Such alterations are expected to be too small to be meaningfully measured or detected (NMFS 2020c). Suspended sediment is most likely to impact sea turtles if the area of elevated concentrations acts as a barrier to movement or normal behaviors. Given the limited spatial scale of the sediment plumes relative to the size of the action area, increased suspended sediment concentrations associated with Project activities are not expected to obstruct the movement of sea turtles in the action area. No adverse effects are anticipated due to sea turtles swimming through the area of elevated suspended sediment or avoiding the area (NMFS 2020c).

In addition to direct effects on sea turtle behavior, suspended sediment can indirectly affect sea turtles through impacts to prey species, including benthic mollusks, crustaceans, sponges, and sea pens.

Elevated suspended sediment concentrations are shown to have adverse effects on benthic communities when they exceed 390 mg/L (NMFS 2020c citing USEPA 1986). Given anticipated TSS concentrations associated with Project dredging, it is anticipated that there may be a short-term impact on the availability of benthic prey species within the area of direct impact; however, it is anticipated that this area would be recolonized within a short period of time after the completion of dredging. Turbidity can also affect submerged aquatic vegetation (e.g., eelgrass), which is a forage item for green sea turtles. Surveys from the Project area, which included the areas that could be dredged for seabed preparation, sand bedform clearing, and HDD pit excavation, did not identify any significant areas of submerged aquatic vegetation (Atlantic Shores 2023). Therefore, turbidity associated with the Proposed Action is not expected to affect submerged aquatic vegetation beds.

Runoff from shoreside construction in the vicinity of the planned O&M Facility in Atlantic City, NJ and the cable landfall sites has the potential to result in localized effects on water quality due to increased turbidity. Turbidity effects associated with shoreside construction would be lower than turbidity effects associated with dredging, and measures would be in place to minimize water quality impacts associated with shoreside construction (e.g., utilization of silt curtains). As turbidity effects associated with shoreside construction during port modifications would be lower than those associated with dredging, shoreside construction is not expected to obstruct movements of ESA-listed sea turtle species; any reductions in benthic prey species would be negligible.

As described above, any effects from increased turbidity levels from construction activities for the Proposed Action on sea turtles or their prey would be isolated and temporary and are so small that they could not be measured, detected, or evaluated and are therefore ***insignificant***. Therefore, the effects of increased turbidity levels from Project construction activities ***may affect, but not likely to adversely affect*** green, Kemp's ridley, leatherback, and loggerhead sea turtles.

Turbidity Effects of the Connected Action

The Connected Action would include hydraulic cutterhead or mechanical dredging. As described in Section 3.3.5.2, dredging would result in localized increases in TSS concentrations. Elevated TSS concentrations associated with cutterhead dredging could reach 550.0 mg/L and would occur within a radius of up to 1,640 feet (500 meters). Best management practices to reduce turbidity (e.g., slow bucket withdrawal) would be used. Given the use of best management practices and low anticipated sea turtle density in the vicinity of the planned O&M facility, turbidity effects associated with dredging for the Connected Action are not expected to obstruct sea turtle movements, and any reductions in benthic prey species would be too small to be meaningfully measured, detected, or evaluated and, thus, ***insignificant***. Therefore, turbidity effects due to dredging for the Connected Action ***may affect, but not likely to adversely affect*** green, Kemp's ridley, leatherback, and loggerhead sea turtles.

3.3.5.6. Vessel Traffic

As detailed in Section 1.3, a variety of vessels would be used to construct, operate, and decommission the Proposed Action (**Table 1-7**). Maximum estimates for the number of vessels required for a single construction activity range from 2 to 16 vessels. In the unlikely event that all construction activities for Project 1 and Project 2, including HRG surveys, foundation installation, scour protection installation, WTG installation, OSS installation, inter-array cable installation, export cable installation, and fuel bunkering, were to occur simultaneously, up to 51 vessels could be operating at a given time. There are no anticipated differences in vessel traffic between Scenario 1 and Scenario 2 under the Proposed Action, and foundation selection for the met tower and OSSs is not expected to affect required vessel trips. Vessel trip information for each anticipated port, divided by Project phase, is provided in **Table 1-9**. Vessel trip information for each vessel type associated with foundation installation is provided in **Table 3-22**. Vessel traffic associated with the Proposed Action could affect ESA-listed sea turtles through vessel strikes. Though not anticipated, Project vessel traffic may result in discharges of fuel, fluids, hazardous material, trash, or debris from Project vessels. In addition to increased risk of vessel strike, vessels produce underwater noise, which was evaluated in Section 3.3.5.1. Vessels would also produce artificial lighting, which is addressed in Section 3.3.5.10, and air emissions, which are addressed in Section 3.3.5.9. Though not anticipated, Project vessel traffic may result in discharges of fuel, fluids, hazardous material, trash, or debris from Project vessels, which are addressed in Section 3.3.5.11.

As described in Section 3.2.5.7, an estimated 1,745 vessel round trips are expected to occur between the Lease Area and ports in New Jersey, Virginia, and Texas over the three-year construction period (**Table 1-9**), which represents a 28 percent increase in traffic in the Lease Area and a 2 percent increase in traffic in waters offshore of Delaware and New Jersey compared to existing traffic (**Table 3-23**). Seventy two percent of construction vessel trips would be between the Lease Area and the New Jersey Wind Port. Eighteen percent of trips would be between the Lease Area and Atlantic City, New Jersey, and 7 percent of trips would be between the Lease Area and Paulsboro, New Jersey. Repauno, New Jersey, Portsmouth, Virginia, and Corpus Christi, Texas are each expected to receive 20 trips (approximately 1 percent of construction vessel traffic) from Project vessels. During the O&M phase, an estimated 1,861 vessel round trips (3,722 one-way trips) are expected to occur annually between the Lease Area and ports in New Jersey and Virginia, (**Table 1-9**) which represents a 91 percent increase in traffic compared to existing vessel traffic in the Lease Area and a 5 percent increase in traffic in waters offshore of Delaware and New Jersey (**Table 3-23**). During the O&M phase, 98 percent of annual vessel trips would be between the Lease Area and Atlantic City. Approximately 2 percent of annual vessel trips would be between the Lease Area and the New Jersey Wind Port. Remaining O&M vessel traffic would be split approximately evenly between ports in Paulsboro, Repauno, Portsmouth. Vessel traffic during decommissioning is expected to be similar to the construction phase.

The Proposed Action would result in increased risk of vessel strike for sea turtles as a result of Project vessel traffic during the construction, O&M, and decommissioning phases of the Project. Vessel strikes are a known source of injury and mortality for sea turtles (Chaloupka et al. 2008). Fifty to 500 loggerhead sea turtles and five to 50 Kemp's ridley sea turtles are estimated to be killed by vessel traffic per year in the United States (NRC 1990). This report is dated and also indicates that this estimate is highly uncertain and could be a large overestimate or underestimate. Though a known threat, vessel strikes may be an increasing concern for these species. The percentage of stranded loggerhead sea turtles with injuries that were apparently caused by vessel strikes increased from approximately 10 percent in the 1980s to over 20 percent in 2004, although some stranded turtles may have been struck post-mortem (NMFS and USFWS 2007). Evidence indicates that observed vessel strike injuries are indicative of the cause of death. Foley et al. (2019) determined that vessel strike or probable vessel strike was the cause of death for large majority (93 percent) of stranded sea turtles with vessel strike injuries. Sea turtles are expected to be most vulnerable to vessel strikes in coastal foraging areas and may not be able to avoid collisions when vessel speeds exceed 2 knots (Hazel et al. 2007).

Data are lacking on the types of vessels most commonly involved in sea turtles strikes. However, correlation between sea turtles strikes and levels of recreational boat traffic have been observed (NRC 1990). As noted in Section 1.3, average vessel speeds for most Project vessels are expected to be below 10 knots (**Table 1-8**). This slow speed would reduce risk of vessel strike for sea turtles, but these species would still be vulnerable when vessels travel over 2 knots.

Aside from vessel speed and type, several factors contribute to the probability of vessel strikes, including sea turtle submergence rates, sea turtle density (**Table 3-24**), time of year, vessel trip numbers (**Table 1-9**), and vessel trip distances. Sea turtles spend at least 20 to 30 percent of their time at the ocean surface (Lutcavage et al. 1997) during which they would be vulnerable to being struck by vessels or struck by vessel propellers. Sea turtles, with the exception of hatchlings and pre-recruitment juveniles, spend a majority of their time submerged (Renaud and Carpenter 1994; Sasso and Witzell 2006), during which time they may be less susceptible to vessel strikes. However, most sea turtles generally prefer to stay within approximately 10 feet (3 meters) of the water surface (Hazel et al. 2007), indicating that they may still be vulnerable to vessel strike when submerged. Leatherback sea turtles only spend approximately 20 percent of their time within 32 feet (10 meters) of the water surface (Borcuk et al. 2017; Watwood and Buonantony 2012), indicating that this species may be less vulnerable to ship strike than other ESA-listed sea turtles. A would occur, as specified in **Table 1-9**.

Increased vessel traffic associated with construction of the Proposed Action will be relatively short-term and localized and is anticipated to represent a minor addition to normal traffic in the area from commercial shipping, personal recreational vessels, passenger vessels, military vessels, and commercial/recreational fishing vessels. As described above, the majority of Project vessel trips are relatively short-distance trips to ports in New Jersey, transiting waters with relatively low sea turtle densities (i.e., north of the Virginia-North Carolina border). For these transits, vessels would traverse waters with relatively low sea turtle densities (**Table 3-24**), with the highest approximate density being estimated for loggerhead sea turtles at around 0.69 turtle per mi^2 (2.59 km^2). At this density, vessel collisions would be statistically unlikely. Vessels transiting from the Gulf of Mexico could potentially traverse waters where sea turtle abundance may be significantly higher. However, there would be a limited number (20) of these long-distance trips into waters with higher sea turtle densities (i.e., south of the Virginia-North Carolina border). Based on the density of sea turtles in the Project area and a maximum of 1,745 total vessel round trips over the 3-year construction and installation period, considered relative to existing vessel traffic, there is a low risk of Project vessel collision with a sea turtle during the construction phase of the Project.

There are limited measures that have been proven to be effective at reducing collisions between sea turtles and vessels (Schoeman et al. 2020). Also, the relatively small size of turtles and the significant time spent below the surface makes their observation by vessel operators extremely difficult. Nevertheless, the use of lookouts and other measures described below and detailed in **Table 1-11** would serve to reduce potential collisions. Atlantic Shores has proposed the use of dedicated lookouts to reduce the risk of collisions with marine mammals and sea turtles (MAR-03, SEA-01) and site-specific training on vessel strike avoidance measures for all crew members (MAR-03, SEA-01). Atlantic Shores has proposed additional measures to avoid, minimize, and mitigate impacts associated with vessel traffic on marine mammals, including vessel speed restrictions and collision avoidance measures (MAR-01, MAR-04), which would also benefit sea turtles. Additional measures to address vessel strike are proposed by BOEM in this BA (Section 1.3.5, **Table 1-11**). These additional measures include utilization of a trained lookout to observe for sea turtles on all vessels operating south of the Virginia/North Carolina border, where sea turtles are present year-round an on vessels operating north of the Virginia/North Carolina border from July 1 through November 30. The trained lookout would monitor https://seaturtlesightings.org/ prior to each trip and report any observations of sea turtles in the vicinity of the planned transit to all vessel operators/captains and lookouts on duty that day. The trained lookout would maintain a vigilant watch and monitor a Vessel Strike Avoidance Zone (1,640 feet [500 meters]) at all times to maintain minimum separation distances from ESA-listed sea turtle species. Alternative monitoring technology (e.g., night vision, thermal cameras, etc.) would be available to ensure effective watch at night and in any other low visibility conditions. Additional measures also include vessel strike avoidance actions when a sea turtle is sighted within 328 feet (100 meters) of the operating vessel’s forward path, including slowing 4 knots (2 meters per second) (unless unsafe to do so) and then proceeding away from the turtle at a speed of 4 knots (2 meters per second) or less until there is a separation distance of at least 328 feet (100 meters). If a sea turtle is sighted within 164 feet (50 meters) of the forward path of the operating vessel, the vessel operator would shift to neutral when safe to do so and then proceed away from the turtle at a speed of 4 knots (2 meters per second). BOEM-proposed measures also include avoidance of areas of visible jellyfish aggregations or floating sargassum lines or mats or speed reductions (i.e., slowing to 4 knots [2 meters per second]) when such areas cannot be avoided. Although the relatively small size of sea turtles and the significant time spent below the surface makes their observation by vessel operators extremely difficult, the use of trained lookouts and other measures described above and detailed in **Table 1-11** would serve to reduce potential collisions.

Although the speed restrictions in certain areas (10 knots) would reduce potential impacts, sea turtle collisions may still occur at slow speeds. Therefore, BOEM has proposed reporting requirements to document the amount or extent of sea turtle take that occurs during all phases of the Proposed Action. During the construction phase and for the first year of operations, monthly reports would detail all project activities carried out in the previous month, including vessel transits (number, type of vessel, and route), and piles installed, and all observations of ESA-listed species. Beginning in year 2 of operations, Atlantic Shores would compile and submit annual reports that include a summary of all project activities carried out in the previous year, including the same information as noted above. Additionally, BOEM and NMFS would meet twice during the first year of project operation to review sea turtle observation records, in September (to review observations through August of that year) and December (to review observations from September to November). The best available information on sea turtle presence, distribution, and abundance, project vessel activity, and observations would be used to estimate the total number of sea turtle vessel strikes in the action area that are attributable to project operations. These meetings would continue on an annual basis following year 1 of operations. Upon mutual agreement of NMFS and BOEM, the frequency of these meetings could be changed. BOEM proposed measures are designed to avoid vessel strikes on sea turtles by reducing vessel speed within important habitat areas or in situations when collision risk may be greatest (**Table 1-11**). For example, Hazel et al. (2007) suggested that there are two situations where speed restrictions may be particularly valuable in protecting sea turtles: (1) where vessels travel across shallow turtle foraging habitat, and (2) where vessels use deeper channels between shoal banks that offer foraging opportunities for turtles. Although not yet proposed by Ocean Wind or BOEM, additional speed reduction measures may be considered in the future for vessel transits through loggerhead sea turtle critical habitat.

Atlantic Shores has estimated that Project O&M would involve daily trips of CTVs, or approximately 1,825 CTV round trips annually, originating from the Atlantic City O&M facility. While the lack of in-water hull reduces the likelihood of a subsurface collision with CTVs, sea turtles resting or breathing on the surface could be affected. Additionally, the high rate of speed of these vessels allows less reaction time from the sea turtles and for the vessel operator conducting a maneuver to avoid the sea turtle. As described above, Atlantic Shores has voluntarily committed to specific measures and BOEM is requiring additional measures, including vessel speed restrictions to avoid and minimize vessel-related risks to marine mammals and dedicated lookouts to reduce risks to sea turtles (**Tables 1-10 and 1-11**). Based on the density of sea turtles in the Project area and a maximum of approximately 1,861 annual round trips during O&M, there is a moderate risk of encountering a sea turtle. Based on the analysis above, the effects of Project vessel traffic leading to vessel strikes of sea turtles are unlikely given the relatively small increase in vessel traffic (an approximately 2 percent increase in vessel traffic in the region during construction and an approximately 5 percent increase in vessel traffic in the region during O&M, as described in Section 3.2.5.7), the seasonality of sea turtle occurrence, and sea turtle densities in the Project area. Given that vessel strikes are unlikely to occur and ***discountable,*** the effects of vessel traffic resulting in vessel strike due to the Proposed Action ***may affect, but not likely to adversely affect*** green, Kemp's ridley, leatherback, and loggerhead sea turtles.

3.3.5.7. Monitoring Surveys

As described in Section 1.3.4, biological monitoring studies for the Proposed Action include otter trawl surveys, trap surveys, hydraulic clam dredge surveys, grab sampling, and underwater imagery. Some of these biological monitoring efforts have the potential to result in capture or entanglement of ESA-listed species or effects on prey or habitat for ESA-listed species. Trawl, trap, and dredge surveys have the potential to capture or entangle ESA-listed species. Survey methods that capture organisms or result in habitat disturbance have the potential to affect prey or habitat for ESA-listed species.

Trawl Surveys

Sea turtle species are susceptible to capture in trawl nets, which may result in injury or death. The capture and mortality of sea turtles in bottom trawl fisheries is well documented (Henwood and Stuntz 1987; NRC 1990; NMFS and USFWS 1991, 1992, 2008). As discussed in recovery plans and 5-year status reviews for all sea turtle species, reduction of sea turtle interactions with fisheries is a priority where these species occur (NMFS and USFWS 1991, 1992, 2015a, 2015b, 2019, 2020b; Conant et al. 2009; NMFS et al. 2011). Finkbeiner et al. (2011) compiled sea turtle bycatch in U.S. fisheries and found that in the Atlantic, a mean estimate of 137,700 interactions, of which 4,500 were lethal, occurred annually since the implementation of bycatch mitigation measures. However, a vast majority of the interactions (98%) and mortalities (80%) occurred in the Southeast/Gulf of Mexico shrimp trawl fishery.

While sea turtles are capable of remaining submerged for long periods of time, they appear to rapidly consume oxygen stores when entangled and forcibly submerged in fishing gear (Lutcavage and Lutz 1997). Limiting tow times to less than thirty minutes is expected to prevent mortality of sea turtles in trawl nets (Epperly et al. 2002; Sasso and Epperly 2006). For the Proposed Action, tow times would be limited to 20 minutes, posing a negligible risk of mortality to ESA-listed sea turtles. This limitation would be expected to eliminate the risk of serious injury and mortality from forced submergence for sea turtles caught in the otter trawl survey gear. While no mortality is expected from proposed otter trawl surveys, incidentally captured individuals would suffer stress and potential injury. Metabolic changes that impair a sea turtle's ability to function can occur within minutes of forced submergence. In the unlikely event that forced submergence occurs, oxygen stores are rapidly consumed, anaerobic glycolysis is activated, and acid-base balance is disturbed, sometimes on lethal levels (NMFS 2012b).

Table 3-34 provides quantitative estimates of sea turtle captures and mortalities under the Proposed Action based on the take estimates for the Northeast Fisheries Science Center trawl survey.

Table 3-34. Estimated Annual Takes of Sea Turtles in Fisheries Monitoring Trawl based on Estimated Future Annual Takes during the Northeast Fisheries Science Center Trawl Survey

Survey	NEFSC Trawl[1]		Fisheries Monitoring Trawl Survey[2]	
Species	Captures	Serious Injuries/Mortalities	Captures	Serious Injuries/Mortalities
Green	(14.7) 15 turtles	(0.19) 1 turtle	(1.8) 2 turtles	0
Kemp's ridley	(13.1) 14 turtles	(0.2) 1 turtle	(1.6) 2 turtles	0
Leatherback	(0.1) 1 turtle	0	0	0
Loggerhead	(0.1) 1 turtle	0	0	0
Total	31 turtles	2 turtles	4 turtles	0 turtles

NEFSC = Northeast Fisheries Science Ceter
[1] Source: NMFS 2021b. Original take calculations were first presented in NMFS (2014). Parenthetical numbers are estimated takes and the number of potential takes is rounded up to a whole number to represent potential turtle takes.
[2] Extrapolation from NMFS (2021b) to the Proposed Action was accomplished by multiplying the estimated take per species by 0.12 (amount of yearly effort of fisheries monitoring trawl surveys [36 hours] compared to yearly effort of NEFSC trawl [300 hours]) and rounded up to a whole number to represent potential turtle takes.

Based on the limited tow times, mortality of ESA-listed sea turtles in trawl surveys is extremely unlikely to occur and is ***discountable***. Therefore, trawl surveys from Project monitoring activities leading to morality ***may affect, but not likely to adversely affect*** green, Kemp's ridley, leatherback, and loggerhead sea turtles. The potential for sea turtles to be captured in trawl surveys cannot be discounted. Therefore, trawl surveys from Project monitoring activities leading to potential capture and/or minor injury ***may***

affect, likely to adversely affect small numbers (i.e., up to four) green, Kemp's ridley, leatherback, and loggerhead sea turtles. As shown in **Table 3-34**, only minor injuries are anticipated, and no serious injuries/mortalities are expected.

Trap Surveys

Ventless traps have the potential to entangle sea turtles in lines and floats. Of all the Atlantic sea turtles, the leatherback seems to be the most vulnerable to entanglement in trap/pot fishing gear, possibly due to its physical characteristics, diving, and foraging behaviors; distributional overlap with the gear; and the potential attraction to prey items that collect on buoys and buoy lines at or near the surface (NMFS 2021b). Individuals entangled in pot gear generally have a reduced ability to forage, dive, surface, breathe, or perform other behaviors essential for survival (Balazs 1985). In addition to mortality, gear entanglement can restrict blood flow to extremities and result in tissue necrosis and death from infection. Individuals that survive may lose limbs or limb function, decreasing their ability to avoid predators and vessel strikes. There is a risk of sea turtle entanglement, particularly for leatherbacks in trap or pot gear. Ventless trap surveys for the Proposed Action would utilize groundlines, ropeless gear, and biodegradable components to reduce entanglement risk, therefore, entanglement in trap gear is extremely unlikely to occur and are ***discountable***. Thus, trap surveys for Project monitoring activities leading to potential mortality, capture, and/or minor injury ***may affect, but not likely to adversely affect*** green, Kemp's ridley, leatherback, and loggerhead sea turtles.

Hydraulic Clam Dredge Surveys

The equipment used in the clam survey poses minimal risk to sea turtles. Tows for the clam survey have a very short duration. Given the short soak time and the extremely unlikely possibility for mortality or serious injury to sea turtles, the clam survey poses minimal risk to sea turtles in the Project area. In the event of a sea turtle capture, survey vessels would be required to carry adequate disentanglement equipment and crew trained in proper handling and disentanglement procedures (**Table 1-11**).

Given the short duration of the tow times, the potential for entanglement or capture of ESA-listed sea turtles in clam survey equipment is considered extremely unlikely to occur and is ***discountable***. Therefore, clam dredge surveys for Project monitoring activities leading to potential mortality, capture, and/or minor injury ***may affect, but not likely to adversely affect*** green, Kemp's ridley, leatherback, and loggerhead sea turtles.

Prey and Habitat Effects

Sea turtle prey items may be captured in trawl, trap, or dredge surveys. Sea turtle prey items such as horseshoe crabs, other crabs, whelks, and fish are removed from the marine environment as bycatch in trawls and trap gear. None of these are typical prey species of leatherback sea turtles or of neritic juvenile or adult green sea turtles. Therefore, the trawl surveys for the Project would not affect the availability of prey for these species in the action area. Neritic juveniles and adults of both loggerhead and Kemp's ridley sea turtles are known to feed on these species that may be caught as bycatch in the bottom trawls. However, all bycatch is expected to be returned to the water alive, dead, or injured to the extent that the organisms would shortly die. Injured or deceased bycatch would still be available as prey for sea turtles, particularly loggerhead sea turtles, which are known to eat a variety of live prey as well as scavenge dead organisms.

Dredge equipment would be towed along the bottom for a short duration. Leatherback sea turtles feed on pelagic prey. Therefore, clam surveys would not affect leatherback sea turtle prey availability. While Kemp's ridley and loggerhead sea turtle prey may be captured in the clam dredge, the relatively small area covered and the fact that collected organisms will be returned to the water result in an unlikely effect on Kemp's ridley and loggerhead sea turtle prey. Clam dredging would likely remove SAV foraged on by green sea turtles. However, the tows are not expected to occur in areas where SAV occurs. Therefore, clam dredging is extremely unlikely to impact green sea turtle prey.

Given this information, any effects on sea turtles from collection of potential sea turtle prey and forage items in monitoring surveys will be so small that they cannot be meaningfully measured, detected, or evaluated and, therefore, effects are considered ***insignificant***. Therefore, Project monitoring surveys leading to potential reduction in availability of prey or forage items ***may affect, but not likely to adversely affect*** green, Kemp's ridley, and loggerhead sea turtles. As monitoring surveys are not expected to collect or affect leatherback prey, Project monitoring surveys leading to potential reduction in prey availability is expected to have ***no effect*** on leatherback sea turtles.

Disturbance of soft-bottom habitat in the action area during monitoring surveys could potentially affect Kemp's ridley sea turtles, which forage in the soft-bottom habitats where monitoring surveys would occur. However, such disturbance would be temporary and would affect a relatively small area of available habitat in the action area. Therefore, impacts of monitoring surveys on availability of foraging habitat would be too small to be meaningfully measured, detected, or evaluated, and are ***insignificant***. Therefore, Project monitoring surveys leading to potential reduction in foraging habitat availability ***may affect, but not likely to adversely affect*** Kemp's ridley sea turtles. As monitoring surveys are not expected to collect or affect green, leatherback, or loggerhead foraging habitat, Project monitoring surveys leading to potential reduction in foraging habitat is expected to have ***no effect*** on these species.

3.3.5.8. Electromagnetic Fields and Heat

The Proposed Action, under either Scenario 1 and Scenario 2, would include installation of up to 342 miles (550 kilometers) of export cables, 37 miles (60 kilometers) of interlink cables, and 584 miles (990 kilometers) of interarray cables, increasing the production of EMF and heat in the action area. EMF and heat effects would be reduced by cable burial to an appropriate depth and the use of shielding, if necessary.

Sea turtles are capable of detecting magnetic fields (Lohmann and Lohmann 1996; Normandeau et al. 2011; Putman et al. 2015), and behavioral responses to such fields have been documented (Luschi et al. 2007). The threshold for behavioral responses varies somewhat among species. Loggerhead sea turtles have exhibited responses to field intensities ranging from 0.0047 to 4,000 microteslas, and green sea turtles have responded to field intensities ranging from 29.3 to 200 microteslas (Normandeau et al. 2011); other species are expected to have similar thresholds due to similar anatomical features, behaviors, and life history characteristics. Juvenile and adult sea turtles may detect EMFs when foraging on benthic prey or resting on the bottom in relatively close proximity to cables. There are no data on EMF impacts on sea turtles associated with underwater cables. Migratory disruptions have been documented in sea turtles with magnets attached to their heads (Luschi et al. 2007), but evidence that EMF associated with future offshore wind activities would likely result in some deviations from direct migration routes is lacking (Snoek et al. 2016). Any deviations are expected to be minor (Normandeau et al. 2011), and any increased energy expenditure due to these deviations would not be biologically significant. Atlantic Shores would bury cables to a minimum depth of 5 to 6.6 feet (1.5 to 2.0 meters) wherever possible. In areas where sufficient cable burial is not feasible, surface cable protection would be utilized. Any potential impacts on ESA-listed sea turtles from EMF associated with the Proposed Action are expected to be too small to be measured and are, ***insignificant***. Therefore, the effects of EMF from the Project ***may affect, but not likely to adversely affect*** green, Kemp's ridley, leatherback, and loggerhead sea turtles**.**

Buried submarine cables can warm the surrounding sediment in contact with the cables up to tens of centimeters (Taormina et al. 2018). There are no data on cable heat effects on sea turtles (Taormina et al. 2018). However, increased heat in the sediment could affect benthic organisms which serve as prey for sea turtles that forage in the benthos. Based on the narrowness of cable corridors and expected weakness of thermal radiation, impacts on benthic organisms are not expected to be significant (Taormina et al.

2018) and would be limited to a small area around the cable. Given the expected cable burial depths, thermal effects would not occur at the surface of the seabed where benthic-feeding sea turtles would forage. Therefore, any effects on sea turtle prey availability would be too small to be detected or meaningfully measured and are ***insignificant***. Therefore, the effects of cable heat from the Project leading to reduction in prey ***may affect, but not likely to adversely affect*** Kemp's ridley and loggerhead sea turtles. As green and leatherback sea turtles do not forage on benthic invertebrates, there would be ***no effect*** on these species.

3.3.5.9. Air Emissions

Air emissions would be generated during the construction, O&M, and decommissioning phases of the Proposed Action, including both Scenario 1 and Scenario 2. Emissions would primarily be generated by Project vessels and the installation equipment on board Project vessels. Atlantic Shores has conducted an air emissions inventory for the Proposed Action, provided in Appendix II-C of the COP (Atlantic Shores 2023a).

Operation of Project vessels and WTG installation equipment during construction would result in short-term increases in Project-related air emissions. During O&M, operation of Project vessels would result in long-term increases in emissions related to the Proposed Action. However, estimated air emissions from O&M activities would generally be lower than emissions generated during construction activities and are not expected to have a significant effect on regional air quality. Air emissions during decommissioning are expected to be similar or less than emissions estimated for construction activities. Atlantic Shores has proposed measures to avoid and minimize air emissions effects, including the use of low-sulfur fuels, the use of vessels that meet Best Available Control Technology and Lowest Achievable Emission Rate requirements, and minimization of engine idling time. Air pollutant concentrations associated with the Proposed Action are not expected to exceed National Ambient Air Quality Standards or New Jersey Ambient Air Quality Standards. Therefore, BOEM anticipates that air quality impacts from Project emissions would be minor.

The effects of air pollution on sea turtles are not well-studied, and air emissions are not a stressor of concern for these species (BOEM 2019a). Given that long-term effects on regional air quality are expected to be insignificant and that the net benefits of replacing fossil-fuel burning power plants with offshore wind farms are expected to improve air quality, the air emissions produced by Project vessels are expected to have ***no effect*** on ESA-listed sea turtles.

3.3.5.10. Lighting of Structures and Vessels

Vessels and offshore structures associated with future offshore wind activity would have deck and safety lighting, producing artificial light during the construction, O&M, and decommissioning phases of the Proposed Action, including Scenario 1 and Scenario 2. Offshore structures would have yellow flashing navigational lighting and red flashing FAA hazard lights, in accordance with BOEM's (2021c) lighting and marking guidelines. Following these guidelines, direct lighting would be avoided, and indirect lighting of the water surface would be minimized to the greatest extent practicable.

The flashing lights on offshore structures associated with the Proposed Action are unlikely to disorient juvenile or adult sea turtles, as they do not present a continuous light source (Orr et al. 2013). However, lighting on vessels and offshore structures could elicit attraction, avoidance, or other behavioral responses in sea turtles. In laboratory experiments, juvenile loggerhead sea turtles consistently oriented toward lightsticks of various colors and types used by pelagic longline fisheries (Wang et al. 2019), indicating that hard-shelled sea turtle species expected to occur in the vicinity of the Projects (i.e., green, Kemp's ridley, and loggerhead) could be attracted to offshore light sources. In contrast, juvenile leatherback sea turtles failed to orient toward or oriented away from lights in laboratory experiments (Gless et al. 2008), indicating that this species may not be attracted to offshore lighting. There is no evidence that lighting on oil and gas platforms in the Gulf of Mexico, which may have considerably more lighting than offshore WTGs, has had any effect on sea turtles over decades of operation (BOEM 2019b). Any behavioral responses to offshore lighting are expected to be localized and temporary.

Atlantic Shores would light WTGs and OSSs in compliance with FAA and USCG standards and BOEM best practices (VIS-04). Atlantic Shores has additionally proposed to consider the use of an ADLS to minimize the time that FAA-required lighting is illuminated on the offshore structures associated with the Proposed Action (BIR-04, BAT-03, VIS-05). With the application of these measures the potential effects on sea turtles from lighting are likely so small that they cannot be meaningfully measured, detected, or evaluated and are ***insignificant***. Therefore, effects of lighting of vessels and offshore structures associated with the Proposed Action ***may affect, but not likely to adversely affect*** green, Kemp's ridley, leatherback, and loggerhead sea turtles.

3.3.5.11. Unexpected/Unanticipated Events

Unexpected or unanticipated events with the potential to affect sea turtles could occur during the construction, O&M, or decommissioning phases of the Proposed Action. Such events would include vessel collisions or allisions (i.e., collisions with stationary structures), severe weather events resulting in equipment failure, oil spills, or encounters with unexploded ordinance.

Vessel collisions or allisions may result in oil spills. Such events are considered unlikely given the lighting requirements for Project vessels and offshore structures, vessel speed restrictions, proposed spacing of Project structures, inclusion of Project structures on navigational charts, and Notices to Mariners issued by the U.S. Coast Guard. Therefore, effects on sea turtles due to vessel collisions or allisions are extremely unlikely to occur and are ***discountable***.

The Lease Area may be affected by extratropical storms, which are common in the area between October and April, or hurricanes. The high winds associated with these events have the potential to result in the failure of WTGs. However, the WTGs will be designed to withstand site-specific weather conditions, including winter storms, hurricanes, and tropical storms. The WTGs will be suitable for sites with wind speeds of up to 127.5 miles per hour (57 meters per second) and gusts of up to 178.5 miles per hour (79.8 meters per second). Therefore, such a failure is highly unlikely and effects on sea turtles associated with WTG failure are extremely unlikely to occur and are ***discountable***.

Vessel traffic associated with the Proposed Action would increase the risk of accidental releases of fuels, fluids, and hazardous materials. Project vessel activities are expected to adhere to USCG regulations for the prevention and control of oil spills (Atlantic Shores 2023a). Given the relatively small volumes of fuels, fluids, and hazardous materials potentially involved and the likelihood of release occurrence, the increase in accidental releases associated Project vessel discharges is expected to fall below the range of releases that occur on an ongoing basis from other activities. There would also be a low risk of leaks of fuel, fluid, or hazardous materials from any of the 200 WTGs anticipated for the Project. The total volume of WTG fuels, fluids, and hazardous materials associated with the Proposed Action was not estimated for Atlantic Shores but such a leak is expected to be unlikely (Atlantic Shores 2023a). BOEM has modeled the risk of spills associated with WTGs and determined that, at maximum, a release of 129,000 gallons is likely to occur no more frequently than once every 1,000 years and a release of 2,000 gallons or less is likely to occur every 50 to 100 years (Bejarano et al. 2013). Sea turtle exposure to oil spills through aquatic contact or inhalation of fumes can result in death (Shigenaka et al. 2010) or sublethal effects, including but not limited to adrenal effects, dehydration, hematological effects, increased disease incidence, hepatological effects, poor body condition, and dermal and musculoskeletal effects (Bembenek-Bailey et al. 2019; Camacho et al. 2013; Mitchelmore et al. 2017; Shigenaka et al. 2010; Vargo et al. 1986). Such sublethal effects would affect individual fitness but are not expected to affect sea turtle populations. Atlantic Shores has developed an OSRP (COP Volume II, Appendix II-C; Atlantic Shores 2023a) with measures to avoid accidental releases and a protocol to respond to such a release if one occurs. Given the low likelihood of occurrence, effects of oil spills on ESA-listed sea turtles are extremely unlikely to occur and are ***discountable***.

As described in Section 1.3.1, the export cable route would be surveyed and cleared for UXO prior to cable installation. A study of munitions and explosives of concern has been conducted and an associated hazard assessment has been provided to BOEM under confidential cover as part of the COP (see Volume II, Appendix II-A). This study indicated that the likelihood of encountering munitions and explosives of concern during construction of the Proposed Action is low. In the event that UXO are found during construction, Atlantic Shores would implement a mitigation strategy to avoid UXO. At this time, no UXO detonation is planned. Given that UXO encounters or responses are extremely unlikely, effects on ESA-listed species are extremely unlikely to occur and are ***discountable***.

As all effects of unexpected/unanticipated events would be ***discountable***, unexpected/unanticipated events associated with the Proposed Action ***may affect, but not likely to adversely affect*** green, Kemp's ridley, leatherback, or loggerhead sea turtles.

3.4. MARINE FISH

Following is a description of the existing conditions for ESA-listed marine fish in the action area, accompanied by the detailed effects assessment for each stressor on ESA-listed marine fish.

Two ESA-listed fish species, Atlantic sturgeon and shortnose sturgeon (*Acipenser brevirostrum*), are likely to occur in the Project area.

3.4.1 Atlantic Sturgeon

3.4.1.1. Description and Life History

Atlantic sturgeon is an anadromous species. This species is benthic-oriented and large-bodied, reaching a maximum total length of approximately 13.1 feet (4 meters) (Bain 1997). Atlantic sturgeon is also long-lived, reaching a maximum age of approximately 60 years (Gilbert 1989). Males reach sexual maturity at about 12 years of age, and females spawn for the first time at 15 years of age or older (Able and Fahay 2010; Bain 1997). Atlantic sturgeon spawn interannually, and spawning periods vary between sexes. Males spawn every one to five years while females spawn every two to five years (Vladykov and Greeley 1963). During spawning, females deposit eggs over hard substrate (e.g., gravel, cobble, and rock) where they are fertilized externally by the males.

Atlantic sturgeon eggs are adhesive and remain attached to hard substrate on the spawning grounds during incubation. Larvae hatch approximately four to six days after fertilization (ASSRT 2007; Mohler 2003). Yolk-sac larvae remain closely associated with benthic substrate on spawning areas (Bain et al. 2000). Yolk-sac absorption occurs over 8 to 12 days. Post yolk-sac larvae are active swimmers but continue to remain closely associated with benthic substrate for approximately two weeks following yolk-sac absorption (ASMFC 2012). Following yolk-sac absorption, juvenile Atlantic sturgeon emerge from the substrate to begin foraging and start their downstream migration (Kynard and Horgan 2002). Juveniles generally remain in their natal river for at least two years (ASMFC 2012). Subadults make their first migration into marine habitats at four to eight years of age (ASSRT 2007). Prior to reaching sexual maturity, subadults return to their natal rivers to forage in the spring and summer months. Adult Atlantic sturgeon spend a majority of their time in marine habitats, often undertaking long-distance migrations along the Atlantic coast, and return to freshwater habitats in their natal rivers to spawn (Bain 1997).

Atlantic sturgeon undergo an ontogenetic shift in diet as they age. Post yolk-sac larvae feed on plankton then transition to benthic omnivores at older life stages. Juvenile diets include aquatic insects and other invertebrates. Subadults and adults consume bivalves, gastropods, amphipods, isopods, polychaete and oligochaete worms, and demersal fish (Able and Fahay 2010; ASSRT 2007; Bigelow and Schroeder

1953). Foraging studies indicate that larger Atlantic sturgeon have a strong preference for polychaetes; these data also show that isopods make up a larger portion of Atlantic sturgeon diets than amphipods (McLean et al. 2013 citing Dadswell 2006; Guilbard et al. 2007; McLean et al. 2013 citing Haley 1999; Johnson et al. 1997; Krebs et al. 2017; McLean et al. 2013; McLean et al. 2013 citing Savoy 2007). Though Atlantic sturgeon are known to forage on small fish, including sand lance (*Ammodytes* spp.), Atlantic tomcod (*Microgadus tomcod*), and American eel (*Anguilla rostrata*), the importance of fish in Atlantic sturgeon diet made up may vary with body size and location (Guilbard et al. 2007; Johnson et al. 1997; Krebs et al. 2017; McLean et al. 2013; Scott and Crossman 1973).

The sturgeon family (Acipenseridae) have a well-developed inner ear that lacks a connection to the swim bladder, indicating that the swim bladder is not involved in hearing. The hearing capabilities of Atlantic sturgeon are unknown. However, inferences may be drawn from hearing studies in other sturgeon species, including the closely-related lake sturgeon (*Acipenser fulvescens*). These studies indicate a generalized hearing range from 50 to approximately 700 Hz, with the greatest sensitivity between 100 and 300 Hz (Lovell et al. 2005; Meyer et al. 2010). Studies measuring the physiological responses of the ear of European sturgeon (*A. sturio*) suggest sturgeon may be capable of detecting sounds ranging in frequency from below 300 Hz to about 1 kHz (Popper 2005).

3.4.1.2. Status and Population Trend

Atlantic sturgeon in the United States are divided into five DPSs: Gulf of Maine, New York Bight, Chesapeake Bay, Carolina, and South Atlantic. In 2012, the New York Bight, Chesapeake Bay, Carolina, and South Atlantic DPSs were listed as endangered, and the Gulf of Maine DPS was listed as threatened (NMFS 2012a, 2012c). Based on genetic analysis of Atlantic sturgeon collected in the vicinity of the New York WEA, sturgeon from the Gulf of Maine, New York Bight, Chesapeake Bay, and South Atlantic DPSs could occur in the Project area. Individuals from the Carolina DPS could also occur in the portion of the action area associated with vessel transits to and from the Gulf of Mexico.

Gulf of Maine DPS

The Gulf of Maine DPS encompasses all Atlantic sturgeon spawned in watersheds from the Maine/Canada border south to Chatham, MA. For its 2020 Biological Opinion (BiOp) on the utilization of New York Offshore Borrow Areas, NMFS (2020a) estimated oceanic abundance for the Gulf of Maine DPS at 7,455 fish, based on data from the Northeast Area Monitoring and Assessment Program (NEAMAP). This DPS has not shown any significant trend in abundance since 2000 and is currently depleted relative to historic levels (ASMFC 2017). Fisheries bycatch and habitat disturbance associated with dredging and other in-water activities are the primary threats for the Gulf of Maine DPS. This DPS may also be affected by degraded water quality (NMFS 2020a).

New York Bight DPS

The New York Bight DPS encompasses all Atlantic sturgeon spawned in watersheds from Chatham, MA south to the Delaware-Maryland border on Fenwick Island. For its 2020 BiOp on the utilization of New York Offshore Borrow Areas, NMFS (2020a) estimated oceanic abundance for the New York Bight DPS at 34,566 fish, based on NEAMAP data. Though this DPS has displayed an increasing trend in abundance since 1998, it is currently depleted relative to historic levels (ASMFC 2017). Degraded water quality, habitat disturbance, fisheries bycatch, and vessel strikes are significant threats for the New York Bight DPS (NMFS 2020a).

Chesapeake DPS

The Chesapeake DPS is composed of all Atlantic sturgeon spawned in Chesapeake Bay watersheds as well as coastal watersheds from Fenwick Island at the Delaware-Maryland border to Cape Henry, VA. Using NEAMAP data, NMFS (2020a) estimated the oceanic population abundance of the Chesapeake

DPS at 8,811 fish for its BiOp for New York Offshore Borrow Areas. This DPS has not shown any significant trend in abundance since 1998 and is depleted relative to historic levels (ASMFC 2017). Similar to the New York Bight DPS, impaired water quality, habitat disturbance, bycatch, and vessel strikes pose threats to the Chesapeake DPS (NMFS 2020a).

Carolina DPS

The Carolina DPS encompasses all Atlantic sturgeon spawned in watersheds from Albemarle Sound south to Charleston Harbor. For its 2020 BiOp on the utilization of New York Offshore Borrow Areas, NMFS (2020a) estimated oceanic abundance for the Carolina DPS at 1,353 fish, based on NEAMAP data. Though some indices for this DPS have displayed an increasing trend in abundance, the Carolina DPS is currently depleted relative to historic levels (ASMFC 2017). Habitat disturbance or inaccessibility and fisheries bycatch are significant threats for this DPS (NMFS 2020a).

South Atlantic DPS

The South Atlantic DPS is made up of Atlantic sturgeon spawned from the Ashepoo, Combahee, and Edisto Rivers basin in South Carolina south to the St. Johns River, FL. As part of its BiOp for New York Offshore Borrow Areas, NMFS (2020a) estimated that the oceanic population abundance for the South Atlantic DPS is 14,911, based on NEAMAP data. This population is considered depleted relative to historic levels and has been stable since 2004 (ASMFC 2017). Main threats to this species include bycatch, habitat disturbance, degraded water quality, and water allocation issues (NMFS 2020a).

3.4.1.3. Distribution and Habitat Use

Atlantic sturgeon are distributed from Labrador, Canada to Cape Canaveral, Florida. In the mid-Atlantic, spawning adults migrate upstream during April and May (Able and Fahay 2010). After spawning, females return to coastal waters within four to six weeks. Males may remain in freshwater habitats into the fall (Able and Fahay 2010).

Juvenile, subadult, and adult Atlantic sturgeon are expected to occur seasonally in the action area. No Atlantic sturgeon were present in Northeast Fisheries Science Center (NEFSC) seasonal trawl surveys within the New Jersey WEA between 2003 and 2016 (Guida et al. 2017). Generally, this species is expected to migrate in spring from marine habitats to inshore coastal waters and return to marine habitats in the fall. Atlantic sturgeon may occur in the offshore portion of the Project Area during fall and winter during migration (Atlantic Shores 2023a).

3.4.2 Shortnose Sturgeon

3.4.2.1. Description and Life History

Shortnose sturgeon is a benthic-oriented anadromous fish species. Compared to other sturgeon, shortnose sturgeon are relatively small, with a maximum total length of approximately 3.6 feet (1.1 meters) (Bain 1997). In the Mid-Atlantic region, female shortnose sturgeon reach sexual maturing at six to ten years of age. Males mature at three to five years of age (Dadswell et al. 1984). Shortnose sturgeon spawn interannually, and spawning intervals vary between the sexes with females spawning every three years and males spawning every two years (Dadswell 1979; SSSRT 2010). The spawning migration begins in late March or early April, and spawning occurs in upstream spawning habitats through early May (SSSRT 2010). Similar to Atlantic sturgeon, female shortnose sturgeon broadcast demersal, adhesive eggs over hard substrates where they are externally fertilized (Able and Fahay 2010).

Shortnose sturgeon eggs hatch approximately 8 to 13 days after fertilization (SSSRT 2010), and yolk-sac absorption occurs over 9 to 12 days (Buckley and Kynard 1981). Once the yolk-sac is absorbed, larvae begin actively feeding and migrating downstream (Kynard and Horgan 2002). Juveniles remain upstream of the salt front for the first year (Dadswell et al. 1984; Kynard 1997).

Shortnose sturgeon also undergo an ontogenetic shift in diet. Larvae consume zooplankton (Buckley and Kynard 1981). As juveniles, shortnose sturgeon feed mainly on benthic crustaceans and insect larvae (Pottle and Dadswell 1979, as cited in Able and Fahay 2010; Carlson and Simpson 1987, as cited in Able and Fahay 2010). In adults, mollusks make up the most significant portion of shortnose sturgeon diets, though adults also feed on polychaetes and small benthic fish (e.g., American eel and winter flounder) (McCleave et al. 1977; Dadswell et al. 1984).

As described in Section 3.4.1, the sturgeon family has a well-developed inner ear that lacks a connection to the swim bladder, indicating that the swim bladder is not involved in hearing. The hearing capabilities of shortnose sturgeon are unknown. However, inferences may be drawn from hearing studies in other sturgeon species, which indicate a generalized hearing range from 50 to approximately 700 Hz, with the greatest sensitivity between 100 and 300 Hz (Lovell et al. 2005; Meyer et al. 2010). Studies measuring the physiological responses of the sturgeon ear suggest sturgeon may be capable of detecting sounds ranging in frequency from below 300 Hz to about 1 kHz (Popper 2005).

3.4.2.2. Status and Population Trend

The shortnose sturgeon is listed as endangered throughout its range (USFWS 1967). There is no current range-wide population estimate for this species. Northeastern populations are generally larger than populations found in the Southeast (SSRT 2010). The population in the northeast is currently below its historic size but is considered stable (Kynard et al. 2016).

3.4.2.3. Distribution and Habitat Use

Shortnose sturgeon occur from New Brunswick, Canada to the Saint Johns River in Florida. The nearest shortnose sturgeon populations are in the Delaware River to the south of the Project Area and in the Hudson River to the north. However, shortnose sturgeon rarely leave their natal rivers (Bemis and Kynard 1997; Zydlewski et al. 2011). The Hudson River population is almost exclusively confined to the river (Kynard et al. 2016; Pendleton et al. 2019), differing from other populations that may use coastal waters to move into smaller coastal rivers nearby. Also, shortnose sturgeon in Delaware River have rarely been documented to migrate south of Philadelphia, PA (O'Herron et al. 1993; Dadswell et al. 1984; Brundage and Meadows 1982). Therefore, occurrence of this species in the action area is likely limited to the Delaware River.

3.4.3 Effects Analysis for Marine Fish

3.4.3.1. Underwater Noise

High levels of underwater noise have the potential to result in take of ESA-listed species in the action area. The Proposed Action would generate temporary noise during the construction phase and long-term noise during the O&M phase. Underwater noise sources associated with the Proposed Action would include impact pile driving, vibratory pile driving, HRG surveys, cable laying, vessels, aircraft, and WTGs. Following the assessment of these noise sources, a summary of overall underwater noise effects to ESA-listed fish species is provided.

Acoustic Criteria

Acoustic criteria to assess the potential effects to fish were developed by FHWG (2008) and are presented in **Table 3-35**. These criteria include thresholds for activities that generate impulsive noise (e.g., impact pile driving) and activities that generate non-impulsive noise (e.g., vibratory pile driving). Pile driving criteria include dual metrics which are used to assess effects to fish exposed to high levels of accumulated energy (SEL or $L_{E,24h}$) for repeated impulsive sounds and to a single strike (L_{pk}). The criteria include a maximum accumulated SEL for lower-level signals and a maximum L_{pk} for a single pile-driving strike (FHWG 2008). NMFS has not established a formal threshold for behavioral disturbance, however, the

150 dB re 1 µPa L_{rms} threshold is typically used and was applied to all noise sources to assess the behavioral response of fish (Andersson et al. 2007; Wysocki et al. 2007; Mueller-Blenkle et al. 2010; Purser and Radford 2011).

The Fisheries Hydroacoustic Working Group (FHWG) was formed in 2004 and consists of biologists from NMFS, USFWS, Federal Highway Administration, USACE, and the California, Washington, and Oregon Departments of Transportation, supported by national experts on underwater sound producing activities that affect fish and wildlife species of concern. In June 2008, the agencies signed a memorandum of agreement documenting criterion for assessing physiological effects of impact pile driving on fish. The criteria were developed for the acoustic levels at which physiological effects to fish could be expected. The FHWG outlines thresholds for fish greater and less than 2 grams in weight for the onset of physiological effects (Stadler and Woodbury 2009), and not necessarily levels at which fish are mortally damaged. These criteria were developed to apply to all fish species.

Table 3-35. Acoustic Metrics and Thresholds for Fish Included in this Analysis

Fish Type	Injury[1]		Behavior[2]
	L_{pk}[3]	$L_{E,\ 24hr}$[4]	L_{rms}[3]
Fish equal to or greater than 2 grams	206	187	150

[1] Applies to impulsive noise sources; Source: FHWG 2008
[2] Applied to impulsive and non-impulsive noise sources; Sources: Andersson et al. 2007; Mueler-Blenkle et al. 2010; Purser and Radford 2011; Wysocki et al. 2007
[3] Measured in decibels referenced to 1 microPascal
[4] Measured in decibels referenced to 1 microPascal squared second

Assessment of Underwater Noise Effects

Impact Pile Driving

Impact pile driving would occur during construction to install WTG and OSS foundations (Section 1.3.1). Impact pile driving generates intense, impulsive underwater noise that may result in physiological or behavioral effects in aquatic species. The severity of the effect is dependent on the received sound level (i.e., the sound level to which the organism is exposed), which is a function of the sound level generated by the noise source, the distance between the source and the organism, and the duration of sound exposure. Underwater sound propagation modeling for impact pile driving was conducted in support of the COP (COP Volume II, Appendix II-L; Atlantic Shores 2023a).

Impact pile driving noise can cause behavioral changes, physiological effects (including TTS), or mortality in fish. Behavioral effects vary among individuals and include, but are not limited to, startle responses, cessation of activity, and avoidance. Extended exposure to mid-level noise or brief exposure to extremely loud sound can cause PTS, which leads to long-term loss of hearing sensitivity. Less-intense noise may cause TTS, resulting in short-term, reversible loss of hearing acuity (Buehler et al. 2015). Developmental abnormalities in early life stages of fishes resulting from pile-driving noise have been documented (Hawkins and Popper 2017; Weilgart 2018). Pile-driving noise could also result in reduced reproductive success while pile-driving is occurring, particularly in species that spawn in aggregate. Pile-driving noise may injure or kill early life stages of finfish and invertebrates at short distances (Hawkins and Popper 2017; Weilgart 2018).

<u>Modeling Approach</u>

Underwater sound propagation modeling for impact pile driving was conducted in support of the COP (COP Volume II, Appendix II-L; Atlantic Shores 2023a). Details regarding the modeling are presented in Section 3.2.5.2. For fish, animal movement was not used to determine exposure ranges, and the number of fish potentially exposed to noises above thresholds was not estimated. ***Modeling Results – Acoustic Ranges (Injury and Behavioral Disturbance)***

To estimate radial distances (i.e., acoustic ranges) to injury thresholds for impact pile driving, fish injury thresholds from the Fisheries Hydroacoustic Working Group (2008) and Stadler and Woodbury (2009) (**Table 3-35**) were used. ESA-listed fish evaluated in this BA include subadult and adult Atlantic sturgeon (i.e., fish larger than 2 grams). To estimate radial distances to behavioral thresholds for fish, criteria developed by the NMFS Greater Atlantic Regional Fisheries Office (Andersson et al. 2007; Mueller-Blenkle et al. 2010; Purser and Radford 2011; Wysocki et al. 2007) were used (**Table 3-35**). For 49-foot (15-meter) monopiles and 16-foot (5-meter) pin piles, impact pile driving sound levels with 10 dB of noise attenuation of 10 dB, could exceed recommended injury thresholds for Atlantic sturgeon within 3.72 miles (5.99 kilometers) and 4.01 miles (6.45 kilometers), respectively (**Tables 3-36 and 3-37**).

Table 3-36. Fish Acoustic Ranges for Monopiles with 10 dB of Noise Attenuation

Faunal Group	49-foot (15-meter)			39-foot (12-meter)		
	Inj.		BD	Inj.		BD
	L_{pk}	$L_{E, 24hr}$	L_{rms}	L_{pk}	$L_{E, 24hr}$	L_{rms}
Fish equal to or greater than 2 grams	0.07 mi (0.11 km)	3.72 mi (5.99 km)	4.49 mi (7.23 km)	0.07 mi (0.11 km)	3.46 mi (5.57 km)	4.42 mi (7.12 km)

BD = behavioral disturbance; dB = decibel; Inj. = injury; mi = mile; km = kilometer;
Source: COP Volume II, Appendix II-L, Tables F-94 and F-97; Atlantic Shores 2023a.
Note: Estimates are based on installation of one monopile per day.

Table 3-37. Fish Acoustic Ranges for 16-foot (5-meter) Pin Piles with 10 dB of Noise Attenuation

Faunal Group	Inj.		BD
	L_{pk}	$L_{E, 24hr}$	L_{rms}
Fish equal to or greater than 2 grams	0.06 mi (0.09 km)	4.01 mi (6.45 km)	4.10 mi (6.60 km)

BD = behavioral disturbance; dB = decibel; Inj. = injury; mi = mile; km = kilometer.
Source: COP Volume II, Appendix II-L, Tables F-101 and F-102; Atlantic Shores 2023a.
Note: Estimates are based on installation of four pin piles per day.

Effects Analysis

Effects of Exposure to Noise Above the Physiological Thresholds

Modeling indicates that for a single pile strike to result in physiological injury, sturgeon would need to be within 370 feet (110 meters) of a 49-foot (15-meter) monopile (**Table 3-36**) and 264 feet (80 meters) of a pin pile (**Table 3-37**) (based on the 206 dB re 1 µPa L_{pk} threshold). Based on the best available information on use of the Lease Area by Atlantic sturgeon, including the capture of Atlantic sturgeon during surveys conducted at similar water depths (Dunton et al. 2010), we expect Atlantic sturgeon to occur at least occasionally in the Lease Area, where they could be exposed to pile driving noise. Individuals present in the area will likely occur intermittently, moving through the Lease Area throughout their spring and fall migrations and may forage opportunistically in areas where benthic invertebrates are present. The area is not known to be a preferred foraging area and has not been identified as an aggregation area, which reduces the potential for impact to this species from impact pile-driving noise. Co-occurrence in time and space is considered extremely unlikely to occur given the dispersed distribution of Atlantic sturgeon in the Lease Area and the small area where exposure to peak noise could occur (extending 370 feet [110 meters] from the pile) and is therefore ***discountable*** for this species.

Shortnose sturgeon are not expected to occur in the portion of the action area affected by impact pile driving noise.

Considering cumulative thresholds, modeling indicates that physiological effects to Atlantic sturgeon may be possible up to 3.72 miles (5.99 km) from impact pile driving of 49-foot (15-meter) monopile foundations and 4.01 miles (6.45 km) from impact pile driving of pin piles (**Tables 3-36 and 3-37**). For injury to occur, however, sturgeon would need to remain within these distances for the duration of the activity. Atlantic Shores would implement measures to avoid, minimize, and mitigate impacts of pile-driving noise on fish, including using soft-start procedures (FIN-09) and noise attenuation (FIN-10). With the implementation of soft starts, the potential for serious injury may be reduced. Soft starts would facilitate a gradual increase of hammer blow energy to allow marine life to leave the area prior to the start of operations at full energy that could result in injury. The potential for injury is also minimized by using a noise mitigation system during all impact pile-driving operations.

Based on this analysis, the potential for Atlantic sturgeon to be exposed to cumulative noise that could result in physiological injury is considered extremely unlikely occur and is therefore ***discountable***. Therefore, the effects of exposure to impact pile driving noise resulting in sound levels exceeding the physiological injury threshold ***may affect, but not likely to adversely affect*** Atlantic sturgeon. As shortnose sturgeon would not occur in the area ensonified by impact pile driving noise, impact pile driving noise associated with the Proposed Action would have ***no effect*** on this species.

Effects of Exposure to Noise Above the Behavioral Thresholds

Modeling indicates that behavioral disturbance to Atlantic sturgeon may be possible up to 4.49 miles (7.23 km) from impact pile driving of 49-foot (15-meter) monopile foundations and 4.10 miles (6.60 km) from impact pile driving of pin piles (**Tables 3-36 and 3-37**). Several studies have been conducted on the behavioral response of fish to impulsive noise sources. Those that have been published show varying results, ranging from avoidance (moving out of the affected area or into deeper water; Dalen and Knutsen 1987; Slotte et al. 2004) to minor changes in behavior (Hassel et al. 2004; Wardle et al. 2001) or no reaction at all (Peña et al. 2013).

As stated above, the potential for Atlantic sturgeon to be present in the Lease Area is considered possible but would occur intermittently, and no preferred foraging areas or aggregation areas have been identified in the Lease Area. Therefore, Atlantic sturgeon could be exposed to noises above the behavioral threshold and may avoid the area. However, avoidance of preferred foraging areas and prevention of access to spawning or overwintering areas would not occur; only cessation of opportunistic foraging during migration periods is expected. Should an exposure occur, it would be temporary with effects dissipating once the activity had ceased or the individual had left the area. Potential effects would be brief (e.g., Atlantic sturgeon may approach the noisy area and divert away from it), and any effects from this brief exposure would be so small that they could not be measured, detected, or evaluated and would therefore be ***insignificant***. Therefore, the effects of exposure to impact pile driving noise resulting in sound levels that exceed the behavioral disturbance threshold ***may affect, but not likely to adversely affect*** Atlantic sturgeon. As shortnose sturgeon would not occur in the area ensonified by impact pile driving noise, impact pile driving noise associated with the Proposed Action would have ***no effect*** on this species.

Atlantic Shores would implement measures to avoid, minimize, and mitigate impacts of pile-driving noise on fish, including using soft-start procedures (FIN-09), which would allow time for fish to leave the area and avoid exposure, and noise attenuation (FIN-10), which would reduce noise levels. With these measures in place, the likelihood of injuries to fish is expected to be minimal.

Vibratory Pile Driving

Vibratory pile driving would occur under Scenario 1 or Scenario 2 over approximately sixteen days during construction to install and remove temporary offshore cofferdams at the exit point of HDD for each of the export cable landfalls and would not occur between Memorial Day and Labor Day. Vibratory pile driving generates non-impulsive underwater noise with lower source levels than impact pile driving. In a study of vibratory and impact pile driving noise associated with sheet pile installation, vibratory pile driving maximum peak sound levels were less than 185 dB re 1 µPa, and sound exposure levels (accumulated over two seconds) were below 188 dB re 1 $\mu Pa^2 s$ at distances of 5 to 23 feet (1.5 to 7 meters) (Hart Crowser and Illingworth and Rodkin 2009). Comparatively, impact hammer maximum peak sound levels reached 195 dB re 1 µPa at 16 feet (5 meters) (Hart Crowser and Illingworth and Rodkin 2009). Noise impacts from non-impulsive noise sources are generally less severe compared to impacts from impulsive noise sources. Due to the relatively lower exposure levels and short duration, vibratory hammer installation noise is unlikely to result in greater noise impacts than impact hammer pile driving described in the previous section.

<u>Effects of Exposure to Noise Above the Behavioral Threshold</u>

Maximum root mean squared sound pressure levels (L_{rms}) measured by Illingworth and Rodkin (2017), which were used to model sound propagation of vibratory pile driving for marine mammals to support Atlantic Shores' LOA application (Section 3.2.4.2), reached 170 dB re 1 µPa at 32.8 feet (10 meters) from the source, exceeding the behavioral threshold for fish (**Table 3-35**). Therefore, Atlantic sturgeon could potentially be exposed to sound levels exceeding their behavioral threshold. However, vibratory pile driving would be limited to a relatively short duration (i.e., 32 days), and Atlantic sturgeon are expected to avoid areas ensonified by sound levels exceeding their behavioral threshold. Therefore, any behavioral effects would likely be brief, and impacts of this brief exposure would likely be too small to be measured, detected, or evaluated and are ***insignificant***. Therefore, the effects of exposure to vibratory pile driving noise resulting in sound levels that exceed the behavioral disturbance threshold ***may affect, but not likely to adversely affect*** Atlantic sturgeon. As shortnose sturgeon would not occur in the area ensonified by vibratory pile driving noise, vibratory pile driving noise associated with the Proposed Action would have ***no effect*** on this species.

High Resolution Geophysical Surveys

G&G surveys for the Proposed Action would occur prior to installation of offshore cables and during the O&M phase of the Project (Section 1.3). Such surveys can generate high-intensity, impulsive noise that has the potential to result in physiological or behavioral effects in aquatic organisms. G&G surveys for the Proposed Action include HRG surveys, which produce less-intense noise and operate in smaller areas than other G&G survey equipment. Several HRG survey sources not likely to be detectable by Atlantic sturgeon as they operate above the hearing sensitivity of this species (above 1 kHz) (**Table 3-16**).

BOEM completed a desktop analysis of nineteen HRG sources in Crocker and Fratantonio (2016) to evaluate the distance to acoustic thresholds for listed species (BOEM 2021b). To provide the greatest impact in these calculations, the highest power level setting for each piece of equipment and most sensitive frequency for each species were used (when the equipment had the option for multiple user settings); a worst-case exposure scenario of 60 continuous minutes was used for fish. All sources were analyzed at a tow speed of 4.5 knots (2.3 m/s), the expected speed of HRG vessels while conducting surveys. Distances to potential onset of physiological injury using the FHWG (2008) thresholds were calculated. Using a spherical spreading model ($20 \log(r)$), BOEM also calculated the distances to the behavioral threshold for fish (i.e., 150 dB re 1 µPa SPL). A summary of the results from the desktop analysis (BOEM 2021b) is presented in **Table 3-38**.

Table 3-38. Summary of Distances (Meters) to Injury and Behavioral Thresholds for Fish from Mobile HRG Sources

HRG Sources	Inj.		BD
	L_{pk}	$L_{E, 24hr}$	L_{rms}
Impulsive, Intermittent Sources			
Boomers, Bubble Guns	3.2	0	708
Sparkers	9	0	1,996[1]
Chirp Sub-Bottom Profilers	N/A	N/A	32
Non-Impulsive, Intermittent Sources			
Multi-beam echosounder (100 kHz)	N/A	N/A	N/A
Multi-beam echosounder (>200 kHz)	N/A	N/A	N/A
Side-scan sonar (>200 kHz)	N/A	N/A	N/A

[1] The calculated distance to the 150 dB rms threshold for the Applied Acoustics Dura-Spark is 1,996 m; however, the distances for other equipment in this category is significantly smaller

Notes: Assumed vessel moving at speeds of 4.5 knots; fish thresholds were taken from FHWG (2008); Spreadsheet and geometric spreading models do not consider the tow depth and directionality of the sources; therefore, these are likely overestimates of actual disturbance distances

Effects of Exposure to Noise Above the Physiological Injury Thresholds

As noted above, several of the HRG survey sources are not likely to be detectable by Atlantic sturgeon as they operate above the hearing sensitivity of this species; distances for these sources are shown in **Table 3-38** as not applicable (N/A). Therefore, physiological injury thresholds are not expected to be exceeded for chirp sub-bottom profilers or non-impulsive HRG survey sources; therefore, these sources would have ***no effect*** on Atlantic sturgeon.

The Applicant has indicated they may use side-scan sonar, multi-beam echosounder, or sub-bottom profilers for HRG surveys for the Proposed Action. The analysis conducted by BOEM (2021b) indicates that none of this equipment would be expected to exceed physiological injury thresholds for Atlantic sturgeon (**Table 3-38**). Therefore, there would be ***no effect*** on Atlantic sturgeon. As shortnose sturgeon would not occur in the area ensonified by HRG surveys, HRG survey noise associated with the Proposed Action would have ***no effect*** on this species.

Effects of Exposure to Noise Above the Behavioral Thresholds

The analysis conducted by BOEM (2021b) indicates that sub-bottom profilers could exceed behavioral thresholds for Atlantic sturgeon at 105 feet (32 meters). However, as the survey equipment is secured to the survey vessel or towed behind a survey vessel and is only turned on when the vessel is traveling along a survey transect, the potential effects are transient and intermittent. Should an exposure occur, the potential effects would be brief (e.g., Atlantic sturgeon may approach the equipment and divert away from it), and no avoidance of preferred foraging area or known aggregation areas is considered likely. Effects of this brief exposure could result in displacement from opportunistic feeding areas; however, any impacts associated with this avoidance would be so small that they could not be measured, detected, or evaluated and are therefore ***insignificant***. Therefore, the effects of exposure to HRG survey noise resulting in sound levels that exceed the behavioral disturbance threshold ***may affect, but not likely to adversely affect*** Atlantic sturgeon. As shortnose sturgeon would not occur in the area ensonified by HRG surveys, HRG survey noise associated with the Proposed Action would have ***no effect*** on this species.

Cable Laying

Noise-producing activities associated with cable laying during construction include trenching, plowing, and backfilling. The action of laying the cables on the seafloor itself is unlikely to generate high levels of underwater noise. Most of the noise energy would originate from the vessels themselves including propellor cavitation noise and noise generated by onboard thruster/stabilization systems and machinery (e.g., generators), including noise emitted by the tugs when moving the anchors.

There is limited information regarding underwater noise generated by cable-laying and burial activities in the literature. Johansson and Andersson (2012) recorded underwater noise levels generated during a comparable operation involving pipelaying and a fleet of nine vessels. Mean noise levels of 130.5 dB re 1 µPa were measured at 0.9 mi (1.5 km) from the source. Reported noise levels generated during a jet trenching operation provided a source level estimate of 178 dB re 1 µPa-m (Nedwell et al. 2003). Modeled impact ranges to perceived noise levels that would induce 100 percent avoidance behavior in fish (cod, dab, herring, and salmon) were predicted to be 3 feet (1 meter) or less from cable laying activities (Nedwell et al. 2012). For perceived noise levels that would generate a behavioral reaction in about 85 percent of fish, modeled ranges were predicted to be from 3 to 217 feet (1 to 66 meters) for cable laying (Nedwell et al. 2012). As the cable-laying vessel and equipment would be continually moving, the ensonified area would also move. Given the mobile nature of the ensonified area, a given location would not be ensonified for more than a few hours. Behavioral effects associated with cable laying noise are considered possible but would be temporary with effects dissipating once the activity or individual has left the area. Should an exposure occur, the potential effects would be brief (e.g., Atlantic sturgeon may approach the noisy area and divert away from it), and any effects due to this brief exposure would be so small that they could not be measured, detected, or evaluated and are therefore ***insignificant***. Therefore, the effects of exposure to cable-laying noise resulting in sound levels that exceed the behavioral disturbance threshold ***may affect, but not likely to adversely affect*** Atlantic sturgeon. As shortnose sturgeon would not occur in the area ensonified by cable-laying noise, cable-laying noise associated with the Proposed Action would have ***no effect*** on this species.

Dredging Noise

Under Scenario 1 or Scenario 2 of the Proposed Action, dredging may be required for seabed preparation prior to foundation installation, sand bedform clearing prior to cable installation, and excavation of the offshore HDD entrance/exit near the cable landing sites. Project dredging may utilize a trailing suction hopper dredge, a cutterhead dredge, and/or a backhoe dredge.

Hydraulic trailing suction hopper dredging and cutterhead dredging involve the use of suction to remove sediment from the seabed. The sound produced by hydraulic dredging results from the combination of sounds generated by the impact and abrasion of the sediment passing through the draghead, suction pipe, and pump. The frequency of the sounds produced by hydraulic suction dredging ranges from approximately 1 to 2 kilohertz, with reported source levels of 172 to 190 dB re 1 µPa-m (McQueen et al. 2019; Robinson et al. 2011; Todd et al. 2015). Robinson et al. (2011) noted that the level of broadband noise generated by suction dredging is dependent on the aggregate type being extracted, with coarse gravel generating higher noise levels than sand. Mechanical dredging refers to grabs used to remove seafloor material. Noise produced by mechanical dredges is emitted from winches and derrick movement, bucket contact with the substrate, digging into substrate, and emptying of material into a barge or scow (Dickerson et al. 2001). Reported sound levels of mechanical dredges range from 107 to 124 dB re 1 µPa at 505 feet (154 meters) from the source with peak frequencies of 162.8 Hz (Dickerson et al. 2001; McQueen et al. 2019). Maximum levels occurred when the dredge bucket made contact with the channel bottom in mixed coarse sand or gravel (Dickerson et al. 2001; McQueen et al. 2019).

Behavioral responses of fish to dredging noise are expected to be similar to responses to vessel noise, which include changes swim speeds, direction, or depth and avoidance, as described below. Behavioral effects associated with dredging noise are considered possible but would be temporary with effects dissipating once the activity has ceased or the individual has left the area. Should an exposure occur, the potential effects would be brief (e.g., Atlantic sturgeon may approach the area and divert away from it), and any effects of this brief exposure would be so small that they could not be meaningfully measured, detected, or evaluated and are therefore ***insignificant***. Therefore, the effects of exposure to dredging noise resulting in sound levels that exceed the behavioral disturbance threshold ***may affect, but not likely to adversely affect*** Atlantic sturgeon. As shortnose sturgeon would not occur in the area ensonified by dredging noise, dredging noise associated with the Proposed Action would have ***no effect*** on this species.

Vessel Noise

The Proposed Action includes the use of vessels during construction, O&M, and decommissioning, as described in Section 1.3. Vessels generate low-frequency (10 to 100 Hz) (MMS 2007), non-impulsive noise that could affect aquatic species. SPL source levels for large vessels range from 177 to 188 dB re 1 µPa-m with most of their energy below 1 kHz and peaks in the 20–100 Hz range (McKenna et al. 2017). Smaller support vessels typically produce higher-frequency sound concentrated in the 1,000 Hz to 5,000 Hz range, with source levels ranging from 150 to 180 dB re 1 µPa-m (Kipple 2002; Kipple and Gabriele 2003).

Continuous sounds produced by marine vessels have been reported to change fish behavior, causing fish to change speed, direction, or depth; induce avoidance of affected areas by fish; or alter fish schooling behavior (De Robertis and Handegard 2013; Engås et al. 1995, 1998; Misund and Aglen 1992; Mitson and Knudsen 2003; Sarà et al. 2007). It was observed that high levels of low-frequency noise (from 10 to 1,000 Hz) may be responsible for inducing an avoidance reaction in fish (Sand et al. 2008).

Behavioral effects are considered possible but would be temporary with effects dissipating once the vessel or individual has left the area. In addition, Atlantic sturgeon and shortnose sturgeon are benthic feeders and therefore, are unlikely to be affected while foraging by a transient vessel noise source. Should an exposure occur, the potential effects would be brief (e.g., Atlantic sturgeon may approach the vessel and divert away from it), and any effects to this brief exposure would be so small that they could not be meaningfully measured, detected, or evaluated and are therefore ***insignificant***. Therefore, the effects of exposure to vessel noise resulting in sound levels that exceed the behavioral disturbance threshold ***may affect, but not likely to adversely affect*** Atlantic sturgeon or shortnose sturgeon.

Aircraft

Helicopters may be used to support construction or O&M of the Proposed Action. Though helicopters produce in-air noise, a small portion of the produced sound can be transmitted through the water surface and propagate in the aquatic environment. Underwater sound produced by helicopters is generally low frequency (less than 500 Hz) and non-impulsive with underwater sound levels at or below 160 dB re 1 µPa (Richardson et al. 1995). As Atlantic sturgeon is a benthic species, sound levels at their typical depths would likely be lower. Kuehne et al. (2020) measured underwater noise from large Boeing EA-18G Growler aircrafts and determined that sound signatures of aircraft at a depth of 98 feet **(**30 meters) below the sea surface had underwater noise levels of 134 (± 3) dB re 1 µPa SPL. Noise from helicopters required for the Project are expected to be less than those generate by these larger aircrafts.

BOEM expects that most aircraft operations would occur above 1,500 feet (457 meters) (i.e., NARW aircraft approach regulation) except under specific circumstances (e.g., helicopter landings on the service operation vessel or visual inspections of WTGs). Exposure to noise above the behavioral threshold is also unlikely but cannot be discounted. Any effects would be temporary, dissipating once the aircraft leaves the area, and would be too small to be meaningfully measured, detected, or evaluated and ***insignificant***. Therefore, the effects of exposure to aircraft noise resulting in sound levels that exceed the behavioral disturbance threshold ***may affect, but not likely to adversely affect*** Atlantic sturgeon. As shortnose sturgeon would not occur in the area ensonified by Project aircraft, aircraft noise associated with the Proposed Action would have ***no effect*** on this species.

Wind Turbine Generators

WTGs operating during the O&M phase of the Proposed Action, under either Scenario 1 or Scenario 2, would generate continuous non-impulsive, underwater noise. Monitoring data in the literature are limited to smaller, geared wind turbines (less than 6.15 MW). The relatively low noise levels produced by these WTGs are expected to decrease to ambient levels within a relatively short distance from the turbine foundations (Dow Piniak et al. 2012b; Elliott et al. 2019; Kraus et al. 2016; Thomsen et al. 2015). At Block Island Wind Farm, turbine noise reached ambient noise levels within 164 feet (50 meters) of the turbine foundations (Miller and Potty 2017). Monitoring data indicate that noise levels increase with higher wind speeds, which lead to higher ambient noise levels due to higher wave action (Kraus et al. 2016; Tougaard et al. 2009).

Available data on large direct-drive turbines, as proposed for this Project, are sparse. Direct-drive turbine design eliminates the gears of a conventional wind turbine, which increases the speed at which the generator spins. Direct-drive generators are larger generators that produce the same amount of power at slower rotational speeds. Only one study of direct-drive turbines presented in Elliott et al. (2019) was available in the literature. The study measured SPLs of 114 to 121 dB re 1 µPa at 164.0 feet (50 meters) for a 6 MW direct-drive turbine.

Based on measurements from WTGs 6.15 MW and smaller, Stöber and Thomsen (2021) estimated that operational noise from larger (10 MW WTG), current-generation WTGs would generate higher source levels (177 dB re 1 µPa-m) than the smaller WTGs measured in earlier research. Additionally, Stöber and Thomsen (2021) estimate that a shift from gear-driven wind turbines to direct drive turbines would decrease sound levels by 10 dB, resulting in a range to the 120 dB re 1 µPa behavioral threshold for marine mammals of 0.9 mile (1.4 kilometer). Using the least-squares fits from Tougaard et al. (2020), SPLs from 11.5 MW turbines (in 20 m/s, gale-force wind) would be expected to fall below the same behavioral threshold within approximately 910 feet (277 meters). In lighter winds (approximately 20 knots [10 meters per second], a “fresh breeze” on the Beaufort scale), the predicted range to threshold would be only approximately 460 feet (140 meters). Both models were based on small turbines and a small sample size, adding uncertainty to the modeling results. Stöber and Thomsen (2021) use only the loudest measurements from each study cited. While this is reasonable practice for most sound source studies, sound from an operating WTG can be expected to correlate with wind speed and therefore with higher environmental noise. Scaling the loudest sound measurements linearly with turbine power will scale environmental noise up along with it and can be expected to overestimate sound levels from larger turbines and is especially concerning as no correlation coefficient was provided to assess the goodness of fit. Tougaard et al. (2020) take wind speed into account for each of the measurements in their fit and scale the level with WTG power using a logarithmic measurement. Because of these factors, range estimates based on Tougaard et al. (2020) are considered more relevant to this assessment.

Atlantic sturgeon may be exposed to noise levels that exceed behavioral thresholds during WTG operations, particularly during high wind events when WTGs generate higher levels of noise. However, during high wind events ambient underwater noise levels are also elevated, potentially reducing the impact of WTG operational noise as high ambient noise conditions would be expected to decrease the distance from the WTG at which operational noise levels fall below ambient noise levels. Behavioral reactions may include avoidance of the area. As described above, it is expected that Atlantic sturgeon would occur intermittently in the Lease Area throughout their spring and fall migrations and may forage opportunistically in areas where benthic invertebrates are present. The area is not known to be a preferred foraging area and has not been identified as an aggregation area, which reduces the potential for impact to this species from long-term operational noise. Given the interim definition for ESA harassment, the animals’ ability to avoid disturbing levels of noise, the lack of preferred foraging areas or known aggregations in the Lease Area, the potential for Atlantic sturgeon to be exposed to underwater noise exceeding behavioral thresholds from WTG operations would not rise to the level of take under the ESA and is therefore considered ***insignificant***. Therefore, the effects of exposure to WTG noise resulting in sound levels that exceed the behavioral disturbance threshold ***may affect, but not likely to adversely affect*** Atlantic sturgeon. As shortnose sturgeon would not occur in the area ensonified by operational WTGs, WTG noise associated with the Proposed Action would have ***no effect*** on this species.

Summary of Noise Effects

Noise generated from Project activities include impulsive (e.g., impact pile driving, some HRG surveys) and non-impulsive sources (e.g., vibratory pile diving, some HRG surveys, cable laying, dredging, vessels, aircraft, turbine operations). Impact pile driving has the potential to cause physiological injury, but risk of exposure to noise above physiological injury thresholds is ***discountable*** for Atlantic sturgeon based on the seasonal migrations of Atlantic sturgeon and pile driving restrictions between January 1 to April 30 and additional mitigation measures outlined in **Table 1-11**, which effectively limit the potential for injury. All noise sources have the potential to result in behavioral disturbance of Atlantic sturgeon. Only vessel noise has the potential to result in behavioral disturbance of shortnose sturgeon. The potential for behavioral effects will vary, but if they were to occur the effects would not rise to the level of ESA-take and are ***discountable*** or ***insignificant***. Therefore, the overall impacts from underwater noise associated with the proposed action ***may affect, but not likely to adversely affect*** Atlantic sturgeon or shortnose sturgeon.

Effects on Prey Organisms

Atlantic sturgeon are opportunistic predators that feed primarily on benthic invertebrates but will adjust their diet to exploit other types of prey resources when available. They have been documented to feed on polychaetes, isopods, amphipods, clams, fish larvae (Johnson et al. 1997), small fish, amphipods, oligochaetes, chironomids, and nematodes (Guilbard et al. 2007). Adult shortnose sturgeon consume primarily mollusks but will also feed on polychaetes and small benthic fish (McCleave et al. 1977; Dadswell et al. 1984).

Invertebrate sound sensitivity is restricted to particle motion, and affects are expected to dissipate rapidly such that any effects are highly localized from the noise source (Edmonds et al. 2016). This indicates that the invertebrate forage base for Atlantic sturgeon or shortnose sturgeon is unlikely to be measurably affected by underwater noise resulting from the Proposed Action.

Impact pile driving may temporarily reduce the abundance of forage fish, eggs, and larvae in proximity to the activity. However, impacts to these species are unlikely to result in an effect on the survival and fitness of Atlantic sturgeon based on the minimal contribution of fish to their overall diet and the ability of the species to adjust their diet to exploit other types of prey resources when available. The effects on Atlantic sturgeon or shortnose sturgeon due to reduction in prey items from underwater noise generated by the Project would be so small that they could not be meaningfully measured, detected, or evaluated and are therefore ***insignificant***. Therefore, impacts from underwater noise sources due to the Proposed Action ***may affect, but not likely to adversely affect*** prey organisms for Atlantic sturgeon.

3.4.3.2. Dredging Effects on Marine Fish

Under Scenario 1 or Scenario 2 of the Proposed Action, dredging may be required for seabed preparation prior to installation of met tower or OSS foundations, sand bedform clearing prior to cable installation, and excavation of HDD pits near the cable landing site, as described in Section 1.3.1. Dredging equipment that may be used for these activities includes trailing suction hopper dredge, cutterhead dredge, and backhoe dredge.

As identified in Section 3.2.5.3, the greatest impact under either Scenario 1 or Scenario 2 would be installation of a met tower with a suction bucket jacket foundation and four large OSSs with suction bucket jacket foundations, assuming seabed preparation is required for all foundations. The least impact, in terms of dredging, under either Scenario would be installation of a met tower and ten small OSSs with piled jacket foundations, assuming seabed preparation is required for all foundations. Including seabed preparation for foundation installation (368.75 acres [1.49 square kilometers] under Scenario 1 or 339.95 acres [1.38-square kilometers] under Scenario 2), sand bedform clearing for cable installation (1,794.09 acres [7.26 square kilometers]), and backhoe dredging for the HDD pit (0.12 acres [less than 0.01 square kilometers), the greatest impact would be a 2,162.96-acre (8.75-square kilometer) area or a 2,134.17-acre (8.58-square kilometer) dredge area under Scenario 1 or Scenario 2, respectively (**Table 1-6**); the least impact would be a 2,139.78-acre (8.66-square kilometer) or a 2,097.03-acre (8.49-square kilometer) dredge area under Scenario 1 or Scenario 2, respectively.

Dredging would result in localized increases in TSS concentrations. Effects of increased TSS concentrations on sea turtles are assessed in Section 3.2.5.5.

Atlantic sturgeon typically have sufficient swim capabilities to avoid or escape the suction associated with cutterhead dredges. Generally, sturgeon would need to be within 3.3 to 6.6 feet (1 to 2 meters) of the dredge head to be at risk of entrainment (Boysen and Hoover 2009; Clarke 2011; Hoover et al. 2011). Based on the low intake velocity and small flow field of cutterhead dredges and the documented swimming performance of Atlantic sturgeon, the overall entrainment risk for Atlantic sturgeon in a hydraulic cutterhead dredge is low. Atlantic sturgeon that could be present in the dredge area for the Proposed Action are expected to avoid mechanical dredge buckets. Since 1990, there has been only one verified record of a live Atlantic sturgeon entrained in a mechanical dredge along the U.S. East Coast (NMFS 2018c). Therefore, the risk of Atlantic sturgeon entrainment in mechanical dredges is low (NMFS 2018c). Atlantic sturgeon entrainment in hopper dredges has been documented (Reine et al. 2014). However, given Atlantic sturgeon occur seasonally in the Project area and are well distributed throughout the Project area when present (Dunton et al. 2010), dredging equipment is unlikely to encounter Atlantic sturgeon in the Project area. Based on the low risk of entrainment, physical interactions between dredging equipment and Atlantic sturgeon are extremely unlikely to occur and ***discountable***. Therefore, the effects of entrainment from Project dredging leading to injury or mortality ***may affect, but not likely to adversely affect*** Atlantic sturgeon**.** As shortnose sturgeon would not occur in the dredging areas, dredging associated with the Proposed Action would have ***no effect*** on this species.

Habitat disturbance and modification associated with dredging could result in short-term reductions in foraging habitat or short-term effects on prey availability for Atlantic sturgeon. Atlantic sturgeon prey upon small bottom-oriented fish (e.g., sand lance), mollusks, polychaete worms, amphipods, isopods, and shrimp, with polychaetes and isopods being the primary and important groups consumed in the Project area (Dadswell 2006; Johnson et al. 1997; Smith 1985). Sand lance could become entrained in a hydraulic dredge due to their bottom orientation and burrowing within sandy sediments that require clearing by the Project. Reine and Clarke (1998) found that not all fish entrained in a hydraulic dredge are expected to die. Studies summarized in Reine and Clarke (1998) indicate a mortality rate of 37.6% for entrained fish. It is expected that dredging in sandwave habitats to allow for cable installation will result in the entrainment and mortality of some sand lance. Dredging is not expected to alter benthic community composition, and the benthic community is expected to recover within one year of disturbance. Given the size of the area where dredging will occur, the short duration of dredging, and the temporary nature of effects, benthic infauna and epifauna will likely experience 100% mortality. However, given the size of the area where dredging will occur and the short duration of dredging, the loss of benthic invertebrates and sand lance will be small, temporary, and localized, and, given the opportunistic feeding nature of Atlantic sturgeon, it is expected any impact of the loss of Atlantic sturgeon prey items to be so small that it cannot be meaningfully measured, evaluated, or detected and thus ***insignificant***. Therefore, the effects of entrainment from Project dredging leading to reduced prey availability ***may affect, but not likely to adversely affect*** Atlantic sturgeon. As shortnose sturgeon would not occur in the dredging areas, dredging associated with the Proposed Action would have ***no effect*** on this species.

Dredging Effects of the Connected Action

Dredging for the Connected Action, which would be conducted with a hydraulic cutterhead dredge or mechanical dredge, may also result in physical interactions and short-term reductions in benthic habitat availability and prey availability for some aquatic species. As noted above, Atlantic sturgeon are generally not known to be vulnerable to physical interactions with cutterhead or mechanical dredges. Therefore, dredging for the Connected Action leading to physical interactions is expected to have ***no effect*** on Atlantic sturgeon. As shortnose sturgeon would not occur in project area for the Connected Action, dredging associated with the Connected Action would have ***no effect*** on this species.

Dredging for the Connected Action may result in short-term reductions in benthic foraging habitat and prey availability for Atlantic sturgeon. Dredging for the Connected Action may increase water depths to -14 feet NAVD88, which is not expected to have a significant impact on benthic community composition. Dredging in the vicinity of the proposed O&M facility is not expected to alter the sediment composition compared to the existing substrate in the dredge area because the area is an existing harbor, which is subject to maintenance dredging. Given there would be no change in sediment composition, changes in benthic community composition would not be expected. Any impacts on Atlantic sturgeon due to effects on habitat and prey associated with port modifications would be ***discountable*** based on the relatively small area of lost foraging habitat relative to available foraging habitat and negligible reductions in prey availability. Therefore, temporary impacts on the benthic habitat and benthic prey availability associated with dredging for the Connected Action ***may affect, but not likely to adversely affect*** Atlantic sturgeon. As shortnose sturgeon would not occur in project area for the Connected Action, dredging associated with the Connected Action would have ***no effect*** on this species.

3.4.3.3. Habitat Disturbance

Activities included in the Proposed Action would result in habitat disturbance or modifications that may cause impacts to benthic and water column habitat. Anticipated habitat disturbance or alterations may result from physical disturbance of sediment, changes in oceanographic and hydrologic conditions, and conversion of soft-bottom habitat to hard-bottom habitat. Following the assessment of these potential sources of habitat disturbance/modification, a summary of overall effects to ESA-listed fish species is provided.

Displacement from Physical Disturbance of Sediment

As described in Section 1.3, geotechnical surveys would be conducted during the pre-construction phase of the Proposed Action under either Scenario. Geotechnical surveys may cause benthic disturbance as a result of physical seafloor sampling. Geotechnical surveys would be limited to the pre-construction phase of the Project and would be conducted at specific WTG locations. Boulder relocation, a pre-lay grapnel run, and anchoring of Project vessels would also result in physical disturbance of the sediment. As identified in Section 3.2.5.4, the greatest impact of geotechnical surveys and anchoring under either Scenario would be 1,386.6 acres (3.5 square miles) of benthic habitat disturbance.

Benthic disturbance associated with the Proposed Action has the potential to reduce foraging habitat or prey availability for Atlantic sturgeon in the action area. These effects would be localized and short-term. Recolonization and recovery of prey species is expected to occur within 2 to 4 years (Van Dalfsen and Essink 2001) but could occur in as little as 100 days (Dernie et al. 2003). Recolonization may occur relatively quickly following geotechnical surveys. Based on the short-term and localized nature of effects, and the availability of similar foraging habitat throughout the action area, effects of benthic habitat disturbance associated with geotechnical surveys, boulder relocation, a pre-lay grapnel run, and anchoring for the Proposed Action would be too small to be meaningfully measured, detected, or evaluated and would therefore be ***insignificant*** effect on ESA-listed Atlantic sturgeon. Therefore, impacts on benthic prey associated with geotechnical surveys, boulder relocation, a pre-lay grapnel run, and anchoring for the

Proposed Action ***may affect, but not likely to adversely affect*** Atlantic sturgeon. As shortnose sturgeon would not occur in area where geotechnical surveys, boulder relocation, a pre-lay grapnel run, and anchoring would occur, physical disturbance of sediment associated with these surveys would have ***no effect*** on this species.

Changes in Oceanographic and Hydrological Conditions due to the Presence of Structures

A detailed description of the potential long-term, O&M effects of the presence of structures on oceanic conditions is presented in Section 3.2.5.4. As identified in Section 3.2.5.4, the greatest oceanographic and hydrological impact for either Scenario 1 or Scenario 2 would be installation of 200 WTGs, 1 met tower, and 10 small OSSs (i.e., the greatest number of structures possible under the Proposed Action). The least impact for either Scenario 1 or Scenario 2 would be installation of 200 WTGs, 1 met tower, and 4 large OSS (i.e., the smallest number of structures possible under the Proposed Action).

The greatest concern for Atlantic sturgeon and changes in oceanographic and hydrologic conditions resulting from structures in the open ocean would be potential impacts to prey sources. However, Atlantic sturgeon consume prey not as closely affected by physical oceanographic features (e.g., sand lance, mollusks, polychaete worms, amphipods, isopods, and shrimp) as other species discussed in this BA. Potential impacts to larval dispersion and survival of Atlantic sturgeon prey species from changes in hydrologic conditions were considered but the effect was deemed likely to be so small that it cannot be meaningfully, measured, detected, or evaluated and are, therefore, ***insignificant***. Therefore, changes in oceanographic and hydrologic conditions due to the presence of Project structures on the OCS leading to effects on prey ***may affect, but not likely to adversely affect*** Atlantic sturgeon. As shortnose sturgeon would not occur offshore, changes in oceanographic and hydrological conditions due to the presence of structures would have ***no effect*** on this species.

Conversion of Soft-Bottom Habitat to Hard-Bottom Habitat

Installation of WTGs, OSSs, and submarine cables, and associated scour and cable protection, during construction would result in habitat conversion and loss. Some soft-bottom habitat would be lost, and some soft-bottom and pelagic habitat would be converted to hard-bottom and hard, vertical habitat, respectively. This habitat loss and conversion would persist through the O&M phase and into decommissioning until the structure is removed.

As identified in Section 3.2.5.4, the greatest habitat conversion impact for either Scenario would be four large OSSs with suction bucket jackets. The least impact for either Scenario would be ten small OSSs with piled jackets (**Table 3-20**). Scenario 1 under the Proposed Action would result in the loss or conversion of 613 to 632 acres of soft-bottom habitat (**Table 3-21**). For Scenario 2 under the Proposed Action, 555 to 593 acres of soft-bottom habitat would be lost or converted.

The loss of soft-bottom habitat in the action area could potentially affect Atlantic sturgeon, which forage in this type of habitat. However, the habitat loss would be small relative to similar habitat available in the action area. Therefore, the effect of habitat loss associated with WTGs and OSSs would be too small to be meaningfully measured, detected, or evaluated and, thus, ***insignificant***. Therefore, the presence of structures leading to loss of soft bottom habitat ***may affect, but not likely to adversely affect*** Atlantic sturgeon. As shortnose sturgeon would not occur in proximity to the Project foundations or submarine cables, the presence of structures leading to loss of soft bottom habitat would have ***no effect*** on this species.

Summary of Habitat Disturbance Effects

Habitat disturbance associated with HRG surveys would be short-term and localized to a small area. Therefore, associated impacts on Atlantic sturgeon would be ***insignificant***. Prey for Atlantic sturgeon are unlikely to be affected by changes in oceanographic and hydrologic conditions, and any effects on Atlantic sturgeon prey due to these changes would be ***discountable***. Habitat conversion and loss associated with WTGs, OSSs, scour protection, and cable protection may reduce foraging habitat for Atlantic sturgeon, but this reduction is expected to be ***insignificant*** given the small area lost relative to similar foraging habitat available in the action area. Given the ***discountable*** or ***insignificant*** impacts anticipated, the effects of habitat disturbance from the proposed action ***may affect, but not likely to adversely affect*** Atlantic sturgeon. As shortnose sturgeon would not occur in the areas where habitat disturbance associated with the Proposed Action would occur, Project habitat disturbance would have ***no effect*** on this species.

3.4.3.4. Secondary Entanglement due to an Increased Presence of Recreational Fishing in Response to Reef Effect

Another long-term impact of the presence of structures during O&M is the potential to concentrate recreational fishing around foundations, potentially increasing the risk of Atlantic sturgeon entanglement in both vertical and horizontal fishing lines and increasing the risk of injury and mortality due to infection and starvation. If there is an increase in recreational fishing in the Project area, it is likely that this will represent a shift in fishing effort from areas outside the wind farm area to within the wind farm area, though an increase in overall effort cannot be discounted. Given vessel safety concerns regarding being too close to foundations and other vessels, the likelihood of recreational fishermen aggregating around the same turbine foundation at the same time is low.

The presence of offshore structures associated with the Proposed Action could displace commercial or recreational fishing vessels to areas outside of the Lease Area or potentially lead to a shift in gear types due to displacement. Assuming fishing vessels are displaced to adjacent areas, risk of interaction with fishing vessels would not be greater than current risk given the patchy distribution of Atlantic sturgeon in the action area. A potential shift in gear types is not expected to result in increased risk of capture for Atlantic sturgeon as this species is vulnerable to mobile gear types.

Due to their benthic foraging strategy, Atlantic sturgeon have a reduced chance of being exposed to recreational fishing lines in the pelagic Lease Area. Thus, exposure of Atlantic sturgeon to entanglement in fishing gear around WTGs is unlikely to occur and, thus, ***discountable***. Therefore, potential secondary entanglement due to increased presence of recreational fishing gear associated with structures during operations ***may affect, but not likely to adversely affect*** Atlantic sturgeon. As shortnose sturgeon would not occur in proximity to the structures, secondary entanglement would have ***no effect*** on this species.

3.4.3.5. Turbidity

Construction activities for the Proposed Action would include pile driving for WTG and OSS foundation installation, cable-laying activities for installation of inter-array and export cables, and dredging for seabed preparation sandform clearing, and HDD pits, as described in Section 1.3. These activities would disturb bottom sediment, resulting in short-term increases in turbidity in the action area. The greatest impact under either Scenario, as identified in Section 3.2.5.6, would result from installation of a met tower with a gravity foundation and four large OSSs with gravity foundations. The least impact under either Scenario would be the installation of a met tower and OSSs with piled or suction bucket foundations.

As described in Section 3.2.5.6, pile driving activities are expected to produce TSS concentrations of approximately 5.0 to 10.0 mg/L above background levels within approximately 300 feet (91 meters) of the pile being driven (NMFS 2020c citing FHWA 2012). Cable installation activities are expected to produce maximum TSS concentrations of approximately 235.0 mg/L at 65 feet (20 meters) (NMFS 2020c citing ESS Group 2008). Sediment transport analysis conducted for the Project predicted that the sediment plumes at or above ambient concentrations (≥ 10 mg/L) would extend between 1.1 and 1.8 miles

(1.7 and 2.9 kilometers) from cable routes or the Lease Area (COP Volume II, Appendix II-J3; Atlantic Shores 2023a). TSS concentrations associated with cutterhead dredge sediment plumes typically range from 11.5 to 282.0 mg/L with the highest levels (550.0 mg/L) detected adjacent to the cutterhead dredge (NMFS 2020c citing USACE 2005, 2010, 2015b; NMFS 2020c citing Nightingale and Simenstad 2001), and elevated suspended sediment levels are expected to be present only within a 984 to 1,640 feet (300 to 500 meters) radius of the cutterhead dredge (NMFS 2020c citing USACE 1983; NMFS 2020c citing Hayes et al. 2000; NMFS 2020c citing LaSalle 1990). Elevated TSS concentrations associated with mechanical dredging could reach 445.0 mg/L (NMFS 2020c citing USACE 2001) and would occur within a radius of up to 2,400 feet (732 meters) (NMFS 2020c citing Burton 1993; NMFS 2020c citing USACE 2015a). Elevated TSS concentrations associated with hopper dredging could reach 475.0 mg/L (NMFS 2020c citing Anchor Environmental 2003) and would occur within a radius of up to 3,937 feet (1,200 meters) (NMFS 2020c citing Wilber and Clarke 2001).

As Atlantic sturgeon may occur within portions of the action area affected by pile driving, cable laying, and dredging, increased turbidity associated with Project activities could potentially affect this species. Studies of the effects of turbid water on fish suggest that concentrations of suspended sediment can reach thousands of milligrams per liter before an acute toxic reaction is expected (NMFS 2020c citing Burton 1993). TSS levels shown to have adverse effects on fish are typically above 1,000 mg/L (see summary of scientific literature in Burton 1993; Wilber and Clarke 2001). Potential physiological effects of suspended sediment on fish include gill clogging and increased stress (NMFS 2017a). High TSS levels can cause a reduction in DO levels, and Atlantic sturgeon may become stressed when DO falls below certain levels (NMFS 2020c). Increased turbidity can also result in behavioral effects in fish, such as foraging interference or inhibition of movement (NMFS 2017a). However, increased turbidity is not expected to impact the ability of Atlantic sturgeon to forage as they are not visual foragers. Sturgeon rely on their barbels to detect prey and are known to forage during nighttime hours (NMFS 2017a). Suspended sediment concentrations below those required for physiological impacts are not expected to inhibit sturgeon movement (NMFS 2017a). While the increase in turbidity associated with the Proposed Action may cause Atlantic sturgeon to alter their normal movements, these minor movements would be too small to be meaningfully measured or detected. TSS is most likely to affect sturgeon if a plume causes a barrier to normal behaviors. However, Atlantic sturgeon are expected to swim through the plume and otherwise avoid the area with no adverse effects (NMFS 2020c).

Increased suspended sediment concentrations could also affect Atlantic sturgeon indirectly by affecting benthic prey species. TSS levels are shown to have adverse effects on benthic communities when they exceed 390.0 mg/L (NMFS 2020c citing USEPA 1986). It is anticipated that there will be a short-term impact on the availability of prey species within the area of direct impact; however, it is expected that this area will be recolonized within a short period of time after dredging is complete. Due to the small area in which benthic communities could be impacted relative the action area and the temporary nature of the impact, the Proposed Action is expected to result in negligible reductions in benthic shellfish and infaunal organisms that serve as prey for ESA-listed species (NMFS 2020c), including Atlantic sturgeon.

Runoff from shoreside construction in the vicinity of the planned O&M Facility in Atlantic City, NJ and the cable landfall sites has the potential to result in localized effects on water quality due to increased turbidity. Turbidity effects associated with shoreside construction for the Proposed Action would be lower than turbidity effects associated with dredging, and measures would be in place to minimize water quality impacts associated with shoreside construction (e.g., utilization of silt curtains). Therefore, shoreside construction is not expected to obstruct movements of ESA-listed Atlantic sturgeon; any reductions in benthic prey species would be negligible.

Given that suspended sediment concentrations associated with the Proposed Action would be below physiological thresholds for sturgeon and reductions in foraging opportunities for Atlantic sturgeon would be negligible, the effects of increased turbidity are too small to be meaningfully measured, detected, or evaluated. Therefore, turbidity effects on ESA-listed Atlantic sturgeon would be ***insignificant***.

As described above, any effects from increased turbidity levels from construction activities for the Proposed Action on Atlantic sturgeon or their prey would be isolated and temporary and are so small that they could not be measured, detected, or evaluated and are therefore ***insignificant***. Therefore, the effects of increased turbidity levels from Project construction activities ***may affect, but not likely to adversely affect*** Atlantic sturgeon. As shortnose sturgeon would not occur in areas that may be affected by turbidity associated with the Proposed Action, elevated turbidity due to Project activities would have ***no effect*** on this species.

Turbidity Effects of the Connected Action

The Connected Action would include hydraulic cutterhead or mechanical dredging. As described in Section 3.4.2.2, dredging would result in localized increases in TSS concentrations. Elevated TSS concentrations associated with cutterhead dredging could reach 550.0 mg/L and would occur within a radius of up to 1,640 feet (500 meters). Best management practices to reduce turbidity (e.g., slow bucket withdrawal) would be used. Given the use of best management practices, turbidity effects associated with dredging for the Connected Action are not expected to obstruct Atlantic sturgeon movements, and any reductions in benthic prey species would be too small to be meaningfully measured, detected, or evaluated and, thus, ***insignificant***. Therefore, turbidity effects due to dredging for the Connected Action ***may affect, but not likely to adversely affect*** Atlantic sturgeon. As shortnose sturgeon would not occur in project area for the Connected Action, turbidity effects would have ***no effect*** on this species.

3.4.3.6. Vessel Traffic

As detailed in Section 1.3, a variety of vessels would be used to construct, operate, and decommission the Proposed Action (**Table 1-7**). Maximum estimates for the number of vessels required for a single construction activity range from 2 to 16 vessels. In the unlikely event that all construction activities for Project 1 and Project 2, including HRG surveys, foundation installation, scour protection installation, WTG installation, OSS installation, inter-array cable installation, export cable installation, and fuel bunkering, were to occur simultaneously, up to 51 vessels could be operating at a given time. There are no anticipated differences in vessel traffic between Scenario 1 and Scenario 2 under the Proposed Action, and foundation selection for the met tower and OSSs is not expected to affect required vessel trips. Vessel trip information for each anticipated port, divided by Project phase, is provided in **Table 1-9**. Vessel trip information for each vessel type associated with foundation installation is provided in **Table 3-22**. Vessel traffic associated with the Proposed Action could affect Atlantic sturgeon through vessel strikes. In addition to increased risk of vessel strike, vessels produce underwater noise, which was evaluated in Section 3.4.2.1. Vessels would also produce artificial lighting, which is addressed in Section 3.4.2.10, and air emissions, which are addressed in Section 3.4.2.9. Though not anticipated, Project vessel traffic may result in discharges of fuel, fluids, hazardous material, trash, or debris from Project vessels, which are addressed in Section 3.4.2.11.

As described in Section 3.2.5.7, an estimated 1,745 total vessel round trips are expected to occur between the Lease Area and ports in New Jersey, Virginia, and Texas over the three-year construction period (**Table 1-9**), which represents a 28 percent increase in traffic in the Lease Area and a 2 percent increase in traffic in waters offshore of Delaware and New Jersey compared to existing traffic (**Table 3-23**). Seventy two percent of construction vessel trips would be between the Lease Area and the New Jersey Wind Port. Eighteen percent of trips would be between the Lease Area and Atlantic City, New Jersey, and 7 percent of trips would be between the Lease Area and Paulsboro, New Jersey. Repauno, New Jersey, Portsmouth, Virginia, and Corpus Christi, Texas are each expected to receive 20 trips (approximately 1 percent of construction vessel traffic) from Project vessels. During the O&M phase, an estimated 1,861 vessel round trips are expected to occur annually between the Lease Area and ports in New Jersey and Virginia, (**Table**

1-9) which represents a 91 percent increase in traffic compared to existing vessel traffic in the Lease Area and a 5 percent increase in traffic in waters offshore of Delaware and New Jersey (**Table 3-23**). During the O&M phase, 98 percent of annual vessel trips would be between the Lease Area and Atlantic City. Approximately 2 percent of annual vessel trips would be between the Lease Area and the New Jersey Wind Port. Remaining O&M vessel traffic would be split approximately evenly between ports in Paulsboro, Repauno, Portsmouth. Vessel traffic during decommissioning is expected to be similar to the construction phase.

The Proposed Action would result in increased risk of vessel strike for Atlantic sturgeon as a result of Project vessel traffic during the construction, O&M, and decommissioning phases of the Project. Vessel strikes are a documented source of mortality for Atlantic sturgeon in riverine habitats (Balazik et al. 2012; Brown and Murphy 2010; Krebs et al. 2019). Deep-draft vessels may be most likely to result in sturgeon injury or mortality in these habitats, but vessel interactions are not limited to deep-draft vessels (NMFS 2018c). In the marine environment, where demersal Atlantic sturgeon would have much more separation from vessel hulls due to deeper water and less constrained ability to avoid vessels (i.e., as opposed to within the confines of a shallower river), the risk of vessel strike may be significantly lower compared to the estuarine/riverine environment. Vessel traffic for the Proposed Action includes trips in estuarine/riverine environments where Atlantic sturgeon and shortnose sturgeon occur, including three ports on the Delaware River: the New Jersey Wind Port, Paulsboro, and Repauno. Project vessels would transit from the Lease Area through New York Bight critical habitat Unit 4 for the New York Bight DPS of Atlantic sturgeon as far upstream as the Paulsboro Marine Terminal in Paulsboro, New Jersey (approximately river mile 86.3 [river kilometer 139]). Project vessels passing between Paulsboro and the Lease Area would transit approximately 38 miles (61 kilometers) through Atlantic sturgeon critical habitat. Between Repauno and the Lease Area, Project vessels would transit approximately 35 miles (56 kilometers) through Atlantic sturgeon critical habitat. Only 2.8 miles (4.5 kilometers) of critical habitat would be transited by those vessels passing between the New Jersey Wind Port and the Lease Area.

Offshore wind project vessel transits to the New Jersey Wind Port, Paulsboro, and Repauno have been addressed in other biological opinions (identified in Section 1.1.2). The Biological Opinions prepared by NMFS for these ports, which were constructed pursuant to USACE permits, considered effects of vessel transits to and from these ports on Atlantic sturgeon, shortnose sturgeon, and critical habitat for the New York Bight DPS of Atlantic sturgeon. In the 2017 biological opinion for Repauno and the 2022 biological opinions for New Jersey Wind Port and Paulsboro, NMFS concluded that construction and operation of these ports was likely to adversely affect shortnose sturgeon and Atlantic sturgeon but not likely to jeopardize shortnose sturgeon or any DPS of Atlantic sturgeon. In offshore areas, the risk of a vessel strike is likely to be minimal due to overall lower densities of sturgeon and available space separating sturgeon and vessels in these areas. The risk of vessel strikes for Atlantic sturgeon is assumed to be extremely low in this environment, as outlined, thus the potential for vessel strikes to ESA-listed Atlantic sturgeon in the marine environment is considered extremely unlikely to occur and ***discountable***. As shortnose sturgeon do not occur in offshore areas, there is no risk of vessel strike in the offshore environment for this species. Given that increased vessel traffic in the Delaware River associated with operation of ports expected to be utilized for this Project have previously been determined by NMFS as likely to adversely affect Atlantic sturgeon and shortnose sturgeon, the effects of vessel strikes from Project vessel activities leading to injury or mortality ***may affect, likely to adversely affect*** Atlantic sturgeon and shortnose sturgeon.

3.4.3.7. Monitoring Surveys

As described in Section 1.3.4, biological monitoring studies for the Proposed Action include otter trawl surveys, trap surveys, hydraulic clam dredge surveys, grab sampling, and underwater imagery. Some of these biological monitoring efforts (i.e., trawl, trap, and dredge surveys) have the potential to result in capture or entanglement of Atlantic sturgeon.

Trawl Survey

Atlantic sturgeon are susceptible to capture in trawl nets, which may result in injury or death, reduced fecundity, and delayed or aborted spawning migrations (Moser and Ross 1995; Collins et al. 2000; Moser et al. 2000). However, the use of trawl gear has been used as a safe and reliable method to capture sturgeon if tow time is limited (NMFS 2014b).

Negative impacts to sturgeon resulting from trawling capture are related to tow speed and duration (Moser et al. 2000). Northeast Fisheries Observer Program data from Miller and Shepherd (2011) indicate that mortality rates of Atlantic sturgeon caught in otter trawl gear used for commercial fisheries is approximately 5 percent. Short tow durations and careful handling of individuals once on deck are likely to result in a very low risk of mortality to captured individuals (NMFS 2014b).

Atlantic sturgeon are captured incidentally in trawls used for scientific studies, including the standard NEFSC bottom trawl surveys and both the spring and fall NEAMAP bottom trawl surveys. However, the shorter tow durations and careful handling of any sturgeon once on deck during fisheries research surveys are likely to result in lower potential for mortality to captured individuals, as commercial fishing trawls tend to be significantly longer in duration. Both the NEFSC and NEAMAP surveys have recorded the capture of hundreds of Atlantic sturgeon since the inception of each. To date, there have been no recorded serious injuries or mortalities. In the Hudson River, a trawl survey that incidentally captures shortnose and Atlantic sturgeon has been ongoing since the late 1970s (NMFS 2021b). To date, no serious injuries or mortalities of any sturgeon have been recorded in those surveys. Several Atlantic sturgeon have been captured in trawl surveys conducted for the South Fork Wind offshore wind project. However, all were minor injuries with no mortalities and were from different DPSs.

Given the dispersed distribution of Atlantic sturgeon in the survey area, the limited number of trawl tows that will be conducted and short tow times (20 minutes) proposed for fisheries monitoring, and the lack of sturgeon injury or mortality in similar surveys (e.g., NEFSC and NEAMAP surveys), BOEM does not anticipate serious injury or mortality of Atlantic sturgeon captured during Project trawl surveys and is considered ***discountable***. Therefore, the effects of trawl surveys from Project monitoring activities leading to potential capture and/or minor injury ***may affect, likely to adversely affect*** small numbers of Atlantic sturgeon. As shortnose sturgeon would not occur in the area where trawl surveys for fisheries monitoring would be conducted, the trawl survey would have ***no effect*** on this species.

Trap Survey

Fixed gear, such as ventless traps, has the potential to incidentally capture Atlantic sturgeon, though the highest potential mortality for fixed gear is associated with gillnets (ASMFC 2017). A review of fisheries bycatch data from 1989 to 2013 showed no capture of Atlantic sturgeon in fish traps (Dunton et al. 2015). BOEM is proposing the training of crew conducting fixed-gear fisheries surveys in the safe handling of Atlantic sturgeon in the unlikely event that one was to be captured (**Table 1-11**). Therefore, serious injury or mortality is extremely unlikely in the even further unlikely event that an Atlantic sturgeon is captured during trap surveys and ***discountable***. Given this information, the effects of trap surveys from Project monitoring activities leading to potential capture and/or minor injury ***may affect, but not likely to adversely affect*** small numbers of Atlantic sturgeon. As shortnose sturgeon would not occur in the area where trap surveys for fisheries monitoring would be conducted, the trap survey would have ***no effect*** on this species.

Hydraulic Clam Dredge Survey

Clam and scallop dredges have not been shown to capture Atlantic sturgeon (Dunton et al. 2015), and tows for the clam survey have a very short duration. Therefore, serious injury or mortality is extremely unlikely in the even further unlikely event that an Atlantic sturgeon is captured during Project-related clam surveys. Based on the above analysis, the potential for capture of Atlantic sturgeon in clam dredge survey equipment is considered extremely unlikely to occur and is ***discountable***. Therefore, the effects of clam dredge surveys from Project monitoring activities leading to potential capture and/or minor injury ***may affect, but not likely to adversely affect*** Atlantic sturgeon. As shortnose sturgeon would not occur in the area where dredge surveys for fisheries monitoring would be conducted, the clam dredge survey would have ***no effect*** on this species.

Prey and Habitat Effects

Atlantic sturgeon prey items (e.g., mollusks or fish), may be captured in trawl, trap, or dredge surveys. However, biological monitoring proposed for the Project is expected to be non-extractive, returning captured organisms at the end of each sampling event. Therefore, monitoring surveys under the Proposed Action will not affect availability of prey for Atlantic sturgeon in the action area, and there would be ***no effect*** on Atlantic sturgeon. As shortnose sturgeon would not occur in the area where monitoring surveys would be conducted, monitoring surveys would have ***no effect*** on this species.

Trawls, dredges, and grabs have the potential to disturb benthic habitat. However, such disturbance would be temporary and would affect a relatively small area of available habitat in the action area. Therefore, impacts of fisheries and habitat surveys on prey and/or habitat for Atlantic sturgeon are expected to be ***insignificant***. Therefore, Project monitoring surveys leading to potential reduction in the availability of foraging habitat ***may affect, but not likely to adversely affect*** Atlantic sturgeon. As shortnose sturgeon would not occur in the area where monitoring surveys would be conducted, monitoring surveys would have ***no effect*** on this species.

3.4.3.8. Electromagnetic Fields and Heat

The Proposed Action would include installation of up to 342 miles (550 kilometers) of export cables, 37 miles (60 kilometers) of interlink cables, and 584 miles (990 kilometers) of inter-array cables, increasing the production of EMF and heat in the action area. EMF and heat effects would be reduced by cable burial to an appropriate depth and the use of shielding, if necessary.

Electromagnetic-sensitive species (e.g., sharks, rays) have been shown to respond to HVAC, but adverse consequences have not been established (Gill et al. 2012). EMF from alternating current cables is not expected to adversely affect commercially and recreationally important species in the southern New England area (CSA Ocean Sciences, Inc. and Exponent 2019), and studies have shown that EMF would not interfere with movement or migration of marine species (Kavet et al. 2016). Atlantic Shores would bury cables to a minimum depth of 5.5 to 6 feet (1.5 to 2.0 meters) wherever possible, which would minimize the strength of the EMF in the water column. Therefore, any potential impacts on Atlantic sturgeon from EMF associated with the Proposed Action are expected to be too small to be measured and therefore, ***insignificant***. Thus, the effects of EMF from the Project ***may affect, but not likely to adversely affect*** Atlantic sturgeon**.** As shortnose sturgeon would not occur in the area where submarine cables would generate EMF and heat, there would be ***no effect*** on this species.

Buried submarine cables can warm the surrounding sediment in contact with the cables up to tens of centimeters, but impacts to benthic organisms are expected to be insignificant (Taormina et al. 2018) and would be limited to a small area around the cable. Given the expected cable burial depths, thermal effects would not occur at the surface of the seabed where Atlantic sturgeon forage. Therefore, any effects on sturgeon prey availability would be too small to be detected or meaningfully measured and are ***insignificant***. Therefore, the effects of cable heat from the Project leading to reduction in prey ***may affect, but not likely to adversely affect*** Atlantic sturgeon. As shortnose sturgeon would not occur in the area where submarine cables would generate EMF and heat, there would be ***no effect*** on this species.

3.4.3.9. Air Emissions

Air emissions would be generated during the construction, O&M, and decommissioning phases of the Proposed Action. Emissions would primarily be generated by Project vessels and the installation equipment on board Project vessels. Atlantic Shores has conducted an air emissions inventory for the Proposed Action, provided in Appendix II-C of the COP (Atlantic Shores 2023a).

Operation of Project vessels and WTG installation equipment during construction would result in short-term increases in Project-related air emissions. During O&M, operation of Project vessels would result in long-term increases in emissions related to the Proposed Action. However, estimated air emissions from O&M activities would generally be lower than emissions generated during construction activities and are not expected to have a significant effect on regional air quality. Air emissions during decommissioning are expected to be similar or less than emissions estimated for construction activities. Atlantic Shores has proposed measures to avoid and minimize air emissions effects, including the use of low-sulfur fuels, the use of vessels that meet Best Available Control Technology and Lowest Achievable Emission Rate requirements, and minimization of engine idling time. Air pollutant concentrations associated with the Proposed Action are not expected to exceed National Ambient Air Quality Standards or New Jersey Ambient Air Quality Standards. Therefore, BOEM anticipates that air quality impacts from Project emissions would be minor.

As Atlantic sturgeon and shortnose sturgeon do not breathe air, Project vessel air emissions would have ***no effect*** on Atlantic sturgeon or shortnose sturgeon.

3.4.3.10. Lighting of Structures

Vessels and offshore structures associated with future offshore wind activity would have deck and safety lighting, producing artificial light during the construction, O&M, and decommissioning phases of the Proposed Action. Offshore structures would have yellow flashing navigational lighting and red flashing FAA hazard lights, in accordance with BOEM's (2021c) lighting and marking guidelines. Following these guidelines, direct lighting would be avoided, and indirect lighting of the water surface would be minimized to the greatest extent practicable.

Artificial lighting could elicit temporary attraction, avoidance, or other behavioral responses in some finfish, potentially affecting distributions near the light source. Atlantic sturgeon are demersal and forage on benthic prey. Therefore, neither the species nor its prey are likely to be exposed to artificial light associated with the Proposed Action. Atlantic Shores would use lighting on the WTGs and OSS that complies with FAA and USCG standards and would follow BOEM best practices to minimize illumination of the water surface (VIS-04). Furthermore, Atlantic Shores has proposed to consider the use of an ADLS to minimize the time that FAA-required lighting is illuminated on the offshore structures (BIR-04, BAT-03, VIS-05). Based on the habitat used by Atlantic sturgeon and the measures in place to reduce artificial lighting of the water surface, lighting effects on Atlantic sturgeon are extremely unlikely to occur and ***discountable***. Therefore, effects of lighting of vessels and offshore structures associated with the Proposed Action ***may affect, but not likely to adversely affect*** Atlantic sturgeon. As shortnose sturgeon would not occur offshore, the lighting of Project structures would have ***no effect*** on this species.

3.4.3.11. Unexpected/Unanticipated Events

Unexpected or unanticipated events with the potential to affect ESA-listed species could occur during the construction, O&M, or decommissioning phases of the Proposed Action. Such events would include vessel collisions or allisions (i.e., collisions with stationary structures), severe weather events resulting in equipment failure, oil spills, or encounters with unexploded ordinance.

Vessel collisions or allisions may result in oil spills. Such events are considered unlikely given the lighting requirements for Project vessels and offshore structures, vessel speed restrictions, proposed spacing of Project structures, inclusion of Project structures on navigational charts, and Notices to Mariners issued by the U.S. Coast Guard. Therefore, effects on ESA-listed species due to vessel collisions or allisions are extremely unlikely to occur and ***discountable***.

The Lease Area may be affected by extratropical storms, which are common in the area between October and April, or hurricanes. The high winds associated with these events have the potential to result in the failure of WTGs. However, the WTGs will be designed to withstand site-specific weather conditions, including winter storms, hurricanes, and tropical storms. The WTGs will be suitable for sites with wind speeds of up to 127.5 miles per hour (57 meters per second) and gusts of up to 178.5 miles per hour (79.8 meters per second). Therefore, such a failure is highly unlikely and effects on ESA-listed species associated with WTG failure are extremely unlikely to occur and ***discountable***.

Vessel traffic associated with the Proposed Action would increase the risk of accidental releases of fuels, fluids, and hazardous materials. There would also be a low risk of leaks of fuel, fluid, or hazardous materials from any of the 200 WTGs anticipated for the Project. The total volume of WTG fuels, fluids, and hazardous materials associated with the Proposed Action was not estimated for Atlantic Shores but such a leak is expected to be unlikely (Atlantic Shores 2023a). Project vessel activities are expected to adhere to USCG regulations for the prevention and control of oil spills (Atlantic Shores 2023a). BOEM has modeled the risk of spills associated with WTGs and determined that, at maximum, a release of 129,000 gallons is likely to occur no more frequently than once every 1,000 years and a release of 2,000 gallons or less is likely to occur every 50 to 100 years (Bejarano et al. 2013). Accidental releases of fuel, fluids, and hazardous materials can cause temporary, localized impacts on finfish, including increased mortality, decreased fitness, and contamination of habitat. The Proposed Action would comply with all laws regulating at-sea discharges of vessel-generated waste and includes BOEM-proposed measures to address accidental releases (Section 1.3.5, **Table 1-11**). Additionally, Atlantic Shores has developed an OSRP (COP Volume II, Appendix II-C; Atlantic Shores 2023a) with measures to avoid accidental releases and a protocol to respond to such a release if one occurs. Given the low likelihood of occurrence, effects of oil spills on Atlantic sturgeon and shortnose sturgeon are extremely unlikely to occur and are ***discountable***.

As described in Section 1.3.1, the export cable route would be surveyed and cleared for UXO prior to cable installation. A study of munitions and explosives of concern has been conducted and an associated hazard assessment has been provided to BOEM under confidential cover as part of the COP (see Volume II, Appendix II-A). This study indicated that the likelihood of encountering munitions and explosives of concern during construction of the Proposed Action is low. In the event that UXO are found during construction, Atlantic Shores would implement a mitigation strategy to avoid UXO. At this time, no UXO detonation is planned. Given that UXO encounters or responses are extremely unlikely, effects on ESA-listed species are extremely unlikely to occur and ***discountable***.

As all effects of unexpected/unanticipated events would be ***discountable***, unexpected/unanticipated events associated with the Proposed Action ***may affect, but not likely to adversely affect*** Atlantic sturgeon and shortnose sturgeon.

4. Conclusions and Effect Determinations

Table 4-1 summarizes the effects determinations for the ESA-listed marine mammals, sea turtles, and fish considered for further analysis in this BA. Effects determinations incorporated both the mitigation measures in the MMPA application outlined in **Table 1-10** and the BOEM-proposed mitigation measures outlined in **Table 1-11**. Four effects determinations were made within the BA:

1. **No effect** – if it is determined the Proposed Action would have no impacts, positive or negative, on ESA-listed species or designated critical habitat. Generally, this means that the species or critical habitat would not be exposed to the Proposed Action and its environmental consequences.
2. **Not likely to adversely affect (Insignificant)** – effects relate to the size or severity of the impact and include those effects that are undetectable, not measurable, or so minor that they cannot be meaningfully evaluated.
3. **Not likely to adversely affect (Discountable)** – effects are those that are extremely unlikely to occur. For an effect to be discountable, there must be a plausible adverse effect (i.e., a credible effect that could result from the action and that would be an adverse effect if it did impact a listed species), but it is extremely unlikely to occur (USFWS and NMFS 1998).[10]
4. **Likely to adversely affect** – effects of the Proposed Action that could not be fully mitigated and was expected to result in an adverse effect on an ESA-listed species that could result in an ESA-level take.

[10] When the terms “discountable” or “discountable effects” appear in this document, they refer to potential effects that are found to support a “not likely to adversely affect” conclusion because they are extremely unlikely to occur. The use of these terms should not be interpreted as having any meaning inconsistent with the ESA regulatory definition of “effects of the action.”

Table 4-1. Effects Determinations by Stressor and Species

Stressor		Project Development Phase	Potential Effect	ESA-Listed Cetaceans	ESA-Listed Sea Turtles	ESA-Listed Marine Fish
Underwater Noise	Impact Pile-Driving	C	PTS	NLAA for NARW and sperm whales LAA for others	NLAA for green sea turtles LAA for others	NLAA for Atlantic sturgeon No effect for shortnose sturgeon
			BD	NLAA for sperm whales LAA for others	NLAA for green sea turtles LAA for others	NLAA for Atlantic sturgeon No effect for shortnose sturgeon
	Vibratory Pile-Driving	C, D	PTS	NLAA for sperm whales LAA for others	NLAA	NLAA for Atlantic sturgeon No effect for shortnose sturgeon
			BD	LAA	NLAA	NLAA for Atlantic sturgeon No effect for shortnose sturgeon
	HRG Surveys	pre-C, C, O&M	PTS	No Effect	NLAA	NLAA for Atlantic sturgeon No effect for shortnose sturgeon
			BD	LAA	NLAA	NLAA for Atlantic sturgeon No effect for shortnose sturgeon

Stressor		Project Development Phase	Potential Effect	ESA-Listed Cetaceans	ESA-Listed Sea Turtles	ESA-Listed Marine Fish
	Cable Laying	C	PTS and BD	NLAA	NLAA	NLAA for Atlantic sturgeon No effect for shortnose sturgeon
	Dredging Noise	C	PTS and BD	NLAA	NLAA	NLAA for Atlantic sturgeon No effect for shortnose sturgeon
	Vessel Noise	pre-C, C, O&M, D	PTS and BD	NLAA	NLAA	NLAA
	Aircraft Noise	pre-C, C, O&M, D	PTS and BD	NLAA	NLAA	NLAA for Atlantic sturgeon No effect for shortnose sturgeon
	WTGs	O&M	PTS and BD	NLAA	NLAA	NLAA for Atlantic sturgeon No effect for shortnose sturgeon
Dredging		C	Injury/mortality	No Effect	NLAA	NLAA for Atlantic sturgeon No effect for shortnose sturgeon
Habitat Disturbance		C, O&M, D	Foraging/Prey availability	NLAA	No Effect for green and loggerhead sea turtles NLAA for others	NLAA for Atlantic sturgeon No effect for shortnose sturgeon

Stressor	Project Development Phase	Potential Effect	ESA-Listed Cetaceans	ESA-Listed Sea Turtles	ESA-Listed Marine Fish
Secondary Entanglement from Increased Recreational Fishing Due to Reef Effect	O&M	Secondary entanglement	NLAA	NLAA for green sea turtles NLAA for others	NLAA for Atlantic sturgeon No effect for shortnose sturgeon
Turbidity	C, D	Foraging/Prey availability	NLAA	NLAA	NLAA for Atlantic sturgeon No effect for shortnose sturgeon
Vessel Traffic	pre-C, C, O&M, D	Injury/mortality	NLAA	NLAA	NLAA for Atlantic sturgeon No effect for shortnose sturgeon
Monitoring Surveys	pre-C, C, O&M	Injury/mortality	NLAA	LAA	LAA for Atlantic sturgeon No effect for shortnose sturgeon
EMF	O&M	Effects on orientation/ migration or navigation	NLAA	NLAA	NLAA for Atlantic sturgeon No effect for shortnose sturgeon
Air Emissions	C, O&M, D	Contaminant exposure	No Effect	No Effect	No Effect
Lighting/Marking of Structures	C, O&M, D	Photoperiod disruption/ Attraction	NLAA	NLAA	NLAA for Atlantic sturgeon No effect for shortnose sturgeon
Unanticipated Events	C, O&M, D	Contaminant exposure	NLAA	NLAA	NLAA
Overall Effects Determination	pre-C, C, O&M, D	PTS/BD	LAA	LAA	LAA

BD = behavioral disturbance; C = construction; D = decommission; EMF = electromagnetic field; ESA = Endangered Species Act; LAA = likely to adversely affect; NLAA = not likely to adversely affect; PTS = permanent threshold shift; Pre-C = pre-construction; O&M = operations and maintenance; TTS = temporary threshold shift

5. REFERENCES

Able, K. W., and M. P. Fahay. 2010. *Ecology of estuarine fishes*. Baltimore, MD: Johns Hopkins University Press.

Andersson, M. H., E. Dock-Åkerman, R. Ubral-Hedenberg, M. C. Öhman, and P. Sigray. 2007. Swimming behavior of roach (*Rutilus rutilus*) and three-spined stickleback (*Gasterosteus aculeatus*) in response to wind power noise and single-tone frequencies. *AMBIO* 36:636–638.

Anderwald, P., A. Brandecker, M. Coleman, C. Collins, H. Denniston, D. Haberlin, M. O'Donovan, R. Pinfield, F. Visser, and L. Walshe. 2013. Displacement responses of a mysticete, and odontocete, and a phocid seal to construction-related vessel traffic. *Endangered Species Research* 21:esr00523.

Atlantic Shores Offshore Wind, LLC (Atlantic Shores). 2022. Atlantic Shores Offshore Wind Application for Marine Mammal Protection Act (MMPA) Rulemaking and Letter of Authorization. July.

Atlantic Shores Offshore Wind, LLC (Atlantic Shores). 2023a. Atlantic Shores Offshore Wind: Construction and Operations Plan. Lease Area OCS-A 0499. October.

Atlantic Shores Offshore Wind, LLC (Atlantic Shores). 2023b. Atlantic Shores Offshore Wind Updates to the Application for Marine Mammal Protection Act (MMPA) Rulemaking and Letter of Authorization. March.

Atlantic States Fisheries Commission (ASMFC). 2012. Habitat Addendum IV to Amendment 1 to the Interstate Fishery Management Plan for Atlantic sturgeon. 15 pp.

Atlantic States Marine Fisheries Commission (ASMFC). 2017. 2017 *Atlantic Sturgeon Benchmark Stock Assessment and Peer Review Report*. 456 pp.

Atlantic Sturgeon Status Review Team (ASSRT). 2007. *Status Review of Atlantic Sturgeon (Acipenser oxyrinchus oxyrinchus)*. Report to National Fisheries Service, Northeast Regional Office. 174 pp.

Bain, M .B. 1997. Atlantic and shortnose sturgeons of the Hudson River: Common and divergent life history attributes. *Environmental Biology of Fishes* 48:347–358.

Bain, M. B., N. Haley, D. Peterson, J. R. Waldman, and K. Arend. 2000. Harvest and habitats of Atlantic sturgeon *Acipenser oxyrinchus* Mitchill, 1815, in the Hudson River Estuary: Lessons for sturgeon conservation. *Boletín Instituto Español de Oceanografía* 16:43–53.

Balazik, M. T., K. J. Reine, A. J. Spells, C. A. Fredrickson, M. L. Fine, G. C. Garman, and S. P. McIninch. 2012. The potential for vessel interactions with adult Atlantic sturgeon in the James River, Virginia. *North American Journal of Fisheries Management* 32:1062–1069.

Balazs, G. H. 1985. Impact of Ocean Debris on Marine Turtles: Entanglement and Ingestion. In R. S. Shomura and O. Yoshida (eds.). *Proceedings of the Workshop on the Fate and Impact of Marine Debris*, pp. 387-429. NOAA Tech. Memo. NMFS-SWFSC-54.

Barkaszi, M. J., M. Butler, R. Compton, A. Unietis, and B. Bennet. 2012. *Seismic Survey Mitigation Measures and Marine Mammal Observer Reports*. OCS Study BOEM 2012-015.

Barkaszi, M. J., and C. J. Kelly. 2019. *Seismic Survey Mitigation Measures and Protected Species Observer Reports: Synthesis Report – Corrected Version.* OCS Study BOEM 2019-012.

Bartol, S. M., J. A. Musick, and M. L. Lenhardt. 1999. Auditory evoked potentials of the loggerhead sea turtle (*Caretta caretta*). *Copeia* 1999:836–840.

Bartol, S. M. 2004. Sea Turtle Hearing and Sensitivity to Acoustic Impact. Appendix H In: *Geophysical and Geophysical Exploration for Mineral Resources on the Gulf of Mexico Outer Continental Shelf*. OCS EIS/EA MMS 2004-054.

Bartol, S. M. 2008. A review of auditory function of sea turtles. *Bioacoustics* 17:57–59.

Bartol, S. M., and I. K. Bartol. 2011. *Hearing Capabilities of Loggerhead Sea Turtles (Caretta caretta) Throughout Ontogeny: An Integrative Approach Involving Behavioral and Electrophysical Techniques*. Final report. Submitted to the Joint Industries Programme.

Bartol S. M., and D. R. Ketten. 2006. Turtle and tuna hearing. In Y. Swimmer and R. Hill, eds. *Sea Turtle and Pelagic Fish Sensory Biology: Developing Techniques to Reduce Sea Turtle Bycatch in Longline Fisheries*, pp. 98–105. NOAA Tech. Memo. NMFS-PIFSC-7.

Bartol, S. M., and J. A. Musick. 2003. Sensory Biology of Sea Turtles. In P. L. Lutz, J. A. Musick, and J. Wyneken (eds.). *The Biology of Sea Turtles*, pp. 79–102. Boca Raton, FL: CRC Press.

Baulch, S., and C. Perry. 2014. Evaluating the impacts of marine debris on cetaceans. *Marine Pollution Bulletin* 80:210–221.

Baumgartner, M. F., T. V. N. Cole, R. G. Campbell, G. J. Teegarden, and E. G. Durbin. 2003. Associations between North Atlantic right whales and their prey, *Calanus finmarchicus*, over diel and tidal time scales. *Marine Ecology Progress Series* 264:155-166.

Baumgartner, M. F. and D. M. Fratantoni. 2008. Diel periodicity in both sei whale vocolization rates and the vertical migration of their copepod prey observed from ocean gliders. *Limnology and Oceanography* 53:2197-2209.

Baumgartner, M. F., N. S. J. Lysiak, C. S. Schuman, J. Urban-Rich, and F. W. Wenzel. 2011. Diel vertical migration behavior of *Calanus finmarchicus* and its influence on right and sei whale occurrence. *Marine Ecological Progress Series* 423:167-184.

Baumgartner, M. F., C. A. Mayo, and R. D. Kenney. 2007. *Enormous Carnivores, Microscopic Food, and a Restaurant That's Hard to Find*. *The Urban Whale: North Atlantic Right Whales at the Crossroads*. Harvard University Press, Cambridge, MA. Pp. 138-171.

Bejarano, A., J. Michel, J. Rowe, Z. Li, D. F. McCay, and D. S. Etkin. 2013. *Environmental Risks, Fate, and Effects of Chemicals Associated with Wind Turbines on the Atlantic Outer Continental Shelf*. U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs, Herndon, VA. OCS Study BOEM 2013-213. Available: https://espis.boem.gov/final%20reports/5330.pdf. Accessed: September 3, 2020.

Bellman, M. A., A. May, T. Wendt, S. Gerlach, P. Remmers, and J. Brinkmann. 2020. *Underwater Noise during Percussive Pile Driving: Influencing Factors on Pile-driving Noise and Technical Possibilities to Comply with Noise Mitigation Values*. ERa Report. 128 pp.

Bembenek-Bailey, S. A., J. N. Niemuth, P. D. McClellan-Green, M. H. Godfrey, C. A. Harms, H. Gracz, and M. K. Stoskopf. 2019. NMR metabolomics analysis of skeletal muscle, heart, and liver of hatchling loggerhead sea turtles (*Caretta caretta*) experimentally exposed to crude oil and/or Corexit. *Metabolites* 9. doi:10.3390/metabo9020021.

Bemis, W. E., and B. Kynard. 1997. Sturgeon rivers: An introduction to Acipenseriform biogeography and life history. *Environmental Biology of Fishes* 48:167–183.

Benhemma-Le Gall, A., I. Graham, N. Merchant, and P. Thompson. 2021. Broad-scale responses of harbor porpoises to pile-driving and vessel activities during offshore windfarm construction. *Frontiers in Marine Science* 8:664724.

Berreiros J. P., and V. S. Raykov. 2014. Lethal lesions and amputation caused by plastic debris and fishing gear on the loggerhead turtle *Caretta caretta* (Linnaeus, 1758). Three case reports from Terceira Island, Azores (NE Atlantic). *Marine Pollution Bulletin* 86:518–522.

Bigelow, H. B., and W.C. Schroeder. 1953. Fishes of the Gulf of Maine. *Fishery Bulletin of the U.S. Fish and Wildlife Service* 53.

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.

Bolten, A. B., L. B. Crowder, M. G. Dodd, A. M. Lauritsen, J. A. Musick, B. A. Schroeder, and B. E. Witherington. 2019. Recovery Plan for the Northwest Atlantic Population of the Loggerhead Sea Turtle (*Caretta caretta*). Second Revision. Assessment of Progress Towards Recovery. 21 pp.

Boysen, K. A., and J. J. Hoover. 2009. Swimming performance of juvenile white sturgeon (*Acipenser transmontanus*): Training and the probability of entrainment due to dredging. *Journal of Applied Ichthyology* 25:54–59.

Brakes, P. and S. R. X. Dall. 2016. Marine mammal behavior: A review of conservation iplications. *Frontiers in Marine Science* 3:87.

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.

Breece, M. W., M. J. Oliver, M. A. Cimino, and D. A. Fox. 2013. Shifting distributions of adult Atlantic sturgeon admidst post-industrialization and future impacts in the Delaware River: a maximum entropy approach. *PLOS ONE* 8:e81321.

Brostörm, G. 2008. On the influence of large wind farms on the uper ocean circulation. *Journal of Marine Systems* 74:585-591.

Brown, J. J., and G. W. Murphy. 2010. Atlantic sturgeon vessel-strike mortalities in the Delaware Estuary. *Fisheries* 35:72–83.

Browne, M. A., A. J. Underwood, M. G. Chapman, R. Williams, R. C. Thompson, and J. A. van Franeker. 2015. Linking effects of anthropogenic debris to ecological impacts. *Proceedings of the Royal Society B* 282:20142929.

Brundage, H. M., and R. E. Meadows. 1982. The Atlantic sturgeon, *Acipenser oxyrinchus*, in the Delaware River Estuary. *Fishery Bulletin* 80:337–343.

Bryant, P. J. C. M. Lafferty, and S. K. Lafferty. 1984. *Reoccupation of Laguna Guerrero Negro, Baja California, Mexico, by Gray Whales*. In M. L. Jones, S. L. Swartz, and S. Leatherwood (eds.). The Gray Whale *Eschrichtius robustus*. Academic Press. Pp. 375-387.

Buckley, J. and B. Kynard. 1981. Spawning and rearing of shortnose sturgeon from the Connecticut River. *The Progressive Fish-Culturist* 43:74–76.

Buehler, P. E., 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*. California Department of Transportation, Division of Environmental Analysis. CTHWANP-RT-15-306.1.1.

Bugoni, L., L. Krause, and M. V. Petry. 2001. Marine debris and human impacts on sea turtles in southern Brazil. *Marine Pollution Bulletin* 42:1330–1334.

Bureau of Ocean Energy Management (BOEM). 2014. *Proposed Geological and Geophysical Activities. Mid-Atlantic and South Atlantic Planning Areas. Final Programmatic Environmental Impact Statement*. Volume I: Chapters 1–8, Figures, Tables, and Keyword Index. OCS EIS/EA BOEM 2014-001. Available: https://www.boem.gov/sites/default/files/oil-and-gas-energy-program/GOMR/BOEM-2014-001-v1.pdf. Accessed: January 2021.

Bureau of Ocean Energy Management (BOEM). 2017. *Gulf of Mexico OCS Proposed Geological and Geophysical Activities Western, Central, and Eastern Planning Areas. Final Programmatic Environmental Impact Statement*. OCS EIS/EA BOEM 2017-051.

Bureau of Ocean Energy Management (BOEM). 2018. *Vineyard Wind Offshore Wind Energy Project Scoping Report*. U.S. Department of the Interior. Available: https://www.boem.gov/Vineyard-Wind/. Accessed: May 7, 2019.

Bureau of Ocean Energy Management (BOEM). 2019a. *National Environmental Policy Act Documentation for Impact-Producing Factors in the Offshore Wind Cumulative Impacts Scenario on the North Atlantic Continental Shelf*. OCS Study 2019-036.

Bureau of Ocean Energy Management (BOEM). 2019b. *Vineyard Wind Offshore Wind Energy Project Biological Assessment*. For the National Marine Fisheries Service.

Bureau of Ocean Energy Management (BOEM). 2021a. *Vineyard Wind 1 Offshore Wind Energy Project Final Environmental Impact Statement*. OCS EIS/EA BOEM 2021-0012. Available: https://www.boem.gov/vineyard-wind.

Bureau of Ocean Energy Management (BOEM). 2021b. Biological Assessment. Data collection and site survey activities for renewable energy on the Atlantic Outer Continental Shelf.

Bureau of Ocean Energy Management (BOEM). 2021c. *Guidelines for Lighting and Marking of Structures Supporting Renewable Energy Development*. Available: https://www.boem.gov/sites/default/files/documents/renewable-energy/2021-Lighting-and-Marking-Guidelines.pdf. Accessed: November 28, 2021.

Bureau of Ocean Energy Management (BOEM). 2021d. *Project Design Criteria and Best Management Practices for Protected Species Associated with Offshore Wind Data Collection*. Available: https://www.boem.gov/sites/default/files/documents//PDCs%20and%20BMPs%20for%20Atlantic%20Data%20Collection%2011222021.pdf. Accessed: September 21, 2022.

Bureau of Ocean Energy Management (BOEM). 2022a. *Empire Offshore Wind Draft Environmental Impact Statement*. OCS EIS/EA BOEM 2022-069.

Bureau of Ocean Energy Management (BOEM). 2022b. *Ocean Wind 1 Offshore Wind Farm Draft Environmental Impact Statement*. OCS EIS/EA BOEM 2022-0021. Available: https://www.boem.gov/renewable-energy/state-activities/ocean-wind-1-draft-environmental-impact-statement-deis-commercial.

Burke, V. J., E. A. Standora, and S. J. Morreale. 1993. Diet of juvenile kemp's ridley and loggerhead sea turtles from Long Island, New York. *Copeia* 1993:1176-1180.

Burton, W. H. 1993. *Effects of Bucket Dredging on Water Quality in the Delaware River and the Potential for Effects on Fisheries Resources*.

Byles, R. A. 1988. *The Behavior and Ecology of Sea Turtles in Virginia*. Ph.D. Dissertation. Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, VA.

Camacho, M., O. P. Luzardo, L. D. Boada, L. F. L. Jurado, M. Medina, M. Zumbado, and J. Orós. 2013. Potential adverse health effects of persistent organic pollutants on sea turtles: Evidence from a cross-sectional study on Cape Verde loggerhead sea turtles. *Science of the Total Environment* 458–460:283–289.

Carpenter, J. R., L. Merckelbach, U. Callies, S. Clark, L. Gaslikova, and B. Baschek. 2016. Potential impacts of offshore wind farms on North Sea stratification. *PLoS ONE* 11:e0160830.

Carr, A. and D. Caldwell. 1956. The ecology and migrations of sea turtles, I. Results of field work in Florida, 1955. *American Museum Novitates* 1793:1-23.

Carroll, A. G., R. Przeslawski, A. Duncan, M. Gunning, and B. Bruce. 2017. A critical review of the potential impacts of marine seismic surveys on fish & invertebrates. *Marine Pollution Bulletin* 114:9–24.

Clarke, D. 2011. Sturgeon protection. Dredged Material Assessment and Management Seminar, Jacksonville, Florida, May 24-26, 2011.

Causon, P. D., and A. B. Gill. 2018. "Linking ecosystem services with epibenthic biodiversity change following installation of offshore wind farms." *Environmental Science and Policy* 89:340–347.

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.

Chaloupka et al. 2008.

Chen, Z., E. Curchitser, R. Chant, and D. Kang. 2018. Seasonal variability of the cold pool over the Mid-Atlantic Bight continental shelf. *Journal of Geophysical Research: Oceans* 123.

Christiansen, N., U. Daewel, B. Djath, and C. Schrum. 2022. Emergence of large-scale hydrodynamic structures due to atmospheric offshore wind farm wakes. Frontiers in Marine Science 9:818501.

Christensen-Dalsgaard, J., C. Brandt, K. L. Willis, C. Bech Christensen, D. Ketten, P. Edds-Walton, R. R. Fay, P. T. Madsen, and C. E. Carr. 2012. Specialization for underwater hearing by the tympanic middle ear of the turtle, *Trachemys scripta elegans*. *Proceedings of the Royal Society B* 279:2816-2824.

Collins, M. R., T. I. J. Smith, W. C. Post, and O. Pashuk. 2000. Habitat utilization and biological characteristics of adult Atlantic sturgeon in two South Carolina rivers. *Transactions of the American Fisheries Society* 129:982-988.

Crocker, S. E. and F. D. Fratantonio. 2016. *Characteristics of Sounds Emitted During High-Resolution Marine Geophysical Surveys*. Naval Undersea Warfare Center Division. Available: https://www.boem.gov/ESPIS/5/5551.pdf.

Cronin, T. W. J. I. Fasick, L. E. Schweiker, S. Johnse, L. J. Kezmoh, and M. F. Baumgartner. 2017. Coping with copepods: Do right whales (*Eubalaena glacialis*) forage visually in dark waters? *Phyilosphical Transactions of the Royal Society of London Series B: Biological Sciences* 372:20160067.

CSA Ocean Sciences, Inc. and Exponent. 2019. *Evaluation of potential EMF effects of fish species of commercia or recreational fishing importance in southern New England*. U.S. Department of the Interior, Bureau of Ocean Energy Management, Headquarters, Sterling, VA. OCS Study BOEM 2019-049.

Dadswell, M. J. 2006. A review of the status of Atlantic sturgeon in Canada, with comparisons to populations in the United States and Europe. *Fisheries* 31:218-229.

Dadswell, M. J., B. D. Taubert, T. S. Squiers, D. Marchette, and J. Buckley. 1984. Synopsis of Biological Data on Shortnose Sturgeon, *Acipenser brevirostrum* LeSueur 1818. FAO Fisheries Synopsis No. 140. NOAA Tech. Rep. NMFS 14. 45 pp.

Dähne, M., A. Gilles, K. Lucke, V. Pechko, S. Alder, K. Krügel, J. Sundermeyer, and U. Siebert. 2013. Effects of pile driving on harbour porpoises (Phocoena phocoena) at the First Offshore Wind Farm in Germany. Environmental Resource Letters 8:025002.

Dalen, J. and G. M. Knutsen. 1987. *Scaring Effects in Fish and Harmful Effects on Eggs, Larvae and Fry by Offshore Seismic Explorations*. In H. M. Merklinger (ed). Progress in Underwater Acoustics. Plenum Press, London. Pp 93-102.

Davies, T. W., J. P. Duffy, J. Bennie, and K. J. Gaston. 2016. Stemming the tide of light pollution encroaching into marine protected areas. *Conservation Letters* 9:164-171.

Davis, G. E., M. F. Baumgartner, J. M. Bonnell, J. Bell, C. Berchok, J. B. Thornton, S. Brault, G. Buchanan, R. A. Charif, D. Cholewiak, and C. W. Clark. 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. 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* 26:4812–4840.

De Robertis, A. and N. O. Handegard. 2013. Fish avoidance of research vessels and the efficacy of noise-reduced vessels: a review. *ICES Journal of Marine Science* 70:34-45.

Deakos, M. H., J. D. Baker, and L. Bejder. 2011. Characteristics of a manta ray *Manta alfredi* population off Maui, Hawaii, and implications for management. *Marine Ecology Progress Series* 429:245–260..

Degraer, S., D. A. Carey, J. W. P. Coolen, and Z. L. Hutchison. 2020. Offshore wind farm artificial reefs affect ecosystem structure and functioning. A synthesis. *Oceanography* 33:48–57.

Delaware River Basin Commission (DRBC). 2021.Dernie, K. M., M. J. Kaiser, E. A. Richardson, and R. M. Warwick. 2003. Recovery rates of benthic communities following physical disturbance. *Journal of Animal Ecology* 72:1043–1056.

Dewar, H., P. Mous, M. Domeier, A. Muljadi, J. Pet, and J. Whitty. 2008. Movements and site fidelity of the giant manta ray, *Manta birostris*, in the Komodo Marine Park, Indonesia. *Marine Biology* 155:121–133.

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

Dickerson, C., K. J. Reine, and D. G. Clarke. 2001. *Characterization of Underwater Sounds Produced by Bucket Dredging Operations*. DOER Technical Notes Collection. ERDC TN-DOER-E14. 17 pp.

Dickerson, D., M. S. Wolters, C. Theriot, and C. Slay. 2004. Dredging impacts on sea turtles in the Southeastern USA: a historical review of protection. *Proceedgings of World Dredging Congress XVII, Dredging in a Sensitive Environment* 27.

Diederichs, A., M. J. Brandt, and G. Nehls. 2010. Does sand extraction near Sylt affect harbour porpoises. *Wadden Sea Ecosystem* 26:199-203.

Dodd, C. K. 1988. Synopsis of the biological data on the loggerhead sea turtle *Caretta caretta* (Linnaeus 1758). U.S. Fish and Wildlife Service Biological Report 88:1–110.

Dolman, S., V. Williams-Grey, R. Asmutis-Silvia, and S. Isaac. 2006. *Vessel Collisions and Cetaceans: What Happens When They Don't Miss the Boat*. A WDCS Science Report.

Doney, S. C., D. S. Busch, S. R. Cooley, and K. J. Kroeker. 2020. The impacts of ocean acidification on marine ecosystems and reliant human communities. *Annual Review of Environment and Resources* 45:83–112.

Dow Piniak, W. E., D. A. Mann, S. A. Eckert, and C. A. Harms. 2012a. Amphibious Hearing in Sea Turtles. In A. N. Popper and A. Hawkins, eds. *The Effects of Noise on Aquatic Life*, pp. 83–87.

Dow Piniak, W. E., S. A. Eckert, C. A. Harms, and E. M. Stringer. 2012b. *Underwater Hearing Sensitivity of the Leatherback Sea Turtle (Dermochelys coriacea): Assessing the Potential Effect of Anthropogenic Noise*. OCS Study BOEM 2012-01156. 25 pp.

Duarte, C. M., K. A. Pitt, C. H. Lucas, J. E. Purcell, S. Uye, K. Robinson, L. Brotz, M. B. Decker, K. R. Sutherland, A. Malej, L. Madin, H. Mianzan, J. Malek, W. M. Graham, and R. H. Condon. 2013. Is global ocean sprawl a cause of jellyfish blooms? *Frontiers in Ecology and the Environment* 2012; doi: 10.1890/110246.

Dunlop, R. A., M. J. Noad, R. D. McCauley, E. Kniest, R. Slade, D. Paton, and D. H. Catol. 2016. Response of humpback whales (*Megaptera novaengliae*). *Marine Pollution Bulletin* 103:72–83

Dunlop, R. A., M. J. Noad, R. D. McCauley, E. Kniest, R. Slade, D. Paton, and D. H. Cato. 2017. The behavioural response of migrating humpback whales to a full seismic airgun array. *Proceedings of the Royal Society of Biology* 284:20171901.

Dunton, K. J. A. Jordaan, D. O. Conover, K. A. McKown, L. A. Bonacci, and M. G. Frisk. 2015. Marine distribution and habitat use of Atlantic sturgeon in New York lead to fisheries interations and bycatch. *Marine and Coastal Fisheries* 7:18-32.

Dunton, K. J., A. Jordaan, K. A. McKown, D. O. Conover, and M. G. Frisk. 2010. Abundance and distribution of Atlantic sturgeon (*Acipenser oxyrinchus*) within the Northwest Atlantic Ocean, determined from five fishery-independent surveys. *Fisheries Bulletin* 108:450-465.

Eckert, K. L., B. P. Wallace, J. G. Frazier, S. A. Eckert, and P. C. H. Pritchard. 2012. *Synopsis of the Biological Data on the Leatherback Sea Turtle (Dermochelys coriacea)*. Biological Technical Publication BTP-R4015-2012. Washington, D.C. U.S. Department of the Interior, U.S. Fish and Wildlife Service.

Edwards, E. F., C. Hall, T. J. Moore, C. Sheredy, and J. V. Redfern. 2015. Global distribution of fin whales Balaenoptera physalus in the post-whaling era (1980–2012). *Mammal Review* 45:197–214.

Edwards, R. E., F. M. Parauka, and K. J. Sulak. 2007. New insights into marine migration and winter habitat of Gulf sturgeon. *American Fisheries Society Symposium* 56:183–196.

Edwards, R. E., K. J. Sulak, M. T. Randall, and C. B. Grimes. 2003. Movements of Gulf sturgeon (*Acipenser oxyrinchus desotoi*) in nearshore habitat as determined by acoustic telemetry. *Gulf of Mexico Science* 21:59–70.

Efroymson, R. A., W. Hodge Rose, S. Nemth, and G. W. Suter II. 2000. *Ecological Risk Assessment Framework for Low Altitude Overflights by Fixed-Wing and Rotary-Wing Military Aircraft*. Research sponsored by Strategic Environmental Research and Development Program of the U.S. Department of Defense under Interagency Agreement 2107-N218-S1. Publication No. 5010. Environmental Science Division, ORNL.

Elliott, J., A. A. Khan, L. Ying-Tsong, T. Mason, J. H. Miller, A. E. Newhall, G. R. Potty, and K. J. Vigness-Raposa. 2019. *Field Observations During Wind Turbine Operations at the Block Island Wind Farm, Rhode Island*. Final Report to the U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs. OCS Study BOEM 2019-028. Available: https://espis.boem.gov/final%20reports/BOEM_2019-028.pdf.

Engås, A., O. A. Misund, A. V. Soldal, B. Horvei, and A. Solstad. 1995. Reactions of penned herring and cod to playback of original, frequency-filtered and time-smoothed vessel sound. *Fisheries Research* 22:243-254.

Engås, A., E. K. Haugland, and J. T. Øverdal. 1998. Reactions of cod (*Gadus morhua* L.) in pre-vessel zone to an approaching trawler under different light conditions. *Hydrobiologia* 371/372:199-206.

English, P. A., T. I. Mason, J. T. Backstrom, B. J. Tibbles, A. A. Mackay, M. J. Smith, and T. Mitchell. 2017. *Improving Efficiencies of National Environmental Policy Act Documentation for Offshore Wind Facilities Case Studies Report*. US Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs. OCS Study – BOEM 2017-026.

Epperly, S., L. Avens, L. Garrison, T. Henwood, W. Hoggard, J. Mitchell, J. Nance, J. Poffenberger, C. Sasso, E. Scott-Denton, and C. Yeung. 2002. *Analysis of Sea Turtle Bycatch in the Commercial Shrimp Fisheries of Southeast U.S. Waters and the Gulf of Mexico*. NOAA Technical Memorandum. NMFS-SEFSC-490. 88 pp.

Erbe, C. 2013. International regulation of underwater noise. *Acoustics Australia* 41:12-19.

Erbe, C., R. Dunlop, and S. Dolman. 2018. Effects of noise on marine mammals. In H. Slabbekoorn, R. J. Dooling, A. N. Popper, and R. R. Fay, eds. *Effects of Anthropogenic Noise on Animals*, pp. 277–309.

Erbe, C., S. A. Marley, R. P. Schoeman, J. N. Smith, L. E. Trigg, and C. B. Embling. 2019. The effects of ship noise on marine mammals—A review. *Frontiers in Marine Science* 6:Article 606.

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

Ernst, C. H., R. W. Barbour, and J. E. Lovich. 1994. *Turtles of the United States and Canada*. Washington, D.C.: Smithsonian Institution Press.

Estabrook, B. J., D. V. Harris, K. B. Hodge, D. P. Salisbury, D. Ponirakis, J. Zeh, S. E. Parks, and A. N. Rice. 2019. *Year 1 Annual Survey Report for New York Bight Whale Monitoring Passive Acoustic Surveys October 2017- July 2018.* Contract C009925. New York State Department of Environmental Conservation. East Setauket, NY.

Estabrook, B. J., D. V. Harris, K. B. Hodge, D. P. Salisbury, D. Ponirakis, J. Zeh, S. E. Parks, and A. N. Rice. 2019. Citing Dunlop, R. A., M. J. Noad, D. H. Cato, and D. Stokes. 2007. The Social Vocalization Repertoire of East Australian Migrating Humpback Whales (*Megaptera novaeangliae*). *Journal of the Acoustical Society of America* 122:2893–2905.

Estabrook, B. J., D. V. Harris, K. B. Hodge, D. P. Salisbury, D. Ponirakis, J. Zeh, S. E. Parks, and A. N. Rice. 2019. Citing Risch, D., M. Castellote, C. W. Clark, G. E. Davis, P. J. Dugan, L. E. Hodge, A. Kumar, K. Lucke, D. K. Mellinger, S. L. Nieukirk, C. M. Popescu, C. Ramp, A. J. Read, A. N. Rice, M. A. Silva, U. Siebert, K. M. Stafford, H. Verdaat, and S. M. Van Parijs. 2014. Seasonal Migrations of North Atlantic Minke Whales: Novel Insights from Large-Scale Passive Acoustic Monitoring Networks. *Movement Ecology* 2:24.

Estabrook, B. J., D. V. Harris, K. B. Hodge, D. P. Salisbury, D. Ponirakis, J. Zeh, S. E. Parks, and A. N. Rice. 2019. Citing Weirathmueller, M. J., W. S. D. Wilcock, and D. C. Soule. 2013. Source Levels of Fin Whale 20 Hz Pulses Measured in the Northwest Pacific Ocean. *Journal of the Acoustical Society of America* 133:741–749.

Fasick, J. I., M. F. Baumgartner, T. W. Cronin, B. Nickle, L. J. Kezmoh. 2017. Visual predation during springtime foraging of the North Atlantic right whale (*Eubalaena glacialis*). *Marine Mammal Science* 33:991-1013.

Finkbeiner, E. M., B. P. Wallace, J. E. Moore, R. L. Lewison, L. B. Crowder, and A. J. Read. 2011. Cumulative estimates of sea turtle bycatch and mortality in USA fisheries between 1990 and 2007. *Biological Conservation* 144:2719-2727.

Finneran, J. J. 2016. *Auditory Weighting Functions and TTS/PTS Exposure Functions for Marine Mammals Exposed to Underwater Noise*. Pp. 38-110 In National Marine Fisheries Service, Technical Guidance for Assessing the Effets of Anthropogenic Sound on Marine Mammal Hearing: Underwater Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts. U.S. Department of Commerce, NOAA. NOAA Technical Memorandum. NMFS-OPR-55.

Finneran, J. J, E. E. Henderson, D. S. Houser, K. Jenkins, S. Kotecki, and J. Muslow. 2017. *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)*. Technical report by Space and Naval Warfare Systems Center Pacific. 183 pp.

Finneran, J. J. and K. Jenkins. 2012. *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis*. San Diego, CA: Department of Navy.

Fisheries Hydroacoustic Working Group. 2008. Agreement in principle for interim criteria for injury to fish from pile driving activities. Technical/Policy Meeting June 11, 2008, Vancouver, Washington.

Foley, A. M., B. A. Stacy, R. F. Hardy, C. P. Shea, K. E. Minch, and B. A. Schroeder. 2019. Characterizing watercraft-related mortality of sea turtles in Florida. *The Journal of Wildlife Management* 83:1057–1072.

Fox, D. A., J. E. Hightower, and F. M. Parauka. 2002. Estuarine and nearshore marine habitat use by Gulf sturgeon from the Choctawhatchee River System, Florida. *American Fisheries Society Symposium* 28:19–34.

Fuentes, M. M. P. B., and D. Abbs. 2010. Effects of projected changes in tropical cyclone frequency on sea turtles. *Marine Ecology Progress Series* 412:283–292.

Gaichas, S. K., J. Hare, M. Pinsky, G. Depiper, O. Jensen, T. Lederhouse, J. Link, D. Lipton, R. Seagraves, J. Manderson, and M. Clark. 2015. *Climate change and variability: A white paper to inform the Mid-Atlantic Fishery Management Council on the impact of climate change on fishery science and management*. Second Draft. Accessed: August 28, 2020. Available: https://static1.squarespace.com/static511cdc7fe4b00307a2628ac6/t/5c5c8fa9652dea319f3f8fe6/1549569962945/MAFMC-Climate-Change-and-Variability-White-Paper_Apr2015.pdf.

Gall, S. C., and R. C. Thompson. 2015. The impact of marine debris on marine life. *Marine Pollution Bulletin* 92:170–179.

Geo-Marine. 2010. *Ocean/Wind Power Ecological Baseline Studies: January 2008 – December 2009. Final Report. Volume III: Marine Mammal and Sea Turtle Studies*. Report by Geo-Marine, Inc. for the New Jersey Department of Environmental Protection, Office of Science. Available: https://tethys.pnnl.gov/sites/default/files/publications/Ocean-Wind-Power-Baseline-Volume3.pdf.

Gilbert, C. R. 1989. Species profiles: Life histories and environmental requirements of coastal fishes and invertebrates (Mid-Atlantic Bight)—Atlantic and shortnose sturgeons. U.S. Fish and Wildlife Service Biological Report 82(11.122). U.S. Army Corps of Engineers TR EL-82-4. 28pp.

Gill, A. B., M. Bartlett, and F. Thomsen. 2012. Potential interactions between diadromous fishes of U.K. conservation importance and the electromagnetic fields and subsea noise from marine renewable energy developments. *Journal of Fish Biology* 81:664–695.

Gill, A. B., I. Gloyne-Phillips, K. J. Neal, and J. A. Kimber. 2005. The Potential Effects of Electromagnetic Fields Generated by Sub-Sea Power Cables Associated with Offshore Wind Farm Developments on Electrically and Magnetically Sensitive Marine Organisms—A Review. Collaborative Offshore Wind Research into the Environment (COWRIE), Ltd, UK. Available: https://tethys.pnnl.gov/sites/default/files/publications/The_Potential_Effects_of_Electromagnetic_Fields_Generated_by_Sub_Sea_Power_Cables.pdf. Accessed: September 9, 2020.

Girondot, M., S. Bédel, L. Selmoitiez, M. Russo, J. Chevalier, L. Guéry, S. Ben Hassine, H. Féon, and I. Jribi. 2015. Spatio-temporal distribution of *Manta birostris* in French Guiana waters. *Journal of the Marine Biological Association of the United Kingdom* 95:153–160.

Gitschlag, G., and M. Renauld. 1989. Sea Turtles and the Explosive Removal of Offshore Oil and Gas Structures. In S. A. Eckert, K. L. Eckert, and T. H. Richardson, eds. *Proceedings of the Ninth Annual Workshop on Sea Turtle Conservation and Biology*, pp. 67–68. 7–11 February 1989. Jekyll Island, Georgia.

Gitschlag, G. R., and B. A. Herczeg. 1994. Sea turtle observations at explosive removals of energy structures. *Marine Fisheries Review* 56:1–8.

Glass, A. H., T. V. N. Cole, and M. Garron. 2010. *Mortality and serious injury determinations for baleen whale stocks along the United States and Canadian eastern seaboards, 2004 – 2008.* NOAA Tech. Mem. NMFS-NE-214.

Gless, J. M., M. Salmon, and J. Wyneken. 2008. Behavioral responses of juvenile leatherbacks *Dermochelys coriacea* to lights used in the longline fishery. *Endangered Species Research* 5:239–247.

Goldbogen, J. A., A. S. Friedlaender, J. Calambokidis, M. F. McKenna, M. Simon, and D. P. Nowacek. 2013. Integrative approaches to the study of baleen whale diving behavior, feeding performance, and foraging ecology. *BioScience* 63:90-100.

Graham, I. M., E. Pirotta, N. D. Merchant, A. Farcas, T. R. Barton, B. Cheney, G. D. Hastie, and P. M. Thompson. 2017. Responses of Bottlenose Dolphins and Harbor Porpoises to Impact and Vibration Piling Noise during Harbor Construction. *Ecosphere* 8:e01793.

Graham, R. T., M. J. Witt, D. W. Castellanos, F. Remolina, S. Maxwell, B. J. Godley, and L. A. Hawkes. 2012. Satellite tracking of manta rays highlights challenges to their conservation. *PLoS ONE* 9:e110071.

Grashorn, S. and E. V. Stanev. 2016. Kàrmàn vortex and turbulent wake generation by wind park piles. *Ocean Dynamics* 66:1543-1557.

Greater Atlantic Regional Fisheries Office (GARFO). 2020. GARFO Acoustics Tool. Updated September 14, 2020. Available: https://s3.amazonaws.com/media.fisheries.noaa.gov/2020-09/GARFO-Sect7-PileDriving-AcousticsTool-09142020.xlsx?.Egxagq5Dh4dpIwJQsmN1gV0nggnk5qX. Accessed: November 2021.

Greene, J. K., M. G. Anderson, J. Odell, and N. Steinberg. 2010. *The Northwest Atlantic Marine Ecoregional Assessment: Species, Habitats, and Ecosystems. Phase One*. Report by The Nature Conservancy, Eastern US Division, Boston, MA.

Gregory, M. R. 2009. Environmental implications of plastic debris in marine settings – Entanglement, ingestion, smothering, hangers-on, hitch-hiking, and alien invasion. *Philosophical Transactions of the Royal Society B* 364:2013–2025.

Grieve, B. D., J. A. Hare, and V. S. Saba. 2017. Projecting the effects of climate change on *Calanus finmarchicus* distribution within the U.S. Northeast Continental Shelf. *Scientific Reports* 7:6264.

Gudger, E. W. 1922. The most northerly record of the capture in Atlantic waters of the United States of the giant ray, *Manta birostris*. *Science* 55:338–340.

Guida, V., A. Drohan, H. Welch, J. McHenry, D. Johnson, V. Kentner, J. Brink, D. Timmons, and E. Estela-Gomez. 2017. *Habitat Mapping and Assessment of Northeast Wind Energy Areas*. U.S. Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2017-088.

Guilbard, F., J. Munro, P. Dumont, D. Hatin, and R. Fortin. 2007. Feeding ecology of Atlantic sturgeon and lake sturgeon co-occurring in the St. Lawrence estuarine transition zone. *American Fisheries Society Symposium* 56:85–104.

Guilpin, M., V. Lesage, I. McQuinn, J. A. Goldbogen, J. Potvin, T. Jeannaird-du-Dot, T. Doniol-Valcroze, R. Michaud, M. Moisan, and G. Winkler. 2019. Foraging energetics and prey density requirements of western North Atlantic blue whales in the Estuary of the Gulf of St. Lawrence, Canada. *Marine Ecology Progress Series* 625:205-223.

Hain, J. H. W., M. A. M. Hyman, R. D. Kenney, and H. E. Winn. 1985. The role of cetaceans in the shelf-edge region of the northeastern United States. *Marine Fisheries Review* 47:13-17.

Hare, J. A., W. E. Morrison, M. W. Nelson, M. M. Stachura, E. J. Teeters, R. B. Griffis et al. 2016. A vulnerability assessment of fish and invertebrates to climate change on the northeast U.S. continental shelf. *PLoS ONE* 11(2):e0146757. Doi:10.1371/journal.pone.0146756.

Hart Crowser, Inc. (Hart Crowser) and Illingworth and Rodkin, Inc. (Illingworth and 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.* 72 pp.

Hassel, A., T. Knutsen, J. Dalen, K. Skaar, S. Løkkeborg, O. A. Misund, Ø. Østensen, M. Fonn, and E. K. Haugland. 2004. Influence of seismic shooting on the lesser sand eel (*Ammodytes marinus*). *Journal of Marine Science* 61:1165-1173.

Hastings, R. W., L. H. Ogren, and M. T. Marbry. 1976. Observations of fish fauna associated with offshore platforms in the Northeastern Gulf of Mexico. *Fisheries Bulletin* 74:387–402.

Hatakeyama, Y., K. Ishii, H. Akamatsu, T. Soeda, T. Shimamura, and T. Kojima. 1994. A review of studies on attempts to reduce the entanglement of the Dall's porpoise, *Phocoenoides dalli*, in the Japanese salmon gillnet fishery. *Report of the International Whaling Commission* 15:549–563.

Hatch, L. T., C. W. Clark, S. M. van Parijs, A. S. Frankel, and D. M. 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. D., and A. N. 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. 2017. *U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments – 2017*. NOAA Technical Memorandum NMFS NE-245. U.S. Department of Commerce, National Marine Fisheries Service.

Hayes, S. A., E. Josephson, K. Maze-Foley, and P. E. Rosel. 2018a. *U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments – 2019*. NOAA Technical Memorandum NMFS NE-264. U.S. Department of Commerce, National Marine Fisheries Service.

Hayes, S. A., E. Josephson, K. Maze-Foley, and P. E. Rosel. 2019. US Atlantic and Gulf of Mexico Marine Mammal Stock Assessments – 2018. NOAA Tech. Mem. NMFS-NE-258. 298 pp.

Hayes, S. A., E. Josephson, K. Maze-Foley, and P. E. Rosel. 2020. US Atlantic and Gulf of Mexico Marine Mammal Stock Assessments – 2019. NOAA Tech. Mem. NMFS-NE-264. 479 pp.

Hayes, S. A., E. Josephson, K. Maze-Foley, P. E. Rosel, and J. Turek. 2021. US Atlantic and Gulf of Mexico Marine Mammal Stock Assessments 2020. NOAA Tech. Mem. NMFS-NE-271. 394 pp.

Hayes, S. A., E. Josephson, K. Maze-Foley, P. E. Rosel, and J. Turek. 2021. Citing Mitchell, E. 1975. Preliminary report on Nova Scotia fishery for sei whales (*Balaenoptera borealis*). *Report of the International Whaling Commission* 25:218–225.

Hayes, S. A., E. Josephson, K. Maze-Foley, P. E. Rosel, and J. Wallace. 2022. US Atlantic and Gulf of Mexico Marine Mammal Stock Assessments 2021. 380 pp.

Hazel, J., I. R. Lawler, H. Marsh, and S. Robson. 2007. Vessel speed increases collision risk for the green turtle *Chelonia mydas*. *Endangered Species Research* 3:105–113.

HDR. 2022. Ocean Wind Offshore Wind Farm. Application for Marine Mammal Protection Act (MMPA) Rulemaking and Letter of Authorization Application. Prepared for: Ocean Wind LLC, Prepared by: HDR. Dated February, 2022.

Heithaus, M. R., J. J. McLash, A. Frid, L. W. Dill, and G. J. Marshall. 2022. Novel insights into green sea turtle behavior using animal-borne video cameras. *Journal of the Marine Biological Association of the UK* 82:1049-1050.

Henderson, D., B. Hu, and E. Bielefeld. 2008. *Patterns and Mechanisms of Noise-Induced Cochlear Pathology*. Pp 195-217 In J. Schacht, A. N. Popper, and R. R. Fay (eds.). Auditory Trauma, Protection, and Repair. Spring, New York.

Henwood, T. A. and W. E. Stuntz. 1987. Analysis of sea turtle captures and mortalitites during commercial shrimp trawling. *Fisheries Bulletin* 85:814-817.

Hoarau, L., L. Ainley, C. Jean, and S. Ciccione. 2014. Ingestion and defecation of marine debris by loggerhead sea turtles, from by-catches in the south-west Indian Ocean. *Marine Pollution Bulletin* 84:90–96.

Holt, M. 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. *JASA Express Letters* 125:EL27-EL32.

Hoover, J. J., K. A. Boysen, J. A. Beard, and H. Smith. 2011. Assessing the risk of entrainment by cutterhead dredges to juvenile lake sturgeon (*Acipenser fulvescens*) and juvenile pallid sturgeon (*Scaphirhynchus albus*). *Journal of Applied Ichthyology* 27:369–375.

Hopkins, S. R., and J. I. Richardson. 1984. Recovery plan for marine turtles. 363 pp.

Illingworth and Rodkin, Inc. (Illingworth and Rodkin). 2017. *Pile-Driving Noise Measurements at Atlantic Fleet Naval Installations: 28 May 2013-28 April 2016*. Report by Illingworth & Rodkin, Inc. under contract with HDR Environmental for NAVFAC. 152 pp. Available: https://www.navymarinespeciesmonitoring.us/files/4814/9089/8563/Pile-driving_Noise_Measurements_Final_Report_12Jan2017.pdf.

Ingram, E. C., R. M. Cerrato, K. J. Dunton, and M. G. Frisk. 2019. Endangered Atlantic sturgeon in the New York Wind Energy Area: Implications of future development in an offshore wind energy site. *Scientific Reports* 9:12432.

Jansen, E. and C. de Jong. 2016. *Underwater Noise Measurements in the North Sea in and Near the Princess Amalia Wind Farm in Operation*. 45th International Congress and Exposition on Noise Control Engineering: Towards a Quieter Future, INTER-NOISE 2016. 21 August 2016 through 24 August 2016, 7846-7857. Berlin, Germany: Deutsche Gesellschaft Fuer Akustik.

Janzen, F. J. 1994. Climate change and temperature-dependent sex determination in reptiles. *Proceedings of the National Academy of Science* 91:7487–7490.

JASCO Applied Science Inc. (JASCO). 2022. Distance to Behavioral Threshold for Vibratory Pile Driving of Sheet Piles. Technical Memorandum by JASCO Applied Sciences for Ocean Wind LLC, Dated 21 March 2022.

Jensen, A. S., and G. K. Silber. 2004. *Large Whale Ship Strike Database*. NOAA Tech. Memo. NMFS-OPR-25.

Johnson, A. 2018. *White Paper on the Effects of Increased Turbidity and Suspended Sediment on ESA Listed Species from Projects Occurring in the Greater Atlantic Regions*. Greater Atlantic Region Policy Series 18-02. NOAA Fisheries. Available: https:/www.greateratlantic.fisheries.noaa.cov/policyseriesindex.phpGARPS/article/view/8/8.

Johnson, S. R. 2002. *Marine Mammal Mitigation and Monitoring Program for the 2001 Odoptu 3-D Seismic Survey, Sakhalin Island, Russia*. International Whaling Commission Working Paper SC/02/WGW/19.

Johnson, T. J. and M. Andersson. 2012. *FOI Ambient Underwater Noise Levels at Norra Midsjöbanken During Construction of the Nord Stream Pipeline*. FOI Report.

Johnson, J. H., D. S. Dropkin, B. E. Warkentine, J. W. Rachlin, and W. D. Andrews. 1997. Food habits of Atlantic sturgeon off the central New Jersey coast. *Transactions of the American Fisheries Society* 126:166–170.

Johnson, A., G. Salvador, J. Kenney, J. Robbins, S. Kraus, S. Landry, and P. Clapham. 2005. Fishing gear involved in entanglement of right and humpback whales. *Marine Mammal Science* 21:635–645.

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. doi: 10.1016/j.marpolbul.2019.110792.

Kastak, D., J. Muslow, A. Ghoul, C. Reichmuth. 2008. Noise-induced permanent threshold shift in a harbor seal. *The Journal of the Acoustical Society of America* 123:2986. Available: https://doi.org/10.1121/1.2932514.

Kavet, R., M. Wyman, A. Klimley, and X. Vergara. 2016. *Assessment of potential impact of electromagnetic fields from undersea cable on migratory fish behavior*. Report by Electric Power Research Institute (EPRI) for Bureau of Ocean Energy Management (BOEM) and U.S. Department of Energy. OCS Study BOEM 2015-041. Accessed: September 10,2020. Available: https://www.boem.gov/sites/default/files/environmental-stewardship/Environmental-Studies/Pacific-Region/Studies/BOEM-2016-041.pdf.

Kellar, N. M., T. R. Speakman, C. R. Smith, S. M. Lane, B. C. Balmer, M. L. Trego, K. N. Catelani, M. N. Robbins, C. D. Allen, R. S. Wells, E. S. Zolman, T. K. Rowles, and L. H. Schwacke. 2017. Low reproductive success rates of common bottlenose dolphins *Tursiops truncatus* in the northern Gulf of Mexico following the Deepwater Horizon Disaster (2010–2015). *Endangered Species Research* 33:1432–158.

Kellison, R. G. T., and G. R. Sedberry. 1998. The effects of artificial reef vertical profile and hole diameter on fishes off South Carolina. *Bulletin of Marine Sciences* 62:763–780.

Kenney, R. D., and H. E. Winn. 1986. Cetacean high-use habitats of the Northeast United States continental shelf. *Fishery Bulletin* 84:345–357.

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*. Technical Report, Ocean Special Area Management Plan.

Ketten, D. R. 1998. *Marine Mammal Auditory Systems: A Summary of Audiometric and Anatomical Data and its Implications for Underwater Acoustic Impacts*. NOAA Technical Memorandum NMFS: NOAA-TM-NMFS-SWFSC-256.

Ketten, D. R. and S. M. Bartol. 2006. *Functional measures of sea turtle hearing*. Woods Hole Oceanographic Institution. Woods Hole, Massachusetts. Available: www.ntis.gov.

Kipple, B. 2002. *Glacier Bay Underwater Noise – Interim Report.* Naval Surface Warfare Center – Detachment Bremerton. Technical Reprot NSWCCD-71-TR-2002/579. December 2002.

Kipple, B. and C. Gabriele. 2003. *Glacier Bay Watercraft Noise*. Naval Surface Warfare Center – Carderock Division – Detachment Bremerton. Technical Report NSWCCD-71-TR-2003/522. February 2003.

Kirschvink, J. L. 1990. Geomagnetic sensitivity in cetaceans: An update with live strandings recorded in the US. In J. Thomas and R. Kastelein, eds. *Sensory Abilities of Cetaceans*, pp. 639–649.

Kite-Powell, H. L., A. Knowlton, and M. Brown. 2007. *Modeling the Effect of Vessel Speed on Right Whale Ship Strike Risk*. Unpublished Report for NOAA/NMFS Project NA04NMF47202394. 8 pp. Available: https://tethys.pnnl.gov/sites/default/files/publications/Kite-Powell-et-al-2007.pdf. Accessed: September 9, 2020.

Knowlton, A. R., P. K. Hamilton, M. K. Marx, H. P. Pettis, and S. D. Kraus. 2012. Monitoring North Atlantic right whale *Eubalaena galcialis e*ntanglement rates: A 30-year retrospective. *Marine Ecology Progress Series* 466:293–302.

Kraus, S. D., M. W. Brown, H. Caswell, C. W. Clark, M. Fujiwara, P. H. Hamilton, R. D. Kenney, A. R. Knowlton, S. Landry, C. A. Mayo, W. A. McLellan, M. J. Moore, D. P. Nowacek, D. A. Pabst, A. J. Read, and R. M. Rolland. 2005. North Atlantic right whales in crisis. *Science* 309:561–562.

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. Final Report*. U.S. Department of the Interior, Bureau of Ocean Energy Management, Sterling, Virginia. OCS Study BOEM 2016-054. Available: https://www.boem.gov/sites/default/files/environmental-stewardship/Environmental-Studies/Renewable-Energy/Northeast-Large-Pelagic-Survey-Collaborative-Aerial-and-Acoustic-Surveys-for-Large-Whales-and-Sea-Turtles.pdf. Accessed: September 9, 2020.

Krebs, J., P. Kilduff, and F. Jacobs. 2017. Linking Atlantic and shortnose sturgeon diets with prey distribution and environmental variables to identify benthic foraging habitat in the Hudson River – Final report on the sturgeon net conservation benefit studies for the New NY Bridge Project (DEC Permit ID 3-9903-00043/00014). Prepared by AKRF, Inc. for NY State Thruway Authority and NY State Department of Environmental Conservation, Hudson River Fisheries Unit. 59 pp.

Krebs, J., C. Manhard, F. Jacobs. 2019. Risks to Atlantic sturgeon from commercial vessels on the Hudson River. Final Report. Submitted in accordance with Conservation Recommendation #8 NMFS Biological Opinion NER-2018-14953. 93pp.

Krzystan, A. M., T. A. Gowan, W. L. Kendall, J. Martin, J. G. Ortega-Ortiz, K. Jackson, A. R. Knowlton, P. Naessig, M. Zani, D. W. Schulte, and C. R. Taylor. 2018. Characterizing residence patterns of North Atlantic right whales in the southeastern USA with a multistate open robust design model. *Endangered Species Research* 36:279–295.

Keuhne, L. M., C. Erbe, E. Ashe, L. T. Bogaard, M. Salerno Collins, and R. Williams. 2020. Above and below: Military aircraft noise in air and under water at Whidbey Island, Washington. *Journal of Marine Science and Engineering* 11:jmse8110923.

Küsel, E. T., M. J. Weirathmueller, K. E. Zammit, S. J. Welch, K. E. Limpert, and D. G. Zeddies. 2022. Underwater Acoustic and Exposure Modeling. Document 02109, Version 1.0 DRAFT. Technical Report by JASCO Applied Sciences for Ocean Wind LLC.

Kynard, B. 1997. Life history, latitudinal patterns, and status of the shortnose sturgeon (*Acipenser brevirostrum*). *Environmental Biology of Fishes* 48:319–334.

Kynard, B., S. Bolden, M. Kieffer, M. Collins, H. Brundage, E.J. Hilton, M. Litvak, M. T. Kinnison, T. King, and D. Peterson. 2016. Life history and status of shortnose sturgeon (*Acipenser brevirostrum* LeSueur, 1818). *Journal of Applied Ichthyology*32:208–248.

Kynard, B., and M. Horgan. 2002. Ontogenetic behavior and migration of Atlantic sturgeon *Acipenser oxyrinchus*, and shortnose sturgeon *A. brevirostrum*, with notes on social behavior. *Environmental Biology of Fishes* 63:137–150.

Laist, D. W., A. R. Knowlton, J. G. Mead, A. S. Collet, and M. Podesta. 2001. Collisions between ships and whales. *Marine Mammal Science* 17:35–75.

Le Prell, C. G. 2012. *Noise-induced Hearing Loss: From Animal Models to Humal Trials*. IN N. Popper and A. Hawkins (eds.). The Effects of Noise on Aquatic Life. 695 pp.

Lenhardt, M. L. 1982. Bone conduction hearing in turtles. *Journal of Auditory Research* 22:153-160.

Lenhardt, M. L. and S. W. Harkins. 1983. Turtle shell as an auditory receptor. *Journal of Auditory Research* 23:251-260.

Lenhardt, M. L., R. C. Klinger, and J. A. Musick. 1985. Marine turtle middle-ear anatomy. *Journal of Auditory Research* 25:66-72.

Lentz, S. J. 2017. Seasonal warming of the Middle Atlantic Bight cold pool. *Journal of Geophysical Research: Oceans* 122:941–954.

Lesage, V., C. Barrette, M. C. S. Kingsley, and B. Sjare. 1999. The effect of vessel noise on the vocal behavior of belugas in the St. Lawrence River Estuary, Canada. *Marine Mammal Science* 15:65–84.

Lindeboom, H. J., H. J. Kouwenhoven, M. J. N. Bergman, S. Bouma, S. Brasseur, R. Daan, R. C. Fijn, D. deHaan, S. Dirksen, R. van Hal, R. Hille Ris Lambers, R. ter Hofstede, K. L. Krijgveld, 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.

Lohmann, K. J., and C. M. F. Lohmann. 1996. Detection of magnetic field intensity by sea turtles. *Nature* 380:59–61.

Lovell, J. M., M. M. Findlay, R. M. Moate, J. R. Nedwell, and M. A. Pegg. 2005. The inner ear morphology and hearing abilities of the paddlefish (*Polyodon spathula*) and the lake sturgeon (*Acipenser fulvescens*). *Comparative Biochemistry and Physiology Part A: Molecular Integrative Physiology* 142:286–289.

Lucey, S. M., and J. A. Nye. 2010. Shifting species assemblages in the Northeast US Continental Shelf Large Marine Ecosystem. *Marine Ecology Progress Series* 415:23–33.

Lucke, K., P. A. Lepper, B. Hoeve, E. Everaarts, N. van Elk, and U. Siebert. 2007. Perception of low-frequency acoustical signals by a harbour porpoise (*Phocoena phocoena*) in the presence of simulated offshore wind turbine noise. *Aquatic Mammals* 33:55-68.

Ludewig., E. 2015. *On the Effect of Offshore Wind Farms on the Atmosphere and Ocean Dynamics*. Cham: Springer International Publishing.

Luschi, P., S. Benhamou, C. Girard, S. Ciccione, D. Roos, J. Sudre, and S. Benvenuti. 2007. Marine turtles use geomagnetic cues during open sea homing. *Current Biology* 17:126–133.

Lutcavage, M. E. and P. L. Lutz. 1997. *Diving Physiology*. IN P. L. Lutz, J. A. Musick (eds.). The Biology of Sea Turtles. CRC Press, Boca Raton, FL. Pp. 277-296.

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., B. Würsig, J. E. Bird, and P. Tyack. 1986. *Behavioural Responses of Gray Whales to Industrial Noise: Feeding Observations and Predictive Modelling*. Final Report. Outer Continental Shelf Environmental Assessment Program. Research Unit 675. August 1986.

Malme, C. I., B. Würsig, J. E. Bird, and P. Tyack. 1988. Observations of feeding gray whale responses to controlled industrial noise exposure. In W. M. Sackinger (ed.). *Port and Ocean Engineering under Arctic Conditions. Vol. II,* pp. 55–73. Fairbanks, AK: University of Alaska Fairbanks.

Martin, K. J., S. C. Alessi, J. C. Gaspard, A. D. Tucker, G. B. Bauer, and D. A. Mann. 2012. Underwater hearing on the loggerhead turtle (*Caretta Caretta*): A comparison of behavioral and auditory evoked potential audiograms. *Journal of Experimental Biology* 215:3001–3009.

Matte, A., and R. Waldhauer. 1984. *Mid-Atlantic Bight Nutrient Variability*. National Marine Fisheries Service, Sandy Hook Laboratory. SHL Report No. 84-15. Available: https://tinyurl.com/3vpu3etj. Accessed: September 3, 2020.

Maybaum, M. L. 1993. Responses of humpback whales to sonar sounds. *Journal of the Acoustical Society of America* 94:18-48.

Mazet, J. A. K., I. A. Gardner, D. A. Jessup, and L. J. Lowenstine. 2001. Effects of petroleum on mink applied as a model for reproductive success in sea otters. *Journal of Wildlife Diseases* 37:686–692.

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.

McCauley, R. D., J. Fewtrell, A. J. Duncan, C. Jenner, M. N. Jenner, J. D. Penrose, R. I. T. Prince, A. Adhitya, J. Murdoch, 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*. Prepared for Australian Petroleum Production Exploration Association by Centre for Maine Science and Technology, Western Australia. 198 pp.

McCleave, J. D., S. M. Fried, and A. K. Towt. 1977. Daily movements of shortnose sturgeon, *Acipenser brevirostrum*, in a Maine estuary. *Copeia* 1977:149-157.

McConnell, A., R. Routledge, and B. M. Connors. 2010. Effect of artificial light on marine invertebrate and fish abundance in an area of salmon farming. *Marine Ecology Progress Series* 419:147-156.

McGregor, F., A. J. Richardson, A. J. Armstrong, A. O. Armstrong, and C. L. Dudgeon. 2019. Rapid wound healing in a reef manta ray masks the extent of vessel strike. *PLoS ONE* 14:e0225681.

McKenna, M., C. Gabriele, and B. Kipple. 2017. Effects of marine vessel management on the underwater acoustic environment of Glacier Bay National Park, AK. *Ocean & Coastal Management* 139:102–112.

McKinstry, C. A., A. J. Westgate, and H. N. Koopman. 2013. Annual variation in the nutritional value of Stage V *Calanus finmarchicus*: Implications for right whales and other copepod predators. *Endangered Species Research* 20:195–204.

McLean, M. F., M. J. Dadswell, and M. J. W. Stokesbury. 2013. Feeding ecology of Atlantic sturgeon, *Acipenser oxyrinchus* Mitchell, 1815 on the infauna of intertidal mudflats of Minas Basin, Bay of Fundy. *Journal of Applied Ichthyology* 29:503–509.

McLean, M. F., M. J. Dadswell, and M. J. W. Stokesbury. 2013. Citing Dadswell, M. J. 2006. A review of the status of Atlantic sturgeon in Canada, with comparisons to populations in the United States and Europe. *Fisheries* 31:218–229.

McLean, M. F., M. J. Dadswell, and M. J. W. Stokesbury. 2013. Citing Haley, N. 1999. A gastric lavage technique for characterizing diets of sturgeons. *North American Journal of Fisheries Management* 18:978–981.

McLean, M. F., M. J. Dadswell, and M. J. W. Stokesbury. 2013. Citing Savoy, T. 2007. Prey eaten by Atlantic sturgeon in Connecticut waters. *American Fisheries Society Symposium* 56:157–165.

McQueen, A., B. Suedel, and J. Wilkens. 2019. Review of the adverse biological effects of dredging-induced underwater sounds. *Journal of Dredging* 17:1-22.

Methratta, E. T. and W. R. Dardick. 2019. Meta-analysis of finfish abundance at offshore wind farms. *Reviews in Fisheries Science & Aquaculture* 27:242-260.

Meyer, M., R. R. Fay, and A. N. Popper. 2010. Frequency tuning and intensity coding of sound in the auditory periphery of the lake sturgeon, *Acipenser fulvescens*. *Journal of Experimental Biology* 213:1567–1578.

Michel, J., A. C. Bejarano, C. H. Peterson, and C. Voss. 2013. *Review of Biological and Biophysical Impacts from Dredging and Handling of Offshore Sand*. OCS Study BOEM 2013-0119. U.S. Department of the Interior, Bureau of Ocean Energy Management. Herndon, Virginia. Available: https://espis.boem.gov/final%20reports/5268.pdf. Accessed: November 16,2021.

Mid-Atlantic Regional Ocean Council (MARCO). 2020. Mid-Atlantic Ocean Data Portal. Available: http://portal_midatlanticocean.org.

Miles, J., T. Martin, and L. Goddard. 2017. Current and wave effects around windfarm monopile foundations. *Coastal Engineering* 121:167–178.

Miller, M. H., and C. Klimovish. 2017. *Endangered Species Act Status Review Report: Giant Manta Ray (Manta birostris) and Reef Manta Ray (Manta alfredi)*.

Miller, J. H., and G. R. Potty. 2017. Overview of underwater acoustic and seismic measurements of the construction and operation of the Block Island Wind Farm. *Journal of the Acoustical Society of America* 141:3993–3993. doi:10.1121/1.4989144.

Miller, T. and G. Shepherd. 2011. *Summary of Discard Estimates for Atlantic Sturgeon*. August 19, 2011. Northeast Fisheries Science Center, Population Dynamics Branch.

Minerals Management Service (MMS). 2007. *Programmatic Environmental Impact Statement for Alternative Energy Development and Production and Alternate Use of Facilities on the Outer Continental Shelf: Final Environmental Impact Statement*. U.S. Department of the Interior. OCS EIS/EA MMS 2007-046. Available: https://www.boem.gov/Guide-To-EIS/. Accessed: July 3, 2018.

Misund, O. A., and A. Aglen. 1992. Swimming behaviour of fish schools in the North Sea during acoustic surveying and pelagic trawl sampling. *ICES Journal of Marine Science* 49:325–334.

Mitchelmore, C. L., C. A. Bishop, and T. K. Collier. 2017. Toxicological estimation of mortality of oceanic sea turtles oiled during the Deepwater Horizon Oil Spill. *Endangered Species Research* 33: 39–50.

Mitson, R. B. and H. P. Knudsen. 2003. Causes and effects of underwater noise on fish abundance estimation. *Aquatic Living Resources* 16:255-263.

Mohler, J. W. 2003. Culture manual for the Atlantic sturgeon *Acipenser oxyrinchus*. A Region 5 U.S. Fish & Wildlife Service Publication, Hadley, Massachusetts. 66 pp.

Mohr, F. C., B. Lasely, and S. Bursian. 2008. Chronic oral exposure to Bunker C fuel oil causes adrenal insufficiency in ranch mink. *Archive of Environmental Contamination and Toxicology* 54:337–347.

Moore, M. J., and J. M. van der Hoop. 2012. The painful side of trap and fixed net fisheries: Chronic entanglement of large whales. *Journal of Marine Biology* 2012:Article 230653.

Moser, M. L. and S. W. Ross. 1995. Habitat use and movements of shortnose and Atlantic sturgeons in the lower Cape Fear River, North Carolina. *Transactions of the American Fisheries Society* 24:225-234.

Moser, M. L., M. Bain, M. R. Collins, N. Haley, B. Kynard, J. C. O'Herron II, G. Rogers, and T. S. Squiers. 2000. *A Protocol for Use of Shortnose and Atlantic Sturgeons*. NOAA Technical Memorandum. NMFS-PR-18.

Mueller-Blenkle, C., P. K. McGregor, A. B. Gill, M. H. Andersson, J. Metcalfe, V. Bendall, P. Sigray, D. T. Wood, and F. Thomsen. 2010. Effects of pile-driving noise on the behaviour of marine fish. COWRIE Ref: Fish 06-08; Cefas Ref: C3371. 62 pp.

National Marine Fisheries Service (NMFS). 2000. Final endangered status for a distinct population segment of anadromous Atlantic salmon (*Salmo salar*) in the Gulf of Maine. 65 FR 69459.

National Marine Fisheries Service (NMFS). 2003. Final endangered status for a distinct population segment of smalltooth sawfish (*Pristis pectinata*) in the United States. 68 FR 15674.

National Marine Fisheries Service (NMFS). 2006. Final listing determinations for elkhorn coral and staghorn coral. 71 FR 26852.

National Marine Fisheries Service (NMFS). 2008. Critical habitat for threatened elkhorn and staghorn corals. 73 FR 72210.

National Marine Fisheries Service (NMFS). 2010a. Final Recovery Plan for the Fin Whale (Balaenoptera physalus). Silver Spring, Maryland: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service.

National Marine Fisheries Service (NMFS). 2010b. Recovery Plan for the Sperm Whale (Physeter macrocephalus). Silver Spring, Maryland: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service.

National Marine Fisheries Service (NMFS). 2011. Final Recovery Plan for the Sei Whale (Balaenoptera borealis). Silver Spring, Maryland: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources.

National Marine Fisheries Service (NMFS). 2012a. Final listing determination for two for distinct population segments of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) in the Southeast. 77 FR 5914.

National Marine Fisheries Service (NMFS). 2012b. North Atlantic right whale (*Eubalaena galcialis*) 5-year review: Summary and evaluation.

National Marine Fisheries Service (NMFS). 2012c. Threatened and endangered status for distinct population segments of Atlantic sturgeon in the Northeast Region. 77 FR 5880.

National Marine Fisheries Service (NMFS). 2013. Biological Opinion. 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. GARFO-2012-00011.

National Marine Fisheries Service (NMFS). 2014a. Critical habitat for the Northwest Atlantic Ocean loggerhead sea turtle distinct population segment (DPS) and determination regarding critical habitat for the North Pacific Ocean loggerhead DPS. 79 FR 39856.

National Marine Fisheries Service (NMFS). 2014b. Draft Programmatic Environmental Assessment for fisheries research conducted and funded by the Northeast Fisheries Science Center.

National Marine Fisheries Service (NMFS). 2014c. Final listing determinations on proposal to list 66 reef-building coral species and to reclassify elkhorn and staghorn corals. 79 FR 53852.

National Marine Fisheries Service (NMFS). 2014d. Threatened and endangered status for distinct population segments of scalloped hammerhead sharks. 79 FR 38214.

National Marine Fisheries Service (NMFS). 2015a. Biological Opinion. Virginia Offshore Wind Advancement Project. NER-2015-12128. GARFO-2014-00019.

National Marine Fisheries Service (NMFS). 2015b. Sperm whale (*Physeter macrocephalus*) 5-year review: Summary and evaluation.

National Marine Fisheries Service (NMFS). 2016a. Critical habitat for endangered North Atlantic right whale. 81 FR 4838.

National Marine Fisheries Service (NMFS). 2016b. Final determination on the proposal to list the Nassau grouper as threatened under the Endangered Species Act. 81 FR 42268.

National Marine Fisheries Service (NMFS). 2016c. *Interim guidance on the Endangered Species Act term "harass."* National Marine Fisheries Service Procedural Instruction 02-110-19.

National Marine Fisheries Service (NMFS). 2016d. Proposed threatened listing determination for the oceanic whitetip shark under the Endangered Species Act (ESA). 81 FR 96304.

National Marine Fisheries Service (NMFS). 2017a. Biological Opinion. CENAP-OP-R-2016-0181-39 DRP Gibbstown shipping Port and logistic center. NER-2017-14371. GARFO-2017-00176. 223 pp.

National Marine Fisheries Service (NMFS). 2017b. Designation of critical habitat for the endangered New York Bight, Chesapeake Bay, Carolina, and South Atlantic distinct population segments of Atlantic sturgeon and the threatened Gulf of Maine distinct population segment of Atlantic sturgeon. 82 FR 39160.

National Marine Fisheries Service (NMFS). 2018a. *2018 Revision to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0). Underwater Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts*. NOAA Tech. Memo. NMFS-OPR-59. 167 pp.

National Marine Fisheries Service (NMFS). 2018b. Biological Opinion. Construction and maintenance of Chesapeake Bay entrance channels and use of sand borrow areas for beach nourishment. F/NER/2018/14816. GARFO-2018-00353. 332 pp.

National Marine Fisheries Service (NMFS). 2018c. Biological Opinion. Deepening and maintenance of the Delaware River Federal navigation channel. NER-2018-15005. 380 pp.

National Marine Fisheries Service (NMFS). 2018d. Final rule to list the giant manta ray as threatened under the Endangered Species Act. 83 FR 2916.

National Marine Fisheries Service (NMFS). 2018e. Listing the oceanic whitetip as threatened under the Endangered Species Act. 83 FR 4153.

National Marine Fisheries Service (NMFS). 2019a. Endangered status of the Gulf of Mexico Bryde's whale. 84 FR 15446.

National Marine Fisheries Service (NMFS). 2019b. Fin whale (*Balaenoptera physalus*) 5-year review: Summary and evaluation.

National Marine Fisheries Service (NMFS). 2019c. Greater Atlantic Regional Fisheries Office Master ESA Species Table – Sea Turtles. Available at https://www.greateratlantic.fisheries.noaa.gov/protected/section7/guidance/maps/garfo_master_esa_species_table_-_sea_turtles_111516.pdf. Accessed January 15, 2019.

National Marine Fisheries Service (NMFS). 2020a. Biological Opinion. New York coastal storm risk management – Beach nourishment projects utilizing the New York Offshore Borrow Areas: Long Beach, Fire Island to Moriches Inlet, East Rockaway, Fire Island to Montauk Point, New York. GARFO-2018-01302.

National Marine Fisheries Service (NMFS). 2020b. Kemp's ridley turtle. Available at https://www.fisheries.noaa.gov/species/kemps-ridley-turtle. Accessed August 25, 2020.

National Marine Fisheries Service (NMFS). 2020c. Section 7 Effect Analysis: Turbidity in the Greater Atlantic Region. Available: https://www.fisheries.noaa.gov/new-england-mid-atlantic/consultations/section-7-effect-analysis-turbidity-greater-atlantic-region. Accessed: August 27, 2020.

National Marine Fisheries Service (NMFS). 2020c. Citing Anchor Environmental. 2003. *Literature Review of Effects of Re-suspended Sediments due to Dredging*. 140 pp.

National Marine Fisheries Service (NMFS). 2020c. Citing Burton, W.H. 1993. Effects of bucket dredging on water quality in the Delaware River and the potential for effects on fisheries resources.

National Marine Fisheries Service (NMFS). 2020c. Citing ESS Group. 2008. Upstate NY Power Corp. Upstate NY Power Transmission Line. Exhibit E-3: Underground construction.

National Marine Fisheries Service (NMFS). 2020c. Citing Federal Highway Administration (FHWA). 2012. Tappan Zee Hudson River Crossing Project. Final Environmental Impact Statement.

National Marine Fisheries Service (NMFS). 2020c. Citing Hayes, D. F., T. R. Crockett, T. J. Ward, and D. Averett. 2000. Sediment resuspension during cutterhead dredging operations. *Journal of Waterway, Port, Coastal, and Ocean Engineering* 126:153–161.

National Marine Fisheries Service (NMFS). 2020c. Citing LaSalle, M. W. 1990. Physical and chemical alterations associated with dredging. In C.A. Simenstad, ed. *Proceedings of the Workshop on the Effects of Dredging on Anadromous Pacific Coast Fishes*, pp. 1-12.

National Marine Fisheries Service (NMFS). 2020c. Citing Nightingale, B., and C. Simenstad. 2001. Dredging Activities. Marine Issues. 119 pp.

National Marine Fisheries Service (NMFS). 2020c. Citing U.S. Army Corps of Engineers (USACE). 1983. Dredging and dredged material disposal. U.S. Dept. Army Engineer Manual 111 0-2-5025.

National Marine Fisheries Service (NMFS). 2020c. Citing U.S. Army Corps of Engineers (USACE). 2001. Monitoring of Boston Harbor confined aquatic disposal cells. ERDC/CHL TR-01-27.

National Marine Fisheries Service (NMFS). 2020c. Citing U.S. Army Corps of Engineers (USACE). 2005. Sediment and elutriate water investigation, Upper James River, Virginia.

National Marine Fisheries Service (NMFS). 2020c. Citing U.S. Army Corps of Engineers (USACE). 2010. Richmond Deepwater Terminal to Hopewell sediment and elutriate water investigation, Upper James River, Virginia.

National Marine Fisheries Service (NMFS). 2020c. Citing U.S. Army Corps of Engineers (USACE). 2015a. Dredging and dredged material management. Engineer Manual.

National Marine Fisheries Service (NMFS). 2020c. Citing U.S. Army Corps of Engineers (USACE). 2015b. New York and New Jersey Harbor Deepening Project – Dredge plume dynamics in New York/New Jersey Harbor: Summary of suspended sediment plume surveys performed during harbor deepening. 133 pp.

National Marine Fisheries Service (NMFS). 2020c. Citing U.S. Environmental Protection Agency (USEPA). 1986. Quality Criteria for Water. EPA 440/5-86-001.

National Marine Fisheries Service (NMFS). 2021a. Active and Closed Unusual Mortality Events. Available: https://www.fisheries.noaa.gov/national/marine-life-distress/active-and-closed-unusual-mortality-events. Accessed: November 19, 2021.

National Marine Fisheries Service (NMFS). 2021b. Biological Opinion. Continued Prosecution of Fisheries and Ecosystem Research Conducted and Funded by the Northeast Fisheries Science Center and the Issuance of a Letter of Authorization under the Marine Mammal Protection Act for the Incidental Take of Marine Mammals Pursuant to those Research Activities. NER-2015-12532.

National Marine Fisheries Service (NMFS). 2021c. Biological Opinion for the Construction, Operation, Maintenance, and Decommissioning of the South Fork Offshore Energy Project (Lease OCS-A 0517). GARFO-2021-00353.

National Marine Fisheries Service (NMFS). 2021d. Fin Whale. Available: https://www.fisheries.noaa.gov/species/fin-whale. Accessed: November 19, 2021.

National Marine Fisheries Service (NMFS). 2021e. Green Turtle. Available: https://www.fisheries.noaa.gov/species/green-turtle#overview. Accessed: October 28, 2021.

National Marine Fisheries Service (NMFS). 2021f. Leatherback Turtle. Available: https://www.fisheries.noaa.gov/species/leatherback-turtle. Accessed: October 29, 2021.

National Marine Fisheries Service (NMFS). 2021g. Loggerhead Turtle. Available: https://www.fisheries.noaa.gov/species/loggerhead-turtle#overview. Accessed: November 3, 2021.

National Marine Fisheries Service (NMFS). 2021h. North Atlantic Right Whale. Available: https://www.fisheries.noaa.gov/species/north-atlantic-right-whale. Accessed: November 19, 2021.

National Marine Fisheries Service (NMFS). 2021i. Programmatic Consultation on Site Assessment and Site Characterization Activities to be Carried Out to Support the Siting of Offshore Wind Energy Development Projects off the U.S. Atlantic Coast. GARFO-2021-0999. Available: https://media.fisheries.noaa.gov/2021-12/OSW%20surveys_NLAA%20programmatic_rev%201_2021-09-30%20%28508%29.pdf.

National Marine Fisheries Service (NMFS). 2021j. Technical corrections for the Bryde's whale (Gulf of Mexico subspecies). 86 FR 47022.

National Marine Fisheries Service (NMFS). 2021k. Sei whale (*Balaenoptera borealis*) 5-year review: Summary and evaluation.

National Marine Fisheries Service (NMFS). 2022a. Atlantic Salmon. Available: https://www.fisheries.noaa.gov/species/atlantic-salmon-protected. Accessed: January 31, 2022.

National Marine Fisheries Service (NMFS). 2022b. Biological Opinion. USACE Permit for the New Jersey Wind Port. GARFO-2021-02227.

National Marine Fisheries Service (NMFS). 2022c. Hawksbill Turtle. Available: https://www.fisheries.noaa.gov/species/hawksbill-turtle. Accessed: January 28, 2022.

National Marine Fisheries Service (NMFS). 2022. National Marine Fisheries Service: Summary of Marine Mammal Protection Act Acoustic Thresholds. Available: https://media.fisheries.noaa.gov/2022-05/MM%20Acoustic%20Thresholds%20%28508%29_secure%20%28May%202022%29.pdf. Accessed: May 2022

National Marine Fisheries Service (NMFS). 2022d. Oceanic Whitetip Shark. Available: https://www.fisheries.noaa.gov/species/oceanic-whitetip-shark. Accessed: January 31, 2022.

National Marine Fisheries Service (NMFS). 2022e. Rice's Whale. Available: https://www.fisheries.noaa.gov/species/rices-whale. Accessed: January 27, 2022.

National Marine Fisheries Service (NMFS). 2022f. Sei Whale. Available: https://www.fisheries.noaa.gov/species/sei-whale. Accessed: December 28, 2022.

National Marine Fisheries Service (NMFS). 2022g. Sperm Whale. Available: https://www.fisheries.noaa.gov/species/sperm-whale. Accessed: December 28, 2022.

National Marine Fisheries Service (NMFS). 2023a. Draft US Atlantic and Gulf of Mexico Marine Mammal Stock Assessments 2022. Available: https://www.fisheries.noaa.gov/s3/2023-01/Draft%202022%20Atlantic%20SARs_final.pdf. Accessed: April 2023.

National Marine Fisheries Service (NMFS). 2023b. Gulf Sturgeon. Available: https://www.fisheries.noaa.gov/species/gulf-sturgeon. Accessed: April 26, 2023.

National Marine Fisheries Service (NMFS). 2023c. Nassau Grouper. Available: https://www.fisheries.noaa.gov/species/nassau-grouper. Accessed: April 26, 2023.

National Marine Fisheries Service (NMFS). 2023d. Smalltooth Sawfish. Available: https://www.fisheries.noaa.gov/species/smalltooth-sawfish. Accessed: April 26, 2023.

National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). 1992. Recovery Plan for Leatherback Turtles in the U.S. Caribbean, Atlantic, and Gulf of Mexico (*Dermochelys coriacea*).

National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). 2007. Green Sea Turtle (*Chelonia mydas*) 5-Year Review: Summary and Evaluation. 102 pp.

National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). 2008. Recovery Plan for the Northwest Atlantic population of the loggerhead sea turtle (*Caretta caretta*). Second revision.

National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). 2010. Proposed listing of nine distinct population segments of loggerhead sea turtles as endangered or threatened. 75 FR 12598.

National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). 2011. Determination of nine distinct population segments of loggerhead sea turtles as threatened or endangered. 76 FR 58868.

National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). 2015a. Identification and proposed listing of eleven distinct population segments of green sea turtles (*Chelonia mydas*) as endangered or threatened and revision of current listings. 80 FR 15272.

National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). 2015a. Citing Van Houtan, K. S., C. M. Smith, M. L. Dailer, M. Kawachi. 2014. Eutrophication and the dietary promotion of sea turtle tumors. *PeerJ* 2:e602.

National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). 2015b. Kemp's Ridley Sea Turtle (*Lepidochelys kempii*) 5-Year Review: Summary and Evaluation. 62 pp.

National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). 2015b. Citing Finkbeiner, E. M., B. P. Wallace, J. E. Moore, R. L. Lewison, L. B. Crowder, and A. J. Read. 2011. Cumulative estimates of sea turtle bycatch and mortality is USA fisheries between 1990 and 2007. *Biological Conservation* 144:2719–2727.

National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). 2015b. Citing Gallaway, B. J., C. W. Caillouet, P. T. Plotikin, W. J. Gazey, J. G. Cole, and S. W. Raborn. 2013. *Kemp's Ridley Stock Assessment Project*. Final Report to the Gulf States Marine Fisheries Commission. 291 pp.

National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). 2015b. Citing Heppell, S. S., D. T. Crouse, L. B. Crowder, S. P. Epperly, W. Gabriel, T. Henwood, R. Márquez, and N. B. Thompson. 2005. A population model to estimate recovery time, population size, and management impacts on Kemp's ridley sea turtles. *Chelonian Conservation Biology* 4:767–773.

National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). 2015b. Citing NMFS. 2014. Programmatic Biological Opinion. U.S. Environmental Protection Agency's issuance and implementation of the final regulations Section 316(b) of the Clean Water Act.

National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). 2016. Final rule to list eleven distinct population segments of the green sea turtle (*Chelonia mydas*) as endangered or threatened and revision of current listings under the Endangered Species Act. 81 FR 20058.

National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). 2017. 90-day finding on a petition to identify the Northwest Atlantic leatherback sea turtle as a distinct population segment and list it as threatened under the Endangered Species Act. 82 FR 57565.

National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). 2019. Recovery Plan for the Gulf of Maine Distinct Population Segment of Atlantic Salmon (*Salmo salar*).

National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). 2020a. 12-month finding on a petition to identify the Northwest Atlantic leatherback sea turtle as a distinct population segment and list it as threatened under the Endangered Species Act. 85 FR 48332.

National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). 2020a. Citing Eckert, K. L., B. P. Wallace, J. R. Spotila, and B. A. Bell. 2015. Nesting, ecology, and reproduction. In J. R. Spotila, and P. Santidrián Tomillo, eds. *The leatherback turtle: Biology and Conservation*, p. 63.

National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). 2020a. Citing Robinson, N. J., and F. V. Paladino. 2015. Diving behavior and physiology of the leatherback turtle. In J. R. Spotila, and P. Santidrián Tomillo, eds. *The leatherback turtle: Biology and Conservation*, pp. 21–31.

National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). 2020a. Citing Saba, V.S. 2013. Oceanic habits and habitats. *The Biology of Sea Turtles* 3:163.

National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). 2020a. Citing Salmon, M., T. T. Jones, and K. W. Horch. 2004. Ontogeny of diving and feeding behavior in juvenile sea turtles: Leatherback sea turtles (*Dermochelys coriacea* L.) and green sea turtles (*Chelonia mydas* L.) in the Florida Current. *Journal of Herpetology* 38:36–43.

National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). 2020b. Endangered Species Act Status Review of the Leatherback Turtle (*Dermochelys coriacea*) 2020. 396 pp.

National Oceanic and Atmospheric Administration (NOAA). 2013. *Draft Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammals: Acoustic Threshold Levels for Onset of Permanent and Temporary Threshold Shifts*.

National Oceanic and Atmospheric Administration (NOAA). 2020b. Blue Whale (Balaenoptera musculus musculus) Western North Atlantic Stock. Available: https://www.federalregister.gov/documents/2018/10/12/2018-22218/endangered-and-threatened-species-recovery-plan-for-the-blue-whale-and-notice-of-initiation-of-a. Accessed June 9, 2022.

National Oceanic and Atmospheric Administration (NOAA). 2020. The Greater Atlantic Region ESA Section 7 Mapper. Available: https://www.fisheries.noaa.gov/resource/map/greater-atlantic-region-esa-section-7-mapper.

National Research Council (NRC). 1990. *Decline of the Sea Turtles: Causes and Prevention*. Washington, DC: National Academy Press.

National Science Foundation (NSF) and U.S. Geological Survey (USGS). 2011. Final Programmatic Environmental Impact Statement/Overseas Environmental Impact Statement for Marine Seismic Research Funded by the National Science Foundation or Conducted by the U.S. Geological Survey. 514 pp. Available: https://www.nsf.gov/geo/oce/envcomp/usgs-nsf-marine-seismic-research/nsf-usgs-final-eis-oeis_3june2011.pdf. Accessed: September 3, 2020.

Nedwell, J. R. and A. W. Turnpenny. 1998. *The Use of Generic Frequency Weighting Scale in Estimating Environmental Effect*. Workshop on Seismic and Marine Mammals. 23-25th June 1998, London, U.K.

Nedwell, J. J. Langworthy, and D. Howell. 2003. *Assessment fo Sub-Sea Acoustic Noise and Vibration from Offshore Wind Turbines and Its Impact on Marine Wildlife*. The Crown Estates Office Reprot 544 R 0424. 72 pp. Available: www.subacoustech/information/downloads/reports/544R0424.pdf.

Nedwell, J. R., A. W. Turnpenny, J. Lovell, S. J. Parvin, R. Workman, and J. A. L. Spinks. 2007. *A Validation of the dBht as a Measure of the Behavioural and Auditory Effects of Underwater Noise.* Report No. 534R1231 prepared by Subacoustech Ltd. For the UK Department of Business, Enterprise and Regulatory Reform under Project No. RDCZ/011/0004. Available: www.subacoustech.com/infrmation/downloads/reports/534R1231.pdf.

Nedwell, J. R., A. G. Brooker, and R. J. Barham. 2012. *Assessment of Underwater Noise During the Installation of Export Power Cables at the Beatrice Offshore Wind Farm*. Subacoustech Environmental Report No. E318R0106. 17pp.

Nelms, S. E., E. M. Duncan, A. C. Broderick, T. S. Galloway, M. H. Godfrey, M. Hamann, P. K. Lindeque, and B. J. Godley. 2016. Plastic and marine turtles: A review and call for research. *ICES Journal of Marine Science* 73:165–181.

Nelson, M., M. Garron, R. L. Merrick, R. M. Pace, and T. V. N. Cole. 2007. *Mortality and Serious Injury Determinations for Large Whale Stocks along the United States Eastern Seaboard and Adjacent Canadian Maritimes, 2001-2005*. Northeast Fisheries Science Center Reference Document 07-05.

Newson, S. E., S. Mendes, H. Q. P. Crick, N. K. Dulvy, J. D. R. Houghton, G. C. Hayes, A. M. Huston, C. D. MacLeod, G. J. Pierce, and R. A. Robinson. 2009. Indicators of the impact of climate change on migratory species. *Endangered Species Research* 7:101–113.

Normandeau Associates, Inc. (Normandeau), Exponent, Inc., T. Tricas, and A. Gill. 2011. *Effects of EMFs from Undersea Power Cables on Elasmobranchs and Other Marine Species. Final Report*. U.S. Department of the Interior, Bureau of Ocean Energy Management, Regulation and Enforcement, Pacific OCS Region, Camarillo, CA. OCS Study BOEMRE 2011-09. Available: https://espis.boem.gov/final%20reports/5115.pdf. Accessed: September 9, 2020.

Normandeau Associates Inc. (Normandeau) and APEM Inc. (APEM). 2018. *Digital Aerial Baseline Survey of Marine Wildlife in Support of Offshore Wind Energy prepared for New York State Energy Research and Development Authority - OPA 2016*. Data downloaded from OBIS-SEAMAP. Available: http://seamap.env.duke.edu/dataset/1817. Accessed: September 8, 2019.

Normandeau Associates Inc. (Normandeau) and APEM Inc. (APEM). 2019a. Digital Aerial Baseline Survey of Marine Wildlife in Support of Offshore Wind Energy: Spring 2019. Taxonomic Analysis Summary Report. Report by Normandeau Associates Inc. and APEM Inc. for New York State Energy Research and Development Authority.

Normandeau Associates Inc. (Normandeau) and APEM Inc. (APEM). 2019b. Digital Aerial Baseline Survey of Marine Wildlife in Support of Offshore Wind Energy: Summer 2016 – Spring 2018. Fourth Interim Report. Second annual report by Normandeau Associates Inc. and APEM Ltd. for New York State Energy Research and Development Authority.

Normandeau Associates Inc. (Normandeau) and APEM Inc. (APEM). 2019c. Digital Aerial Baseline Survey of Marine Wildlife in Support of Offshore Wind Energy: Fall 2018. Taxonomic Analysis Summary Report. Report by Normandeau Associates Inc. and APEM Inc. for New York State Energy Research and Development Authority.

Normandeau Associates Inc. (Normandeau) and APEM Inc. (APEM). 2020. Digital Aerial Baseline Survey of Marine Wildlife in Support of Offshore Wind Energy: Winter 2018–2019. Taxonomic Analysis Summary Report. Report by Normandeau Associates Inc. and APEM Inc. for New York State Energy Research and Development Authority.

North Atlantic Right Whale Consortium (NARWC). 2021. NARWC Databases. Available: https://www.narwc.org/narwc-databases.html.

Northeast Fisheries Science Center (NEFSC) and Southeast Fisheries Science Center (SEFSC). 2011a. 2010 Annual Report to the Inter-Agency Agreement M10PG00075/0001: A comprehensive assessment of marine mammal, marine turtle, and seabird abundance and spatial distribution in U.S. waters of the Western North Atlantic Ocean.

Northeast Fisheries Science Center (NEFSC) and Southeast Fisheries Science Center (SEFSC). 2011b. *Preliminary Summer 2010 Regional Abundance Estimate of Loggerhead Turtles (Caretta caretta) in Northwestern Atlantic Ocean Continental Shelf Waters*. Northeast Fisheries Science Center Reference Document 11-03.

Northeast Fisheries Science Center (NEFSC) and Southeast Fisheries Science Center (SEFSC). 2012. 2011 Annual Report to the Inter-Agency Agreement M10PG00075/0001: A Comprehensive Assessment of Marine Mammal, Marine Turtle, and Seabird Abundance and Spatial Distribution in US Waters of the Western North Atlantic Ocean. Prepared by NMFS-NEFSC, Woods Hole, Massachusetts and NMFS-SEFSC, Miami, Florida.

Northeast Fisheries Science Center (NEFSC) and Southeast Fisheries Science Center (SEFSC). 2014a. *2013 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.*

Northeast Fisheries Science Center (NEFSC) and Southeast Fisheries Science Center (SEFSC). 2014b. *2014 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.*

Northeast Fisheries Science Center (NEFSC) and Southeast Fisheries Science Center (SEFSC). 2015. *2015 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.*

Northeast Fisheries Science Center (NEFSC) and Southeast Fisheries Science Center (SEFSC). 2016. *2016 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.*

Northeast Fisheries Science Center (NEFSC) and Southeast Fisheries Science Center (SEFSC). 2018. *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.*

Northeast Fisheries Science Center (NEFSC) and Southeast Fisheries Science Center (SEFSC). 2019. *2018 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.*

Northeast Regional Ocean Council. 2018. Northeast Ocean Data. Maps and data for ocean planning in the northeastern United States. Available: https://www.northeastoceandata.org.

Northeast Ocean Data Portal (NROC). 2021. Northeast Ocean Data Portal. Available: http://www.northeastoceandata.org.

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.

O'Herron, J. C., T. Lloyd, and K. Laidia. 1993. Movements of shortnose sturgeon (*Acipenser brevirostrum*) in the Delaware River. *Estuaries* 16:235–240.

Orr, T. L., S. M. Herz, and D. L. Oakley. 2013. *Evaluation of Lighting Schemes for Offshore Wind Facilities and Impacts to Local Environments*. Bureau of Ocean Energy Management, Office of Renewable Energy Programs, Herndon, VA. OCS Study BOEM 2013-0116. Available: https://espis.boem.gov/final%20reports/5298.pdf. Accessed: September 2, 2020.

OSPAR Commission. 2009. *Overview of the Impacts of Anthropogenic Underwater Sound in the Marine Environment*. London, UK: OSPAR Commission.

Pace, R. M. III. 2021. *Revisions and Further Evaluations of the Right Whale Abundance Model*: *Improvements for Hypothesis Testing*. NOAA Technical Memorandum NMFS-NE 269. Available: https://apps-nefsc. Fisheris.noaa.gov/rcb/publiations/tm269.pdf. Accessed August 9, 2021.

Pace, R. M., III and R. L. Merrick. 2008. *Northwest Atlantic Ocean Habitats Important to the Conservation of North Atlantic Right Whales* (*Eubalaena glacialis*). Northeast Fisheries Science Center Reerence Document 08, 7.

Pace, R. M., and G. K. Silber. 2005. Simple Analysis of Ship and Large Whale Collisions: Does Speed Kill? Presentation at the Sixteenth Biennial Conference on the Biology of Marine Mammals, San Diego, CA, December 2005.

Pacific Marine Environmental Laboratory (PMEL). 2020. Ocean Acidification: The Other Carbon Dioxide Problem. Available: https://www.pmel.noaa.gov/CO_2/story/Ocean+Acidification. Accessed: February 11, 2020.

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, Detloff, M. Warden, K. Murray, and C. Orphanides. 2017. Atlantic Marine Assessment Program for Protected Species: 2010–2014. OCS Study BOEM 2017-071.

Parks, S. E., D. R. Ketten, J. T. O'Malley, and J. Arruda. 2007b. Anatomical predictions of hearing in the North Atlantic Right Whale. *Anatomical Record* 290:734-744.

Paskvabi, M. B. and I. Fer. 2012. Upper ocean response to large wind farm effect in the presence of surface gravity waves. Selected papers from *Deep Sea Offshore Wind R&D Conference* 24:45-254.

Patenaude, N. J., W. J. Richardson, M. A. Smultea, W. R. Koski, and G. W. Miller. 2002. Aircraft sound and disturbance to bowhead and beluga whales during spring migration in the Alaskan Beaufort Sea. *Marine Mammal Science* 18:309–335.

Pendleton, R. M., C. R. Standley, A. L. Higgs, G. H. Kenney, P. J. Sullivan, S. A. Sethi, and B. P. Harris. 2019. Acoustic telemetry and benthic habitat mapping inform the spatial ecology of shortnose sturgeon in the Hudson River, New York, USA. *Transactions of the American Fisheries Society* 148:35–47.

Peña, H., N. O. Handegard, and E. Ona. 2013. Feeding herring schools do not react to seismic airgun surveys. *ICES Journal of Marine Science* 70:1174-1180.

Pezy, J. P., A. Raoux, J. C. Dauvin, and S. Degraer. 2018. An ecosystem approach for studying the impact of offshore wind farms: A French case study. *ICES Journal of Marine Science* 77:1238–1246. https://academic.oup.com/icesjms/article-abstract/77/3/1238/5096674.

Pile Dynamics. 2010. GRLWEAP. Available: https://www.pile.com/.

Pirotta, E., B. E. Laesser, A. Hardaker, N. Riddoch, M. Marcoux, and D. Lusseau. 2013. Dredging displaces bottlnose dolphins from an unbanised forage patch. *Marine Pollution Bulletin* 15:396-402.

Plotkin, P. T. M. K. Wicksten, and A. F. Amos. 1993.Feeding ecology of the loggerhead sea turtle, *Caretta*, in the northwestern Gulf of Mexico. *Marine Biology* 115:1-15.

Popper, A. N. 2005. *A Review of Hearing by Sturgeon and Lamprey*. 23 pp.

Popper, A. N., A. D. Hawkins, R. R. Fay, D. A. Mann, S. Bartol, T. J. Carlson, S. Coombs, W. T. Ellison, R. L. Gentry, M. B. Halvorsen, S. Løkkeborg, P. H. Rogers, B. L. Southall, D. G. Zeddies, and W. N. Tavolga. 2014. *Sound Exposure Guidelines for Fishes and Sea Turtles*. A technical Report Prepared by ANSI Accredited Standards Committee S3/SC1 and Registered With ASNI. ASA S3/SC1.4 TR-2014. Springer Briefs in Oceanography. ASA Press and Springer. https://doi.org/10.1007/978-3-319-06659-2. Available: https://www.researchgate.net/profile/Arthur_Popper/publication/279347068_Sound_Exposure_Guidelines/links/5596735d08ae99aa62c777b9/Sound-Exposure-Guidelines.pdf.

Public Service Enterprise Group (PSEG). 2021. Biological Assessment. Potential Impacts to Sturgeons, Sea Turtles and Marine Mammals associated with the Construction and Operation of the New Jersey Wind Port at Artificial Island on the Delaware River.

Purser, J., and A. N. Radford. 2011. Acoustic noise induces attention shifts and reduces foraging performance in three-spined sticklebacks (*Gasterosteus aculeatus*). *PLoS One* 6:e17478.

Putman, N. F., P. Verley, C. S. Endres, and K. J. Lohmann. 2015. Magnetic navigation behavior and the oceanic ecology of young loggerhead sea turtles. *Journal of Experimental Biology* 218:1044–1050.

Raoux, A., G. Lassalle, J. P. Pezy, S. Tecchio, G. Safi, B. Ernande, C. Mazé, F. Le Loc'h, J. Laquesne, V. Girardin, J. Dauvin, and N. Niquil. 2019. Measuring sensitivity of two OSPAR indicators for a coastal food web model under offshore wind farm construction. *Ecological Indicators* 96:728–738.

Raoux, A., S. Tecchio, J. P. Pezy, G. Lassalle, S. Degraer, S. Wilhelmsson, M. Cachera, B. Ernande, C. Le Guen, M. Haraldsson, K. Grangeré, F. Le Loc'h, J. C. Dauvin, and N. Niquil. 2017. Benthic and fish aggregation inside an offshore wind farm: Which effects on the trophic web functioning? *Ecological Indicators* 72:33–46.

Read, A. J., P. Drinker, and S. Northridge. 2006. Bycatch of marine mammals in U.S. and global fisheries. *Conservation Biology* 20:163–169.

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 North Atlantic right whales. *Oceanography* 32:163–169.

Reichmuth, C., J. M. Sills, and A. Ghoul. 2019. Long-term evidence of noise-induced permanent threshold shift in a harbor seal (*Phoca vitulina*). *Journal of the Acoustical Society of America* 146:2552:2561.

Reine, K., D. Clarke, M. Balazik, S. O'Haire, C. Dickerson, C. Frederickson, G. Garman, C. Hager, A. Spells, and C. Turner. 2014. *Assessing Impacts of Navigation Dredging on Atlantic Sturgeon (Acipenser oxyrinchus*). ERDC/EL TR-14-12.

Reine, K. J. and D. G. Clarke. 1998. *Entrainment by hydraulic dredges – A review of potential impacts*. Technical Note DOER-E1. U.S. Army Corps of Engineers, Engineer Research and Development Center, Vicksburg, M.S. pp 1-14.

Renaud, M. L., and J. A. Carpenter 1994. Movements and submergence patterns of loggerhead turtles (*Caretta caretta*) in the Gulf of Mexico determined through satellite telemetry. *Bulletin of Marine Science* 55:1–15.

Richardson, W. J., B. Würsig, and C. R. Greene. 1990. Reactions of bowhead whales, *Balaena mysticetus*, to drilling and dreding noise in the Canadian Beafort sea. *Marine Environmental Research I29:135-160.*

Richardson, W. J., C. R. Greene, C. I. Malme, and D. H. Thomson. 1995. *Marine mammals and noise*. San Diego: Academic Press.

Richardson, W. J., G. W. Miller, and C. R. Greene. 1999. Displacement of migrating bowhead whales by sounds from seismic surveys in shallow waters of the Beaufort Sea. *Journal of the Acoustical Society of America* 106:228.

Richardson, W. J., B. Würsig, and C. R. Greene. 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.

Ridgway, S. H., E. G. Wever, J. G. McCormick, J. Palin, and J. H. Anderson. 1969. Hearing in the giant sea turtle, *Chelonia mydas*. *Proceedings of the National Academy of Science* U.S. 64:884-890.

Risch, D., U. Siebert, and S. M. Van Parijs. 2014. Individual calling behavior and movements of North Atlantic minke whales (*Balaenoptera acustorostrata*).

Roberts, J. J., B. D. Best, L. Mannocci, P. N. Halpin, D. L. Palka, L. P. Garrison, K. D. Mullin, T. V. N. Cole, and W. M. McLellan. 2015. Density Model for Seals (Phocidae) Along the U.S. East Coast, Preliminary Results. Version 3.2. Marine Geospatial Ecology Lab, Duke University, Durham, NC.

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. M. McLellan, D. A. Pabst, and G. G. Lockhart. 2016a. Habitat-based cetacean density models for the U.S. Atlantic and Gulf of Mexico. *Scientific Reports* 6:22615. doi: 10.1038/srep22615.

Roberts J. J., L. Mannocci, and P. N. Halpin. 2016b. *Final Project Report: Marine Species Density Data Gap Assessments and Update for the AFTT Study Area, 2015-2016 (Base Year).* Document version 1.0. Report prepared for Naval Facilities Engineering Command, Atlantic by the Duke University Marine Geospatial Ecology Lab, Durham, NC.

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 the 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. Report prepared for Naval Facilities Engineering Command, Atlantic by the 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, Durham, NC.

Roberts, J., T. Yack, and P. Halpin. 2022. Habitat-based Marine Mammal Density Models for the U.S. Atlantic. Updated June 20, 2022. Available: https://seamap.env.duke.edu/models/Duke/EC/.

Roberts, J. J., L. Mannocci, R. S. Schick, and P. N. Hapin. 2021a. *Final Project Report: Marine Species Density Data Gap Assessment and Update for the AFTT Study Area, 2020 (Option Year 4)*. Document Version 2.2. Report prepared for Naval Facilitites Engineering Command, Atlantic by the Duke University Marine Ecology Lab, Durham, N.C.

Roberts, J. J., B. McKenna, L. Ganley, and S. Mayo. 2021b. *Right Whale Abundance Estimates for Cap Cod Bay in December*. Document Version 3. 16 Feb 2021. Prepared by the Duke University Marine Geospatial Ecology Lab, Durham. N.C.

Robinson, S., P. Theobald, G. Hayman, L. Wang, P. Lepper, V. Humphrey, and S. Mumford. 2011. *Measurement of Underwater Noise Arising from Marine Aggregate Dredging Operations*. Final Report for the Marine Aggregate Levy Sustainability Fund. MEPF Ref No: MEFP 09/P108.

Rolland, R. M., S. E. Parks, K. E. Hunt, M. Castellote, P. J. Corkeron, D. P. Nowacek, S. K. Wasser, and S. D. Krauss. 2012. Evidence that ship noise increases stress in right whales. *Proceedings of the Royal Society B*. 279:2363–2368. doi:10.1098/rspb.2011.2429.

Rosman, I., G. S. Boland, L. Martin, and C. Chandler. 1987. *Underwater Sightings of Sea Turtles in the Northern Gulf of Mexico*. U.S. Dept. of the Interior, Minerals Management Service. OCS Study/1VIIVIS 87/0107. 37 pp.

Ross, S. T., W. T. Slack, R. J. Heise, M. A. Dugo, H. Rogillio, B. R. Bowen, P. Mickle, and R. W. Heard. 2009. Estuarine and coastal habitat use of Gulf sturgeon (*Acipenser oxyrinchus desotoi*) in the North-Central Gulf of Mexico. *Estuaries and Coasts*

Ross, S. T., W. T. Slack, R. J. Heise, M. A. Dugo, H. Rogillio, B. R. Bowen, P. Mickle, and R. W. Heard. 2009. Citing Sulak, K. J., and J. P. Clugston. 1999. Recent advances in life history of Gulf of Mexico sturgeon, *Acipenser oxyrinchus desotoi*, in the Suwannee River, Florida: A synopsis. *Journal of Applied Ichthyology* 18:519–528.

Rothermel, E. R., M. T. Balazik, J. E. Best, M. W. Breece, D. A. Fox, B. I. Gahagan, D. E. Haulsee, A. L. Higgs, M. H. P. O'Brien, M. J. Oliver, I. A. Park, and D. H. Secor. 2020. Comparative migration ecology of striped bass and Atlantic sturgeon in the US southern mid-Atlantic bight flyway. *PLoS ONE* 15:e0234442.

Ruckdeschel, C. A. and C. R. Shoop. 1988. *Gut Contents of Loggerheads: Findings, Problems, and New Questions*. IN B. A. Schroeder (Ed.) Proceedings of the Eighth Annual Workshop on Sea Turtle Biology and Conservation 97-98. 146 pp.

Russell, D. J., S. M. Brasseur, D. Thompson, G. D. Hastie, V. M Janik, G. Aarts, B. T. McClintock, J. Matthiopoulos, S. E. Moss, and B. McConnell. 2014. Marine mammals trace anthropogenic structures at sea. *Current Biology* 24:R638-R639.

Russell, D. J. F., G. D. Hastie, D. Thompson, V. M. Janik, P. S. Hammond, L. A. S. 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.

Samuel, Y., S. J. Morreale, C. W. Clark, C. H. Greene, and M. E. Richmond. 2005. Underwater, low-frequency noise in a coastal sea turtle habitat. *Journal of the Acoustical Society of America* 117: 1465–1472.

Sand, O., H. E. Karlsen, and F. R. Knudsen. 2008. Comment on "Silent reserach vessels are not quiet." *Journal of the Acoustical Society of America* 123:1831-1833.

Sarà, G., J. M. Dean, D. D'Amato, G. Buscaino, A. Oliveri, S. Genovese, S. Ferro, G. Buffa, M. L. Martire, and S. Mazzola. 2007. Effect of boat nose on the behaviour of bluefin tuna *Thunnus thynnus* in the Mediterranean Sea. *Marine Ecology Progress Series* 331:243-253.

Sasso, C. R. and S. P. Epperly. 2006. Seasonal sea turtle mortality risk from forced submergence in bottom trawls. *Fisheries Research* 81:86-88.

Sasso and Witzell 2006

Saunders, J. C., S. P. Dear, and M. E. Schneider. 1985. The anatomical consequences of acoustic injury: A review and tutorial. *Journal of the Acoustical Society of America* 78:833-860.

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. doi:10.1088/1748-9326/6/2/025102.

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.

Schmid, J. R. 1988. Marine turtle populations on the west-central coast of Florida: Results of tagging studies at the Cedar Keys, Florida, 1986-1995. *Fishery Bulletin* 96:589-602.

Schoeman, R. P., C. Patterson-Abrolat, and S. Plön. 2020. Global review of vessel collisions with marine animals. *Frontiers in Marine Science*: fmars.2020.00637.

Schultze, L., L. Merckelbach, S. Raasch, N. Christiansen, U. Daewel, C. Schrum, and J. Carpenter. 2020. Turbulence in the Wake of Offshore Wind Farm Foundations and its Potential Effects on Mixing of Stratified Tidal Shelf Seas. Presentation at Ocean Sciences Meeting 2020, San Diego, CA, USA.

Schuyler, Q. A., C. Wilcox, K. Townsend, B. D. Hardesty, and N. J. Marshall. 2014. Mistaken identity? Visual similarities of marine debris to natural prey items of sea turtles. *BMC Ecology* 14. doi:10.1186/1472-6785-14-14.

Scott, W. B., and E. J. Crossman. 1973. Freshwater fishes of Canada. *Fisheries Research Board of Canada Bulletin* 184.

Seminoff, J. A., C. D. Allen, G. H. Balazs, P. H. Dutton, T. Eguchi, H. L. Haas, S. A. Hargrove, M. Jensen, D. L. Klemm, A. M. Lauritsen, S. L. MacPherson, P. Opay, E. E. Possardt, S. Pultz, E. Seney, K. S. Van Houtan, and R. S. Waples. 2015. *Status Review of the Green Turtle (Chelonia mydas) under the Endangered Species Act*. NOAA Tech. Mem. NMFS-SWFSC-539. 571 pp.

Shelledy, K., B. Phelan, J. Stanley, and H. Soulen. 2018. *Could Offshore Wind Energy Construction Affect Black Sea Bass Behavior?*

Shigenaka, G., S. Milton, P. Lutz, R. Hoff, R. Yender, and A. Mearns. 2010. *Oil and Sea Turtles: Biology, Planning, and Response*. Reprinted in 2010. NOAA Office of Restoration and Response Publication. 116 pp.

Shoop, C. R., and R. D. Kenney. 1992. Seasonal distributions and abundances of loggerhead and leatherback sea turtles in waters of the northeastern United States. *Herpetological Monographs* 6:43–67.

Shortnose Sturgeon Status Review Team (SSSRT). 2010. *A Biological Assessment of Shortnose Sturgeon (*Acipenser brevirostrum*)*. Report to National Marine Fisheries Service, Northeast Regional Office. 417 pp.

Slavik, K., C. Lemmen, W. Zhang, O. Kerimoglu, K. Klingbell, and K. W. Wirtz. 2019. The large-scale impact of offshore wind farm structures on pelagic primary productivity in the southern North Sea. *Hydrobiologia* 845:35–53. doi:10.1007/s10750-018-3653-5.

Slotte, A., K. Kansen, J. Dalen, and E. Ona. 2004. Acoustic mapping of pelagic fish distribution and abundance in relation to a seismic shooting area off the Norwegian west coast. *Fisheries Research* 67:143-150.

Smith, T. I. J. 1985. The fishery, biology, and management of Atlantic sturgeon, *Acipenser oxyrhynchus*, in North America. *Environmental Biology of Fishes* 14:61-72.

Smith, C. R., T. K. Rowles, L. B. Hart, F. I. Townsend, R. S. Wells, E. S. Zolman, B. C. Balmer, B. Quigley, M. Ivnacic, W. McKercher, M. C. Tumlin, K. D. Mullin, J. D. Adams, Q. Wu, W. McFee, T. K. Collier, and L. H. Schwacke. 2017. Slow recovery of Barataria Bay dolphin health following the Deepwater Horizon Oil Spill (2013–2014), with evidence of persistent lung disease and impaired stress response. *Endangered Species Research* 33:127–142.

Snoek, R., R. de Swart, K. Didderen, W. Lengkeek, and M. Teunis. 2016. *Potential Effects of Electromagnetic Fields in the Dutch North Sea*. Final Report submitted to Rijkswaterstaat Water, Verkeer en Leefmgeving. 95 pp.

Southall, B. L., A. E. Bowles, W. T. Ellison, J. J. Finneran, R. L. Gentry, C. R. Greene Jr., D. Kastak, D. R. Ketten, J. H. Miller, P. E. Nachtigall, W. J. Richardson, J. A. Thomas, and P. L. Tyack. 2007. Marine mammal noise exposure criteria: Initial scientific recommendations. *Aquatic Mammals* 33:411–521.

Southall, B. L., D. P. Nowacek, A. E. Bowles, V. Senigaglia, L. Bejder, and P. L. Tyack. 2021. Marine mammal noise exposure criteria: Assessing the severity of marine mammal behavioral responses to human noise. *Aquatic Mammals* 45:421-464.

Sparling, C. E., A. C. Seitz, E. Madsen, K. Smith. 2020. Collision risk for animals around turbines. In: *OES-Environmental 2020 State of the Science Report: Environmental effects of marine renewable energy development around the world*. Report for Ocean Energy Systems (OES). Doi:102172/ 1632878. Available: https://tethys.pnnl.gov/publications/state-of-the-science-2020. Accessed: November 9, 2020.

Stadler, J. H., and D. P. Woodbury. 2009. Assessing the effects to fishes from pile driving: Application of new hydroacoustic criteria. *Inter-Noise 2009: Innovations in Practical Noise Control*, Ottawa, Canada.

Stewart, J. D., C. S. Beale, D. Fernando, A. B. Sianipar, R. S. Burton, B. X. Semmens, and O. Aburto-Oropeza. 2016. Spatial ecology and conservation of *Manta birostris* in the Indo-Pacific. *Biological Conservation* 200:178–183.

Stewart, J. D., F. R. A. Jaine, A. J. Armstrong, A. O. Armstrong, M. B. Bennett, K. B. Burgess, L. I. E. Couturier, D. A. Croll, M. R. Cronin, M. H. Deakos, C. L. Dudgeon, D. Fernando, N. Froman, E. S. Germanov, M. A. Hall, S. Hinojosa-Alvarez, J. E. Hosegood, T. Kashiwagi, B. J. L. Laglbauer, N. Lezama-Ochoa, A. D. Marshall, F. McGregor, G. N. di Sciara, M. D. Palacios, L. R. Peel, A. J. Richardson, R. D. Rubin, K. A. Townsend, S. K. Venables, and G. M. W. Stevens. 2018. Research priorities to support effective manta and devil ray conservation. *Frontiers in Marine Science* 5:314.

Stöber, U. and F. Thomsen. 2021. How could operational underwater sound from future offshore wind turbines impact marine life *Journal of the Acoustical Society of America* 149:1791-1795.

Sullivan, L., T. Brosnan, T. K. Rowles, L. Schwacke, C. Simeone, and T. K. Collier. 2019. *Guidelines for Assessing Exposure and Impacts of Oil Spills on Marine Mammals*. NOAA Tech. Memo. NMFS-OPR-62. 82 pp.

Takeshita, R., L. Sullivan, C. Smith, T. Collier, A. Hall, T. Brosnan, T. Rowles, and L. Schwacke. 2017. The Deepwater Horizon Oil Spill marine mammal injury assessment. *Endangered Species Research* 33:96–106.

Taormina B., J. Bald, A. Want, G. Thouzeau, M. Lejart, N. Desroy, and A. Carlier. 2018. A review of potential impacts of submarine cables on the marine environment: Knowledge gaps, recommendations, and future directions. *Renewable and Sustainable Energy Reviews* 96:380–391.

Tetra Tech and LGL. 2019. *Annual Survey Report Year 2 for New York Bight Whale Monitoring Aerial Surveys March 2018 – February 2019*. Technical Report produced By Tetra Tech and LGL for NYSDEC under contract C009926.

Tetra Tech and LGL. 2020. *Final Comprehensive Report Years 1-3 for New York Bight Whale Monitoring Aerial Surveys March 2017 – February 2020*. Technical Report produced By Tetra Tech and LGL for NYSDEC under Tetra Tech contract C009926.

Tetra Tech and Smultea Sciences. 2018. *Annual Survey Report Year 1 for New York Bight Whale Monitoring Aerial Surveys March 2018 – February 2018.* Technical Report produced by Tetra Tech and Smultea Sciences for NYSDEC under contract C009926.

Thomsen, F., A. B. Gill, M. Kosecka, M. Andersson, M. André, S. Degraer, T. Folegot, J. Gabriel, A. Judd, T. Neumann, A. Norro, D. Risch, P. Sigray, D. Wood, and B. Wilson. 2015. *MaRVEN—Environmental Impacts of Noise, Vibrations and Electromagnetic Emissions from Marine Renewable Energy*. doi:10.2777/272281. Luxembourg: Publications Office of the European Union, 2015. Available: https://www.researchgate.net/publication/301296662_MaRVEN_-_Environmental_Impacts_of_Noise_Vibrations_and_Electromagnetic_Emissions_from_Marine_Renewable_Energy. Accessed: September 9, 2020.

Teilmann, J., and J. Cartensen. 2012. Negative long-term effects on harbour porpoises from a large scale offshore wind farm in the Baltic—Evidence of slow recovery. *Environmental Resource Letters* 7:045101.

Todd, V. G. L., I. B. Todd, J. C. Gardiner, E. C. N. Morin, N. A. MacPherson, and F. Thomsen. 2015. A review of impacts of marine dredging activities on marine mammals. *ICES Journal of Marine Science* 72:328-340.

Tomás, J., R. Guitart, R. Mateo, and J. A. Raga. 2002. Marine debris ingestion in loggerhead turtles, *Caretta caretta*, from the western Mediterranean. *Marine Pollution Bulletin* 44:211–216.

Tougaard, J., J. Cartensen, J. Teilmann, H. Skov, and P. Rasmussen. 2009. Pile driving zone of responsiveness extends beyond 20 km for harbour porpoises (*Phocoena phocoena*). *Journal of the Acoustical Society of America* 126:11-14.

Tougaard, J., J. Carstensen, M. S. Wisz, M. Jespersen, J. Teilmann, N. I. Bech, and H. Skov. 2006. *Harbor Porpoises on Horns Reef – Effects of the Horns Reef Wind Farm*. NERI Technical Report National Environmental Research Institute, Aarhus University, Roskilde, Denmark.

Tougaard, J., L. Hermannsen, and P. T. Madsen. 2020. How loud is the underwater noise from operating offshore wind turbines? *Journal of the Acoustical Society of America* 148:2885–2892.

U.S. Army Corps of Engineers (USACE). 2020. South Atlantic Regional Biological Opinion for Dredging and Material Placement Activities in the Southeast United States. 646 pp. Available: https://www.fisheries.noaa.gov/webdam/download/109184041. Accessed: September 3, 2020.

U.S. Department of the Navy (Navy). 2018. Hawaii-Southern California Training and Testing EIS/OEIS. Available: https://www.hstteis.com/portals/hstteis/files/hstteis_p3/feis/section/HSTT_FEIS_3.08_Reptiles_October_2018.pdf. Accessed: September 3, 2020.

U.S. Fish and Wildlife Service (USFWS). 1967. Native fish and wildlife. Endangered species. 32 FR 4001.

U.S. Fish and Wildlife Service (USFWS). 1970. List of endangered foreign fish and wildlife. 35 FR 18319.

U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS). 1998. *Endangered Species Consultation Handbook. Procedures for Conducting Consultation and Conference Activities under Section 7 of the Endangered Species Act*.

U.S. Fish and Wildlife Service (USFWS) and National Oceanic and Atmospheric Administration (NOAA). 1991. Threatened status for the Gulf Sturgeon. 56 FR 49653.

United States Environmental Protection Agency (EPA). 2016. National Aquatic Resource Surveys. Indicators Used in the National Aquatic Resource Surveys. Available: https://www.epa.gov/national-aquatic-resource-surveys/indicators-used-national-aquatic-resource-surveys.

United States Nuclear Regulatory Commission (USNRC). 2010. Biological Assessment. Salem Nuclear Generating Station Units 1 and 2. Hope Creek Generating Station Unit 1. License Renewal. Docket Numbers 50-272, 50-311, and 50-354.

United States Nuclear Regulatory Commission (USNRC). 2010. Citing National Oceanic and Atmospheric Administration (NOAA). 2010. Green turtle (*Chelonia mydas*). Available: http://www.nmfs.noaa.gov/pr/species/turtles/green.htm. Accessed: November 15, 2010.

van Berkel, J., H. Burchard, A. Christensen, L.). Mortensen, O. S. Petersen, and F. Thomsen. 2020. The effects of offshore wind farms on hydrodynamics and implications for fishes. *Oceanography* 33:108-117.

Van Dalfsen, J. A., and K. Essink. 2001. Benthic community response to sand dredging and shoreface nourishment in Dutch coastal waters. *Senckenbergiana Maritima* 31:329–32.

van der Hoop, J. M., D. P. Nowacek, M. J. Moore, and M. S. Triantafyllou. 2017. Swimming kinematics and efficiency of entangled North Atlantic right whales. *Endangered Species Research* 32:1–17.

Vanderlaan, A. S. M., and C. T. Taggart. 2007. Vessel collisions with whales: The probability of lethal injury based on vessel speed. *Marine Mammal Science* 23:144–156.

Vargo, S., P. Lutz, D. Odell, E. Van Vleet, and G. Bossart. 1986. *Effects of Oil on Marine Turtles*. Final Report prepared for the Minerals Management Service (MMS). 12 pp. Available: http://www.seaturtle.org/PDF/VargoS_1986a_MMSTechReport.pdf. Accessed: September 3, 2020.

Vasconcelos, R. O., M. C. P. Amorim, and F. Ladich. 2007. Effects of ship noise on the detectability of communication signals in the Lusitanian toadfish. *Journal of Experimental Biology* 210:2104-2112.

Vegter, A. C., M. Barletta, C. Beck, J. Borrero, H. Burton, M. L. Campbell, M. F. Costa, M. Eriksen, C. Eriksson, A. Estrades, K. V. K. Gilardi, B. D. Hardesty, J. A. Ivar do Sul, J. L. Lavers, B. Lazar, L. Lebreton, W. J. Nichols, C. A. Ribic, P. G. Ryan, Q. A. Schuyler, S. D. A. Smith, H. Takada, K. A. Townsend, C. C. C. Wabnitz, C. Wilcox, L. C. Young, and M. Hamann. 2014. Global research priorities to mitigate plastic pollution impacts on marine wildlife. *Endangered Species Research* 25:225–247.

Vikingsson, G. A. 1997. Feeding of fin whales (*Balaenoptera physalus*) off Iceland – Diurnal and seasonal variation and possible rates. *Journal of Northwest Atlantic Fisheries Science* 22:77-89.

Vladykov, V. D., and J. R. Greely. 1963. Order Acipenseroidei. In *Fishes of Western North Atlantic*. Y.H. Olsen, ed. 24-29. Sears Foundation for Marine Research, Yale University, New Haven, CT.

Walker, M. M., C. E. Diebel, and J. L. Kirschvink. 2003. Detection and use of the Earth's magnetic field by aquatic vertebrates. In S.P. Collin and N.J. Marshall, eds. *Sensory Processing in Aquatic Environments*, pp. 53–74.

Wang, J., X. Zou, W. Yu, D. Zhang, and T. Wang. 2019. Effects of established offshore wind farms on energy flow of coastal ecosystems: A case study of the Rudong Offshore Wind Farms in China." *Ocean & Coastal Management* 171:111–118.

Wardle , C. S., T. J. Carter, G. G. Urquhart, A. D. F. Johnstone, A. M. Ziolkowski, G. Hampson, and D. Mackie. 2001. Effects of seismic airguns on marine fish. *Continental Shelf Research* 21:1005-1027.

Waring, G. T., E. Josephson, K. Maze-Foley, and P. E. Rosel. 2011. US Atlantic and Gulf of Mexico Marine Mammal Stock Assessments – 2010. NOAA Tech. Memo. NMFS-NE-219.

Watkins, W. A., M. A. Daher, K. M. Fristrup, T. J. Howald, and G. Notarbartolo di Sciara. 1993. Sperm whales tagged with transponders and tracked underwater by sonar. *Marine Mammal Science* 9:55–67.

Watwood, S. L. and D. M. Buonantony. 2012. *Dive Distribution and Group Size Parameters for Marine Species Occurring in Navy Training and Testing Aras in the North Atlantic and North Pacific Oceans*. Newport, Rhode Island. NUWC-NPT Technical Document 12,085. March 2012. Available: https://apps.dtic.mil/sti/pdfs/ADA560975.pdf. Accessed June 28, 2022.

WCS Ocean Giants. 2020. *Acoustic Monitoring in Equinor Wind Lease 0512: WCS-WHOI Collaboration, Phase 1, 2019-2022*. Year 1 Progress Report.

Weilgart, L. S. 2007. The impacts of anthropogenic ocean noise on cetaceans and implications for management. *Canadian Journal of Zoology* 85:1091–1116.

Weilgart, L. 2018. *The impact of ocean noise pollution on fish and invertebrates*. Ocean Care and Dalhousie University. May 2018. 34 pp.

Weirathmueller, M. J., W. S. D. Wilcok, and D. C. Soule. 2013. Source levels of fin whale 20 Hz pulses measured in the Northeast Pacific Ocean. *Journal of the Acoustical Society of America* 133:741–749.

Werner, S., A. Budziak, J. van Franeker, F. Galgani, G. Hanke, T. Maes, M. Matiddi, P. Nilsson, L. Oosterbaan, E. Priestland, R. Thompson, J. Veiga, and T. Vlachogianni. 2016. *Harm Caused by Marine Litter*. MSFD GES TG Marine Litter—Thematic Report; JRC Technical report; EUR 28317 EN. doi:10.2788/690366. Available: https://publications.jrc.ec.europa.eu/repository/bitstream/JRC104308/lbna28317enn.pdf. Accessed: September 9, 2020.

Whitt, A. D., K. Dudzinski, and J. R. Laliberte. 2013. North Atlantic right whale distribution and seasonal occurrence in nearshore waters off New Jersey, USA and implications for management. *Endangered Species Research* 20:50–69.

Wilber, D. H. and D. G. Clarke. 2001. Biological effects of suspended sediments: A review of suspended sediment impacts on fish and shellfish with relation to dredging activities in estuaries. *North American Journal of Fisheries Management* 21:855-875.

Wilber, D. H. and D. G. Clarke. 2001. Citing Sherk, J. A., J. M. O'Connor, D. A. Neumann, R. D. Prince, and K. V. Wood. 1974. *Effects of Suspended and Deposited Sediments on Estuarine Organisms. Phase II.* University of Maryland Natural Resources Institute, Reference 74-20.

Witt, M. J., L. A. Hawkes, M. H. Godfrey, B. J. Godley, and A. C. Broderick. 2010. Predicting the impacts of climate change on a globally distributed species: The case of the loggerhead turtle. *The Journal of Experimental Biology* 213:901–911.

Woods Hole Oceanographic Institute (WHOI). 2018. Autonomous real-time marine mammal detections – New York Bight Buoy. Available: http://dcs.whoi.edu/nyb0218/nyb0218_buoy.shtml.

Woods Hole Oceanographic Institute (WHOI). 2022. Effects of noise on marine life: Study finds that turtles are among animals vulnerable to hearing loss. Available: www.sciencedaily.com/releases/2022/03/220302190004.htm. Accessed: December 2022.

Würsig, B., C. R. Greene, Jr., and T. A. Jefferson. 2000. Development of an air bubble curtain to reduce underwater noise of percussive piling. *Marine Environmental Research* 49:79-93.

Wysocki, L. E., S. Amoser, and F. Ladich. 2007. Diversity in ambient noise in European freshwater habitats: Noise levels, spectral profiles, and impact on fishes. *The Journal of the Acoustical Society of America* 121:2559–2566.

Yost, W. A. 2000. *Fundamentals of Hearing: An introduction*. New York: Academic Press.

Zydlewski, G. B., M. T. Kinnison, P. E. Dionne, J. Zydlewski, and G. S. Wippelhauser. 2011. Shortnose sturgeon use small coastal rivers: The importance of habitat connectivity. *Journal of Applied Ichthyology* 27:41–44.