NATIONAL MARINE FISHERIES SERVICE
ENDANGERED SPECIES ACT SECTION 7 CONSULTATION
BIOLOGICAL OPINION

AGENCY:	Bureau of Ocean Energy Management Bureau of Safety and Environmental Enforcement National Marine Fisheries Service – Office of Protected Resources U.S. Army Corps of Engineers U.S. Coast Guard U.S. Environmental Protection Agency
ACTIVITY CONSIDERED:	Construction, Operation, Maintenance, and Decommissioning of the Ocean Wind 1 Offshore Energy Project (Lease OCS-A 0498) GARFO-2022-02397
CONDUCTED BY:	National Marine Fisheries Service Greater Atlantic Regional Fisheries Office
DATE ISSUED:	April 3, 2023
APPROVED BY:	____________________ Michael Pentony Regional Administrator

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1.0 INTRODUCTION

This constitutes NOAA's National Marine Fisheries Service's (NMFS) biological opinion (Opinion) issued to the Bureau of Ocean Energy Management (BOEM), as the lead federal agency, in accordance with section 7 of the Endangered Species Act of 1973 (ESA), as amended, on the effects of the construction, operation, maintenance, and decommissioning of the Ocean Wind 1 Offshore Wind Project (Lease OCS-A 0498). Ocean Wind is proposing to construct and operate a commercial-scale offshore wind energy facility within Lease Area OCS-A 0498 that would generate up to approximately 1,100 megawatts (MW) of electricity.

BOEM is the lead federal agency for purposes of section 7 consultation; the other action agencies include the Bureau of Safety and Environmental Enforcement (BSEE), the U.S. Army Corps of Engineers (USACE), the U.S. Coast Guard (USCG), the U.S. Environmental Protection Agency (EPA), and NMFS Office of Protected Resources[1]. This Opinion considers effects of the proposed Federal actions on ESA-listed whales, sea turtles, fish, and designated critical habitat that occur in the action area. A complete administrative record of this consultation will be kept on file at our Greater Atlantic Regional Fisheries Office.

1.1 Regulatory Authorities

The Energy Policy Act of 2005 (EPAct), Public Law 109-58, added section 8(p)(1)(c) to the Outer Continental Shelf Lands Act. The new section authorized the Secretary of Interior to issue leases, easements, and rights-of-way (ROW) in the Outer Continental Shelf (OCS) for renewable energy development, including wind energy. The Secretary delegated this authority to the former Minerals Management Service, and later to BOEM. Final regulations implementing this authority (30 CFR part 585) were promulgated on April 22, 2009. These regulations prescribe BOEM's responsibility for determining whether to approve, approve with modifications, or disapprove Ocean Wind's Construction and Operations Plan (COP). Ocean Wind filed their COP with BOEM on August 15, 2019, with subsequent revisions through May 27, 2022[2]. BOEM issued a Notice of Intent to prepare an Environmental Impact Statement (EIS) under the National Environmental Policy Act (NEPA) (42 USC § 4321 et seq.) on March 30, 2021, to assess the potential biological and physical environmental impacts of the Proposed Action and Alternatives (83 FR 13777). A draft EIS (DEIS) was published on June 24, 2022.[3]

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/enforcement actions as appropriate, oversee closeout verification efforts, oversee facility removal inspections/monitoring, and oversee bottom clearance confirmation.

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[1] The NMFS Office of Protected Resources (OPR), located in NMFS' Silver Spring, MD, Headquarters (HQ) Office, is proposing to issue an Incidental Take Authorization under the MMPA and is thus an action agency responsible for consulting under Section 7 of the ESA, whereas NMFS's Gloucester, MA, Greater Atlantic Regional Fisheries Office (GAR) is the consulting agency, under ESA regulations at 50 C.F.R. part 402.

[2] COP is available online at: https://www.boem.gov/renewable-energy/state-activities/ocean-wind-1 Last accessed January 19, 2023.

[3] The DEIS is available online at: https://www.boem.gov/renewable-energy/state-activities/ocean-wind-1 Last accessed January 19, 2023.

USACE issued a Public Notice (NAP-2017-00135-84[4]) describing its consideration of Ocean Wind's request for a permit pursuant to Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. 403) and Section 404 of the Clean Water Act (33 U.S.C. 1344) on June 17, 2022. In the notice, USACE notes that work regulated and proposed for permitting by USACE, through section 10 of the Rivers and Harbors Act of 1899 and section 404 of the Clean Water Act, will include the construction of up to 98 wind turbine generators (WTGs), up to three offshore alternating current (AC) substations, array cables linking the individual turbines to the offshore substation(s) (OSS), one substation interconnector cable linking two offshore substations to each other, offshore export cables, an onshore export cable system which includes underground cables, two onshore substations, and connections to the existing electrical grid in New Jersey.

The USCG administers the permits for private aids to navigation (PATON) located on structures positioned in or near navigable waters of the United States. PATONS and federal aids to navigation (ATONS), 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, OSS, and along the offshore export cable corridor may be required. These aids serve as a visual reference to support safe maritime navigation. . Federal regulations governing PATON are found within 33 CFR part 66 and address the basic requirements and responsibilities.

The Marine Mammal Protection Act of 1972 (MMPA) as amended, and its implementing regulations (50 CFR part 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 assuming certain statutory and regulatory findings are made. To "take" is defined under the MMPA (50 CFR§ 216.3) as,

> to 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.

"Incidental taking" means "an accidental taking. This does not mean that the taking is unexpected, but rather it includes those takings that are infrequent, unavoidable, or accidental." (50 C.F.R. §216.103). NMFS Office of Protected Resources (OPR) has received a request for Incidental Take Regulations (ITR) and associated Letter of Authorization (LOA) from Ocean Wind, LLC (Ocean Wind), a subsidiary of Orsted Wind Power North America, LLC and a joint venture partner of the Public Service Enterprise Group Renewable Generation, LLC, for the incidental take of small numbers of marine mammals during the construction of the Ocean Wind

[4]Public Notice is online at https://www.nap.usace.army.mil/Missions/Regulatory/Public-Notices/Article/3066660/2017-00135-84/
Last accessed January 19, 2023.

project.[5] The requested ITR would govern the authorization of take, by both Level A and Level B harassment[6], of small numbers of marine mammals over a 5-year period incidental to construction-related pile driving activities (impact and vibratory), potential unexploded ordnances or munitions and explosives of concern detonation, and high-resolution geophysical (HRG) site characterization surveys conducted by Ocean Wind in Federal and State waters off of New Jersey for the Ocean Wind 1 offshore wind energy facility. A final ITR would allow for the issuance of a LOA to Ocean Wind for a 5-year period.

Ocean Wind may choose to obtain a Letter of Acknowledgment (LOA) from NMFS for certain fisheries survey activities. An LOA acknowledges, but does not authorize, certain activities as scientific research conducted from a scientific research vessel. (See 50 CFR §600.745(a)). Scientific research activities are activities that would meet the definition of fishing under the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act), but for the statutory exemption provided for scientific research. (16 USC § 1802(16)). Such activities are statutorily exempt from any and all regulations promulgated under the Magnuson-Stevens Act, provided they continue to meet the definition of scientific research activities conducted from a scientific research vessel. To meet the definition of a scientific research vessel, the vessel must be conducting a scientific research activity and be under the direction of one of the following: Foreign government agency; U.S. Government agency; U.S. state or territorial agency; University (or other educational institution accredited by a recognized national or international accreditation body); International treaty organization; or, Scientific institution. In order to meet this definition, vessel activity must be dedicated to the scientific research activity, and cannot include commercial fishing. Scientific research activity includes, but is not limited to, sampling, collecting, observing, or surveying the fish or fishery resources within the Exclusive Economic Zone. Research topics include taxonomy, biology, physiology, behavior, disease, aging, growth, mortality, migration, recruitment, distribution, abundance, ecology, stock structure, bycatch or other collateral effects of fishing, conservation engineering, and catch estimation of fish species considered to be a component of the fishery resources. The issuance of a Magnuson-Stevens Act LOA by NMFS is not a federal action subject to section 7 consultation, and it is not an authorization or permit to carry out an activity. However, as BOEM's action we are consulting on includes some surveys that may be carried out with a Magnuson-Stevens Act LOA, and these surveys' effects would not occur but for the Ocean Wind project, it is appropriate to consider them in this Opinion and, to the extent the surveys cause incidental take, in this Opinion's Incidental Take Statement.

2.0 CONSULTATION HISTORY AND APPROACH TO THE ASSESSMENT

As explained above, BOEM is the lead federal agency for the section 7 consultation. BOEM submitted a draft Biological Assessment (BA) on February 11, 2022. BOEM submitted a revised BA and request for consultation on July 14, 2022, as the lead federal agency for the ESA

[5] Application, Proposed Rule, and Supporting Materials are available online at: https://www.fisheries.noaa.gov/action/incidental-take-authorization-ocean-wind-lcc-construction-ocean-wind-1-wind-energy-facility; Last accessed January 19, 2023

[6] Level A harassment means any act of pursuit, torment, or annoyance that has the potential to injure a marine mammal or marine mammal stock in the wild. Level B harassment refers to acts that have the potential to disturb (but not injure) a marine mammal or marine mammal stock in the wild by disrupting behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering.

consultation and on behalf of BSEE, USACE, EPA, and the USCG. We requested additional information in correspondence dated August 11, 2022. On September 12, 2022, we received a draft Notice of Proposed Incidental Take Regulations for the Taking of Marine Mammals Incidental to the Ocean Wind 1 Energy Facility, from our Office of Protected Resources and an accompanying request for ESA section 7 consultation. At that time, we considered that we had received all of the information necessary to initiate consultation. However, during meetings held in October 2022, new information on project work in Barnegat Bay was presented by Orsted. The follow up information received by us on November 4 and November 16 provides us all of the information required to initiate this formal consultation. As explained in our December 21, 2022 letter, consultation was formally initiated, therefore, on November 16, 2022. Additional clarifying information was provided to us by BOEM staff throughout the consultation period. To harmonize various regulatory reviews, increase certainty among developers regarding anticipated regulatory timelines, and allow sufficient time for NMFS' production of a final biological opinion, BOEM and NMFS have agreed to a standardized ESA Section 7 consultation timeline under the OSW program that typically allocates 150 days for consultation and production of a biological opinion for each proposed offshore wind project, unless extended. Issuance of the Ocean Wind biological opinion ultimately was scheduled for completion on or before April 3, 2023.

Consideration of Activities Addressed in Other ESA Section 7 Consultations
As described in section 3 below, some Ocean Wind 1 project vessels will utilize the Paulsboro Marine Terminal in Paulsboro, NJ, the New Jersey Wind Port in Hope Creek, NJ, and the Nexans Cable Plant in Charleston, SC. NMFS GARFO has completed ESA section 7 consultation with the USACE for the construction and operation of the Paulsboro Marine Terminal and the New Jersey Wind Port.[7] The Biological Opinions prepared by NMFS for the Paulsboro Marine Terminal (July 19, 2022, "2022 Paulsboro Opinion") and New Jersey Wind Port (February 25, 2022, "2022 NJWP Opinion") considered effects of all vessels transiting to/from these ports on shortnose sturgeon, Atlantic sturgeon and critical habitat designated for the New York Bight distinct population segment (DPS) of Atlantic sturgeon. NMFS Southeast Regional Office (SERO) completed ESA section 7 consultation with the USACE for the construction and operation of Nexans facility. The May 4, 2020, Biological Opinion prepared by NMFS SERO considers the effects of the construction and use of the Nexans Plant (2020 Nexans Opinion) on shortnose sturgeon, Atlantic sturgeon, and critical habitat designated for the Carolina DPS of Atlantic sturgeon.

Each of these three Biological Opinions analyzed an overall amount of vessel transits, of which Ocean Wind would contribute a small part. The effects analyzed in the three completed port Opinions will be considered as part of the *Environmental Baseline* of this Opinion, given the definition of that term at 50 CFR §402.02. The effects specific to Ocean Wind's vessel use of those ports will be discussed in the *Effects of the Action* section by referencing the analysis in three port Opinions and determining whether the effects of Ocean Wind's vessels transiting to and from those ports are consistent with those analyses or anticipated to cause additional effects. In the *Integration and Synthesis* section, if we determine any additional effects of Ocean Wind's vessels will be caused by the proposed action we will evaluate them in addition to the effects

[7] USACE has requested reinitiation of consultation; however, NMFS has requested additional information before determining whether to reinitiate consultation.

included in the *Environmental Baseline*, which already includes the effects of vessel transits analyzed in the three port Biological Opinions. By using this methodology, this Opinion ensures that all of the effects of Ocean Wind's vessel transits to and from the ports analyzed in other Biological Opinions will be considered in the *Integration and Synthesis* section and reflected in this Opinion's final determination under ESA 7(a)(2). This methodology also ensures this Opinion does not "double-count" effects of Ocean Wind's vessel transits to and from the ports– once in the *Environmental Baseline* and once in the *Effects of the Action* section. Any incidental take anticipated by Ocean Wind's vessel transits, even if already specified and exempted in the port Biological Opinions' Incidental Take Statements, will also be specified in this Opinion's Incidental Take Statement and will be subject to reasonable and prudent measures and terms and conditions from the port Opinions. This approach is being taken because BOEM was not a party to the three port Biological Opinions, yet Ocean Wind's vessel transits would not occur but for BOEM's COP approval. Therefore, is it necessary and appropriate to specify this incidental take, as well as non-discretionary measures to minimize, monitor, and report such take, in this Opinion's Incidental Take Statement that will apply to BOEM.

Consideration of the 2019 ESA Regulations
On July 5, 2022, the U.S. District Court for the Northern District of California issued an order vacating the 2019 regulations that were revised or added to 50 CFR part 402 in 2019 ("2019 Regulations," see 84 FR 44976, August 27, 2019) without making a finding on the merits. On September 21, 2022, the U.S. Court of Appeals for the Ninth Circuit granted a temporary stay of the district court's July 5 order. On November 14, 2022, the Northern District of California issued an order granting the government's request for voluntary remand without vacating the 2019 regulations. The District Court issued a slightly amended order two days later on November 16, 2022. As a result, the 2019 regulations remain in effect, and we are applying the 2019 regulations here. For purposes of this consultation and in an abundance of caution, we considered whether the substantive analysis and conclusions articulated in the biological opinion and incidental take statement would be any different under the pre-2019 regulations. We have determined that our analysis and conclusions would not be any different.

3.0 DESCRIPTION OF THE PROPOSED ACTIONS ON WHICH CONSULTATION WAS REQUESTED

In this section and throughout the Opinion we use a number of different terms to describe different geographic areas of interest. For clarity, we define those terms here. Wind Development Area (WDA) is the area consisting of the location of the wind turbine generators, offshore substations, interarray cables, and the cable corridors between the substations and the landfall sites in New Jersey. The Wind Farm Area (WFA) is that portion of Ocean Wind 1's lease (OCS-A 0498) where the wind turbine generators and OSS will be installed and operated (i.e., the offshore portion of the WDA minus the cable routes to shore). The project area is the area consisting of the location of the wind turbine generators, offshore substations, interarray cables, and the cable corridors to shore, as well as all vessel transit routes to ports in New Jersey, Virginia, and South Carolina (i.e., the WDA plus these transit routes). The area encompassing the effects of vessel transit routes to and from Europe are also part of the action area, but will be referred to as such. The action area is defined in section 3.4 below.

3.1 Overview of Proposed Federal Actions

BOEM is the lead federal agency for the project for purposes of this ESA consultation and coordination under NEPA and other statutes; BOEM requested consultation on its proposal to approve[8] a COP to authorize the construction, operation and maintenance, and eventual decommissioning of the Ocean Wind 1 Offshore Wind Farm Project (i.e., facilities, cables, pipelines, obstructions, and clear the seabed of obstructions created by the proposed project). BSEE will provide recommendations to BOEM for enforcing safety, environmental, and conservation compliance with any associated legal and regulatory requirements during project construction and future operations; oversee inspections/enforcement actions, as appropriate; oversee closeout verification efforts; oversee facility removal and inspections/monitoring; and oversee bottom clearance confirmation. BOEM's August 11, 2022 request for consultation also included: EPA's proposal to issue an Outer Continental Shelf Air Permit; the USACE's proposal to issue a permit for in-water work, structures, and fill under Section 10 of the Rivers and Harbors Act of 1899 and Section 404 of the Clean Water Act including authorization of dredging and associated activities; USACE anticipates that a "Section 408 permission" will be required pursuant to Section 14 of the RHA (33 USC§408) for any proposed alterations that have the potential to alter, occupy, or use any federally authorized civil works projects (i.e., Federal navigation channels); and the USCG proposal to issue a Private Aids to Navigation (PATON) Authorization. BOEM addressed NMFS OPR's proposal to issue a Marine Mammal Protection Act (MMPA) Incidental Take Authorization (ITA) in their request for consultation and NMFS OPR submitted a separate request for consultation on September 12, 2022. Through the provisions of the Clean Water Act, EPA has delegated authority to issue permits under the National Pollutant Discharge Elimination System (NPDES) to the State of New Jersey. Ocean Wind LLC (Ocean Wind 1) plans to apply for a New Jersey Pollutant Discharge Elimination System (NJPDES) permit as necessary for discharges related to onshore construction activities. The issuance of State permits is not an action subject to ESA section 7 consultation; however, this consultation considers the effects of water quality impacts of all activities that would not occur but for the Ocean Wind 1 proposed actions that may affect listed species.

As described in the DEIS, vessels are required to adhere to state and federal regulations, including NPDES standards. Additionally, BOEM indicated it will require, through COP approval, all Project construction vessels to adhere to existing state and federal regulations related to ballast and bilge water discharge, including USCG ballast discharge regulations (33 CFR §151.2025) and EPA National Pollutant Discharge Elimination System Vessel General Permit standards.

3.2 Ocean Wind 1 Offshore Wind Farm Project

3.2.1. Overview

BOEM is proposing to authorize Ocean Wind LLC (Ocean Wind), an affiliate of Ørsted Wind Power North America LLC, to construct, operate, maintain, and eventually decommission an offshore wind energy project in Lease Area OCS-A 0498, located within the New

[8] BOEM's regulations state at 30 CFR § 585.628(f): "Upon completion of our technical and environmental reviews and other reviews required by Federal law (e.g., CZMA), BOEM may approve, disapprove, or approve with modifications your COP."

Jersey Wind Energy Area (NJ WEA). The other Federal actions identified in Section 3.1 authorize various aspects of the proposed action including the incidental take of marine mammals caused by the project. The information presented here reflects the proposed action described by BOEM in their BA and the BA Addendum provided to NMFS GAR in November 2022. Here, for simplicity, we may refer to BOEM's authorization when that authorization may also include other Federal actions (e.g., construction of the wind turbines requires authorizations from BOEM, USACE, EPA, USCG, and NMFS OPR).

Ocean Wind 1's Lease Area OCS-A 0498 is located approximately 15 miles (13 nautical miles) southeast of Atlantic City, New Jersey. Water depths in the Wind Development Area (WDA) range from approximately 15–38 meters (m) (49-125 feet (ft.)). The project includes two main components: the Ocean Wind 1 Offshore Wind Farm, which would consist of up to 98 offshore wind turbine generators (WTGs)[9] and their foundations, up to three offshore substations (OSSs) and their foundations, scour protection for foundations, and a submarine transmission cable network connecting the WTGs (inter-array cables) to the OSSs, all located within the lease area; and, offshore export cables from the lease area to the landfall location. The total capacity of the project will be approximately 1,100 MW. The project's export cables include both offshore and onshore segments. The offshore export cables will be alternating current (AC) electric cables that will connect the project to the mainland electric grid in Lacey Township, New Jersey, and Upper Township, New Jersey. The offshore export cables will be located in federal waters and New Jersey State territorial waters. Up to three AC cables (installed within two export route corridors) would be located offshore. In addition to the export cables there are two interconnector cables that connect the OSSs to each other. The onshore export cable segments will be located in Berkeley, Lacey, Ocean, and Upper Townships, New Jersey, and Ocean City, New Jersey. The offshore export cables will connect with onshore export cables at transition joint bays (TJBs) with landfall sites located along the BL England and Oyster Creek export cable routes.

Prior to export cable installation, dredging may be required in Barnegat Bay to facilitate vessel access in an area west of Island Beach State Park and near the landfall sites at Lacey or Ocean Township. In addition, Ocean Wind 1 is proposing to dredge the Oyster Creek Federal Channel to the authorized width and depth to allow for safe and reliable passage of construction vessels into Barnegat Bay, in the event that the channel has not been dredged to its authorized depth and width by the time project vessels would need to access the channel. The authorized depth is 8 feet below MLW plus overdredge allowance and 200 feet wide. The Oyster Creek Federal Channel in Barnegat Bay is part of the Barnegat Inlet Federal Navigation Project, which is operated and maintained by the USACE. If necessary, dredging of approximately 18,000 cubic yards (CY) within a 3.7-acre area would be completed via the use of a hydraulic cutterhead dredge or closed-clamshell bucket dredge. Dredged material would be transferred to an upland disposal facility via a pipeline system, barge, or scow and disposed of in accordance with EPA Guidelines, USACE Guidelines, N.J.A.C. 7:7 Appendix G for the Management and Regulation of Dredging Activities and Dredged Material in New Jersey's Tidal Waters, and applicable State Surface Water Quality Standards at N.J.A.C. 7:9B and permit conditions.

[9] WTG capacity is not a PDE parameter in the COP; however, Ocean Wind has selected the GE Haliade-X 12 MW offshore wind turbine (Ocean Wind 2022).

The project also includes a number of survey components including high-resolution geophysical surveys (HRG), geotechnical surveys, passive acoustic monitoring, and biological monitoring surveys, submerged aquatic vegetation (SAV) monitoring surveys, inclusive of surveys that support the Fisheries Monitoring and Benthic Monitoring Plans. These survey activities will occur during the pre-construction, construction, and operation and maintenance phases of the project.

Construction and installation of the Ocean Wind 1 Wind Farm and offshore export cables is anticipated to occur over an approximately two and a half year period, currently anticipated to occur between 2023 and 2025; with land-based components and landfall activities commencing as early as quarter three of 2023, followed by offshore construction in approximately quarter two of 2024. The proposed Project is being developed and permitted using the Project Design Envelope (PDE) concept; this means that the "maximum impact scenario" (i.e., greatest number of piles, largest turbines, etc.) is proposed for authorization by BOEM and is being analyzed in accompanying review documents (see Table 3.2.1). Further discussion of construction methods and schedule are provided in COP Volume 1, Section 4.0 (Ocean Wind 2022) and summarized below. Additional relevant details of the proposed activities are also included in the Effects of the Action section of this Opinion.

Table 3.2.1. Maximum Design Parameters for Turbines and Foundations.

Design Parameter	Maximum Design Parameters
WIND TURBINE GENERATOR (WTG)	
Minimum lower blade tip height (ft.) (relative to MLLW)	70.8
Maximum upper blade tip height (ft.) (relative to MLLW)	906
Maximum rotor diameter (ft.)	788
MONOPILE FOUNDATION	
Outer diameter at seabed of main tubular structure (ft.)	37
Sea surface diameter (ft.)	27
Scour protection (if required) diameter (yards)	61
Scour protection (if required) layer thickness (ft.)	8.2
Seabed structure area per monopile (acres)	0.023
Seabed scour protection (if required) area per monopile (acres)	0.59
Seabed permanent area affected per monopile (acres)	0.85
Scour protection (if required) volume per monopile (cubic yards)	7,764
Pile structure grout volume per monopile (cubic yards)	144
Seabed penetration (ft.)	164

Maximum hammer energy kilojoules (kJ)	4,000
Indicative continuous piling duration per turbine (hours)	4

Source: Ocean Wind COP Volume 1 (2022)

3.2.2 Construction - Offshore Activities

Wind Turbine Generators

Ocean Wind would erect up to 98 WTGs extending up to 906 feet (276 m) above mean lower low water (MLLW) with a spacing between WTGs of approximately one nautical mile (nm) by 0.8 nm in a southeast-northwest orientation within the 68,450-acre (277-square-kilometer [km^2])WFA. Each WTG would be mounted on a monopile foundation, a long steel tube driven 164 feet (50 m) into the seabed. Where required, Ocean Wind would place scour protection around foundations to stabilize the seabed near the foundations as well as the foundations themselves. The scour protection would be a maximum of 8.2 feet (2.5 m) in height, would extend away from the foundation as far as 73 feet (22.3 m), and would have a volume of 7,764cubic yards (yd^3) (5,936 cubic meters [m^3]) per monopile. Each WTG would contain approximately 1,585 gallons (6,000 liters) of transformer oil and 146 gallons (553 liters) of general oil (for hydraulics and gearboxes). Use of other chemicals would include diesel fuel, coolants/refrigerants, grease, paints, and sulfur hexafluoride.

Inter-array Cables, Substation Interconnector Cables, and Offshore Substations (OSSs)

Inter-array cables would connect the individual WTGs to a substation and would transfer power between the WTGs and the three proposed OSSs. Each individual OSS may be placed on either a single monopile or pin pile jacket foundations. Pile jacket foundations being considered for the OSSs would involve installation of up to 48 2.44 m diameter pin piles total (16 per OSS) via impact hammer to an expected penetration depth of 230 feet (70 m).

Ocean Wind's PDE includes a cable design that encompasses a conservative range of parameters, detailed in Table 3.2.2 below. OSSs would include step-up transformers and other electrical equipment needed to connect the 66-kilovolt (kV) inter-array cables to the 275 kV or 220 kV offshore export cables. Substation interconnector cables would connect the offshore substations to each other. Up to two interconnection cables would be installed with each cable linking two substations. The array and interconnector cables contain three conductors, screens, insulators, fillers, sheathing, armor, and fiber optic communications cables. Between three and five WTGs would be connected through the inter-array cable that would be buried 4 to 6 feet (1.2 to 1.8 m) below the seabed where possible and then connected to the OSS. Cable protection may be placed on the seabed where sufficient burial depth cannot be achieved, or protection is required due to array cables crossing other cables or pipelines. Additional armoring and other cable protection methods may include rock placement, concrete mattresses, frond mattresses, rock bags, and seabed spacers.

Table 3.2.2. Maximum Design Parameters for Array and Interconnector Cables.

Design Parameter	Maximum Design Parameters
INTER-ARRAY CABLES	
Cable diameter (inches)	8
Estimated total length of cable (miles)	190
Typical voltage (kV)	66
Maximum voltage (kV)	170
Target burial depth (ft.) (final burial depth based on Cable Burial Risk Assessment)	4 – 6
Cable separation - typical (ft.)	328
Offshore Cable disturbance corridor width (ft.)	82
SUBSTATION INTERCONNECTOR CABLES	
Number of substation interconnector cables	2
Estimated total length of cable (miles)	19
Cable diameter (inches)	13
Maximum voltage (kV)	275
Target burial depth (ft.) (final burial depth dependent on cable burial risk assessment and coordination with agencies)	4 – 6
Cable seabed disturbance width (ft.)	82

Source: Ocean Wind COP Volume 1 (2021)

The OSSs would serve as the interconnection points between the offshore and onshore components. The primary purpose of the OSSs is to collect electric energy generated by the WTGs and transform voltage from the inter-array cables to the offshore export cables and would also house the Supervisory Control and Data Acquisition (SCADA) system for monitoring and control between the WTGs, substations, and onshore remote operation(s). As noted above, the OSSs would consist of a topside structure with one or more decks on either a monopile or pin piled jacket foundation. According to the PDE, the total maximum height (including ancillary structures) of each OSS would be 296 feet (90.2 m), measured from mean sea level to the top of the substation (Table 3.2.3).

WTGs and the OSSs would include lighting and marking that complies with Federal Aviation Administration (FAA) and USCG standards, and be consistent with BOEM best practices. A detailed description of inter-array cables, substation interconnector cables, and OSSs is provided in COP Volume 1, Section 6.1.1.3, Section 6.1.1.4, and Section 6.1.1.5 (Ocean Wind 2022).

Table 3.2.3. Maximum Design Parameters for Topside Offshore Substations and Substation Foundations.

Design Parameter	Maximum Design Parameters
TOPSIDE OFFSHORE SUBSTATIONS	
Number of substations	3
Length of topside main structure (ft.)	230
Width of topside main structure (ft.)	230
Length of topside main structure inclusive of ancillary structures (ft.)	295
Width of topside main structure inclusive of ancillary structures (ft.)	295
Total structure height - including ancillary structures (ft.) (relative to MLLW)	296
Bridge links link length (ft.)	328
SUBSTATION FOUNDATIONS – MONOPILE FOUNDATION SCENARIO	
Maximum number of structures	3
Maximum scour protection (if required) dimension (yards)	72
Outer diameter at seabed of main tubular structure (ft.)	37
Sea surface diameter (ft.)	27
Scour protection (if required) layer thickness (ft.)	8.2
Seabed structure area (acres)	0.04
Seabed scour protection (if required) area (acres)	1
Seabed permanent area affected per monopile (acres)	0.85
Scour protection (if required) volume per monopile (cubic yards)	7,764
Pile structure grout volume per monopile (cubic yards)	144
Seabed penetration (ft.)	164
Maximum hammer energy kilojoules (kJ)	4,000
Indicative continuous piling duration per turbine (hours)	4
SUBSTATION FOUNDATIONS – PIN PILE (JACKET FOUNDATION) SCENARIO	
Maximum number of structures	3
Maximum structure dimension at seabed (yards)	77
Maximum structure dimension at sea surface (yards)	77
Number of legs per foundation	6

Number of piles per foundation (4 piles per corner)	16
Seabed total permanent area (acres)	0.6
Separation of adjacent legs at seabed (ft.)	230
Separation of adjacent legs at sea surface(ft.)	230
Height of platform above MLLW (ft.)	131
Jacket leg diameter (ft.)	15
Pin pile outer diameter at seabed (ft.)	8
Mud-mat area (ft^2)	4,306
Seabed structure area (acre)	<0.1
Seabed scour protection (if required) area (acres)	0.2
Seabed total permanent area (acres)	0.6
Scour protection (if required) volume (cubic yards)	1,721
Pile-structure grout volume (cubic yards)	222
Embedment depth (below seabed) (ft.)	230
Maximum hammer energy (kJ)	2,500
Maximum piling duration per foundation (days)*	15
Indicative continuous piling duration per pile (hours)*	4

* The 15 days is inclusive of activities (i.e., mobilization, clearance times, and demobilization) and not just pile driving. The indicative piling duration per pile is 4 hours. The maximum active piling duration per foundation would be up to 64 hours (16 piles per foundation x 4 hours per pile) spread over up to 15 days.

WTG Installation

Ocean Wind would install foundations and WTGs using installation vessels, as well as necessary support vessels and barges. These installation vessels would be equipped with a crane, a pile gripper, and a pile-driving hammer. Prior to commencing installation activities, high-resolution geophysical and geotechnical (HRG&G) surveys would be conducted in the Wind Farm Area to identify detailed seabed conditions and morphology. As necessary, significant debris, such as large boulders, would be moved outside this area. Excavation would be required where debris is buried or partially buried.

An installation vessel or a feeder barge will be used to transport the monopiles and transition pieces to the installation site. A pile gripper mounted on the side of the installation vessel will upend each monopile in a vertical position. After the monopile is placed onto the seabed and leveled, the hammer would be picked up and placed on top of the monopile. Each monopile will be driven to its final penetration target depth using an impact hammer (IHC-4000 or IHC-S-2500 kilojoule impact hammer or similar).

Once the monopile is installed to the target depth, the impact hammer would be removed; the monopile would be released from the pile gripper; and an anode cage would be installed on the monopile. To complete the installation, a transition section would be grouted or bolted to the top of the monopile. A transition piece may include boat landing features, access ladders, or other ancillary features.

Where required, scour protection would be placed around all foundations, and would consist of engineered rock placed around the base of each monopile in a 55.8 meter (183 ft.) diameter circle. The scour protection would serve to stabilize the seabed near the foundations as well as the foundations themselves. Methods for scour protection installation may include side stone dumping, fall pipe, or crane placement. See COP Volume 1, Section 6.1.1 for detail specifications of proposed scour protection (Ocean Wind 2021).

Pile Installation Activities According to the COP

According to the COP, impact pile driving for WTG and OSS foundations will not occur between January 1 and April 30. Impact pile-driving activities would therefore take place between May 1 and December 31. For WTGs, a single vertical hollow monopile would be installed for each location using an impact hammer. Installation of a single monopile is expected to take 9 hours (1 hour pre-clearance period, 4 hours piling, and 4 hours moving to the next location). Up to two monopiles are expected to be installed per 24-hour period. This assumes a 24-hour work window (i.e., ability to carry out at least some construction and vessel activities at all hours of the day) and no delays due to weather, sea conditions, or other circumstances. Duration of impact pile driving is anticipated to be approximately 4 hours per monopile.

OSSs are generally installed in two phases: first, the foundation substructure is installed in a method similar to that described above; then, the topside structure is installed on the foundation structure. More information on installation can be found in COP Volume I, Section 6.1.2 (Ocean Wind 2022). Ocean Wind would construct up to three OSSs to collect the electricity generated by the offshore turbines. OSSs help stabilize and maximize the voltage of power generated offshore, reduce potential electrical losses, and transmit energy to shore. OSSs would consist of a topside structure with one or more decks on either a monopile or piled jacket foundation. For the OSS, a piled jacket foundation or monopile will be used. The piled jacket foundation would involve installing 52- by 8-foot (16- by 2.44-meter) diameter piles as a foundation for each OSS foundation using an impact hammer (IHC-S-2500 kilojoule impact hammer or similar) to an expected penetration depth of 230 feet (70 meters). Alternatively, a single monopile like the ones used for WTGs may be used for each OSS. A maximum of three pin piles would be installed per 24-hour period. Each pin pile takes approximately 4 hours to install.

Concurrent driving (i.e., the driving of more than one pile at the same time) would not occur and is not analyzed in this Opinion. As detailed below, a number of measures to minimize and monitor effects of pile driving and other construction activities will be required and are considered part of the proposed action.

As stated above, Ocean Wind is proposing two piling scenarios that may be implemented during construction of the OSSs: (1) all monopile build-out for 98 WTGs and 3 OSSs (101 monopiles total), and (2) a joint-monopile 98 WTG and 3 OSS pin pile jacket foundation build-out (98 monopiles and 48 pin piles total). For monopiles, 10,846 hammer strikes would be required per pile. In the all monopile construction scenario, this would result in 404 non-contiguous hours of pile driving. Installation of pin piles require 13,191 hammer strikes per pile. A joint monopile/pin pile foundation scenario would result in 392 hours of pile driving for monopiles and 192 hours of pile driving for the pin piles.

During the installation of monopile foundations, Ocean Wind is proposing a 24-hour work window. Pile installation will occur during daylight hours and could, if Ocean Wind meets NMFS OPR's proposed requirements (see *Proposed Measures to Minimize and Monitor Effects of the Action* section), potentially occur during nighttime hours to: (1) allow for flexibility to initiate piles day or night from the start of construction to optimize use of specialty vessels and reduce overall time for construction offshore; (2) when a pile installation is started during daylight and, due to unforeseen circumstances, would need to be finished after dark; and, (3) for new piles, after dark initiation of pile driving is necessary to meet schedule requirements due to unforeseen delays. However, after dark initiation of pile driving would only be allowed if Ocean Wind submits a low visibility pile driving monitoring plan that BOEM, NMFS OPR, and NMFS GARFO approve. Such approval would only be provided if the plan supports a conclusion that the proposed monitoring would be as effective as the daytime monitoring protocol.

Cable Laying

Cable burial operations will occur both offshore for the inter-array cables, the substation interconnector cables, and the offshore export cables and onshore at the sea to shore transition locations. Ocean Wind would bury array cables, substation interconnector cables, and offshore export cables by jetting, vertical injection, control flow excavation, trenching, or plowing. Cable burial produces temporary and permanent disturbances to the seabed. Maximum seabed footprint is listed in Table 3.2.4. Prior to installation of the cables, a pre-lay grapnel run would be performed in all instances to locate and clear obstructions such as abandoned fishing gear and other marine debris. Following the pre-lay grapnel run, dredging within the WFA and along the offshore cable export corridor would occur (where necessary) to allow for effective cable laying through the sand waves. Controlled flow excavation (CFE) or a sandwave removal plow may also be used for sand wave clearance, and multiple passes may be required. The majority of dredging would occur on large sand waves, which are mobile features. An estimation of sand wave clearance volumes based on sand wave height, anticipated cable burial depth, likely installation technique, and required clearance area is listed in Table 3.2.4. Ocean Wind anticipates that dredging would occur on sand waves with an average height of 17 ft. (5.2 m) within a corridor that is 98 ft. (29.9 m) wide. In the event that cables cannot achieve proper burial depths or where the proposed offshore export cable crosses existing infrastructure, Ocean Wind is proposing to use the following protection methods: (1) rock placement, (2) concrete mattresses, (3) frond mattresses, (4) rock bags, or (5) seabed spacers. Ocean Wind conservatively estimated up to 10 percent of the inter-array, substation interconnection, and offshore export cables would require one of the protective measures.

Table 3.2.4. Maximum Design Parameters for Array Cables, Substation Interconnector Cables, and Offshore Export Cables Seabed Footprints.

Design Parameter	Maximum Design Parameters
INTER-ARRAY CABLES	
Full corridor width seabed disturbance (acres)	1,850[1]
Boulder clearance - seabed disturbance (acres)	2,220[2]
Sandwave clearance - seabed disturbance (acres)	220[6]
Sandwave clearance - material volume (cubic yards)	588,580[3]
Burial spoil: jetting/plowing/control flow excavation material volume (cubic yards)	2,354,000[4]
Cable protection area (acres)[5]	77
SUBSTATION INTERCONNECTOR CABLES	
Total seabed disturbed - full corridor width (acres)	185[1]
Seabed disturbed- boulder clearance (acres)	222[2]
Seabed disturbed- sandwave clearance (acres)	2[6]
Sandwave clearance volume (cubic yards)	58,860[3]
Burial spoil - jetting/plowing/control flow excavation volume (cubic yards)	235,000[4]
Cable protection area (acres)[5]	8
OFFSHORE EXPORT CABLE – OYSTER CREEK	
Full corridor width seabed disturbance (acres)	1,430[1]
Boulder clearance - seabed disturbance (acres)	1,710[2]
Sandwave clearance- seabed disturbance (acres)	17[6]
Sandwave clearance- material volume (cubic yards)	451,240[3]
Burial spoil: vertical injection material volume (cubic yards)	665,000[4]
Burial spoil: plowing/control flow excavation material volume (cubic yards)	1,805,000
Cable protection area (acres)[5]	70
Cable/pipe crossings: pre- and post-lay rock berm area (acres)	48
OFFSHORE EXPORT CABLE – BL ENGLAND	
Full corridor width seabed disturbance (acres)	320[1]
Boulder clearance - seabed disturbance (acres)	400[2]
Sandwave clearance- seabed disturbance (acres)	4[6]

Sandwave clearance- material volume (cubic yards)	100,060[3]
Burial spoil: vertical injection material volume (cubic yards)	148,000[4]
Burial spoil: plowing/control flow excavation material volume (cubic yards)	400,000
Cable protection area (acres)[5]	16
Cable/pipe crossings: pre- and post-lay rock berm area (acres)	12.6

[1]Assumes 82-foot wide corridor disturbed
[2]Assumes 98-foot wide corridor and 100% of route affected
[3]Assumes 98-foot wide corridor, 17-foot average height, and 1% of route affected
[4]Assumes 95% with shallow burial depth (4-6 ft.) and 5% with deep burial (33 ft.)
[5]Could be rock, mattress, frond mattress, rock bags, or seabed spacers as described in COP Volume 1, Section 6.1.2.6.3.
[6]Assumes 98-foot wide corridor and 1% of route affected

More information on cable laying associated with the proposed project is provided in COP Volume 1, Section 6.1.1 (Ocean Wind 2022).

Unexploded Ordnance/Munitions and Explosives of Concern (UXO/MEC)
Prior to seafloor preparation, cable routing, and micrositing of all assets, Ocean Wind will implement a UXO/MEC Risk Assessment with Risk Mitigation Strategy (RARMS) designed to evaluate and reduce risk in accordance with the As Low As Reasonably Practicable (ALARP) risk mitigation principle. The RARMS consists of a phased process beginning with a Desktop Study and Risk Assessment that identifies potential sources of UXO/MEC hazard based on charted UXO/MEC locations and historical activities, assesses the baseline (pre-mitigation) risk that UXO/MEC pose to the Project, and recommends a strategy to mitigate that risk to ALARP. Avoidance is proposed as the preferred approach for UXO/MEC mitigation; however, there may be instances where confirmed UXO/MEC avoidance is not possible due to layout restrictions, presence of archaeological resources, or other factors that preclude micrositing.

BOEM describes in the BA that during Project construction, once the ALARP standard has been achieved, the likelihood of UXO/MEC encounter is very low. Ocean Wind will work with BOEM to identify appropriate response actions, which may include developing an emergency response plan, conducting UXO/MEC specific safety briefings, or retaining an on-call UXO/MEC consultant. In such situations, confirmed UXO/MEC are proposed to be removed through physical relocation to another suitable location on the seabed within the WDA or previous designated disposal areas for wet storage using a "Lift and Shift" operation. Selection of a mitigation strategy will depend on the location, size, and condition of the confirmed UXO/MEC, and will be made in consultation with a UXO/MEC specialist and in coordination with the appropriate agencies. Safety measures such as the use of guard vessels, enforcement of safety zones, and others will be identified in coordination with a UXO/MEC specialist and the appropriate agencies and implemented as directed.

For the purposes of evaluating the risk of encountering unexploded ordnance (UXO) and munitions and explosives of concern (MEC), Ocean Wind conservatively assumed that up to 10 UXOs may have to be detonated in place. BOEM has included these activities in their BA and request for consultation; therefore, we are assessing the potential effects in this Opinion. As described in the BA, Ocean Wind indicates in the COP that no UXO detonations are planned between January 1 and April 30 (Ocean Wind 2022). In their BA, BOEM has proposed an extension of Ocean Wind's seasonal restriction so that no UXOs can be detonated from November 1 to April 30 in the offshore areas greater than three nautical miles from the coast. Therefore, no UXO detonations would take place between November 1 and April 30 in federal waters and January 1 to April 30 in state waters. Additionally, no UXOs would be detonated during nighttime hours (defined as 1.5 hours before civil sunset to one hour after civil sunrise). If UXO detonation were necessary, no more than one detonation would occur within a 24-hour period. Both low-order (deflagration) and high-order (detonation) methods would be considered in situations where UXOs cannot be physically relocated to another suitable location and are part of the action that BOEM requested consultation on. High-order detonation is conducted by exploding a donor charge placed adjacent to the UXO munition (Albright 2012, Aker *et al*. 2012, Sayle *et al*. 2009, Cooper and Cooke 2018, Robinson *et al*. 2020). Deflagration, a low-order detonation method, consists of a shape charge with insufficient shock to detonate, and with the explosive material inside the UXO reaching with a rapid burning rather than a chain reaction that would lead to a full explosion (ESTCP 2002, Robinson *et al*. 2020, Lepper, pers. comm. 2022).

Construction-Related Vessel Activity
As described in the BA, the most intense period of vessel traffic would occur during the construction phase when wind turbine foundations, inter-array cables, and WTGs are installed in parallel. Ocean Wind estimates that construction would involve approximately 20 to 65 vessels of various classes operating in the WDA at any given time (COP Volume 1, Section 6.1.2.6.5; Volume 3, NSRA, Section 5; Ocean Wind 2021). Many of these vessels could remain in the project area for days or weeks at a time, potentially making only infrequent trips to port for bunkering and provisioning, as needed. The maximum number of vessels involved in the proposed project at one time is highly dependent on the Project's final schedule, the final design of the Project's components, and the logistics solution used to achieve compliance with the Jones Act. The Jones Act requires project components that move between U.S. ports be transported on Jones Act compliant, U.S.-flagged vessels. The number of vessel trips from outside the U.S. and their ports of origin would not be fully known until contractors are selected and supply chains are established; however, BOEM has estimated that up to 200 round trips are likely to occur. This Opinion considers Ocean Wind's current assumptions that vessel trips would originate from ports in Atlantic City, New Jersey; Paulsboro, New Jersey; Norfolk, Virginia; Hope Creek, New Jersey; Port Elizabeth, New Jersey; Charleston, South Carolina; or Europe.

Probable vessel classes used to construct the offshore infrastructure include primary installation vessels (e.g., jack-up vessels, jack-up barges (towed by tugs), sheerleg barges (either self-propelled or towed by tugs), Heavy-Lift Vessels), material transport barges, feeder barges, and support vessels (Table 3.2.5). A rock-dumping fallpipe vessel or a side stone dumping vessel would be used to place scour protection, and up to three main cable-laying vessels and three cable-burial vessels would be used to place the inter-array cables and the substation interconnection cables. Main cable-laying vessels, jointing vessels, and burial vessels would be used to place the offshore export cables (see Table 3.2.5). Transport vessels would be used to rotate construction crews to and from area ports. Small support vessels would be used for construction monitoring. When considering the number of construction vessels and trips per activity (Table 3.2.5) in terms of when and the duration the construction activity would be expected to occur and if equal distribution of trips occurs across each quarter, vessel activity would be spread out as shown in Table 3.2.6. Materials for construction may be transported from ports outside the WDA, including Port Elizabeth, New Jersey; Charleston, South Carolina; or Europe. This analysis assumes trips could originate from ports in Europe because many offshore wind components are currently manufactured there. The values provided in Tables 3.2.5 and 3.2.6 are based on Ocean Wind's current assumptions and are subject to change based on unforeseen circumstances. Currently, most industry-specific vessels are located in Europe but as the industry matures in the United States, fewer trips from Europe will be necessary

BOEM indicates that the following ports may be used for fabrication, assembly, or deployment activities for the Wind Farm Area: Paulsboro, New Jersey; Norfolk, Virginia; Hope Creek, New Jersey; Charleston, South Carolina; therefore, vessel transits from these ports may occur as a result of the Project (Table 3.2.5).

Table 3.2.5 Estimated Total Number of Vessels and Trips for Construction Activities (source: BOEM 2022)

Primary Port	Purpose	Total Number of Vessels	Total Number of Trips
Atlantic City, New Jersey	Construction Management – All CTVs	134	2,259
Paulsboro, New Jersey	Foundation Scope	5	149
OR Europe		5	149
Norfolk, Virginia	WTG Scope	2	99
OR Hope Creek, New Jersey		2	99
Port Elizabeth, New Jersey	Cable Staging	15	346
OR Charleston, South Carolina		15	346
OR Europe		15	346

Source: Ocean Wind 2022.

Table 3.2.6. Construction Vessel Summary

Vessel Type	Maximum Number of Simultaneous (at any one time) Vessels Required in the Project Area[a]	Maximum Number of Round Trips per Vessel Type	Approximate Vessel Draft (meters)[b]	Average/Normal Operating Speed (knots)
WTG FOUNDATION INSTALLATION				
Scour Protection Vessel	1	50	8	6.5
Installation Vessel	4	99	13.5	10

Vessel Type	Maximum Number of Simultaneous (at any one time) Vessels Required in the Project Area[a]	Maximum Number of Round Trips per Vessel Type	Approximate Vessel Draft (meters)[b]	Average/Normal Operating Speed (knots)
Support Vessels	16	396	CTV: 3 SOV: 7.5 Noise Mitigation & monitoring vessel: 7	23
Material Transport/Feeder Vessels (including tugs)	40	396	7	4
- of which are anchored	2	198		
WTG STRUCTURE INSTALLATION				
Installation Vessels	2	99	6.5	10
Material Transport/Feeder Vessels	12	99	6.5	4
Other Support Vessels	24	594	7	23
SUBSTATION INSTALLATION[c]				
Primary Installation Vessels	2	12	13.5	10
Support Vessels	12	72	7	23
Material Transport Vessels	4	24	6	4
ARRAY CABLE INSTALLATION[d]				
Main Laying Vessels	3	99	5	2.4
Main Burial Vessels	3	99	5	2.4
Support Vessels	12	594	7	23
SUBSTATION INTER-LINK CABLE INSTALLATION[e]				
Main Laying Vessels	Included in numbers for export and array cables	8	5	2.4
Main Burial Vessels		8	5	2.4
Support Vessels		12	7	23
OFFSHORE EXPORT CABLE INSTALLATION[f]				
Main Laying Vessels	3	48	5	2.4

Vessel Type	Maximum Number of Simultaneous (at any one time) Vessels Required in the Project Area[a]	Maximum Number of Round Trips per Vessel Type	Approximate Vessel Draft (meters)[b]	Average/Normal Operating Speed (knots)
Main Cable Joining Vessels	3	36	6.5	2.4
Main Burial Vessels	3	48	5	2.4
Support Vessels	15	72	7	23
FEDERAL CHANNEL DREDGING				
Dredging	1	1	<2.4	4
Scow/Barge/Tug	2	4	<2.4	4

[a] "Simultaneous" refers to the number of vessels needed for an activity and indicates that the vessels would be required at the same time for the duration of the activity.
[b] "Vessel draft" is approximate and represents a conservative value that is subject to change.
[c] Substation installation is anticipated to occur over a maximum duration of 67 days.
[d] Array cable installation is anticipated to occur over a maximum duration of 12 months. The installation of each cable section is anticipated to occur over 3.5 days.
[e] Substation inter-link cable installation is anticipated to occur over a maximum duration of 1 month. The installation of each cable section is anticipated to occur over 20 days.
[f] Offshore export cable installation is anticipated to occur over a maximum duration of 6 months. The installation of each cable section is anticipated to occur over 59 days.
CTV = crew transfer vessel; SOV = surface operation vessel; WTG = wind turbine generator
Source: BOEM Ocean Wind 1 BA (2022)

Table 3.2.7. Construction Vessel Numbers and Trip Distribution per Quarter and Activity

Activity	2023				2024				2025			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
WTG Foundation Installation						61/314	61/314	61/313				
WTG Structure Installation							38/132	38/132	38/132	38/132	38/132	38/132
Substation Installation							18/18	18/18	18/18	18/18	18/18	18/18
Array Cable Installation							18/264	18/264	18/264			
Substation Cable Installation					NA/10	NA/9	NA/9					
Offshore Export Cable				12/34	12/34	12/34	12/34	12/34	12/34			
Dredging				1/1								
Scow/Barge/Tug				2/4								
Total	00/00	00/00	00/00	15/39	12/40	73/354	147/768	147/762	86/448	56/150	56/150	56/150

Note: Vessel and trip numbers are represented in each cell with the top number denoting the estimated maximum number of vessels used for that particular construction activity separated with a "/" from the bottom number denoting the estimated maximum number of vessel trips for that particular construction activity.
N/A = not applicable; Q = quarter; WTG = wind turbine generator
Source: BOEM Ocean Wind 1 BA (2022)

3.2.3 Construction - Federal Channel Dredging and HDD in-water Exit Pits

The transition of the export cables from offshore to onshore would be accomplished by horizontal directional drilling (HDD) or open cut trenching, which would bring the proposed cables beneath nearshore areas, the tidal zone, beach, adjoining coastal areas to the proposed landfall sites. Ocean Wind has proposed HDD at four potential shoreline locations:

1. Island Beach State Park Atlantic Ocean (Atlantic Ocean to Island Beach State Park; sea-to-shore); and
2. Island Beach State Park Barnegat Bay (Island Beach State Park to Barnegat Bay; shore-to-bay; southern route option); and
3. Lacey and Ocean Township (Barnegat Bay to Oyster Creek; bay-to-shore); and
4. Ocean City (Atlantic Ocean to BL England; sea-to-shore).

While HDD is under evaluation at the Farm Property landfall (bayside of Oyster Creek; bay-to-shore) on the east side of Barnegat Bay, unfavorable soil conditions identified at this landfall location present significant risks to the HDD construction method associated with managing and controlling drilling fluids. Given the risks associated with the site soils, an open cut solution is also being evaluated at this location. Ocean Wind has proposed open cut trenching at the Island Beach State Park Barnegat Bay (Island Beach State Park to Barnegat bay; shore-to-bay; prior channel/northern route). Open cut installation entails excavation of a trench using a land-based or barge-mounted excavator, positioning and securing the cable, burial and backfill to restore pre-existing contours, and revegetation.

The HDD process will be supported by a marine spread, which includes an offshore work platform and support vessels. Dredging may be required in shallow areas in Barnegat Bay to allow vessel access for the HDD marine construction spread west of Island Beach State Park (Berkley Township) as well as near the landfall at Lacey or Ocean Township. If dredging is determined to be necessary, Ocean Wind will dredge Barnegat Inlet and the Oyster Creek Channel within the authorized width and depth according to USACE Guidelines (i.e., not to exceed the authorized depths (8 to 10 feet) and widths (200 to 300 feet) of the relevant channel section). A hydraulic cutterhead or closed-clamshell bucket dredge would be used to dredge approximately 18,000 cubic yards within a 3.7-acre area. Dredged material would be transferred to an upland disposal facility via a pipeline system, barge, or scow and disposed of in accordance with EPA Guidelines, USACE Guidelines, N.J.A.C. 7:7 Appendix G for the Management and Regulation of Dredging Activities and Dredged Material in New Jersey's Tidal Waters, and applicable State Surface Water Quality Standards at N.J.A.C. 7:9B and permit conditions.

Where a trenchless solution has been identified for a specific landfall location, the offshore export cable would be pulled into a dedicated high-density polyethylene (HDPE) conduit previously installed using HDD construction methods. Onshore, the export cable would then be routed into an underground transition junction bay (TJB) located in proximity to each specific landfall site. Each HDD installation will consist of completing the pilot bore, reaming the bore to its final diameter (in one or more passes), performing a swab pass to gauge the condition of the bore, and ending with the installation of the HDPE conduit. To facilitate management and control of drilling fluids, a small exit pit, trench box, or cofferdam may be used at the offshore exit location. All activities in the vicinity of the exit pit would be completed with the use of marine vessels. Dredging would be required at the HDD exit pit at the Oyster Creek landfall site, on the west and east sides of Island Beach State Park, and at the HDD exit pit for the BL England landfall site. HDD exit pit excavation would involve using a mechanical clamshell dredge to remove of up to 0.4 acres (164 ft. x 98 ft.) of sediment to a depth of 15 ft.

Ocean Wind may install temporary sheet piled cofferdams into the seafloor at the HDD exit sites and may install temporary sheet piling for shoreline stabilization in the event an open cut is used. Cofferdams would be installed using a vibratory hammer to drive AZ-type sheet piles into the seafloor or a gravity cell structure placed on the seafloor using ballast water. Assuming the use of sheet pile structures, cofferdam installation is anticipated to take up to 18 hours over 2 days, with vibratory driving taking place for no longer than 12 hours each day over the installation period. Mitigation measures proposed for pile driving are described in Table 3.3.1. Temporary cofferdams would be removed upon completion of the HDD and subsequent cable installation. Removal of the cofferdam will be accomplished using a vibratory extractor and is expected to take up to 18 hours over 2 days, with no more than 12 hours of vibratory removal each day. Cofferdam installation/removal will take place only during daylight hours.

Onshore Facilities

Onshore infrastructure would consist of a buried onshore export cable system, substations, and a buried connection to the existing electrical grid at each interconnection point. Ocean Wind has proposed two offshore export cable route corridors: Oyster Creek and BL England. The inshore export cable route corridor to Oyster Creek would exit the bay side of the Island Beach State Park and cross Barnegat Bay Southwest to make landfall near Oyster Creek in either Lacey or Ocean Township. The BL England offshore export cable route corridor would make landfall in Ocean City, New Jersey. See COP Volume 1, Section 5.1.3 for a detailed description of the proposed landfall sites (Ocean Wind 2021).

The transition of export cables from offshore to onshore would be accomplished by HDD or open cut trenching and would require connections at underground transition junction bays (TJBs) at the Oyster Creek and BL England landfall sites. Underground TJBs would be accessible after construction via a manhole. Inside the TJBs, each three-core offshore export cable would be separated and spliced into three separate single-core cables. Each of these single-core cables comprise a single circuit of the onshore transmission cable system. From the TJBs, the transmission cable system would be contained within an underground duct bank to the proposed onshore substations. The onshore cable route to reach the BL England substation would traverse upland road right-of-way (ROW) of existing roadways, but may also affect adjacent tidal wetlands. At Oyster Creek, several export cable routes are under consideration, which potentially traverse tidal wetlands. Further discussion of the proposed landfall site construction approach is provided in COP Volume 1, Section 6.2.2.1 (Ocean Wind 2022).

The proposed onshore export cables would terminate at the proposed substation sites. These previously developed sites are adjacent to existing substations on parcels zoned for commercial and industrial use, where power would be transmitted to the electrical grid.

Detailed specifications of the onshore export cable are provided in COP Volume 1, Section 6.2.1.1. Further discussion of the proposed onshore export cable construction approach is provided in COP Volume 1, Section 6.2.2.3 (Ocean Wind 2022).

3.2.4 Operations and Maintenance
Ocean Wind's lease with BOEM (Lease OCS-A 0498) has an operations term of 25 years that would commence on the date of COP approval. Ocean Wind would have to apply for an extension if it wished to operate the proposed Project for more than 25 years. This consultation considers operation of the proposed Project for the 35-year designed life span as this is the timeframe that BOEM requested consultation on as part of its proposed action. Ocean Wind would remotely monitor and operate the wind farm infrastructure and offshore export cables 24-hour a day / seven days a week from an onshore facility in Atlantic City, New Jersey, sited at the location of a retired marine terminal. Monitoring would include regular inspections, tests, and repairs, as well as periodic review of anomalies in cable charging current, power factor, and protection devices.

Regular maintenance typically consists of routine inspections and preventative maintenance activities. These activities would require the use of a variety of vessels to support operations and maintenance (O&M) including CTVs, service operation vessels, jack-up vessels, and supply vessels. Ocean Wind anticipates that in a year, the proposed Project would generate a maximum of 908 crew vessel trips, 102 jack-up vessel trips, and 104 supply vessel trips; and a maximum of 2,278 CTV trips or service operations vessel trips (Table 3.2.7, Ocean Wind 2022).

As indicated in the COP and BA, Ocean Wind is developing a cable monitoring and maintenance plan that will be included in the Facility Design Report and reviewed by the Certified Verification Agent. Additional operations and maintenance information can be found in COP Section 6.1.3 (Ocean Wind 2022).

Table 3.2.7. Operations and Maintenance Phase Annual Vessel Trip Summary

Homeport	Approx. Distance to Project (nautical miles)	Vessel Type	Number of Expected Trips per year	Approximate Vessel Draft (meters)[a]	Average/ Normal Operating Speed (knots)
Atlantic City	24.4	CTV	908	3	23
Atlantic City	24.4	Jack-Up	102	5	10
Atlantic City	24.4	Supply Vessel	104	7	11
Atlantic City	24.4	CTV/Service Operations	2,278	CTV: 3 SOV: 7	23

[a] Vessel draft is approximate and represents a conservative value that is subject to change. CTV = crew transfer vessel; SOV = surface operation vessel
Source: BOEM Ocean Wind 1 BA (2022)

3.2.5 Decommissioning

Project components would be decommissioned when these facilities reach the end of their designed service life; here, we consider decommissioning following the 35-year operations period. Ocean Wind's COP (Ocean Wind 2022) describes a conceptual decommissioning plan. The same types of vessels and equipment used during construction would be employed for decommissioning. According to 30 CFR § 285.902[10] and other BSEE requirements, Ocean Wind would be required to remove or decommission all installations and clear the seabed of all obstructions (and marine debris) created by the proposed Project. All facilities would need to be removed 15 feet (4.6 meters) below the mudline (BML; 30 CFR § 285.910(a)). Absent permission from BSEE, Ocean Wind would have to complete decommissioning within two years of termination of the lease and either reuse, recycle, or responsibly dispose of all materials removed.

Offshore cables would be retired in place, removed, or a combination of both. Removal of the array cables would be accomplished using controlled-flow excavation or a grapnel to lift the cables from the seabed. Ocean Wind has stated that the dismantling and removal of OSS topside structures and WTG components (e.g., blades, nacelles, and towers) would be a "reverse installation" process subject to the same constraints as the original construction phase. A jack-up or heavy lift dynamic positioning vessel would be used to dismantle turbine components and OSS topside structures. Foundations would be temporarily emptied of sediment and cut 15 feet

[10] On January 31, 2023, the Department of Interior published a final rule in the Federal Register (88 FR6376) reassigning regulations pertinent to safety and environmental oversight of OCS renewable energy activities from BOEM's oversight in the 30 CFR part 585 part to 30 CFR part 285. These include decommissioning facilities authorized within a lease (§285.900 et seq.)

(4.6 meters) BML. Ocean Wind will base cutting depth on seabed conditions (e.g., dynamics and site characteristics) and developing industry best practices. The portion buried below 15 feet (4.6 meters) or final cutting depth would remain, and the depression would be refilled with the sediment that had been temporarily removed. Cutting would be accomplished using mechanical cutting, water jet cutting, or other common industry practices. In consideration of marine life that may have established itself on the substrate, Ocean Wind has stated that scour protection place around the base of each monopile would be left in place.

A cable-laying vessel would be used to remove as much of the inter-array and export transmission cables from the seabed as practicable to recover and recycle valuable metals. A material barge would transport components to a recycling yard where the components would be disassembled and prepared for re-use and/or recycling for scrap metal and other materials. Cable segments that cannot be easily recovered would be left buried below the seabed or rock armoring, contingent upon approval from BOEM for abandonment-in-place (AIP). However, requests for AIP will require substantial justification/review and final disposition may include removal of all cable segments. Site clearance of the sea bottom will be required following removal of the structure pursuant to 30 C.F.R. 285.902(a) (2). Site clearance verification (SCV) procedures are expected to include side-scan or sector-scanning sonar and visual surveys using ROV camera surveys. All vessel strike avoidance measures would be required for vessel operations associated with decommissioning and SCV. Site-clearance verification using high-resolution side scan sonar equipment would most likely operate at frequencies above the hearing ranges of all listed species (greater than 180 kilohertz [kHz]). BOEM has estimated that 120 vessel trips (round trip) are anticipated during the decommissioning phase.

Decommissioning is intended to recover valuable recyclable materials, including steel piles, turbines and related control equipment, and the copper transmission lines, as well as remove debris and any other seafloor obstructions created by activities on the lease. The decommissioning process involves the same types of equipment and procedures used during the construction phase, aside from pile driving, and would have similar impacts on the environment.

As detailed in 30 CFR §585.902(b), the lessee must submit an application and receive approval from BOEM before commencing with the decommissioning process. Final approval of this application is a separate process from approval of the conceptual decommissioning methodology in the COP. By maintaining an inventory list of all components of the proposed Project, the decommissioning team would be able to track each piece so that no component would be lost or forgotten. The above decommissioning plans are subject to a separate approval process under BSEE. This process will include an opportunity for public comment and consultation with municipal, state, and federal management agencies. Ocean Wind would require separate and subsequent approval from BOEM to retire any portion of the project facilities in place. Inventory lists and component tracking will be assessed during the process; however, BSEE regulations[11] default to clearing the seafloor of all obstructions created by activities on the lease through the implementation of SCV requirements as part of decommission application conditions[12] to ensure that any items inadvertently lost and not retrieved during lease operations

[11] 30 CFR 285.902(a)(2)

[12] 30 CFR 285.907(d)

can be detected and retrieved to reduce conflicts with other OCS users and return the site to prelease conditions.

3.2.6 Pre and Post-Construction Survey Activities

Ocean Wind is proposing to carry out or BOEM is proposing to require that Ocean Wind carry out a number of ecological surveys/monitoring activities as conditions of COP approval. These activities are described in the BA and are part of the proposed action that BOEM has requested consultation on and are summarized here.

3.2.6.1 High-Resolution Geophysical Surveys

As described in the BA, high-resolution geophysical (HRG) surveys will be carried out before, during, and after construction and during decommissioning. Survey activities would include multibeam depth sounding, seafloor imaging, and shallow and medium penetration sub-bottom profiling within the Wind Farm Area and along the two export cable routes. Although the final survey plans would not be completed until construction contracting commences, Ocean Wind anticipates that survey activities would be conducted 24 hours a day with an average daily distance of 435 miles (70 km) per day at 4 knots (kn) (2.1 meters per sec [m/s]). During Years 1, 4, and 5 (the pre- and post-construction years), HRG surveys are anticipated to operate during any month of the year for a maximum of 88 days annually (47.5 survey days for the Wind Farm Area and 40.5 survey days for the two offshore export cables) for a total of 3,797 miles (6,110 km) per year. During Years 2 and 3 (the during construction years), HRG surveys are anticipated to operate during any month of the year for a maximum of 180 days annually for a total of 15,699 miles (25,265 km) per year. Geotechnical surveys for engineering purposes and to resolve adverse effects to archaeological resources would take place prior to construction. No geotechnical surveys are planned for the construction or post-construction phases.

HRG equipment will either be deployed from ROVs or mounted to or towed behind the survey vessel at a typical survey speed of approximately 4.0 knots (7.4 km). Up to three vessels may survey concurrently throughout the project area. As described in the notice of proposed ITA, the geophysical survey activities proposed by Ocean Wind would include the following:

- Shallow-penetration non-impulsive, non-Parametric SBPs (compressed high-intensity radiated pulses (CHIRP SBPs)) are used to map the near-surface stratigraphy (top 0 to 5 m (0 to 16 ft.)) of sediment below the seabed. A CHIRP system emits sonar pulses that increase in frequency sweep from approximately 2 to 20 kHz over time. The pulse length frequency range can be adjusted to meet Project variables. These shallow penetration SPBs are typically mounted on a pole, rather than towed, either over the side of the vessel or through a moon pool in the bottom of the hull, reducing the likelihood that an animal would be exposed to the signal.
- Medium penetration SBPs (Boomers) to map deeper subsurface stratigraphy as needed. A boomer is a broadband sound source operating in the 3.5 Hz to 10 kHz frequency range. This system is typically mounted on a sled and towed behind the vessel.
- Medium penetration SBPs (Sparkers) to map deeper subsurface stratigraphy as needed. A sparker creates acoustic pulses from 50 Hz to 4 kHz omni-directionally from the source that can penetrate several hundred meters into the seafloor. These are typically towed behind the vessel with adjacent hydrophone arrays to receive the return signals.
- Multibeam echosounder (MBES) to determine water depths and general bottom

topography. MBES sonar systems project sonar pulses in several angled beams from a transducer mounted to a ship's hull. The beams radiate out from the transducer in a fan-shaped pattern orthogonally to the ship's direction.
- Seafloor imaging (sidescan sonar) for seabed sediment classification purposes, to identify natural and man-made acoustic targets resting on the bottom as well as any anomalous features. The sonar device emits conical or fan-shaped pulses down toward the seafloor in multiple beams at a wide angle, perpendicular to the path of the sensor through the water. The acoustic return of the pulses is recorded in a series of cross-track slices, which can be joined to form an image of the sea bottom within the swath of the beam. They are typically towed beside or behind the vessel or from an autonomous vehicle.

3.2.6.2 Benthic Resource Monitoring

Monitoring of soft bottom habitats will focus on measuring physical changes and indicators of benthic function (bioturbation and utilization of organic deposits, Simone and Grant 2020) as a proxy for measuring changes in the community composition. Monitoring of novel hard bottom habitats will focus on measuring changes in macrofaunal-attached communities (native vs. non-native species groups), percent cover, and physical characteristics (rugosity, boulder density) as a proxy for measuring changes in the complex food web.

A ROV video survey is planned to monitor novel hard bottom habitats associated with WTGs and cable protection. High-resolution video imagery at WTGs/OSS foundations, scour protection layers, and cable protection layers will be processed and analyzed using photogrammetry methodologies that generate spatial models from static images. As described in the proposed Benthic Monitoring Plan, Ocean Wind has identified three benthic habitat types along the export cables (sand and muddy sand; coarse sediment; and sandy mud) and two benthic habitat types within the Wind Farm Area (sand and muddy sand; and coarse sediment) (Inspire 2022a in Ocean Wind 2022). Three WTG locations and three cable protection areas will be randomly selected for monitoring within each habitat type. One of the three OSS foundations will be selected for benthic monitoring.

Soft bottom habitats associated with cables and sand ridges will be randomly selected for monitoring at segments along the export cables and the inter-array cable. Soft bottom monitoring will be conducted within the project area with a Sediment Profile and Plan View Imaging (SPI/PV) system. SPI/PV provides an integrated, multi- dimensional view of the benthic and geological condition of seafloor sediments and will support characterization of the function of the benthic habitat and physical changes that result from construction and operation of Ocean Wind 1 Wind Farm.

A Before-After-Gradient (BAG) survey design will be used to determine the spatial scale of potential impacts on soft bottom benthic habitats and biological communities associated with WTGs and cables. Benthic surveys conducted six months prior to the start of construction activity will be used to represent soft bottom associated with WTGs and sand ridges prior to potential disturbance. Monitoring of soft bottom habitats will use the same wind structure foundations selected for the novel hard bottom monitoring survey. Data on the mean currents near the Wind Farm Area will be used to establish up current and down current transects extending from each selected WTG foundation.

Subsequent surveys will be conducted in late summer post-construction (Year 0) and in the same seasonal time frame of Years 1,2,3, and 5 after construction is completed. The SPI/PV surveys will be conducted in the Wind Farm Area using fixed stations to assess the spatial scale and extent of wind farm effects on benthic habitat over time. The surveys will be conducted from research vessel(s) with scientists onboard to collect images utilizing a SPI/PV camera system. Collecting seafloor imagery does not require disturbance of the seafloor or collection of physical samples.

3.2.6.3 Fisheries Resource Surveys and Monitoring
Ocean Wind will implement a Fisheries Monitoring Plan (Ocean Wind 2022) that includes trawl surveys, environmental DNA (eDNA) sampling, structure-associated fishes surveys, clam surveys, pelagic fish surveys, and acoustic telemetry monitoring. As described in the Plan, the overarching objective is to assess fisheries status in the project area and a nearby control site throughout the pre-construction, construction, and post-construction phases.

Trawl Surveys
Ocean Wind will conduct trawl surveys once per season, or four times per year (April, July, late September or early October, and January) beginning in 2023 and 2024 during pre-construction and construction phases and continue for two years post-construction in 2025 and 2026. Trawl surveys will occur aboard the F/V Darana R to assess the finfish community in the Ocean Wind WDA and adjacent control area. The surveys will be conducted using the same equipment and methods as the NEFSC trawl surveys. During a trawl survey event, 20 tows will be conducted in the project area and additional 20 tows will occur in the control area.

Tows will be conducted during daylight hours (after sunrise and before sunset) for 20 minutes each at a speed of 2.9 to 3.3 knots (1.5 to 1.7 m/s). Tows will be completed using 158- by 5 inch (400- by 12 cm), three-bridle four-seam bottom trawl with Thyboron, Type IV 66-inch (168-cm) doors and a 1-inch (2.5 cm) knotless codend. Transits for the F/V Darana R from its homeport in Wanchese, North Carolina, to the project area will be approximately 493 miles (428 nm, 793 km) round trip for each seasonal survey.

Structure-Associated Fishes Surveys
The multi-method survey for structure-associated fish will be conducted concurrently with the trawl survey; however, surveys will occur aboard the F/V Dana Christine II. The structure-associated fisheries surveys will collect data on the distribution, abundance, and composition of fishes in the Ocean Wind 1 WDA and an adjacent control area. Multi-method sampling approaches include chevron traps, rod-and-reel fishing, and baited remote underwater video (BRUV). A total of 24 separate survey events will occur over six years (i.e., four surveys per year). Sampling dates will occur in January, April, July, and late September or early October. Ocean Wind expects 12 to 15 locations to be sampled over three days using each of the three survey methods.

Each location, inside the project area, as well as at a nearby control site, will consist of six baited chevron traps spaced 656 feet (200 meters) apart. Each trap will have a vertical buoy line and soak for 90 minutes. After the fishing vessel anchors, the BRUV method will occur concurrently at the same location as the chevron traps. BRUVs will use a weighted line attached to surface and subsurface buoys that will hold a stereo-camera system in the water column and a system at the seafloor. BRUVs will be deployed at each site for 60 minutes. Rod-and-reel sampling will be conducted at the same time as the chevron trap and BRUV deployments. At each sampling location, four to five anglers will complete four to five 3-minute timed fishing “drops” from the stern of the vessel using a terminal tackle with baited hooks. Ocean Wind expects a total of 16 to 25 drops at each location. Transits for the F/V Dana Christine II from its homeport in Barnegat Light, New Jersey to the project area will be approximately 104 miles (90 nm, 167 km) roundtrip for each seasonal survey.

Clam, Oceanography, and Pelagic Fishes Surveys
The clam survey will collect data on quahog and surfclam resources in the project area and in two control areas in August during the pre-construction and construction phases and continue for two years post-construction. The clam survey will be conducted over a 2-day cruise using a towed, modified sampling dredge that will be pulled by the F/V Joey D. During a clam survey event, sampling will occur at 10 stations at each of the two control areas. Ocean Wind anticipates up to 50 tows annually. Tows will be conducted for 2 minutes at a speed of 3 knots (1.5 m/s). Although target tow duration may be modified following the first sampling trip, Ocean Wind anticipates that each survey trip will consist of 40 minutes of dredging (i.e., 20 minutes in the project area and 10 minutes at each of the control areas). Transits for the F/V Joey D from its homeport in Atlantic City, New Jersey, will be approximately 51 miles (44 nm, 81 km) roundtrip for each annual survey.

Oceanographic surveys will be conducted to study conditions in the WDA. Gliders will be deployed to collect data on ocean temperature, ocean salinity, ocean density, ocean currents, and the observed distribution of primary producers. One glider deployment will occur during each of the three Project phases: Pre-construction, construction, and post-construction. Glider deployment will occur in October and span 3 to 4 weeks. These deployments will coincide with one of the other vessel-based surveys.

The pelagic fish survey will focus on the habitat use of larger more mobile pelagic species that will not be well sampled using a trawl. Survey approaches for the pelagic fish survey include towed BRUVs and the deployment of autonomous gliders equipped with echosounders. Survey methods associated with the pelagic fish survey will occur while all survey vessels of opportunity (e.g., trawl survey vessel, clam survey vessel, glider deployment vessel, and structure-associated habitat survey vessel) are underway. The pelagic fish survey will not result in additional vessel traffic.

Acoustic Telemetry Monitoring Surveys
The acoustic telemetry survey will be conducted in the Ocean Wind 1 WDA and in adjacent inshore areas. Acoustic telemetry surveys will consist of fish tagging efforts during bottom trawl and multi-method sampling. To assess the movements of summer flounder, black sea bass, smooth dogfish, horseshoe crabs, and clearnose skate, acoustic telemetry surveys will use a combination of fixed station receivers and active mobile telemetry via an omnidirectional hydrophone. Surveys will occur four times annually aboard the Research Vessel (R/V) Resilience. Although transits for the R/V Resilience are unclear, Ocean Wind anticipates that a boat ramp from Ocean City or Atlantic City, New Jersey will be selected as a departure location.

Based on this assumption, transits for the R/V Resilience will be approximately 48 to 53 miles (42 to 46 nm, 78 to 85 km) roundtrip for each survey event.

3.2.6.4 Passive Acoustic Monitoring
Moored Passive Acoustic Monitoring (PAM) systems or autonomous PAM platforms such as gliders or autonomous surface vehicles will be used periodically over the lifetime of the project. PAM will be used to record ambient noise and marine mammal vocalizations in the project area before, during, and after construction to monitor project impacts relating to vessel noise, pile driving noise, UXO detonations, HRG surveys, WTG operational noise, and to document whale detections in the WDA.

3.2.6.5 Submerged Aquatic Vegetation Monitoring
As described in the SAV Monitoring Plan (Inspire 2022), the objective of pre-construction and post-construction surveys is to further characterize baseline SAV conditions and any potential impacts to SAV beds associated with cable installation activities. Pre-construction survey approaches will include pre-construction SAV mapping and pre-construction SAV characterization.

The pre-construction mapping survey will use a combination of drop video, towed video, and visual observations by a person wading in the water to estimate SAV bed and SAV habitat acreage and delineation within the project area as well as the percent cover and species composition of the observed SAV. The mapping survey will be conducted during the SAV growing season (late April-October) on a small vessel capable of transiting through waters as shallow as 2 feet. The pre-construction SAV characterization survey will occur after the SAV mapping survey and be completed during the SAV growing season within six months of the start of cable installation activities. The pre-construction SAV characterization survey will use a systematic transect design to assess percent cover, shoot density, and/or biomass in the area of potential affect and in adjacent control areas. Transects will be positioned perpendicular to the open trench cable route and perpendicular to the HDD exit location (i.e., at the landfall on the western side of Barnegat Bay). The post-construction SAV characterization survey will follow the same survey design used in the pre-construction survey. A BAG survey design will be used to assess the spatial scale and extent of impacts associated with cable installation activities (i.e., resuspension and sedimentation). Post-construction sampling will occur systematically along predetermined transects and in adjacent control areas immediately following construction during the SAV growing season and annually for three years following construction during the same month of the year during SAV growing season.

3.2.7 MMPA Incidental Take Authorization (ITA) Proposed for Issuance by NMFS
In response to their application, the NMFS Office of Protected Resources (OPR) has proposed to issue Ocean Wind an ITA for the take of small numbers of marine mammals incidental to construction of the Ocean Wind 1 Project with a proposed duration of five years. More information on the proposed Incidental Take Regulation (ITR) and associated Letter of Authorization (LOA), including Ocean Wind's application is available online (*https://www.fisheries.noaa.gov/action/incidental-take-authorization-ocean-wind-lcc-construction-ocean-wind-1-wind-energy-facility*). As described in the Notice of Proposed Rule (87 FR 64868; October 26, 2022), take of marine mammals may occur incidental to the

construction of the project due to in-water noise exposure resulting from impact pile driving activities associated with installation of WTG and OSS foundations, vibratory pile driving associated with the installation and removal of temporary cofferdams nearshore, HRG surveys of the inter-array cable and export cable construction areas, and potential detonations of UXOs.

3.2.7.1 Amount of Take Proposed for Authorization

The proposed ITA would be effective for a period of five years, and, if issued as proposed, would authorize harassment as the only type of take expected to result from activities during the construction phase of the project. Section 3(18) of the Marine Mammal Protection Act defines ‘‘harassment’’ as any act of pursuit, torment, or annoyance, which (i) has the potential to injure a marine mammal or marine mammal stock in the wild (Level A harassment); or (ii) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering (Level B harassment). It is important to note that the MMPA definition of harassment is not the same as the ESA definition. This issue is discussed in further detail in the *Effects of the Action* section of this Opinion.

The proposed ITA would authorize the take, by Level A and Level B harassment, of some species of ESA listed marine mammals. MMPA authorized take for this Project would primarily be by Level B harassment resulting from continuous, intermittent, and impulsive exposure to noise from pile driving, site characterization surveys, and UXO detonations. NMFS OPR predicts that marine mammals are likely to be behaviorally harassed in a manner consistent with Level B harassment when exposed to underwater anthropogenic noise above received levels of 120 dB re 1 mPa (rms) for continuous sources (e.g., vibratory pile driving) and 160 dB re 1 mPa (rms) for impulsive and/or intermittent sources (*e.g.,* impact pile driving). For some species, NMFS OPR predicts that there is also some potential for auditory injury (Level A harassment) from exposure to some activities considered here.

Installation of Monopiles and Pin Piles with Impact Hammer

As described in the Notice of Proposed ITA, modeling has been completed to estimate the sound fields associated with a number of noise producing activities and to estimate the number of individuals likely to be exposed to noise above identified thresholds. Table 3.2.8 show the proposed Level A and Level B take to be authorized resulting from impact pile driving for the full monopile scenario (WTG and OSS) and joint foundation approach (WTGs use monopiles; OSSs use jackets with pin piles) assuming 10 dB attenuation (as required by conditions of the proposed ITA).

Table 3.2.8. Level A and B Harassment Take Proposed for Authorization through the MMPA ITA Resulting from Impact Pile Driving Associated with the Monopile and Pin Pile Options for three OSSs

Species	Three 8/11-m Monopile Foundation Scenario		48 2.44-m Pin Pile (Jacket Foundation) Scenario	
	Level A Harassment	Level B Harassment	Level A Harassment	Level B Harassment
North Atlantic right whale	0	0	0	1
Blue whale	0	0	0	0
Fin whale	0	0	0	2
Sei whale	0	0	0	0
Sperm whale	0	0	0	3

Vibratory Pile Driving
As described in the Notice of Proposed ITA, for vibratory pile driving (non-impulsive sounds), sound source characteristics were generated by JASCO using GRLWEAP 2010 wave equation model (Pile Dynamics, Inc., 2010). Installation and removal of the cofferdam were modeled from a single location that was deemed representative of the two potential cable routes. The radiated sound waves were modeled as discrete point sources over the full length of the pile in the water. Removal of the cofferdam using a vibratory extractor is expected to be acoustically comparable to installation activities. No noise mitigation system will be used during vibratory piling.

Cofferdam installation and removal is planned to occur during Year 1 of the construction activities, specifically from October through March; however, a small number of cofferdam removals could occur in Year 2 during April or May. Table 3.2.9 shows the proposed Level A and Level B harassment take NMFS OPR is proposing to authorize for installation and removal of the temporary cofferdams. These values considered that cofferdam installation and removal could occur in any month October – May.

Table 3.2.9. Level A and B Harassment Take Proposed for Authorization through the MMPA ITA Resulting From Vibratory Pile Driving Associated With the Installation and Removal of Temporary Cofferdams

Species	Requested Level A Harassment	Requested Level B Harassment
North Atlantic right whale	0	1
Blue whale	0	0
Fin whale	0	2
Sei whale	0	1
Sperm whale	0	0

Potential MEC/UXO Detonations

As described in the Notice of Proposed ITA, for potential UXO detonations, acoustic modeling was conducted based on previous underwater acoustic assessment work that was performed jointly between NMFS and the United States Navy. The effects thresholds for behavioral disturbance, TTS, PTS, and non-auditory injury were modeled using a maximum charge weight of 454 kg at sites that were deemed representative of both the export cable and the wind farm area. The charge weight was modeled at four different locations consisting of different depths (12 m (Site S1), 20 m (Site S2), 30 m (Site S3), and 45 m (Site S4)). Based on the depths within the project area, Site S1 (12 m) was chosen as the most representative depth to assess UXO detonations within the export cable route corridor. Sites S2, S3, and S4 (20 m, 30 m, and 45 m) are applicable to the wind farm area. Ocean Wind expects that up to ten 454 kg charges would be split between the different depths. A noise mitigation system (e.g., bubble curtain or similar device) capable of achieving 10 dB of sound attenuation will be used during detonations. Ocean Wind will not conduct more than one detonation per day. Table 3.2.10 shows the amount of Level A and Level B harassment that NMFS OPR is proposing to authorize resulting from the detonation of 10 UXOs, assuming 10 dB of sound attenuation.

Table 3.2.10. Level A Harassment and B Harassment Takes Proposed for Authorization through the MMPA ITA Resulting From The Detonation Of Up To 10 UXOs, Assuming 10 dB of Sound Attenuation

Species	Level A Harassment	Level B Harassment (TTS)
North Atlantic right whale	0	1
Blue whale	0	0
Fin whale	0	3
Sei whale	0	1
Sperm whale	0	3

HRG Surveys

The Notice of Proposed ITA includes a description of the modeling used to predict the amount of incidental take proposed for authorization under the MMPA. Results of modeling using the methodology described indicated that, of the HRG survey equipment planned for use by Ocean Wind that has the potential to result in Level B harassment of marine mammals, sound produced by the Applied Acoustics Dura-Spark UHD sparkers and GeoMarine Geo-Source sparkers would propagate furthest to the Level B harassment threshold (141 m). For the purposes of the exposure analysis, it was conservatively, yet reasonably, assumed that sparkers would be the dominant acoustic source for all survey days. Thus, the distances to the isopleths corresponding to the threshold for Level B harassment for sparkers (141 m) was used as the basis of the take calculation for all marine mammals. The amount of Level A and Level B harassment take proposed for authorization by NMFS OPR is illustrated in Table 3.2.11.

Table 3.2.11. Level A and B Harassment Take Proposed for Authorization through the MMPA ITA Resulting from High-Resolution Site Characterization Surveys Over 5-years.

Marine Mammal Species	Pre- and Post-Construction Phases (Years 1, 4, 5; 88 days annually)		During Construction Phase (Years 2 and 3; 180 days annually)	
	Level A Harassment	Level B Harassment	Level A Harassment	Level B Harassment
North Atlantic right whale	0	1	0	2
Blue whale	0	0	0	0
Fin whale	0	2	0	3
Sei whale	0	0	0	1
Sperm whale	0	3	0	3

Take Estimates

The methodology for estimating marine mammal exposure and incidental take is described fully in the Notice of Proposed ITA and discussed further in the *Effects of the Action*. For the purposes of the proposed ITA, NMFS OPR estimated the amount of take by considering: (1) acoustic thresholds above which NMFS OPR determined the best available scientific information indicates marine mammals will be behaviorally harassed or incur some degree of permanent hearing impairment; (2) the area or volume of water that will be ensonified above these levels in a day; (3) the density or occurrence of marine mammals within these ensonified areas; and, (4) and the number of days of activities. Take estimates for pile driving using a noise attenuation device, vibratory pile driving, potential UXO detonations, and HRG surveys are provided in Table 3.2.13. As described in the Notice of Proposed ITA, the take numbers NMFS OPR proposes for authorization are considered conservative for the following key reasons:

- Proposed take numbers for impact pile driving assume a maximum piling schedule (two monopiles or three pin piles installed per 24-hour period);
- Proposed take numbers for vibratory pile driving assume that a sheet pile temporary cofferdam will be installed (versus the alternative installation of a gravity cell cofferdam, for which no take is anticipated);
- Proposed take numbers for pile driving are conservatively based on maximum densities across the proposed construction months;
- Proposed Level A harassment take numbers do not fully account for the likelihood that marine mammals will avoid a stimulus when possible before the individual accumulates enough acoustic energy to potentially cause auditory injury, or the effectiveness of the proposed mitigation measures.

Table 3.2.13. Total Take (Level A Harassment And Level B Harassment) Proposed to be Authorized Through the MMPA ITA

Species	Proposed MMPA take authorization combined for all construction and HRG activities over 5-years	
	Proposed Level A takes	Proposed Level B takes
Fin whale	4	27
Sei whale	1	6
North Atlantic right whale	0	14
Blue whale	0	4
Sperm whale	0	21

Source: Table 35. Federal Register Notice of Proposed ITA (86 FR 8490)

3.2.7.2 Mitigation Measures Included in the Proposed ITA

The proposed ITA includes a number of minimization and monitoring methods that would be required to be implemented by Ocean Wind and are designed to ensure that the proposed project has the least practicable adverse impact upon the affected species or stocks and their habitat. The proposed ITA, inclusive of the proposed mitigation requirements, has been published in the FR (87 FR 64868). These include restrictions on pile driving, establishment of clearance zones for all activities, shutdown measures, soft start of pile driving, ramp up of HRG sources, noise mitigation for impact pile driving, and vessel strike avoidance measures. For the purposes of this section 7 consultation, all minimization and monitoring measures included in the ITA proposed by NMFS OPR are considered as part of the proposed action for this consultation. We note that some of the measures identified here overlap or are duplicative with the measures described by BOEM in the BA as part of the proposed action (see Tables 3.3.1 and 3.3.2).

Mitigation Measures Included in the October 2022 Proposed ITA

(a) *General conditions*.

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

(2) Ocean Wind must conduct briefings between construction supervisors, construction crews, and the PSO/PAM team prior to the start of all construction activities (as described in § 217.260), and when new personnel join the work, in order to explain responsibilities, communication procedures, marine mammal monitoring and reporting protocols, and operational procedures. An informal guide must be

included with the Marine Mammal Monitoring Plan to aid personnel in identifying species if they are observed in the vicinity of the project area;

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

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

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

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

(7) Any large whale sighted by a PSO or acoustically detected by a PAM operator that cannot be identified as a non-North Atlantic right whale must be treated as if it were a North Atlantic right whale.

(b) *Vessel strike avoidance measures*.

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

(i) Sightings of marine mammals and other protected species known to occur or which have the potential to occur in the Ocean Wind 1 project area;

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

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

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

(v) Confirmation of marine mammal observer training (including an understanding of the LOA requirements) must be documented on a training course log sheet and reported to NMFS.

(2) All vessels must abide by the following:

(i) All vessel operators and crews, regardless of their vessel's size, must maintain a vigilant watch for all marine mammals and slow down, stop their vessel, or alter course, as appropriate, to avoid striking any marine mammal;

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

(iii) Year-round, all vessel operators must monitor, the project's Situational Awareness System, WhaleAlert, US Coast Guard VHF Channel 16, and the Right Whale Sighting Advisory System (RWSAS) for the presence of North Atlantic right whales once every 4-hour shift during project-related activities. The PSO and

PAM operator monitoring teams for all activities must also monitor these systems no less than every 12 hours. If a vessel operator is alerted to a North Atlantic right whale detection within the project area, they must immediately convey this information to the PSO and PAM teams. For any UXO/MEC detonation, these systems must be monitored for 24 hours prior to blasting;

(iv) Any observations of any large whale by any Ocean Wind staff or contractor, including vessel crew, must be communicated immediately to PSOs and all vessel captains to increase situational awareness;

(v) All vessels must comply with existing NMFS vessel speed regulations, as applicable, for North Atlantic right whales;

(vi) Between November 1st and April 30th, all vessels, regardless of size, must operate at 10 kts or less when traveling between ports in New Jersey, New York, Maryland, Delaware, and Virginia;

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

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

(ix) If a vessel is traveling at greater than 10 knots, in addition to the required dedicated visual observer, Ocean Wind must monitor the transit corridor in real-time with PAM prior to and during transits. If a North Atlantic right whale is detected via visual observation or PAM within or approaching the transit corridor, all crew transfer vessels must travel at 10 kts or less for 12 hours following the detection. Each subsequent detection shall trigger a 12-hour reset. A slowdown in the transit corridor expires when there has been no further visual or acoustic detection in the transit corridor in the past 12 hours;

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

(xi) All vessels must maintain a minimum separation distance of 500 m from North Atlantic right whales. If underway, all vessels must steer a course away from any sighted North Atlantic right whale at 10 kts or less such that the 500-m minimum separation distance requirement is not violated. If a North Atlantic right whale is sighted within 500 m of an underway vessel, that vessel must shift the engine to neutral. Engines must not be engaged until the whale has moved outside of the vessel's path and beyond 500 m. If a whale is observed but cannot be confirmed as a species other than a North Atlantic right whale, the vessel operator must assume that it is a North Atlantic right whale and take the vessel strike avoidance measures described in this paragraph (b)(2)(xi);

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

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

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

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

(xvi) For in-water construction heavy machinery activities other than impact or vibratory pile driving, if a marine mammal is on a path towards or comes within 10 m of equipment, Ocean Wind must cease operations until the marine mammal has moved more than 10 m on a path away from the activity to avoid direct interaction with equipment.

(c) *Fisheries monitoring surveys*—

(1) *Training*.

(i) All crew undertaking the fishery survey activities must receive protected species identification training prior to activities occurring.

(ii) [Reserved]

(2) *During vessel use*.

(i) Marine mammal monitoring must occur prior to, during, and after haul-back, and gear must not be deployed if a marine mammal is observed in the area;

(ii) Trawl operations must only start after 15 minutes of no marine mammal sightings within 1 nm of the sampling station; and

(iii) During daytime sampling for the research trawl surveys, Ocean Wind must maintain visual monitoring efforts during the entire period of time that trawl gear is in the water from deployment to retrieval. If a marine mammal is sighted before the gear is removed from the water, the vessel must slow its speed and steer away from the observed animal(s).

(3) *Gear-specific best management practices (BMPs)*.

(i) Baited remote underwater video (BRUV) sampling and chevron trap usage, for example, would utilize specific mitigation measures to reduce impacts to marine mammals. These specifically include the breaking strength of all lines being less than 1,700 pounds (771 kg), limited soak durations of 90 minutes or less, no gear being left without a vessel nearby, and a delayed deployment of gear if a marine mammal is sighted nearby;

(ii) The permit number will be written clearly on buoy and any lines that go missing will be reported to NOAA Fisheries' Greater Atlantic Regional Fisheries Office (GARFO) Protected Resources Division as soon as possible;

(iii) If marine mammals are sighed near the proposed sampling location, chevron traps and/or BRUVs will not be deployed;

(iv) If a marine mammal is determined to be at risk of interaction with the deployed gear, all gear will be immediately removed;

(v) Marine mammal monitoring would occur during daylight hours and begin prior to the deployment of any gear (*e.g.*, trawls, longlines) and continue until all gear has been retrieved; and

(vi) If marine mammals are sighted in the vicinity within 15 minutes prior to gear deployment and it is determined the risks of interaction are present regarding the research gear, the sampling station will either move to another location or suspend activities until there are no marine mammal sightings for 15 minutes within 1 nm.

(d) *Wind turbine generator (WTG) and offshore substation (OSS) foundation installation*—

(1) *Seasonal and daily restrictions*.

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

(ii) No more than two foundation monopiles may be installed per day;

(iii) Ocean Wind must not initiate pile driving later than 1.5 hours after civil sunset or 1 hour before civil sunrise unless Ocean Wind submits an Alternative Monitoring Plan to NMFS for approval that proves the efficacy of their night vision devices; and

(iv) Monopiles must be no larger than 11-m in diameter, representing the larger end of the tapered 8/11-m monopile design. If jacket foundations are used for OSSs, pin piles must be no larger than 2.44-m in diameter. For all monopiles and pin piles, the minimum amount of hammer energy necessary to effectively and safely install and maintain the integrity of the piles must be used. Hammer energies must not exceed 4,000 kJ.

(2) *Noise abatement systems*.

(i) Ocean Wind must deploy dual noise abatement systems that are capable of achieving, at a minimum, 10 dB of sound attenuation, during all impact pile driving of foundation piles.

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

(B) A double big bubble curtain (dBBC) may be used without being paired with another noise attenuation device.

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

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

(iv) No parts of the ring or other objects may prevent full seafloor contact.

(v) Construction contractors must train personnel in the proper balancing of airflow to the ring. Construction contractors must submit an inspection/performance report for approval by Ocean Wind within 72 hours following the performance test. Corrections to the bubble ring(s) to meet the performance standards must occur prior to impact pile driving of monopiles. If Ocean Wind uses a noise mitigation device in addition to the BBC, Ocean Wind must maintain similar quality control measures as described here.

(3) *Sound field verification*.

(i) Ocean Wind must perform sound field verification (SFV) during all impact pile driving of the first three monopiles and a full jacket foundation (16 total pin piles) and must empirically determine source levels (peak and cumulative sound exposure level), the ranges to the isopleths corresponding to the Level A harassment (permanent threshold shifts (PTS)) and Level B harassment (temporary threshold shifts (TTS)) thresholds, and estimated transmission loss coefficients.

(ii) If a subsequent monopile and pin pile installation and location is selected that was not represented by previous three locations (*i.e.*, substrate composition, water depth), SFV must be conducted.

(iii) Ocean Wind must measure received levels at a standard distance of 750 m from the monopiles and pin piles.

(iv) If SFV measurements on any of the first three piles indicate that the ranges to Level A harassment and Level B harassment isopleths are larger than those modeled, assuming 10-dB attenuation, Ocean Wind must modify and/or apply additional noise attenuation measures (*e.g*., improve efficiency of bubble curtain(s), modify the piling schedule to reduce the source sound, install an additional noise attenuation device) before the second pile is installed. Until SFV confirms the ranges to Level A harassment and Level B harassment isopleths are less than or equal to those modeled, assuming 10-dB attenuation, the shutdown and clearance zones must be expanded to match the ranges to the Level A harassment and Level B harassment isopleths based on the SFV measurements. If the application/use of additional noise attenuation measures still does not achieve ranges less than or equal to those modeled, assuming 10-dB attenuation, and no other actions can further reduce sound levels, Ocean Wind must expand the clearance and shutdown zones according to those identified through SFV, in consultation with NMFS.

(v) If acoustic measurements indicate that ranges to isopleths corresponding to the Level A harassment and Level B harassment thresholds are less than the ranges predicted by modeling (assuming 10 dB attenuation), Ocean Wind may request a modification of the clearance and shutdown zones for impact pile driving of monopiles and pin piles. For a modification request to be considered by NMFS, Ocean Wind must have conducted SFV on three or more monopiles and at least one entire jacket foundation (16 pin piles) to verify that zone sizes are consistently smaller than predicted by modeling (assuming 10 dB attenuation).

(vi) Ocean Wind must submit a SFV Plan at least 180 days prior to the planned start of impact pile driving. The plan would describe how Ocean Wind would ensure that the first three monopile and jacket foundation installation sites selected for SFV are representative of the rest of the monopile and pin pile installation. In the case that these sites are not determined to be representative of all other monopile and pin pile installation sites, Ocean Wind must include information on how additional sites would be selected for SFV. The plan must also include methodology for collecting, analyzing, and preparing SFV data for submission to NMFS. The plan must describe how the effectiveness of the sound attenuation methodology would be evaluated based on the results. Ocean Wind must also provide, as soon as they are available but no later than 48 hours after each installation, the initial results of the SFV measurements to NMFS in an interim report after each monopile for the first three piles and pin pile installation for the first full jacket foundation (16 pin piles).

(4) *PSO and PAM use*.

(i) Ocean Wind must have a minimum of four PSOs actively observing marine mammals before, during, and after (specific times described in this paragraph (d)(4)) the installation of foundation piles (monopiles and/or pin piles). At least four PSOs must be actively observing for marine mammals. At least two PSOs must be actively observing on the pile driving vessel while at least two PSOs must be actively observing on a secondary, PSO-dedicated vessel. At least one active PSO on each platform must have a minimum of 90 days at-sea experience working in those roles in offshore environments with no more than 18 months elapsed since the conclusion of the at-sea experience. Concurrently, at least one acoustic PSO (*i.e.*, PAM operator) must be actively monitoring for marine mammals before, during and after impact pile driving.

(ii) All visual PSOs and PAM operators used for the Ocean Wind project must meet the requirements and qualifications described in § 217.265(a), (b), and (c), respectively, and as applicable to the specified activity.

(5) *Clearance and shutdown zones*.

(i) Ocean Wind must establish and implement clearance and shutdown zones (all distances to the perimeter are the radii from the center of the pile being driven) as described in the LOA for all WTG and OSS foundation installation.

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

(iii) PSOs must be able to visually clear (*i.e.*, confirm no marine mammals are present) an area that extends around the pile being driven as described in the LOA. The entire minimum visibility zone must be visible (*i.e.*, not obscured by dark, rain, fog, *etc.*) for a full 30 minutes immediately prior to commencing impact pile driving (based on season; summer and winter minimum visibility zones). Clearance zones extending beyond this minimum visibility zone may be cleared using both visual and acoustic methods.

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

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

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

(vii) Ocean Wind must immediately cease pile driving upon orders of the PSO unless shutdown is not practicable due to imminent risk of injury or loss of life to an individual, pile refusal, or pile instability. In this situation, reduced hammer energy must be implemented instead, as determined to be practicable.

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

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

(x) Upon re-starting pile driving, soft start protocols must be followed.

(6) *Soft start*.

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

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

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

(e) *Cofferdam installation*—

(1) *Seasonal and daily restrictions*.

(i) Ocean Wind must only conduct cofferdam installation/removal from October through March, although some removal shall also be allowed to occur in April or May.

(ii) Ocean Wind must conduct vibratory pile driving associated with cofferdam installation and removal during daylight hours only.

(2) *PSO use*.

(i) All visual PSOs used for the Ocean Wind project must meet the requirements and qualifications described in § 217.265(a) and (b), as applicable to the specified activity.

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

(3) *Clearance and shutdown zones*.

(i) Ocean Wind must establish and implement clearance and shutdown zones as described in the LOA.

(ii) Prior to the start of vibratory pile driving activities, at least two PSOs must monitor the clearance zone for 30 minutes, continue monitoring during pile driving and for 30 minutes post pile driving.

(iii) If a marine mammal is observed entering or is observed within the clearance zones, piling must not commence until the animal has exited the zone or a specific amount of time has elapsed since the last sighting. The specific amount of time is 30 minutes for large whales and 15 minutes for dolphins, porpoises, and pinnipeds.

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

(v) Ocean Wind must immediately cease pile driving upon orders of the PSO unless shutdown is not practicable due to imminent risk of injury or loss of life to an individual, pile refusal, or pile instability.

(vi) Pile driving must not restart until either the marine mammal(s) has voluntarily left the specific clearance zones and have been visually or acoustically confirmed beyond that clearance zone, or, when specific time periods have elapsed with no further sightings or acoustic detections have occurred. The specific time periods are 15 minutes for small odontocetes and 30 minutes for all other marine mammal species.

(f) *UXO/MEC detonation(s)*—

(1) *General*.

(i) Ocean Wind shall only detonate a maximum of 10 UXO/MECs, of varying sizes, during the entire effective period of this subpart and LOA.

(ii) Upon encountering a UXO/MEC of concern, Ocean Wind may only resort to high-order removal (*i.e.*, detonation) after all other means by which to remove the UXO/MEC have been exhausted. Ocean Wind must not detonate a UXO/MEC if another means of removal is practicable.

(iii) Ocean Wind must utilize a noise abatement system (*e.g.*, bubble curtain or similar noise abatement device) around all UXO/MEC detonations and operate that system in a manner that achieves maximum noise attenuation levels practicable.

(2) *Seasonal and daily restrictions*.

(i) Ocean Wind must not detonate UXOs/MECs from November 1st through April 31st, annually.

(ii) Ocean Wind must only detonate UXO/MECs during daylight hours.

(3) *PSO and PAM use*.

(i) All visual PSOs and PAM operators used for the Ocean Wind project must meet the requirements and qualifications described in

§ 217.265(a), (b), and (c), respectively, and as applicable to the specified activity.

(ii) Ocean Wind must use at least six visual PSOs and one acoustic PSO to clear the area prior to detonation. These PSOs would be located on at least two dedicated PSO vessels or, if the largest clearance zone is greater than 5 km, one dedicated PSO vessel and one aerial platform (*i.e.*, airplane).

(4) *Clearance zones*.

(i) Ocean Wind must establish and implement clearance zones using both visual and acoustic monitoring, as described in the LOA.

(ii) Clearance zones must be fully visible for at least 60 minutes and all marine mammal(s) must be confirmed to be outside of the clearance zone for at least 30 minutes prior to detonation. PAM must also be conducted for at least 60 minutes and the zone must be acoustically cleared during this time.

(iii) If a marine mammal is observed entering or within the clearance zone prior to denotation, the activity must be delayed. Detonation may only commence if all marine mammals have been confirmed to have voluntarily left the clearance zones and been visually confirmed to be beyond the clearance zone, or when 60 minutes have elapsed without any redetections for whales (including the North Atlantic right whale) or 15 minutes have elapsed without any redetections of delphinids, harbor porpoises, or seals.

(5) *Sound field verification*.

(i) During each UXO/MEC detonation, Ocean Wind must empirically determine source levels (peak and cumulative sound exposure level), the ranges to the isopleths corresponding to the Level A harassment and Level B harassment thresholds, and estimated transmission loss coefficient(s).

(ii) If SFV measurements on any of the detonations indicate that the ranges to Level A harassment and Level B harassment thresholds are larger than those modeled, assuming 10-dB attenuation, Ocean Wind must modify the ranges, with approval from NMFS, and/or apply additional noise attenuation measures (*e.g.*, improve efficiency of bubble curtain(s), install an additional noise attenuation device) before the next detonation event.

(g) *HRG surveys*—

(1) *General*.

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

(ii) Ocean Wind must deactivate acoustic sources during periods where no data is being collected, except as determined to be necessary for testing. Any unnecessary use of the acoustic source(s) must be avoided.

(iii) Ocean Wind must instruct all vessel personnel regarding the authority of the marine mammal monitoring team(s). For example, the vessel operator(s) would be required to immediately comply with any call for a shutdown by the Lead PSO. Any disagreement between the Lead PSO and the vessel operator would only be discussed after shutdown has occurred.

(iv) Any large whale sighted by a PSO within 1 km of the boomer, sparker, or Compressed High-Intensity Radiated Pulse (CHIRP) that cannot be identified as a non-North Atlantic right whale must be treated as if it were a North Atlantic right whale.

(2) *PSO use*.

(i) Ocean Wind must use at least one PSO during daylight hours and two PSOs during nighttime operations, per vessel. Any PSO shall have the authority to call for a delay or shutdown of the survey activities.

(ii) PSOs must establish and monitor the appropriate clearance and shutdown zones (*i.e.*, radial distances from the acoustic source in-use and not from the vessel).

(iii) PSOs must begin visually monitoring 30 minutes prior to the initiation of the specified acoustic source (*i.e.*, ramp-up, if applicable), through 30 minutes after the use of the specified acoustic source has ceased.

(3) *Ramp-up*.

(i) Any ramp-up activities of boomers, sparkers, and CHIRPs must only commence when visual clearance zones are fully visible (*e.g.*, not obscured by darkness, rain, fog, *etc.*) and clear of marine mammals, as determined by the Lead PSO, for at least 30 minutes immediately prior to the initiation of survey activities using a specified acoustic source.

(ii) Prior to starting the survey and after receiving confirmation from the PSOs that the clearance zone is clear of any marine mammals, Ocean Wind must ramp-up sources to half power for 5 minutes and then proceed to full power, unless the source operates on a binary on/off switch in which case ramp-up is not feasible. Ramp-up activities would be delayed if a marine mammal(s) enters its respective shutdown zone. Ramp-up would only be reinitiated if the animal(s) has been observed exiting its respective shutdown zone or until additional time has elapsed with no further sighting. The specific time periods are 15 minutes for small odontocetes and seals, and 30 minutes for all other species.

(4) *Clearance and shutdown zones*.

(i) Ocean Wind must establish and implement clearance zones as described in the LOA.

(ii) Ocean Wind must implement a 30-minute clearance period of the clearance zones immediately prior to the commencing of the survey or when there is more than a 30-minute break in survey activities and PSOs are not actively monitoring.

(iii) If a marine mammal is observed within a clearance zone during the clearance period, ramp-up would not be allowed to begin until the animal(s) has been observed voluntarily exiting its respective clearance zone or until an additional time period has elapsed with no further sighting (*i.e.*, 15 minutes for small odontocetes and seals, and 30 minutes for all other species).

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

(v) Once the survey has commenced, Ocean Wind must shut down boomers, sparkers, and CHIRPs if a marine mammal enters a respective shutdown zone.

(vi) In cases when the shutdown zones become obscured for brief periods due to inclement weather, survey operations would be allowed to continue (*i.e.*, no shutdown is required) so long as no marine mammals have been detected.

(vii) The use of boomers, sparkers, and CHIRPS would not be allowed to commence or resume until the animal(s) has been confirmed to have left the Level B harassment zone or until a full 15 minutes (for small odontocetes and seals) or 30 minutes (for all other marine mammals) have elapsed with no further sighting.

(viii) Ocean Wind must immediately shutdown any boomer, sparker, or CHIRP acoustic source if a marine mammal is sighted entering or within its respective shutdown zones (500 m for North Atlantic right whale; 100 m for all other marine mammals, except for those specified here). The shutdown requirement does not apply to small delphinids of the following genera: *Delphinus*, *Stenella*, *Lagenorhynchus,* and *Tursiops*. If there is uncertainty regarding the identification of a marine mammal species (*i.e.,* whether the observed marine mammal belongs to one of the delphinid genera for which shutdown is waived), the PSOs must use their best professional judgment in making the decision to call for a shutdown. Shutdown is required if a delphinid that belongs to a genus other than those specified here is detected in the shutdown zone.

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

(A) PSOs have maintained constant observation; and

(B) No additional detections of any marine mammal occurred within the respective shutdown zones.

(x) If a boomer, sparker, or CHIRP was shut down for a period longer than 30 minutes, then all clearance and ramp-up procedures must be initiated.

3.3 COP-Related Proposed Measures to Minimize and Monitor Effects of the Action

There are a number of measures that Ocean Wind, through its COP, is proposing to take and/or BOEM is proposing to require as conditions of COP approval that are designed to avoid, minimize, or monitor effects of the action on ESA listed species. For the purpose of this consultation, the mitigation and monitoring measures included in the October 2022 proposed ITA and additional measures proposed by BOEM and/or USACE and identified in the BA as part of the action that BOEM is requesting consultation on are considered as part of the proposed action. The ITA only proposes mitigation and monitoring measures for marine mammals including threatened and endangered whales considered in this Opinion. Although some measures also apply to and provide minimization of potential impacts to listed sea turtle and fish species (e.g., pile driving soft start minimize potential effects to all listed species), they do not completely cover all threatened and endangered species mitigation, monitoring, and reporting needs. The measures considered as part of the proposed action as described in BOEM's BA are included in Tables 3.3.1 and Table 3.3.2 below. These are in addition to the conditions of the proposed ITA outlined above.

Table 3.3.1. Mitigation and monitoring measures considered as part of the Proposed Action

Measure	Description	Project Phase
PSO/ Passive acoustic monitoring (PAM) training and requirements	PSO and PAM operators will have completed NMFS-approved PSO training, and have team leads with 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; PSOs and PAM operators will complete a Permits and Environmental Compliance (PECP) training and a two day training and refresher session with the PSO provider and the Project compliance representatives before the anticipated start of Project activities.	Construction
General PSO Measures	• PSOs must be provided by a third-party provider. • 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. • Each PSO will be provided 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 and other protected species using night-vision goggles with thermal clip-ons, a hand-held spotlight, and/or a mounted thermal camera system. • Activities with larger monitoring zones will use 25 x 150 mm “big eye” binoculars. • Vessel personnel will be instructed to report any sightings to the PSO team as soon as they are able, and it is safe to do so. • Members of the monitoring team will consult with NMFS’ North Atlantic right whale reporting system for the presence of North Atlantic right whales in the Project area. • If a NARW is involved in any of the above-mentioned incidents, then the vessel captain or PSO onboard should also notify the Right Whale • Sighting Advisory System (RWSAS) hotline immediately and no later than within 24 hours.	Construction, O&M, decommissioning

Measure	Description	Project Phase
Vessel Strike Avoidance Policy – General Measures	The Project will implement a vessel strike avoidance policy for all vessels under contract to Ørsted to reduce the risk of vessel strikes, and the likelihood of death and/or serious injury to marine mammals, sea turtles, or ESA-listed fish that may result from collisions with vessels. Vessel operators and crews shall receive protected species identification training. This training will cover sightings of marine mammals and other protected species known to occur or which have the potential to occur in the Project area. It will include training on making observations in both good weather conditions (i.e., clear visibility, low wind, low sea state) and bad weather conditions (i.e., fog, high winds, high sea states, in glare). Training will include not only identification skills but information and resources available regarding applicable federal laws and regulations for protected species. It will also cover any Critical Habitat requirements, migratory routes, seasonal variations, behavior identification, etc. All attempts shall be made to remain parallel to the animal's course when a travelling marine mammal is sighted in proximity to the vessel in transit. All attempts shall be made to reduce any abrupt changes in vessel direction until the marine mammal has moved beyond its associated separation distance (as described below). If an animal or group of animals is sighted in the vessel's path or in proximity to it, or if the animals are behaving in an unpredictable manner, all attempts shall be made to divert away from the animals or, if unable due to restricted movements, reduce speed and shift gears into neutral until the animal(s) has moved beyond the associated separation distance (except for voluntary bow riding dolphin species). All vessels will comply with NMFS regulations and speed restrictions and state regulations as applicable for NARW (see vessel speed restriction Standard Plan and Adaptive Plan outlines below). All vessels will comply with the approved adaptive speed plan which will include additional measures including travel within established NARW Slow zones Ocean Wind will submit a final NARW Vessel Strike Avoidance Plan at least 90 days prior to commencement of vessel use that details the Adaptive Plan and specific monitoring equipment to be used. The plan will, at minimum, describe how PAM, in combination with visual observations, will be conducted to ensure the transit corridor is clear of NARWs. The plan will also provide details on the vessel-based observer protocols on transiting vessels.	Construction, O&M, decommissioning
Vessel separation distances	Vessels will maintain, to the extent practicable, separation distances of: >500 m (546 yards) distance from any sighted North Atlantic right whale or unidentified large marine mammals; >100 m (109 yards) from all other whales; >50 m (54 yards) for dolphins, porpoises, seals, and sea turtles. Specific requirements that will be implemented should an animal enter the vessel separation distance are outlined below in, Measures #5 and 6.	Construction, O&M, decommissioning

Measure	Description	Project Phase
Vessel speed restrictions - Standard Plan	All vessels will comply with NMFS regulations and speed restrictions and state regulations as applicable for NARW. All vessels 65 feet (20 meters) or longer subject to the jurisdiction of the U.S. will comply with a 10-knot speed restriction when entering or departing a port or place subject to U.S. jurisdiction, and in any SMA during NARW migratory and calving periods from November 1 to April 30 (Mid-Atlantic SMAs specific to the Project area: ports of New York/New Jersey and the entrance to the Delaware Bay in the vicinity of the Project area); also, in the following feeding areas as follows: from January 1 to May 15 in Cape Cod Bay; from March 1 to April 30 off Race Point; and from April 1 to July 31 in the Great South Channel. Between November 1st and April 30th: Vessels of all sizes will operate port to port (from ports in NJ, NY, MD, DE, and VA) at 10 knots or less. Vessels transiting from other ports outside those described will operate at 10 knots or less when within any active SMA or within the Offshore Wind Area, including the lease area and export cable route. Year Round: Vessels of all sizes will operate at 10 knots or less in any DMAs. Between May 1st and October 31st: 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° direction of the forward path of the vessel (90° port to 90° starboard). Visual observers must be equipped with alternative monitoring technology for periods of low visibility (e.g., darkness, rain, fog, etc.). The dedicated visual observer must receive prior training on protected species detection and identification, vessel strike minimization procedures, how and when to communicate with the vessel captain, and reporting requirements. Visual observers may be third-party observers (i.e., NMFS-approved PSOs) or crew members.	Construction, O&M, decommissioning

Measure	Description	Project Phase
Vessel speed restrictions – Adaptive Plan	• The Standard Plan outlined above will be adhered to except in cases where crew safety is at risk, and/or labor restrictions, vessel availability, costs to the Project, or other unforeseen circumstance make these measures impracticable. To address these situations, an Adaptive Plan will be developed in consultation with NMFS to allow modification of speed restrictions for vessels. Should Ocean Wind choose not to implement this Adaptive Plan, or a component of the Adaptive Plan is offline (e.g., equipment technical issues), Ocean Wind will default to the Standard Plan (described above). • The Adaptive Plan will not apply to vessel 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 such that confirmed NARW detections are regularly transmitted to a central information portal and disseminated through the situational awareness network. – The transit corridor and Offshore Wind Area will be divided into detection action zones. – Localized detections of NARWs in an action zone would trigger a slow-down to 10 knots or less in the respective zone for the following 12-h. Each subsequent detection would trigger a 12-h reset. A zone slow-down expires when there has been no further visual or acoustic detection in the past 12 h within the triggered zone. – The detection action zones 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° direction of the forward path of the vessel (90° port to 90° starboard). Visual observers must be equipped with alternative monitoring technology for periods of low visibility (e.g., darkness, rain, fog, etc.). The dedicated visual observer must receive prior training on protected species detection and identification, vessel strike minimization procedures, how and when to communicate with the vessel captain, and reporting requirements. Visual observers may be third-party observers (i.e., NMFS-approved PSOs) or crew members. • Year-round: any DMA is established that overlaps with an area where a Project vessel would operate, that vessel, regardless of size when entering the DMA, may transit that area at a speed of >10 knots. Any active action zones within the DMA may trigger a slow down as described above. • If PAM and/or automated visual systems are offline, the Standard Plan measures will apply for the respective zone (where PAM is offline) or vessel (if automated visual systems are offline).	Construction, O&M, decommissioning

Measure	Description	Project Phase
Situational Awareness System/Common Operating Picture	Ocean Wind will establish a situational awareness network for marine mammal and sea turtle detections through the integration of sighting communication tools such as Mysticetus, Whale Alert, WhaleMap, etc. Sighting information will be made available to all Project vessels through the established network. Ocean Wind's Marine Coordination Center will serve to coordinate and maintain a Common Operating Picture. Systems within the Marine Coordination Center, along with 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.	Construction, O&M, decommissioning
PSO/PAM data recording	All data will be recorded using industry-standard software. Data recorded will include information related to ongoing operations, observation methods and effort, visibility conditions, marine mammal detections, and any mitigation actions requested and enacted. See below for additional details on reporting requirements.	Construction, O&M
Long-term Monitoring – Marine Mammals	Pre-construction marine mammal surveys will provide a baseline set of data for comparison against the monitoring efforts during construction. Post-construction marine mammal surveys will provide for an assessment of the potential long-term impacts of the Project. Survey will involve a combination of visual and acoustic monitoring techniques	Pre-Construction, Construction, O&M, decommissioning
Operational Monitoring – Marine Mammals	Visual monitoring and PAM for marine mammals will occur during vessel transits to and from the Project area as described above under vessel speed restrictions (standard and adaptive plans)	Construction, O&M, decommissioning
Long-term Monitoring - Turtles	Visual monitoring will be employed to assess the potential impacts of the Project on sea turtles in the Project area. . Several different methodologies will be employed to assess Project-related impacts, including vessel-based visual surveys.	Pre-Construction, Construction, O&M, decommissioning
Sound Field Verification (SFV) Plan		

Measure	Description	Project Phase
SFV measurement plan	All measurements will be performed according to the ISO 18406:2017 standard. The foundation installation noise will be measured using omnidirectional hydrophones capable of measuring frequencies between 20 Hz and 20 kHz. The hydrophone signals will be verified before deployment and after recovery by means of a pistonphone calibrator on deck or similar method. Each measurement position will consist of two hydrophones at approximately mid-depth and 2 meters above the seafloor. Deployment will be made using a heavy weight as anchor - to prevent equipment drifting (typically total ballast weight exceeding 100 kg) Deployment and retrieval position of each hydrophone will be recorded using hand-held GPS equipment, or alternative precise method. The hydrophones will be placed at various distances from the installation location. The equipment, methodology, placement, and analysis will be the same for all pile measurements. Output results will include sound pressure level and frequency context. Measurements will be conducted in a detailed configuration at the beginning of installation.	Construction
Level A harassment and level B harassment distance verification for impact pile driving	Ocean Wind will conduct SFV under the following circumstances: – Impact driving of the first three monopiles installed over the duration of the LOA; – If Ocean Wind obtains technical information that indicates a subsequent monopile is likely to produce larger sound fields – At least three monopiles of the same size if a reduction to the clearance and/or shutdown zones is requested. A SFV Plan will be submitted to NMFS for review and approval at least 90 days prior to planned start of pile driving. This plan will describe how Ocean Wind will ensure that the first three monopile installation sites selected for SFV are representative of the rest of the monopile installation sites and, in the case that they are not, how additional sites will be selected for SFV. Ocean Wind will conduct a SFV to empirically determine the distances to the isopleths corresponding to Level A harassment and Level B harassment thresholds, including at the locations corresponding to the modeled distances to the Level A harassment and Level B harassment thresholds, or as agreed to in the SFV Plan. As a secondary method, Ocean Wind may also estimate distances to Level A harassment and Level B harassment thresholds by extrapolating from in situ measurements at multiple distances from the monopile, including at least one measurement location at 750 meters from the pile. For verification of the distance to the Level B harassment threshold, Ocean Wind will report the measured or extrapolated distances where the received levels L_{rms} decay to 160 dB, as well as integration time for such L_{rms}.	Construction

Measure	Description	Project Phase
Modification of shutdown and monitoring zones	For a modification request to be considered by NMFS, Ocean Wind must have conducted SFV on at least 3 piles to verify that zone sizes are consistently smaller than predicted by modeling. If a subsequent piling location is selected that was not represented by previous locations (e.g., substrate composition, water depth), SFV will be conducted. Ocean Wind may request a modification to the size of shutdown and monitoring zones based on the results of pile measurements. The zones will be determined as follows: – The large whale pre-start clearance zone will be calculated as the radius of the maximum Level A exposure range of any mysticete. – The right whale pre-start clearance zone will be equal to the marine mammal Level B zone. – The large whale, including right whale, shutdown zone will be calculated as the radius of the maximum Level A exposure range of any mysticete. – The harbor porpoise and seal pre-start clearance zone and shutdown zone will be determined as the extent of the level A exposure range. – For all mid-frequency cetaceans other than sperm whales, no pre-clearance or shutdown zones will be implemented because the physical placement of the noise mitigation system (NMS) will preclude take (i.e., the Level A zone is smaller than the distance of the NMS from the pile)	Construction
Impact Pile Driving		
Impact pile-driving time-of-year restriction	No pile installation will occur from 01 January to 30 April to avoid the times of year when NARW are present in higher densities.	Construction
Noise mitigation systems (NMS) during impact pile driving	The Project will use a dual NMS system for all impact piling events. The NMS will be a combination of two devices (e.g., bubble curtain, hydrodamper) to reduce noise propagation during monopile foundation pile driving. The Project is committed to achieving ranges associated with 10 dB of noise attenuation.	Construction
PAM for impact pile driving	• At least one PAM operator will be actively monitoring for marine mammals before, during and after pile driving In some cases where vessels work under 24-hour operations2, 4-hour PAM operator rotations may be scheduled For PAM operators, minimum standard shifts are typically restricted to no more than 3 hours but can be reduced if NMFS or BOEM directs a shorter shift. In the cases where PAM systems are monitored remotely (i.e., shore side) alternative rotations to the above may be requested on a case-by-case basis. There will be a PAM operator on duty conducting acoustic monitoring in coordination with the visual PSOs during all pre-start clearance periods, piling, and post-piling monitoring periods Passive acoustic monitoring will include, and extend beyond the largest shutdown zone for low and mid-frequency cetaceans The NARW pre-clearance zone will be monitored visually out to the extent of the low-frequency cetacean clearance/shutdown zone and acoustically out to 3,800 meters in winter and 3,500 meters in summer	Construction

Measure	Description	Project Phase
Visual monitoring for impact pile driving	- Six to eight visual PSOs and PAM operators (may be located onshore) on the pile driving vessel and four to eight visual PSOs and PAM operators on any secondary marine mammal monitoring vessel. - Two visual PSOs will hold watch on each construction and secondary vessel during pre-start clearance, throughout pile driving, and 30 minutes after piling is completed. - Passive acoustic monitoring will include, and extend beyond the largest shutdown zone for low and mid-frequency cetaceans - The NARW pre-clearance zone will be monitored visually out to the extent of the low-frequency cetacean clearance/shutdown zone and acoustically out to 3,800 meters in winter and 3,500 meters in summer (see Table 3.3.1C).	Construction

Daytime visual monitoring for impact pile driving (Daytime visual monitoring is defined by the period between nautical twilight rise and set for the region)

- There will be a PAM operator on duty conducting acoustic monitoring in coordination with the visual PSOs during all pre-start clearance periods, piling, and post-piling monitoring periods
- Passive acoustic monitoring will include, and extend beyond the largest shutdown zone for low and mid-frequency cetaceans
- The NARW pre-clearance zone will be monitored visually out to the extent of the low-frequency cetacean clearance/shutdown zone and acoustically out to 3,800 meters in winter and 3,500 meters in summer (see Table 3.3.1C). PSOs will monitor the shutdown zone with the naked eye and reticle binoculars while one PSO periodically scans outside the shutdown zone using the mounted big eye binoculars.
- The secondary vessel will be positioned and circling at the outer limit of the low-frequency and mid-frequency cetacean shutdown zones (Table 3.3.1B).
- Monitoring equipment planned for use during standard daytime and low visibility and nighttime piling is presented in Table 3.3.1A.

Table 3.3.1A. Monitoring equipment planned for use during standard daytime and low visibility and nighttime piling (adapted from PSMMP dated April 2022).

Item	Standard Daytime		Monitoring for Nighttime and Low Visibility	
	Number on Construction Vessel	Number on Secondary Vessel	Number on Construction Vessel	Number on Secondary Vessel
Reticle binoculars	2	2	0	0
Visual PSOs on watch	2	2	2	2
PAM operators on duty[1]	1	1	1	1
Mounted thermal/IR camera system[1]	1	1	1	1
Mounted “big-eye” binocular	1	1	0	0
Monitoring station for real time PAM system[2]	1	1	1	1
Hand-held or wearable NVDs	0	0	2	2
IR spotlights	0	0	2	2
Data collection software system	1	1	1	1
PSO-dedicated VHF radios	2	2	2	2
Digital single-lens reflex camera equipped with 300-	1	1	0	0

Construction

Measure	Description	Project Phase
	mm lens | | | | Source: HDR, Inc. 2022a PAM= passive acoustic monitoring; NVD= night vision devices; PSO = protected species observer; VHF = very high frequency; mm = millimeter [1] PAM operator may be stationed on the vessel or at an alternative monitoring location [2] The camera systems will be automated with detection alerts that will be checked by a PSO on duty; however, cameras will not be manned by a dedicated observer. [3] The selected PAM system will transmit real time data to PAM monitoring stations on the vessels and/or a shore side monitoring station.	
Daytime periods of reduced visibility for impact pile driving	- If the monitoring zone is obscured, the two PSOs on watch will continue to monitor the shutdown zone using thermal camera systems, handheld night-vision devices (NVD), and mounted infrared (IR) camera (as able). - All PSOs on duty will be in contact with the on-duty PAM operator who will monitor the PAM systems for acoustic detections of marine mammals that are vocalizing in the area.	Construction
Nighttime visibility for construction and secondary vessels	- Pile driving during nighttime hours could potentially occur when a pile installation is started during daylight and, due to unforeseen circumstances, would need to be finished after dark. New piles could be initiated after dark to meet schedule requirements. - Visual PSOs will rotate in pairs: one observing with a handheld NVD and one monitoring using thermal camera systems, handheld NVD and the IR thermal imaging camera system (as able) - The mounted thermal cameras may have automated detection systems or require manual monitoring by a PSO. - PSOs will focus their observation effort during nighttime watch periods within the Shutdown zones and waters immediately adjacent to the vessel. - Deck lights will be extinguished or dimmed during night observations when using night-vision devices; however, if the deck lights must remain on for safety reasons, the PSO will attempt to use the NVD in areas away from potential interference by these lights. If a PSO is unable to monitor the visual clearance or shutdown zones with available NVDs piling will not commence or will be halted (as safe to do so).	Construction

Measure	Description	Project Phase
Acoustic monitoring during impact pile driving	PAM should begin at least 30-minutes prior to the start of piling. One PAM operator on duty during both daytime and nighttime/low visibility monitoring. Since visual observations within the applicable Shutdown zones can become impaired at night or during daylight hours due to fog, rain, or high sea states, visual monitoring with thermal and NVDs will be supplemented by PAM during these periods PAM operator will monitor during all pre-start clearance periods, piling, and post-piling monitoring periods (daylight, reduced visibility, and nighttime 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. PSOs will acoustically monitor zones outlined in Table 3.3.1C for all marine mammals, as well as the NARW specific clearance zones. It is expected there will be a PAM operator stationed on at least one of the dedicated monitoring vessels in addition to the PSOs; or located remotely/onshore. PAM operators will complete specialized training for operating PAM systems prior to the start of monitoring activities. All on-duty PSOs will be in contact with the PAM operator on-duty, who will monitor the PAM systems for acoustic detections of marine mammals that are vocalizing in the area. The PAM operator will inform the Lead PSO on duty of animal detections approaching or within applicable ranges of interest to the pile-driving activity via the data collection software system (i.e., Mysticetus or similar system) who will be responsible for requesting the designated crewmember to implement the necessary mitigation procedures. Acoustic monitoring during nighttime and low visibility conditions during the day will complement visual monitoring (e.g., PSOs and thermal cameras) and will cover an area of at least the PAM Clearance Zone presented in Table 3.3.1C around each foundation.	Construction

- Shutdown zones and pre-clearance zones for Project impact pile driving activities are presented in Tables 3.3.1B and 3.3.1C for winter and summer seasons separately as sound speed profiles are faster during winter conditions and therefore have larger corresponding shutdown zones. The NARW pre-start clearance zones presented in Table 3.3.1C are equal to the Level B zone to avoid any unnecessary takes related to behavioral disturbance.

Table 3.3.1B. Mitigation and Monitoring Zones[1,2,3,4] during Impact Pile Driving for Summer and Winter (adapted from PSMMP dated April 2022)

Species	Summer (May through November)		Winter (December only)	
	Pre-start Clearance Zone (m)[5]	Shutdown Zone (m)[6]	Pre-start Clearance Zone (m)[5]	Shutdown Zone (m)[6]
Low-frequency cetaceans (see Table 1-11C below for NARW)	1,650	1,650	2,490	2,490
Mid-frequency cetaceans (sperm whale only)	1,650	1,650	2,490	2,490
Sea Turtles	500	500	500	500

Source: HDR, Inc. 2022b
PSMMP = Protected Species Mitigation and Monitoring Plan; m = meters; NARW = North Atlantic right whale; dB = decibels
[1] Zones are based upon the following modeling assumptions:
• 8/11-m (tapered) monopile with 10 dB broadband sound attenuation.
• Either one or two monopiles driven per day, and either two or three pin piles driven per day. When modeled injury (Level A) threshold distances differed among these scenarios, the largest for each species group was chosen for conservatism.
[2] Zone monitoring will be achieved through a combined effort of passive acoustic monitoring and visual observation (but not to monitor vessel separation distance).
[3] Zones are derived from modeling that considered animal movement and aversion parameters (see more details in Section 3.2.6.2)
[4]Though zones for high-frequency cetaceans and seals were calculated, since these groups contain only non-ESA-listed species, they have been excluded from this table.
[5] The pre-start clearance zones for large whales are based upon the maximum Level A zone for each group. Turtle pre-clearance zones for impact pile driving
were based on the JASCO Animal Simulation Model Including Noise Exposure (JASMINE) open-source marine mammal movement and behavior model (3MB;
Houser 2006).
[6] The shutdown zones for large whales (including NARW) are based upon the maximum Level A zone for each group. No Level A exposures were calculated for blue whales resulting in no expected Level A exposure range; therefore, the exposure range for fin whales was used as a proxy due to similarities in species.
Turtle shutdown zones for impact pile driving were based on the same

Shutdown zones for impact pile driving

Construction

<table>
<tr><th>Measure</th><th>Description</th><th>Project Phase</th></tr>
<tr><td></td><td>JASMINE open-source marine mammal movement and behavior model as pre-clearance
zones (3MB; Houser 2006).

Table 3.3.1C. NARW Clearance and Real-time PAM Monitoring Zones1 during Impact Piling in Summer and Winter (adapted from
PSMMP dated April 2022)
<table>
<tr><th>Season</th><th>Minimum Visibility Zone[2]</th><th>PAM Clearance Zone (m)[3]</th><th>Visual Clearance Delay or Shutdown Zone (m)</th><th>PAM Clearance Delay or Shutdown Zone (m)</th></tr>
<tr><td>Summer</td><td>1,650</td><td>3,500</td><td>Any Distance[4]</td><td>1,650</td></tr>
<tr><td>Winter</td><td>2,490</td><td>3,800</td><td>Any Distance</td><td>2,490</td></tr>
</table>
Source: HDR, Inc. 2022b
NARW = North Atlantic right whale; PAM = passive acoustic monitoring; PSMMP = Protected Species Mitigation and Monitoring Plan; m = meters
[1] Ocean Wind may request modification to zones based on results of sound field verification
[2] The minimum visibility zones for NARWs are based upon the maximum Level A zones for the whale group.
[3] The PAM pre-start clearance zone was set equal to the Level B zone to avoid any unnecessary take.
[4.] If a NARW is visually observed at any distance during the pre-clearance period prior to piling start, piling will be delayed. If a NARW is visually observed at any distance during piling, then piling will be shut down as described. In other words, if a NARW enters an observer's field of view at any distance, construction delay and/or shutdown will be implemented.</td><td></td></tr>
<tr><td>Pre-start clearance for impact pile driving</td><td>

Ocean Wind has proposed that piling may be initiated at 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 and sea turtles for a minimum of 30 minutes and continue at all times during pile driving.
All shutdown zones will be confirmed to be free of marine mammals and sea turtles prior to initiating ramp-up and the low frequency cetacean shutdown zone will be fully visible, and the NARW acoustic zone monitored for at least 30 minutes prior to commencing ramp-up.
If a marine mammal or sea turtle is observed entering or within the relevant shutdown 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) or sea turtle(s) has voluntarily left the respective shutdown zones and been visually or acoustically confirmed beyond that shutdown zone, or when the additional time period has elapsed with no further sighting or acoustic detection (i.e., 15 minutes for dolphins, porpoises and seals and 30 minutes for whales, 30 minutes for sea turtles).
A PSO will observe a behavioral monitoring zone of 1,200 meters for all species of sea turtle; however the shutdown zone remains 500 meters.
</td><td>Construction</td></tr>
</table>

Measure	Description	Project Phase
Ramp-up (soft start) for impact pile driving	• Each monopile installation will begin with a minimum of 20-minute soft-start procedure. • Soft-start procedure will not begin until the shutdown zone has been cleared by the visual PSO and PAM operators. • If a marine mammal is detected within or about to enter the applicable shutdown zone, prior to or during the soft-start procedure, pile driving will be delayed until the animal has been observed exiting the shutdown zone or until an additional time period has elapsed with no further sighting (i.e., and 30 minutes for whales, and 30 minutes for sea turtles).	Construction
Shutdowns for impact pile driving	• If a marine mammal or sea turtle is detected entering or within the respective shutdown zones after pile driving has commenced, an immediate shutdown of pile driving will be implemented unless determined shutdown is not feasible due to an imminent risk of injury or loss of life to an individual (as described in the PSMMP dated April 2022). • If shutdown is called for but it is determined that shutdown is not feasible due to risk of injury or loss of life, there will be a reduction of hammer energy. • Following shutdown, pile driving will only be initiated once all shutdown zones are confirmed by PSOs to be clear of marine mammals and sea turtles for the minimum species-specific time periods. • The shutdown zone will be continually monitored by PSOs and PAM operators during any pauses in pile driving. • If a marine mammal or sea turtle is sighted within the shutdown zones 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 or sea turtles for 30 minutes.	Construction
Post-impact piling monitoring	PSOs will continue to survey the shutdown zones throughout the duration of pile installation and for a minimum of 30 minutes after piling has been completed.	Construction
Sound measurement s for impact pile driving	• Received sound measurements will be collected during driving of the first three monopiles installed over the course of the Project using an NMS. • The goals of the field verification measurements using an NMS include verification of modeled ranges; and providing sound measurements of impact pile driving using International Organization for Standardization (ISO)-standard methodology to build data that are comparable among projects. • Based on the sound field measurement results the Project may request a modification of the clearance and/or Shutdown zones	Construction
Impact Pile Driving Reporting	• All data recording will be conducted using Mysticetus or similar software. • Operations, monitoring conditions, observation effort, all marine mammal detections, and any mitigation actions will be recorded. • Members of the monitoring team must consult NMFS' NARW reporting systems for the presence of NARWs in the Project area. • DMAs will be reported across all Project vessels. • See additional details regarding reporting is provided below under "Reporting"	Construction
Vibratory Pile Driving		

<table>
<tr><th>Measure</th><th>Description</th><th>Project Phase</th></tr>
<tr><td>Visual monitoring for vibratory pile driving</td><td>• 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.
• PSOs will continue to survey the shutdown zone using visual protocols throughout the installation of each cofferdam sheet pile and for a minimum of 30 minutes after piling has been completed.
• Monitoring Equipment shall include:
– Two sets of 7 x 50 reticle binoculars
– Two hand-held or wearable NVDs
– Two IR spotlights
– One data collection software system
– Two PSO-dedicated VHF radios
– One digital single-lens reflex camera equipped with 300-mm lens</td><td>Construction</td></tr>
<tr><td>Daytime visual monitoring for vibratory pile driving</td><td>• Two PSOs will concurrently maintain watch from the construction or support vessel during the pre-start clearance period, throughout vibratory pile driving, and 30 minutes after piling is completed.
• Two PSOs will conduct observations concurrently.
• One observer will monitor the shutdown zones with the naked eye and reticle binoculars; one PSO will monitor in the same way but will periodically scan outside the shutdown zones.</td><td>Construction</td></tr>
<tr><td>Daytime visual monitoring during periods of low visibility for vibratory pile driving</td><td>One PSO will monitor the shutdown zone with the mounted infrared camera while the other maintains visual watch with the naked eye/binoculars.</td><td>Construction</td></tr>
<tr><td>Shutdown zones for vibratory pile driving</td><td>Shutdown zones and pre-clearance zones for Project vibratory pile driving activities are presented in Table 3.3.1D.

Table 3.3.1D. Mitigation and Monitoring Zones during Project Vibratory Sheet Pile Driving (adapted from PSMMP dated April 2022)
<table>
<tr><th>Species</th><th>Pre-start Clearance Zone[1] (m)</th><th>Shutdown Zone[2] (m)</th></tr>
<tr><td>Low-Frequency Cetaceans including NARW and Sperm whales</td><td>150</td><td>100</td></tr>
<tr><td>Medium-Frequency Cetaceans</td><td>150</td><td>50</td></tr>
<tr><td>Turtles</td><td>500</td><td>500</td></tr>
</table>
Notes: Zones are based on modeling with no animal movement or aversions applied.
m = meters
[1] The pre-start clearance zones for large whales, porpoises, and seals are based upon the maximum Level A zone (128.2 m) and rounded up for PSO clarity.
[2] The shutdown zones for low-frequency cetaceans (including NARW) and high-frequency cetaceans are based upon the maximum Level A zone for each group and rounded up for PSO clarity. Shutdown zones for mid-frequency cetaceans (e.g., other dolphins and pilot whales) were set using precautionary distances. PTS zones for sea turtles were not modeled so the same shutdown zone as impact pile driving were applied.</td><td>Construction</td></tr>
</table>

Measure	Description	Project Phase
Pre-start clearance for vibratory pile driving	- PSOs will monitor the shutdown zone for 30 minutes prior to the start of vibratory pile driving. - If a marine mammal or sea turtle is observed entering or within the respective shutdown zones, piling cannot commence until the animal(s) has exited the shutdown zone or time has elapsed since the last sighting (15 minutes for dolphins (mid-frequency cetaceans) and porpoises (high-frequency cetaceans) and pinnipeds, 30 minutes for large whales (low-frequency cetaceans) and 30 minutes for sea turtles). - Throughout the duration of all pile driving activity (impact and vibratory), a PSO will observe a behavioral monitoring zone of 1,200 meters for all species of sea turtles and will initiate a shutdown protocol if a sea turtle encroaches or is observed within 500 meters.	Construction
Shutdowns for vibratory pile driving	- If a marine mammal or sea turtle is observed entering or within the respective shutdown zones after sheet pile installation has commenced, a shutdown will be implemented as long as health and safety is not compromised. - The shutdown zone must be continually monitored by PSOs during any pauses in vibratory pile driving, activities will be delayed until the animal(s) has moved outside the shutdown zone and no marine mammals are sighted for a period of 30 minutes for whales or 15 minutes for dolphins, porpoises and pinnipeds, and sea turtles for 30 minutes.	Construction
Reporting	- All data recording will be conducted using Mysticetus or similar software. - Operations, monitoring conditions, observation effort, all marine mammal detections, and any mitigation actions will be recorded. - Members of the monitoring team must consult NMFS' NARW reporting systems for the presence of NARWs in the Project area. - Dynamic Management Areas (DMA) will be reported across all Project vessels. - See additional details regarding reporting is provided below under "Reporting"	Construction
HRG Surveys		

General Visual monitoring for HRG surveys	• The following mitigation and monitoring measures for HRG surveys apply only to sound sources with operating frequencies below 180 kHz. There are no mitigation or monitoring protocols required for sources operating >180 kHz. • Shutdown, pre-start clearance, and ramp-up procedures will not be conducted during HRG survey operations using only non-impulsive sources (e.g., Ultra-Short BaseLine [USBL] and parametric SBPs) other than non-parametric SBPs (e.g., CHIRPs). Pre-clearance and rampup, but not shutdown, will be conducted when using non-impulsive, non-parametric SBPs. • Shutdowns will be conducted for impulsive, non-parametric HRG survey equipment other than CHIRP SBPs operating at frequencies <180 kHz. • Monitoring Equipment − Two pairs of 7x50 reticle binoculars − One mounted thermal/IR camera system during nighttime and low visibility conditions − Two hand-held or wearable NVDs − Two IR spotlights − One data collection software system − Two PSO-dedicated VHF radios − One digital single-lens reflex camera equipped with a 300-mm lens • The PSOs will be responsible for visually monitoring and identifying marine mammals approaching or entering the established zones during survey activities. • Visual monitoring of the established Shutdown zones and monitoring zone will be performed by PSO teams on each survey vessel: − Four to six PSOs on all 24-hour survey vessels. − Two to three PSOs on all 12-hour survey vessels. − PSOs will work in shifts such that no one PSO will work more than 4 consecutive hours without a 2-hour break or longer than 12 hours during any 24-hour period. • Table 3.3.1E provides the list of the personnel on watch and monitoring equipment available onboard each HRG survey vessel. • Observations will take place from the highest available vantage point on all the survey vessels. General 360° scanning will occur during the monitoring periods, and target scanning by the PSO will occur if cued to a marine mammal. PSOs will adjust their positions appropriately to ensure adequate coverage of the entire shutdown and monitoring zones around the respective sound sources. • It will be the responsibility of the Lead PSO on duty to communicate the presence of marine mammals as well as to communicate and enforce the action(s) that are necessary to ensure mitigation and monitoring requirements are implemented as appropriate. • The PSOs will begin observation of the shutdown zones prior to initiation of HRG survey operations and will continue throughout the survey activity and/or while equipment operating below 180 kHz is in use. • PSOs will monitor the NMFS North Atlantic right whale reporting systems including WhaleAlert and SAS once every 4-hour shift during Project-related activities.	Construction, O&M

<table>
<tr><th>Measure</th><th>Description</th><th>Project Phase</th></tr>
<tr><td></td><td>

PSOs will monitor Mysticetus (or similar data system) and/or appropriate data systems for DMAs established within their survey area.
PSOs will also monitor the NMFS North Atlantic right whale reporting systems including Whale Alert and RWSAS once every 4-hour shift during Project-related activities within, or adjacent to, Seasonal Management Areas (SMA) and/or DMAs.

Table 3.3.1E. Personnel and Equipment Compliment for Monitoring Vessels during HRG Surveys.
<table>
<tr><td>Item</td><td>Number on Survey Vessel</td></tr>
<tr><td>PSOs on watch (Daytime)</td><td>1</td></tr>
<tr><td>PSOs on watch (Nighttime)</td><td>2</td></tr>
<tr><td>Reticle binoculars</td><td>2</td></tr>
<tr><td>Mounted thermal/IR camera system</td><td>1</td></tr>
<tr><td>Hand-held or wearable NVD</td><td>2</td></tr>
<tr><td>IR spotlights</td><td>2</td></tr>
<tr><td>Data collection software system</td><td>1</td></tr>
<tr><td>PSO-dedicated VHF radios</td><td>2</td></tr>
<tr><td>Digital single-lens reflex camera equipped with 300-mm lens</td><td>1</td></tr>
</table>
IR = infrared; NVD = night vision devices; PSO = protected species observer; VHF = very high frequency.
</td><td></td></tr>
<tr><td>Autonomous Surface Vehicle/ (ASV) Operations for HRG Surveys</td><td>

Mobile and hybrid PAM systems utilizing autonomous surface vehicles (ASVs) and radio-linked autonomous acoustic recorders (AARs) shall be considered when they can meet monitoring and mitigation requirements in a cost-effective manner.
Should an ASV be utilized during surveys, the following procedures will be implemented:

PSOs will be stationed aboard the mother vessel to monitor the ASV in a location which will offer a clear, unobstructed view of the ASV’s shutdown and monitoring zones.
When in use, the ASV will be within 800 meters (2,625 ft.) of the primary vessel while conducting survey operations.
For monitoring around an ASV, if utilized, a dual thermal/high definition (HD) camera will be installed on the mother vessel facing forward and angled in a direction so as to provide a field of view ahead of the vessel and around the ASV.
PSOs will be able to monitor the real-time output of the camera on hand-held iPads. Images from the cameras can be captured for review and to assist in verifying species identification.
A monitor will also be installed on the bridge displaying the real-time picture from the thermal/HD camera installed on the front of the ASV itself, providing an additional forward field of view of the craft.
Night-vision goggles with thermal clip-ons, as mentioned above, and a hand-held spotlight will be provided such that PSOs can focus observations in any direction around the mother vessel and/or the ASV.

</td><td>Construction, O&M</td></tr>
</table>

Measure	Description	Project Phase
Daytime visual monitoring for HRG surveys *(period between nautical twilight rise and set for the region)*	• One PSO on watch during all pre-clearance periods and all source operations. • PSOs will use reticle binoculars and the naked eye to scan the monitoring zone for marine mammals and sea turtles	Construction, O&M
Nighttime and low visibility visual monitoring for HRG surveys	• The lead PSO will determine if conditions warrant implementing reduced visibility protocols. • Two PSOs on watch during all pre-clearance periods and operations. • Each PSO will use the most appropriate available technology (i.e., IR camera and NVD) and viewing locations to monitor the shutdown zones and maintain vessel separation distances.	Construction, O&M
Shutdown zones for HRG surveys	• North Atlantic right whale: 500 meters (547 yards). • Fin whale, sei whale, blue whale, sperm whale, and all species of sea turtles: 100 meters (110 yards).	Construction, O&M
Pre-start clearance for HRG surveys	• Pre-start clearance survey will only be conducted for non-impulsive, non-parametric SBPs and impulsive, non-parametric HRG survey equipment other than CHIRP SBPs operating at frequencies <180 kHz • Prior to the initiation of equipment ramp-up, PSOs and PAM operators will conduct a 30-minute watch of the shutdown zones to monitor for marine mammals. • The shutdown zones must be visible using the naked eye or appropriate visual technology during the entire clearance period for operations to start; if the shutdown zones are not visible, source operations <180 kHz will not commence. • If a marine mammal is observed within its respective shutdown zone during the pre-clearance period, ramp-up will not begin until the animal(s) has been observed exiting its respective shutdown zone or until an additional time period has elapsed with no further sighting (i.e., 30 minutes for large whales, and 30 minutes for sea turtles).	Construction, O&M

Measure	Description	Project Phase
Ramp-up (soft start) for HRG surveys	- Ramp-ups will only be conducted for non-impulsive, non-parametric SBPs and impulsive, non-parametric HRG survey equipment other than CHIRP SBPs operating at frequencies <180 kHz. - Where technically feasible, a ramp-up procedure will be used for HRG survey equipment capable of adjusting energy levels at the start or restart of HRG survey activities. Ramp-up procedures provide additional protection to marine mammals near the Project area by allowing them to vacate the area prior to the commencement of survey equipment use. - Ramp-up will not be initiated during periods of inclement conditions or if the shutdown 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 in power 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. - Ramp-up will continue once 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, 30 minutes for all other marine mammal species, and 30 minutes for sea turtles).	Construction, O&M
Shutdowns for HRG surveys	- Shutdowns will only be conducted for impulsive, non-parametric HRG survey equipment other than CHIRP SBPs operating at frequencies <180 kHz if a marine mammal or sea turtle is sighted at or within its respective shutdown zone. - Shutdowns will not be implemented for dolphins that voluntarily approach the survey vessel. - An immediate shutdown of the applicable HRG survey equipment (i.e., select sources operating <180 kHz) will be required if a marine mammal is sighted at or within its respective shutdown zone. - The vessel operator must comply immediately with any call for shutdown by the Lead PSO. Any disagreement between the Lead PSO and vessel operator should be discussed only after shutdown has occurred. - Subsequent restart of the survey equipment can be initiated if the animal has been observed exiting its respective shutdown zone within 30 minutes of the shutdown 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). Survey vessels may power down electromechanical equipment to lowest power output that is technically feasible for these species. - 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 or sea turtle have occurred within the respective shutdown zones. - If the acoustic source is shut down for a period longer than 30 minutes or PSOs were unable to maintain constant observation, then ramp-upand pre-start clearance procedures will be initiated.	Construction, O&M

Measure	Description	Project Phase
Shutdown zones for HRG surveys	Shutdowns will only be conducted for impulsive, non-parametric HRG survey equipment other than CHIRP SBPs operating at frequencies <180 kHz. Shutdown Zones: – North Atlantic right whale: 500 meters (547 yards). – Fin whale, minke whale, sei whale, humpback whale, blue whale, sperm whale, Risso's dolphin, long & short-finned pilot whales, harbor porpoise, gray seal, harbor seal, and all species of sea turtles: 100 meters (110 yards). Delphinids (Atlantic white sided dolphin, Atlantic spotted dolphin, short-beaked common dolphin, and bottlenose dolphin [coastal and offshore stocks]): no shutdown zone.	Construction, O&M
Post-construction HRG survey reporting	All data recording will be conducted using Mysticetus or similar software. Operations, monitoring conditions, observation effort, all marine mammal detections, and any mitigation actions will be recorded. Post-construction, Ocean Wind will provide to BOEM and NMFS a final report annually for HRG survey activities. The final report must address any comments on the draft report provided to Ocean Wind by BOEM and NMFS. The report must include a summary of survey activities, all PSO and incident reports, and an estimate of the number of listed marine mammals observed and/or taken during these survey activities. See additional details regarding reporting is provided below under "Reporting"	Construction
UXOs		

Measure	Description	Project Phase
Visual monitoring during UXO detonations (vessel based)	Monitoring Equipment – 2 visual PSOs and 1 PAM operator will be on watch on each PSO vessel. – There will be a team of six to eight visual and acoustic PSOs on UXO monitoring vessels. – A single vessel is anticipated to adequately cover a radius of 2000 meters. See additional details regarding reporting is provided below under "Reporting" – PAM operators may be located remotely/onshore. – 2 reticle binoculars – 1 pair of mounted "big eye" binoculars – Data collection software system – PSO-dedicated VHF radios Digital single-lens reflex camera equipped with 300-mm lens. Visual monitoring will be conducted from the primary monitoring vessel, and an additional vessel in cases where the monitoring zone is greater than 2,000 meters. (see Table 3.3.1F below). Daytime visual monitoring is defined by the period between civil twilight rise and set for the region. During the 60 minutes pre-start clearance period and 60 minutes after the detonation event, two PSOs will always maintain watch on the primary vessel; likewise, two PSOs will also maintain watch during the same time periods from the secondary vessel. The total number of observers will be dictated by the personnel necessary to adhere to standard shift schedule and rest requirements while still meeting mitigation monitoring requirements for the Project. During daytime observations, two PSOs on each vessel will monitor the clearance zones with the naked eye and reticle binoculars. One PSO will periodically scan outside the clearance zones using the mounted big eye binoculars. PSOs will visually monitor the maximum low frequency (Large Whale) preclearance zones. This zone encompasses the maximum Level A exposure ranges for all ESA-listed marine mammal species. The number of vessels deployed will depend on monitoring zone size and safety set back distance from detonation. Enough vessels will be deployed to cover the clearance and shutdown zones 100% and be determined by: the detonation category and associated clearance zone size, use of NMS, and minimum distance allowed to the detonation location. There will be a PAM operator on duty conducting acoustic monitoring in coordination with the visual PSOs during all pre-start clearance periods and post-detonation monitoring periods. Acoustic monitoring will include, and extend beyond, the pre-start clearance zone identified in Table 3.3.1E. Fish mitigation and monitoring measures during UXO detonations will include the use of an NMS and post-detonation monitoring for injured and/or dead fish. It is not possible to maintain pre-start clearance zones or conduct visual monitoring for fish prior to UXO detonations. Any fish kills involving protected species will be reported to the appropriate agencies.	Construction

Measure	Description	Project Phase
Visual Monitoring during UXO detonations (Aerial Alternative)	- Aerial surveys are typically limited by low cloud ceilings, aircraft availability, survey duration, and HSE considerations and therefore are not considered feasible or practical for all detonation monitoring. However, some scenarios may necessitate the use of an aerial platform. For unmitigated detonations with clearance zones greater than 5 km, deployment of sufficient vessels may not be feasible or practical. For these events, visual monitoring will be conducted from an aerial platform. - During the 60-minute pre-start clearance period and after the detonation event as flight time allows, two PSOs will be deployed on an aerial platform. - Surveys will be conducted in a grid with 1 km line spacing, encompassing the clearance zone. - PSOs will monitor the clearance zones with the naked eye and reticle binoculars. - Aerial PSOs may exceed 4-hour watch duration but will be limited by total flight duration not likely to exceed 6 hours. - PSOs will visually monitor the maximum low-frequency cetacean pre-start clearance zones (Table 3.3.1F). This zone encompasses the maximum Level A exposure ranges for all marine mammal species except harbor porpoise, where Level A take has been requested due to the large zone sizes associated with high-frequency cetaceans (e.g., up to 16 km for an E12 detonation). - There will be a PAM operator on duty conducting acoustic monitoring in coordination with the visual PSOs during all pre-start clearance periods and post-detonation monitoring periods. - Acoustic monitoring, will include, and extend beyond, the low-frequency cetaceans pre-start clearance zone.	Construction
Time of Year/ Nighttime Restrictions	- No UXO detonations are planned between January and April. - No UXO will be detonated during nighttime hours.	Construction

Measure	Description	Project Phase
Passive acoustic monitoring during UXO detonations	Acoustic monitoring will be conducted prior to any UXO detonation event in addition to visual monitoring in order to ensure that no marine mammals are present in the designated pre-clearance zones. PAM operators will acoustically monitor a zone that encompasses a minimum of a 10-km radius around the source. PAM will be conducted in daylight as no UXO will be detonated during nighttime hours. One PAM operator may be stationed on the vessel or at an alternative monitoring location It is expected there will be a PAM operator stationed on at least one of the dedicated monitoring vessels in addition to the PSOs; or located remotely/onshore. PAM operators will complete specialized training for operating PAM systems prior to the start of monitoring activities. All on-duty PSOs will be in contact with the PAM operator on-duty, who will monitor the PAM systems for acoustic detections of marine mammals that are vocalizing in the area. For real-time PAM systems, at least one PAM operator will be designated to monitor each system by viewing data or data products that are streamed in real-time or near real-time to a computer workstation and monitor located on a Project vessel or onshore. The PAM operator will inform the Lead PSO on duty of animal detections approaching or within applicable ranges of interest to the detonation activity via the data collection software system (i.e., Mysticetus or similar system) who will be responsible for requesting the designated crewmember to implement the necessary mitigation procedures.	Construction

<table>
<tr><th>Measure</th><th>Description</th><th>Project Phase</th></tr>
<tr><td>Pre-start clearance for UXO detonations</td><td>

A 60-minute pre-start clearance period will be implemented prior to any UXO detonation. Visual PSOs will begin surveying the monitoring zone at least 60 minutes prior to the detonation event. PAM will also begin 60 minutes prior to the detonation event
The pre-clearance zones (Table 3.3.1F) must be fully visible for at least 60 minutes prior to commencing detonation.
All marine mammals must be confirmed to be out of the clearance zone prior to initiating detonation.
If a marine mammal is observed entering or within the relevant clearance zones prior to the initiation of detonation activity, the detonation must be delayed.
The detonation may commence when either the marine mammal(s) has voluntarily left the respective clearance zone and been visually confirmed beyond that clearance zone, or, when 60 minutes have elapsed without redetection for whales, including the NARW.

Table 3.3.1F. Mitigation and Monitoring Zones Associated with Mitigated (10 dB attenuation) UXO Detonation of Binned Charge Weights (adapted from PSMMP dated April 2022).
<table>
<tr><th rowspan="2">Species</th><th>E4 (2.3 kg)</th><th>E6 (9.1 kg)</th><th>E8 (45.5 kg)</th><th>E10 (227 kg)</th><th>E12 (454 kg)</th></tr>
<tr><th>Pre-Start Clearance Zone[2] (m)</th><th>Pre-Start Clearance Zone[2] (m)</th><th>Pre-Start Clearance Zone[2] (m)</th><th>Pre-Start Clearance Zone[2] (m)</th><th>Pre-Start Clearance Zone[2] (m)</th></tr>
<tr><td>Low-Frequency Cetaceans</td><td>552</td><td>982</td><td>1,730</td><td>2,970</td><td>3,780</td></tr>
<tr><td>Mid-Frequency Cetaceans</td><td>50</td><td>75</td><td>156</td><td>337</td><td>461</td></tr>
<tr><td>Turtles</td><td><50</td><td>54</td><td>159</td><td>348</td><td>472</td></tr>
</table>
Source: Hannay and Zykov 2022
Notes:
[1] UXO charge weights are groups of similar munitions defined by the U.S. Navy and binned into five categories (E4-E12) by weight (equivalent weight in TNT). Four project sites (S1-S4) were chosen and modeled for the detonation of each charge weight bin.
Though zones for high-frequency cetaceans and phocid pinnipeds were calculated, since these groups contain only non-ESA-listed species, they have been excluded from this table.
[2] Pre-start clearance zones were calculated by selecting the largest R95% distance to the permanent threshold shift (PTS) threshold found in Tables 21 through 24 of Hannay And Zykov 2022 and based on the SEL thresholds. The chosen values were the most conservative per charge weight bin across each of the four modeled sites. All values were taken from sites 1 and 2 which had the highest R95% ranges for the onset of PTS in low frequency cetaceans, mid-frequency cetaceans, and sea turtles.
UXO = unexploded ordinance; PSMMP = Protected Species Mitigation and Monitoring Plan; m = meters; kg = kilograms; TNT = trinitrotoluene; PK = peak pressure level; SEL = sound exposure level.
</td><td>Construction</td></tr>
</table>

Measure	Description	Project Phase
Noise attenuation for UXO detonations	Ocean Wind will use an NMS for all detonation events and is committed to achieving the modeled ranges associated with 10 dB of noise attenuation	Construction
Fisheries Monitoring		
General Measures	• Fisheries Monitoring for the Project will consist of regular surveys carried out by academic partners from Rutgers University, Monmouth University, and Delaware State University. • Fisheries monitoring was designed in accordance with recommendations set forth in "Guidelines for Providing Information on Fisheries for Application for Renewable Energy Development on the Atlantic Outer Continental Shelf" (BOEM 2019) and consideration to the Responsible Offshore Science Alliance (ROSA) Offshore Wind Project Monitoring Framework and Guidelines. • All vessels will comply with the vessel speed plan as outlined above for vessel speed restrictions – standard and adaptive plans • Marine mammal watches and monitoring will occur during daylight hours prior to deployment of gear (e.g., trawls, longline gear) and will continue until gear is brought back on board. • If marine mammals are sighted in the area within 15 minutes prior to deployment of gear and are considered to be at risk of interaction with the research gear, then the sampling station is either moved or canceled or the activity is suspended until there are no sightings of any marine mammal for 15 minutes within 1 nautical mile (1852 meters) of sampling location.	Pre-Construction, Construction, O&M, decommissioning

Measure	Description	Project Phase
Trawl Surveys	- Marine mammal monitoring will be conducted by the captain and/or a member of the scientific crew before, during, and after haul back. - Trawl operations will commence as soon as possible once the vessel arrives on station; the target tow time will be limited to 20 minutes. - Ocean Wind will initiate marine mammal watches (visual observation) within 1 nautical mile (1852 meters) of the site 15 minutes prior to sampling. - If a marine mammal is sighted within 1 nautical mile (1,852 meters) of the planned sampling station in the 15 minutes before gear deployment, Ocean Wind will delay setting the trawl until marine mammals have not been resighted for 15 minutes or Ocean Wind may move the vessel away from the marine mammal to a different section of the sampling area. If, after moving on, marine mammals are still visible from the vessel, Ocean Wind may decide to move again or to skip the sampling station. - Ocean Wind will maintain visual monitoring effort during the entire period of time that trawl gear is in the water (i.e., throughout gear deployment, fishing, and retrieval). If marine mammals are sighted before the gear is fully removed from the water, (i.e., prior to haul back) the vessel will slow its speed and steer away from the sighted animal in order to minimize potential interactions. Further mitigating actions can be taken following consultation with and guidance from the NMFS Protected Resources Division. - Ocean Wind will open the codend of the net close to the deck/sorting area to avoid damage to animals that may be caught in gear. - Gear will be emptied as close to the deck/sorting area and as quickly as possible after retrieval. - Trawl nets will be fully cleaned and repaired (if damaged) before setting again. - Ocean Wind does not anticipate and is not requesting take of marine mammals incidental to research trawl surveys but, in the case of a marine mammal interaction, the Marine Mammal Stranding Network will be contacted immediately.	Pre-Construction, Construction, O&M, decommissioning

Measure	Description	Project Phase
Structured Habitat Surveys (Chevron traps and Baited Remote Underwater Video [BRUVs])	- The chevron traps and BRUVs will be deployed on a limited soak duration (90 minutes or less), and the vessel will remain on location with the gear while it is sampling. - Buoy/end lines with a breaking strength of <1,700 pounds (lbs) will be used. All buoy line will use weak links that are chosen from the list of NMFS approved gear. This may be accomplished by using whole buoy line that has a breaking strength of 1,700 lbs; or buoy line with weak inserts that result in line having an overall breaking strength of 1,700 lbs. - All buoys will be labeled as research gear, and the scientific permit number will be written on the buoy. All markings on the buoys and buoy lines will be compliant with the regulations, and all buoy markings will comply with any specific marking instructions received by staff at NOAA Greater Atlantic Regional Fisheries Office Protected Resources Division. - Any lines that go missing will be reported to the NOAA Greater Atlantic Regional Fisheries Office Protected Resources Division as soon as possible. - The Project Team will not deploy either the chevron traps or the BRUVs if marine mammals are sighted near the proposed sampling station. Gear will not be deployed if marine mammals are observed within the area and if a marine mammal is deemed to be at risk of interaction, all gear will be immediately removed.	Pre-Construction, Construction, O&M, decommissioning
Acoustic Telemetry Surveys	- No specific mitigation relevant to this type of survey - Vessel mitigation measures outlined above for all Project vessels will be employed while collecting samples.	Pre-Construction, Construction, O&M, decommissioning
eDNA Sampling	- Will coincide with the bottom trawl survey and associated mitigation measures. No specific mitigation relevant to this type of survey. - Vessel mitigation measures outlined above for all Project vessels will be employed while collecting samples.	Pre-Construction, Construction, O&M, decommissioning
Rod and reel surveys	- No specific mitigation relevant to this type of survey - Vessel mitigation measures outlined above for all Project vessels will be employed while collecting samples.	Pre-Construction, Construction, O&M, decommissioning
Clam Survey	- No specific mitigation relevant to this type of survey - Vessel mitigation measures outlined above for all Project vessels will be employed while collecting samples.	Pre-Construction, Construction, O&M, decommissioning

Measure	Description	Project Phase
Glider – Oceanography	• No specific mitigation relevant to this type of survey • Vessel mitigation measures outlined above for all Project vessels will be employed while retrieving equipment	Pre-Construction, Construction, O&M, decommissioning
Pelagic Fish	• Similar mitigation will be applied as described above for Structured Habitat Surveys • Vessel mitigation measures outlined above for all Project vessels will be employed while retrieving equipment and collecting samples	Pre-Construction, Construction, O&M, decommissioning
Reporting Requirements		
Injured protected species reporting	• Any potential, strikes, stranded, entangled, or dead/injured protected species regardless of cause, should be reported by the vessel captain or the PSO onboard to the Greater Atlantic (Northeast) Region Marine Mammal and Sea Turtle Stranding and Entanglement Hotline (866-755-NOAA [6622]) within 24 hours of a sighting, regardless of whether the injury or death is caused by a vessel. • If the injury or death was caused by a Project activities, the vessel captain or PSO on board will ensure that NMFS is notified immediately to the NMFS Office of Protected Resources and Greater Atlantic Regional Fisheries Office and no later than within 24 hours. The notification will include date and location (latitude and longitude) of the incident, name of the vessel/platform involved, and the species identification or a description of the animal, if possible. If the Project activity is responsible for the injury or death, Ocean Wind will supply a vessel to assist in any salvage effort as requested by NMFS. • If a NARW is involved in any of the above-mentioned incidents then the vessel captain or PSO onboard should also notify the Right Whale • Sighting Advisory System (RWSAS) hotline immediately and no later than within 24 hours. • PSOs/PAM operators will report any observations concerning impacts on marine mammals to NMFS within 48 hours. • BOEM and NMFS will be notified within 24 hours if any evidence of a fish kill during construction activity is observed. • Any NARW sightings will be reported as soon as possible, and no later than within 24 hours, to the NMFS RWSAS hotline or via the Whale Alert Application. Any NARW sightings will be reported as soon as possible, and no later than within 24 hours, to the NMFS RWSAS hotline or via the Whale Alert Application.	Construction, O&M, decommissioning
Report of activities and observations	Ocean Wind will provide NMFS with a report within 90 calendar days following the completion of construction and HRG surveys, including a summary of the activities and an estimate of the number of marine mammals taken.	Construction, O&M, decommissioning

Measure	Description	Project Phase
Report information	- Data on all marine mammal observations will be recorded and based on standards of marine mammal observer collection data by the PSOs. This information will include dates, times, and locations of survey operations; time of observation, location and weather; details of marine mammal sightings (e.g., species, numbers, behavior); and details of any observed taking (e.g., behavioral disturbances or injury). - All vessels will utilize a standardized data entry format. - A QA/QC'd database of all sightings and associated details (e.g., distance from vessel, behavior, species, group size/composition) within and outside of the designated shutdown zones, monitoring effort, environmental conditions, and Project-related activity will be provided after field operations and reporting are complete. 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 0498 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 Wednesday following a Sunday-Saturday period. - Final reports will follow a standardized format for PSO reporting from activities requiring marine mammal mitigation and monitoring. - 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.	Construction, O&M, decommissioning
SAV/Seabed Disturbance		
Siting	Site cable landfall and offshore facilities to avoid known locations of sensitive benthic habitat, to the extent practicable. Avoid SAV communities, where practicable and restore any damage to these communities.	Construction, O&M, decommissioning
Port construction and vessel traffic	Use existing port and onshore operations and maintenance facilities to the extent practicable and minimize impacts to seagrass by restricting vessel traffic to established traffic routes where these resources are present.	Construction, O&M, decommissioning
Monitoring	Develop and implement a site-specific monitoring program to ensure environmental conditions are monitored during construction, operation, and decommissioning phases, designed to ensure environmental conditions are monitored and reasonable actions are taken to avoid and/or minimize seabed disturbance and sediment dispersion, consistent with permit conditions. The monitoring plan will be developed during the permitting process, in consultation with resource agencies.	Construction, O&M, decommissioning
Construction	- To the extent practicable, use appropriate installation technology designed to minimize disturbance to seagrass beds; avoid anchoring on sensitive habitat; and implement turbidity reduction measures to minimize impacts to sensitive habitats from construction. - Take reasonable actions (use BMPs) to minimize seabed disturbance and sediment dispersion during cable installation and construction of Project facilities	Construction

Measure	Description	Project Phase
Mitigation	Implement the SAV Mitigation Plan dated November 2022 (Ocean Wind 2022b), which includes mapping efforts, monitoring activities, restoration of documented activities at an in-situ 1:1 ratio, annual reporting, as well as additional research to improve SAV mitigation in the future.	Pre-construction, construction, O&M
BOEM PDCs/BMPs		
COP PDCs/APMs	Site offshore facilities to avoid known locations of sensitive habitat or species during sensitive periods; important marine habitat; and sensitive benthic habitat to the extent practicable. Avoid hard-bottom habitats and seagrass communities, where practicable, and restore any damage to these communities	Pre-construction
COP PDCs/APMs	Use standard underwater cables which have electrical shielding to control the intensity of EMF.	Construction, O&M
COP PDCs/APMs	Conduct an SAV survey of the proposed inshore export cable route.	Pre-construction
COP PDCs/APMs	Evaluate geotechnical and geophysical survey results to identify sensitive habitats and avoid these during construction, to the extent practicable.	Construction
COP PDCs/APMs	Obtain necessary permits to address potential impacts on marine mammals from underwater noise and established appropriate and practicable mitigation and monitoring measures in coordination with regulatory agencies.	Construction, O&M
COP PDCs/APMs	Lessees and grantees should evaluate marine mammal use of the proposed Project area and should design the Project to minimize and mitigate the potential for mortality or disturbance. The amount and extent of ecological baseline data required should be determined on a project basis.	Pre-construction
COP PDCs/APMs	Vessels related to Project planning, construction, and operation should travel at reduced speeds when assemblages of cetaceans are observed. Vessels also should maintain a reasonable distance from whales, small cetaceans, and sea turtles, and these should be determined during site-specific consultations.	Construction, O&M, decommissioning
COP PDCs/APMs	Lessees and grantees should minimize potential vessel impacts to marine mammals and sea turtles by having Project-related vessels follow the National Marine Fisheries Service (NMFS) Regional Viewing Guidelines while in transit. Operators should undergo training on applicable vessel guidelines.	Construction, O&M, decommissioning
COP PDCs/APMs	Lessees and grantees should take efforts to minimize disruption and disturbance to marine life from sound emissions, such as pile driving, during construction activities.	Construction, O&M, decommissioning

Measure	Description	Project Phase
COP PDCs/APMs	Lessees and grantees should avoid and minimize impacts to marine species and habitats in the Project area by posting a qualified observer on site during construction activities. These observers are approved by NMFS.	Construction
Dredge BMP – USACE 2022	- Utilizing closed environmental clamshell bucket equipped with sensors - Controlled lift speed - Holding times for water decanting - No barge overflow - Limited rinsing/hosing of barge to prevent runoff - Discharge of decant water into same water body from which it came - Water quality (TSS & turbidity) monitoring - Silt curtain (along shallow areas vs construction area) as feasible. For example, during the HDD exit pit excavation dredging within Barnegat Bay along the Oyster Creek export cable routes. Additionally, during ultrashallow dredging in proximity to SAV beds, the installation of silt curtains is being considered parallel to the SAV beds to reduce sediment deposition in these sensitive areas.	Construction, O&M, decommissioning
Jetting Installation BMPs – USACE 2022	- Modifying installation speed/jetting pressure to minimize sediment resuspension - Water quality (TSS & turbidity) monitoring - Silt curtain (along shallow areas vs construction area) as feasible	Construction, O&M, decommissioning
BMPs for SAV	- Use of horizontal directional drilling (HDD) where feasible will allow the Project to avoid areas of SAV during construction on the eastern and western shorelines of Barnegat Bay and in Peck Bay - Although some in-water work in Barnegat Bay within 500 feet of SAV beds will occur in September and October, the current Ocean Wind construction schedule enables most of the in-water work within known SAV habitat to be conducted late fall through early spring which is outside the growing season for SAV - BMPs to be implemented when construction activities are within 500 feet (152 meters) from SAV beds: – Use of silt curtains along shallow areas to the maximum extent practicable (based on hydrodynamics and water depth) – Utilization of a closed environmental clamshell bucket equipped with sensors during dredging activities – Modifying installation speed/jetting pressure during cable lay to minimize sediment resuspension and water quality (TSS and turbidity)	Construction, O&M, decommissioning

Measure	Description	Project Phase
SAV site-specific monitoring program	The Project will develop and implement a site-specific monitoring program to ensure that environmental conditions are monitored before and after construction to determine the amount of restoration required. The monitoring plan is in the process of being developed in consultation with resource agencies. If required based on the results of monitoring, restoration may include the following: onsite in-kind restoration which may include transplanting or seed dispersion to restore the disturbed area to its preconstruction contours and conditions, offsite in-kind restoration, onsite ecological enhancement of similar ecological function and value, other options including stakeholder mitigation to be coordinated with the NJDEP, NOAA and consulting parties or a combination of the above.	Construction, O&M, decommissioning

Source: Ocean Wind 2022 HDR, Inc. 2022a, 2022b

AAR = autonomous acoustic recorder; APM = Applicant Proposed Measure; ASV = autonomous surface vehicle; BMP = best management practice; BOEM = Bureau of Ocean Energy Management; CHIRP = compressed high-intensity radar pulse, dB = decibels; DE = Delaware; DMA = Dynamic Management Area; EMF = electromagnetic field; ESA = Endangered Species Act; ft. = feet; h = hour; HD = high definition; HRG = high-resolution geophysical; IR = infrared; HSE = health, safety, and environment; IR = infrared; ISO = International Organization for Standardization; ITA = Incidental Take Authorization; kg = kilograms; kHz = kilohertz; km = kilometers; lbs = pounds; LOA = Letter of Authorization; Lrms = root mean squared sound pressure level; m = meters; MD = Maryland; mm = millimeters; NARW = North American right whale; NJ = New Jersey; NMFS = National Marine Fisheries Service; NMS = noise mitigation system; NOAA = National Oceanic and Atmospheric Administration; NVD = night-vision device; NY = New York; O&M = operations and maintenance; OSS = offshore substation; PAM = passive acoustic monitoring; PDC = Project Design Criteria; PECP = permits and environmental compliance; PSMMP = Protected Species Mitigation and Monitoring Plan; PSO = protected species observer; PTS = permanent threshold shift; QA/QC = quality assurance/quality control; ROSA = Responsible Offshore Science Alliance; RWSAS = Right Whale Sighting Advisory System; SAS = sighting advisory system; SAV = submerged aquatic vegetation; SBP = sub-bottom profiler; SFV = sound field verification; SMA = Seasonal Management Area; SPL = sound pressure level; USBL = Ultra-Short BaseLine; USACE 2022 = Ocean Wind USACE Permit Application Package, Attachment 02 Environmental Assessment, April 27, 2022; UXO = unexploded ordnance; VHF = very high frequency

Table 3.3.2. Additional Proposed Mitigation Monitoring, and Reporting Measures – BOEM Proposed

Measure	Description	Project Phase
Incorporate LOA requirements	The measures required by the final MMPA LOA would be incorporated into COP approval, and BOEM and/or BSEE would monitor compliance with these measures.	Years 1–5 construction and post-construction activities
PAM Plan	BOEM and USACE would ensure that Ocean Wind 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.	Construction and post-construction monitoring

Measure	Description	Project Phase
Pile driving monitoring plan	BOEM would ensure that Ocean Wind prepare and submit 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 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 Ocean Wind 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. Ocean Wind would obtain NMFS' concurrence with this plan prior to starting any pile driving.	Construction
PSO Coverage	BOEM and USACE would ensure that PSO coverage is sufficient to reliably detect whales and sea turtles at the surface in the identified clearance and shutdown zones to execute any pile driving delays or shutdown requirements. 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.	Construction
Sound field verification	BOEM and USACE would ensure that if the clearance and/or shutdown zones are expanded due to the 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.	Construction
Shut down zones	BOEM and USACE may consider reductions in the shutdown zones for sei, fin or sperm whales based upon sound field verification of a minimum of 3 piles; however, BOEM/USACE would ensure that the shutdown zone for sei whales, fin whales, blue whales, and sperm whales is not reduced to less than 1,000 meters, or 500 meters for sea turtles. No reductions in the clearance or shutdown zones for North Atlantic right whales would be considered regardless of the results of sound field verification of a minimum of three piles.	Construction
UXO detonations – Atlantic sturgeon	Ocean Wind would extend the APM seasonal restriction of UXO detonations (January to April) to include months of increased Atlantic sturgeon presence in the offshore wind area. No UXOs can be detonated from November to April in the offshore areas greater than 3 nautical miles (state waters). UXO surveys are expected in Fall of 2022 which defines the exact location and size of UXO.	Construction
Monitoring zone for sea turtles	BOEM and USACE would ensure that Ocean Wind monitors the full extent of the area where noise would exceed the 175 dB rms threshold for 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.	Construction

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, Ocean Wind would have a trained lookout posted on all vessel transits during all phases of the project to observe for sea turtles. The trained lookout would communicate any sightings, in real time, to the captain so that the requirements in I below can be implemented. b. For all vessels operating south of the Virginia/North Carolina border, year-round, Ocean Wind would have a trained lookout posted on all vessel transits during all phases of the project to observe for sea turtles. The trained lookout would communicate any sightings, in real time, to the captain so that the requirements I(e) below can be implemented. This requirement is 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 Vessel Strike Avoidance Zone (500 meters) at all times to maintain minimum separation distances from ESA-listed 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. 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 meters 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 meters at which time the vessel may resume normal operations. If a sea turtle is sighted within 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. 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 emergency basis. If any such incidents occur, they would 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 North Atlantic right whales, an additional lookout is not required and this PSO or trained lookout would 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.	All phases

Measure	Description	Project Phase
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
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 black and yellow 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
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
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 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).	All stages

Measure	Description	Project Phase
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 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 Ocean Wind 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.	Trawl and ventless trap surveys
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

Measure	Description	Project Phase
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/dammigration/sturgeon_&_sea_turtle_take_sops_external.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 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/dammigration/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 this 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://www.fisheries.noaa.gov/new-england-midatlantic/consultations/section-7-take-reporting-programmaticsgreater-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 NMFS Take Report Form would be filled out for each individual sturgeon and sea turtle (download at: https://media.fisheries.noaa.gov/2021-41507/Take%20Report%20Form%2007162021.pdf?null) and submitted to NMFS as described below.	All fisheries surveys

Measure	Description	Project Phase
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/dammigration/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 Actions. 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 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/dammigration-miss/Resuscitation-Cards-120513.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.	All fisheries surveys

Measure	Description	Project Phase
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 email 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 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.	All fishery surveys
Monthly/ annual reporting requirements	BOEM would ensure that Ocean Wind 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, Ocean Wind 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, Ocean Wind 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 BOEM, the frequency of reports can be changed.	Construction and operations

Measure	Description	Project Phase
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.	Construction and year 1 of operations
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 Ocean Wind project as applicable.	All phases

Measure	Description	Project Phase
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, or use of PAM and must demonstrate the ability and effectiveness to maintain all clearance and shutdown zones during daytime as outlined below in Part 1 and nighttime as outlined 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 2.4.2.5.4 of the Protected Species Mitigation Monitoring Plan (PSMMP). The Lessee would notify BOEM and NMFS of any shutdown occurrence during piling driving operations with 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 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 Ocean Wind's 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.	Construction

Measure	Description	Project Phase
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 10 of the WTGs located closest to shore in the Ocean Wind 1 Lease Area (OCS-A 0498) annually. Survey design and effort may be modified with review and concurrence by DOI. The Lessee may 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 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 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). Annual reports must also include claim data attributable to the Ocean Wind 1 project from Ørsted's corporate gear loss compensation policy and procedures. Required data and reports may be archived, analyzed, published, and disseminated by BOEM	Operations
PDC Minimize Vessel Interactions with Listed 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 specified 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 meters 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 meters 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 meters.	All phases
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 would be reviewed and approved by BOEM and NMFS.	Operations

AMP = Alternative Monitoring Plan; APM = Applicant Proposed Measure; BA = Biological Assessment; BMP = best management practice; BOEM = Bureau of Ocean Energy Management; BSEE = Bureau of Safety and Environmental Enforcement; CFR = Code of Federal Regulations; COP = Construction and Operations Plan; dB = decibels; DOI = Department of the Interior; DPS = distinct population segment; ESA = Endangered Species Act; GARFO = Greater Atlantic Regional Fisheries Office; GPR = Global Pocket Reader; GPS = global positioning system; IR = infrared; kHz = kilohertz; km/hr = kilometers per hour; LOA = Letter of Authorization; m = meters; m/s = meters per second; MMPA = Marine Mammal Protection Act of 1972; NEFOP = Northeast Fisheries Observer Program; NMFS = National Marine Fisheries Service; NOAA = National Oceanic and Atmospheric Administration; NVD = night vision device; PAM = passive acoustic monitoring; PIT = passive integrated transponder; PRD = Protected Resources Division; PSMMP = Protected Species Mitigation and Monitoring Plan; PSO = protected species observer; rms = root mean squared; STDN = Sea Turtle Disentanglement Network; SZ = shutdown zone;

USACE = U.S. Army Corps of Engineers; USCG = U.S. Coast Guard; UXO = unexploded ordnance; VHF = very high frequency; WTG = wind turbine generator

BOEM and NMFS OPR are proposing to require maintenance of clearance and shutdown zones before and during pile driving as well as clearance zones prior to UXO detonation. More information is provided in the *Effects of the Action* section of this Opinion. These zones are summarized in table 3.3.3. If a marine mammal is entering or within the respective shutdown zones after pile driving has commenced, an immediate shutdown of pile driving will be implemented unless Ocean Wind and/or its contractor determines shutdown is not feasible due to an imminent risk of injury or loss of life to an individual; or risk of damage to a vessel that creates risk of injury or loss of life for individuals. If shutdown is called for but Ocean Wind and/or its contractor determines shutdown is not feasible due to risk of injury or loss of life, reduced hammer energy must be implemented. As described in Ocean Wind's application for an MMPA ITA, there are two scenarios, approaching pile refusal and pile instability, where this imminent risk could be a factor; however, Ocean Wind describes a low likelihood of occurrence for the pile refusal/stuck pile or pile instability scenario as explained below.

Stuck Pile

If the pile driving sensors indicate the pile is approaching refusal, and a shut-down would lead to a stuck pile, shut down may be determined to be infeasible if the stuck pile is determined to pose an imminent risk of injury or loss of life to an individual, or risk of damage to a vessel that creates risk for individuals. This risk comes from the instability of a pile that has not reached a penetration depth where the pile would be considered stable. The pile could then fall and damage the vessel and/or personnel on board the vessel. In the MMPA ITA application, Ocean Wind describes their mitigation of this risk as follows, "Each pile is specifically engineered to manage the sediment conditions at the location at which it is to be driven, and therefore designed to avoid and minimize the potential for piling refusal. Orsted uses these pre-installation engineering assessments and design together with real-time hammer log information during installation to track progress and continuously judge whether a stoppage would cause a risk of injury or loss of life. Due to this advanced engineering and planning, circumstances under which piling could not stop if a shutdown is requested are very limited."

Pile Instability

A pile may be deemed unstable and unable to stay standing if the piling vessel were to "let go." During these periods of instability, the lead engineer may determine a shut-down is not feasible because the shutdown combined with impending weather conditions may require the piling vessel to "let go" which then poses an imminent risk of injury or loss of life to an individual, or risk of damage to a vessel that creates risk for individuals from a falling pile. In the MMPA ITA application, Ocean Wind describes their mitigation of this risk as follows, "For a specified project and installation vessel, weather conditions criteria will be established that determine when a piling vessel would have to "let go" of a pile being installed for safety reasons. To reduce the risk that a requested shutdown would not be possible due to weather, Orsted actively assesses weather, using two independent forecasting systems. Initiation of piling also requires a Certificate of Approval by the Marine Warranty Supervisor. In addition to ensuring that current weather conditions are suitable for piling, this Certificate of Approval process considers forecasted weather for 6 hours out and will evaluate if conditions would limit the ability to shut down and "let go" of the pile. If a shutdown is not feasible due to pile instability and weather, piling would continue only until a penetration depth sufficient to secure the pile is achieved. As piling instability is most likely to occur during the soft start period, and soft start cannot commence till the Marine Warranty Supervisor has issued a Certificate of Approval that signals there is a current weather window of at least 6 hours, the likelihood is low for the pile to not achieve stability within the 6-hour window inclusive of stops and starts."

Table 3.3.3. Proposed clearance and exclusion zones

Species	Clearance Zone (m)	Shutdown Zone (m)
Impact pile driving[a]		
North Atlantic right whale – visual PSO	any distance	any distance
North Atlantic right whale – PAM	3,500 (3,800)	1,650 (2,500)
Blue, fin, sei, and sperm whale	2,000 (2,500)	1,800 (2,500)
Sea Turtles	500	500
Vibratory pile driving		
NARW, blue, fin, sei, and sperm whale	150	100
Sea Turtles	500	500
UXO detonations		
NARW, blue, fin, and sei whale	10,000	NA
Sperm whale	2,000	NA
Sea Turtles	472	NA
HRG Surveys		
North Atlantic right whale	500	500
Blue, fin, sei, and sperm whale	100	100
Sea Turtles	100	100

a - Winter (i.e., December) distances are presented in parentheses.

3.4 Action Area

The action area is defined in 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 includes the WDA where project activities will occur and the surrounding areas ensonified by proposed Project noise; the two offshore export cable route corridors, Oyster Creek and BL England (see Figures 3.4.1, 3.4.2, 3.4.3, 3.4.4); the areas where HRG and fisheries and benthic resource surveys will take place; the vessel transit areas between the WDA and ports in New Jersey, Virginia, and South Carolina; and the routes used by vessels transporting manufactured components from Europe inclusive of the portion of the Atlantic Ocean that will be transited by those vessels and the territorial sea of nations along the European Atlantic coast from which those vessels will originate.

Materials for construction may be transported from ports outside the WDA, including Europe. The number of trips from outside of the United States, and which ports those trips could originate from, would not be fully known until contractors are selected and supply chains are established. Trips could originate from ports in Europe because many offshore wind components are currently manufactured there. Currently, most industry-specific vessels are located in Europe but as the industry matures in the United States, fewer trips from Europe will be necessary. Vessels transporting parts from the South Atlantic and/or Mid-Atlantic ports are expected to take the most direct route to the WDA and/or to ports in New Jersey, South Carolina, or Virginia, thus, we consider the action area to include portions of the North Atlantic Ocean where any project vessels transiting from the South Atlantic and/or Mid-Atlantic ports may operate. All trips originating from Europe will either travel directly to the project site within the NJ WEA or to one of the ports in Paulsboro, New Jersey; Norfolk, Virginia; or Hope Creek, New Jersey that were identified in the *Construction-Related Vessel Activity* section above. At this time, the port(s) of origin are unknown. All vessel routes will depend, on a trip-by-trip basis, on weather and sea-state conditions, other vessel traffic, and any maritime hazards. We assume that vessels traveling from Europe to the WDA or the NJ or VA ports will take the most direct route; thus, we consider the action area to include portions of the North Atlantic Ocean where project vessels transiting from Europe may operate.

Figure 3.4.1. Ocean Wind 1 Offshore Wind Farm proposed port turbine locations, inter-array cables, and export cable route locations

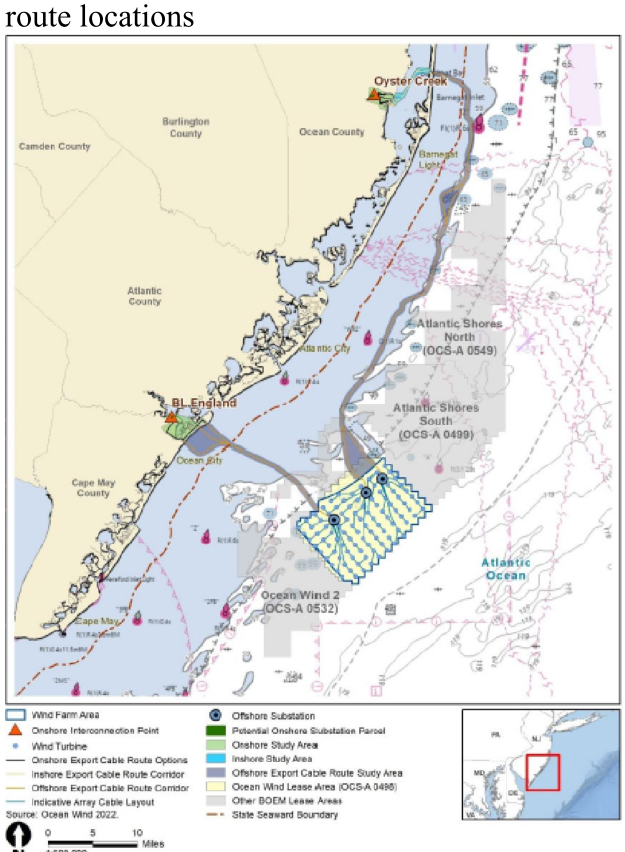


Figure 3.4.2. Project Location - Oyster Creek.

Figure 5.1-1. Project location - Oyster Creek.

Figure 3.4.3. Project Location – Barnegat Bay/Oyster Creek.

Source: Ocean Wind 2022

Figure 3.4.4. Project Location – BL England.
Source: Ocean Wind 2022

4.0 SPECIES AND CRITICAL HABITAT NOT CONSIDERED FURTHER IN THIS OPINION

In the BA, BOEM concludes that the proposed action is not likely to adversely affect giant manta rays, hawksbill sea turtles, the Northeast Atlantic DPS of loggerhead sea turtles, oceanic whitetip sharks, the Gulf of Maine DPS of Atlantic salmon, and shortnose sturgeon. BOEM also concludes that the proposed action is not likely to adversely affect critical habitat designated for North Atlantic right whales, the Northwest Atlantic DPS of loggerhead sea turtles, and Atlantic sturgeon. As explained below, we have determined that the project will have no effect on the Gulf of Maine DPS of Atlantic salmon or critical habitat designated for the North Atlantic right whale, Carolina DPS of Atlantic sturgeon, or the Northwest Atlantic DPS of loggerhead sea turtles. We concur with BOEM's determination that the proposed action is not likely to adversely affect giant manta rays, hawksbill sea turtles, the Northeast Atlantic DPS of loggerhead sea turtles, and oceanic whitetip sharks; we conclude consultation informally for these species and critical habitat designations. Effects to shortnose sturgeon and critical habitat designated for the New York Bight DPS of Atlantic sturgeon are addressed in section 7.0 of this Opinion.

4.1. ESA Listed Species

Giant Manta Ray (Manta birostris) – Threatened

The giant manta ray inhabits temperate, tropical, and subtropical waters worldwide, primarily between 35° N and 35° S latitudes. In the western Atlantic Ocean, this includes waters off South Carolina south to Brazil and Bermuda. Giant manta rays also occur in the Gulf of Mexico. On the U.S. Atlantic coast, nearshore distribution is limited to areas off the Florida coast; otherwise, distribution occurs in offshore waters at the shelf edge. Occasionally, manta rays are observed as far north as Long Island (Miller and Klimovich 2017, Farmer et al. 2021); however, these sightings are in offshore waters along the continental shelf edge and the species is considered rare in waters north of Cape Hatteras. As described in section 3.4, the action area includes: the lease area (OCS-A 0498) and the surrounding areas ensonified by proposed Project noise; the two offshore export cable route corridors; the areas within the lease and along the cable corridors where HRG, fisheries, and benthic resource surveys will take place; the vessel transit areas between the lease area and ports in New Jersey, Virginia, and South Carolina; and the routes used by vessels transporting manufactured components from Europe inclusive of the portion of the Atlantic Ocean that will be transited by those vessels and the territorial sea of nations along the European Atlantic coast from which those vessels will originate. Distribution of Giant manta rays is limited by their thermal tolerance (19-22°C off the U.S. Atlantic coast) and influenced by depth. As noted by Farmer et al. (2021), cold winter air and sea surface temperatures in the western North Atlantic Ocean likely create a physiological barrier to manta rays that restricts the northern boundary of their distribution. Giant manta rays frequently feed in waters at depths of 656 to 1,312 feet (200 to 400 meters) (NMFS 2019a); the only portion of the action area with these depths is along the vessel transit routes south and east of the lease area. Based on the documented distribution of the species, Giant manta rays are not anticipated to occur in the lease area, in areas that will experience project noise, in areas where surveys will occur, or along the cable routes. The only portion of the action area that overlaps with the distribution of Giant manta rays are the vessel transit routes south of Delaware Bay (i.e., to/from ports in Delaware Bay, Virginia, and South Carolina) and east of the lease area (i.e., to/from ports in Europe where vessels travel across the continental shelf edge south of 40°N). As described below, surveys in and near the lease area support this determination.

From 2003-2008, trawl surveys off the coast of New Jersey, inclusive of the Ocean Wind lease area, the area where increased noise will be experienced, and the two cable corridors, were carried out to collect fish and fisheries information for the New Jersey Department of Environmental Protection (NJDEP) Ocean/Wind Power Ecological Baseline Studies. During this time 1,120 trawl tows were completed and no giant manta rays were reported (GeoMarine 2010, Volume IV). In this same area, ancillary fish observations were collected during the ship surveys from January 2008 to December 2009 and from the aerial surveys from January to June 2009; four unidentified rays were reported during those surveys (GeoMarine 2010, Volume IV). All sightings were several miles south and/or east of the lease area and the area that will experience project noise. Farmer et al. (2021) summarized results of NYSERDA surveys carried out from nearshore to offshore marine environments of New York, with temporal coverage during the spring/summer of 2016–2019 and fall/winter of 2016–2018 (NYSERDA 2021). The area surveyed extended from the south coast of Long Island southeast to the continental shelf break. This area includes waters east of the Ocean Wind lease area that may be transited by project vessels traveling to/from ports in Europe. Of the 21,539 rays identified in the surveys, 7 were manta rays. Farmer et al. (2021) reports that despite comprehensive coast to shelf survey coverage, manta ray sightings were exclusively in August on the continental shelf edge.

Based on the documented distribution of Giant manta rays, the only project activity that individuals could be exposed to are vessels traveling to/from Europe (with exposure limited to the portion of the trip near the continental shelf edge) and vessels traveling to/from ports in Virginia, and South Carolina (with exposure limited to the portion of the trips that are south of Delaware Bay). As the vessel transit routes are not expected to travel through areas where the species is known to concentrate (e.g., coast of Florida), we expect that any manta rays along the transit routes will be dispersed and in small numbers. Here, we consider the potential for effects of project vessels. Giant manta rays can be frequently observed traveling just below the surface and will often approach or show little fear toward humans or vessels (Coles 1916), which may also make them vulnerable to vessel strikes (Deakos 2010); vessel strikes can injure or kill giant manta rays, decreasing fitness or contributing to non-natural mortality (Couturier et al. 2012; Deakos et al. 2011); however, vessel strikes are considered rare. Information about interactions between vessels and giant manta rays is limited. We have at least some reports of vessel strike, including a report of five giant manta rays struck by vessels from 2016 through 2018; individuals had injuries (i.e., fresh or healed dorsal surface propeller scars) consistent with a vessel strike. These interactions were observed by researchers conducting surveys from Boynton Beach to Jupiter, Florida (J. Pate, Florida Manta Project, pers. comm. to M. Miller, NMFS OPR, 2018) and it is unknown where the manta was at the time of the vessel strike. The geographic area considered to have the highest risk of vessel strikes for giant manta ray is nearshore coastal waters and inlets along the east coast of Florida where recreational vessel traffic is concentrated; this area does not overlap with the action area. Given the few instances of confirmed or suspected strandings of giant manta rays attributed to vessel strike injury, the risk of giant manta rays being struck by vessels is considered low. This lack of documented mortalities could also be the result of other factors that influence carcass detection (i.e., wind, currents, scavenging, decomposition etc.); however, giant manta rays appear to be able to be fast and agile enough to avoid most moving vessels, as anecdotally evidenced by videos showing rays avoiding interactions with high-speed vessels (Barnette 2018).

The speed and maneuverability of giant manta rays, the slow operating speed of project vessels transiting through the portion of the action area where Giant manta rays occur, and the dispersed nature of Giant manta ray distribution in the open ocean area where these vessels will operate, and the small number of potential vessel trips through the range of Giant manta rays make any effects of the proposed action extremely unlikely to occur. No effects from potential exposure to vessel noise are anticipated. No take is anticipated. The proposed action is not likely to adversely affect the giant manta ray.

Hawksbill sea turtle (Eretmochelys imbricate) – Endangered

The hawksbill sea turtle is typically found in tropical and subtropical regions of the Atlantic, Pacific, and Indian Oceans, including the coral reef habitats of the Caribbean and Central America. Hawksbill turtles generally do not migrate north of Florida and their presence north of Florida is rare (NMFS and USFWS 1993). As described in BOEM's BA, no sightings of Hawksbill turtles have been documented within Atlantic coastal waters off New Jersey (CWFNJ

2021), and they were not observed in the New Jersey Department of Environmental Protection's (NJDEP's) Ocean/Wind Power Ecological Baseline Studies (NJDEP 2010) mentioned above. Two sightings of one individual each occurred during the Atlantic Marine Assessment Program for Protected Species (AMAPPS) study in 2019 off central Florida, but no sightings in the action area were recorded prior to 2019 or since (Palka et al. 2017; NEFSC and SEFSC 2020, 2021).

Given their rarity in waters north of Florida, hawksbill sea turtles are highly unlikely to occur in the action area, including along any of the vessel transit routes. As such, it is extremely unlikely that any hawksbill sea turtles will be exposed to any effects of the proposed action. No take is anticipated. The proposed action is not likely to adversely affect the hawksbill sea turtle.

Oceanic White Tip Shark (Carcharhinus longimanus) – Threatened
The oceanic whitetip shark is usually found offshore in deep waters of the open ocean, on the outer continental shelf, and around oceanic islands in deep water greater than 184 m. As noted in Young et al. 2017, the species has a clear preference for open ocean waters between 10° N and 10° S, but can be found in decreasing numbers out to latitudes of 30°N and 35°S, with abundance decreasing with greater proximity to continental shelves. In the western Atlantic, oceanic whitetips occur in deep offshore waters from Maine to Argentina, including the Caribbean and Gulf of Mexico (Young et al. 2017). In the central and eastern Atlantic, the species occurs from Madeira, Portugal south to the Gulf of Guinea, and possibly in the Mediterranean Sea.

The lease area and cable corridors, as well as the area where noise from project construction, operation, and decommissioning, and where survey activities will occur is outside of the deep offshore areas where Oceanic whitetip sharks occur. The only portion of the action area that overlaps with their distribution is the open ocean waters that may be transited by vessels from Europe. Vessel strikes are not identified as a threat in the status review (Young et al., 2017), listing determination (83 FR 4153) or the recovery outline (NMFS 2018). We have no information to suggest that vessels in the ocean have any effects on oceanic white tip sharks. Considering the lack of any reported vessel strikes, their swim speed and maneuverability (Papastamatiou et al. 2017), and the slow speed of ocean-going vessels, vessel strikes are extremely unlikely even if migrating individuals occur along the vessel transit routes. No effects from potential exposure to vessel noise are anticipated. No take is anticipated. The proposed action is not likely to adversely affect the oceanic white tip shark.

Northeast Atlantic DPS of Loggerhead Sea Turtles (Caretta caretta) – Endangered
The Northeast Atlantic DPS of loggerhead sea turtles occurs in the Northeast Atlantic Ocean north of the equator, south of 60° N. Lat., and east of 40° W. Long., except in the vicinity of the Strait of Gibraltar where the eastern boundary is 5°36′ W. Long (76 FR 58867). The only portion of the action area that loggerheads from the Northeast Atlantic DPS are present in is along the portion of any vessel transit routes from Europe that are east of 40° W. Long. As noted in section 3.0 of this Opinion, vessel transits between the project site and ports in Europe may occur during the construction phase of the project. In this portion of the action area, co-occurrence of project vessels and individual sea turtles is expected to be extremely unlikely; this is due to the seasonal distribution and dispersed nature of sea turtles in the open ocean, and intermittent presence of project vessels. Together, these factors make it extremely unlikely that any Northeast Atlantic DPS loggerheads will be struck by a vessel as a result of the project. No

effects from potential vessel noise are anticipated. No take is anticipated. The proposed action is not likely to adversely affect the Northeast Atlantic DPS of loggerhead sea turtles.

Gulf of Maine DPS of Atlantic salmon (Salmo salar) – Endangered
The only remaining populations of Gulf of Maine DPS Atlantic salmon are in Maine. Smolts migrate from their natal rivers in Maine north to foraging grounds in the Western North Atlantic off Canada and Greenland (Fay et al. 2006). After one or more winters at sea, adults return to their natal river to spawn. Atlantic salmon do not occur in the lease area or along the cable corridors or in the portion of the action area that will experience increased noise during project construction, operations, or decommissioning or where surveys will occur. We also do not expect any of the vessel transit routes, including those to/from Europe, to overlap with the distribution of Atlantic salmon. However, even if migrating salmon occurred along the routes of vessels transiting from Europe, we do not anticipate any effects to Atlantic salmon. There is no evidence of interactions between vessels and Atlantic salmon and we do not anticipate any effects from exposure to vessel noise. Vessel strikes are not identified as a threat in the listing determination (74 FR 29344) or the recent recovery plan (NMFS and USFWS 2019). We have no information to suggest that vessels in the ocean have any effects on migrating Atlantic salmon, and we do not expect there would be any due to Atlantic salmon migrating at depths below the draft of project vessels. Therefore, we do not expect any effects to Atlantic salmon even if migrating individuals co-occur with project vessels moving between the project site and ports in Europe or Canada. No take is anticipated. The proposed action will have no effect on the Gulf of Maine DPS of Atlantic salmon.

4.2. Critical Habitat

Critical Habitat Designated for North Atlantic right whales
On January 27, 2016, NMFS issued a final rule designating critical habitat for North Atlantic right whales (81 FR 4837). Critical habitat includes two areas (units) located in the Gulf of Maine and Georges Bank Region (Unit 1) and off the coast of North Carolina, South Carolina, Georgia and Florida (Unit 2). The only project activity that would overlap with right whale critical habitat is the potential transit of project vessels through Unit 2 if Charleston, South Carolina, is used for cable staging. No other effects of the project will extend to Unit 1 or Unit 2.

Consideration of Potential Effects to Unit 1
There are no project activities that overlap with Unit 1. Here, we explain our consideration of whether any project activities located outside of Unit 1 may affect Unit 1. As identified in the final rule (81 FR 4837), the physical and biological features essential to the conservation of the North Atlantic right whale that provide foraging area functions in Unit 1 are: The physical oceanographic conditions and structures of the Gulf of Maine and Georges Bank region that combine to distribute and aggregate *C. finmarchicus* for right whale foraging, namely prevailing currents and circulation patterns, bathymetric features (basins, banks, and channels), oceanic fronts, density gradients, and temperature regimes; low flow velocities in Jordan, Wilkinson, and Georges Basins that allow diapausing *C. finmarchicus* to aggregate passively below the convective layer so that the copepods are retained in the basins; late stage *C. finmarchicus* in

dense aggregations in the Gulf of Maine and Georges Bank region; and diapausing *C. finmarchicus* in aggregations in the Gulf of Maine and Georges Bank region.

We have considered whether the proposed action would have any effects to right whale critical habitat. Copepods in critical habitat originate from Jordan, Wilkinson, and George's Basin. The effects of the proposed action, including those of vessels going to/from Europe, do not extend to these areas, and we do not expect any effects to the generation of copepods in these areas that could be attributable to the proposed action. The proposed action will also not affect any of the physical or oceanographic conditions that serve to aggregate copepods in designated critical habitat. Offshore wind farms can reduce wind speed and wind stress which can lead to less mixing, lower current speeds, and higher surface water temperature (Afsharian et al. 2019), cause wakes that will result in detectable changes in vertical motion and/or structure in the water column (e.g. Christiansen & Hasager 2005, Broström 2008), as well as detectable wakes downstream from a wind farm by increased turbidity (Vanhellemont and Ruddick, 2014). However, there is no information to suggest that effects from the Ocean Wind project would extend to Unit 1. The Ocean Wind project is a significant distance from right whale critical habitat and, thus, it is not anticipated to affect the oceanographic features of that critical habitat. Further, the Ocean Wind project is not anticipated to cause changes to the physical or biological features of critical habitat by worsening climate change; as described in the DEIS, given the overall net beneficial impact on criteria pollutant and ozone precursor emissions as well as greenhouse gases. Therefore, we have determined that the proposed action will have no effect on Unit 1 of right whale critical habitat.

Consideration of Potential Effects to Unit 2
As identified in the final rule (81 FR 4837), the physical and biological features essential to the conservation of the North Atlantic right whale, which provide calving area functions in Unit 2, are: (i) Sea surface conditions associated with Force 4 or less on the Beaufort Scale; (ii) Sea surface temperatures of 7 °C to 17 °C; and, (iii) Water depths of 6 to 28 meters, where these features simultaneously co-occur over contiguous areas of at least 231 nmi^2 of ocean waters during the months of November through April. When these features are available, they are selected by right whale cows and calves in dynamic combinations that are suitable for calving, nursing, and rearing, and which vary, within the ranges specified, depending on factors such as weather and age of the calves.

Vessel transits will have no effect on the features of Unit 2; this is because vessel operations do not affect sea surface state, water temperature, or water depth. Therefore, we have determined that the proposed action will have no effect on Unit 2 of right whale critical habitat.

Critical Habitat Designated for Atlantic sturgeon
Critical habitat has been designated for all five DPSs of Atlantic sturgeon (82 FR 39160; effective date September 18, 2017). The action area overlaps with a portion of the Delaware River critical habitat unit designated for the New York Bight DPS; effects to this critical habitat unit are addressed in the *Effects of the Action* (section 7.0 of this Opinion). The action area also overlaps with a portion of Unit 7 (Santee-Cooper) of critical habitat designated for the Carolina DPS of Atlantic sturgeon. We note that the Port of Norfolk is located downstream of the lower limit of Unit 5 (James River) of critical habitat designated for the Chesapeake Bay DPS of

Atlantic sturgeon. Therefore, the action area does not overlap with the James River critical habitat unit, i.e., the proposed action will not affect that critical habitat unit.

Critical Habitat Designated for the Carolina DPS
The critical habitat designation for the Carolina DPS is for habitats that support successful Atlantic sturgeon reproduction and recruitment. Carolina Unit 7 includes the Santee River (below the Wilson Dam), the Rediversion Canal (below the St. Stephens Dam), the North Santee River, the South Santee River, and Tailrae Canal – West Branch Cooper River (below Pinopolis Dam) and the mainstem Cooper River.

On May 4, 2020, NMFS Southeast Regional Office issued a Biological Opinion to the USACE on the effects of construction and operation of the Nexans Cable Facility (NMFS SERO 2020). The subsea cable plant is located along the Cooper River in Charleston, South Carolina, within Unit 7 of the critical habitat designated for the Carolina DPS.

In the 2020 Nexans Biological Opinion, NMFS concluded that the construction and use by vessels of the Nexans Facility was likely to adversely affect but not likely to destroy or adversely modify critical habitat designated for the Carolina DPS of Atlantic sturgeon (NMFS SERO 2020). As explained in the 2020 Nexans Biological Opinion, NMFS determined that there would be temporary and permanent effects to the critical habitat in the Copper River as a result of dredging and riprap associated with the construction of the facility. No effects of vessel use on critical habitat were anticipated in the Opinion and we do not expect any will occur as a result of the Ocean Wind project vessel's use of this facility.

Critical Habitat for the Northwest Atlantic Ocean DPS of Loggerhead Sea Turtles
Critical habitat for the Northwest Atlantic Ocean DPS of loggerhead sea turtles was designated in 2014 (79 FR 39855). Specific areas for designation include 38 occupied marine areas within the range of the Northwest Atlantic Ocean DPS. These areas contain one or a combination of habitat types: Nearshore reproductive habitat, winter area, breeding areas, constricted migratory corridors, and/or *Sargassum* habitat. There is no critical habitat designated in the lease area. The only project activities whose effects may overlap with Northwest Atlantic loggerhead DPS critical habitat are vessels transiting between the project site and Charleston, South Carolina.

Nearshore Reproductive
The PBF of nearshore reproductive habitat is described as a portion of the nearshore waters adjacent to nesting beaches that are used by hatchlings to egress to the open-water environment as well as by nesting females to transit between beach and open water during the nesting season.

Primary Constituent Elements (PCEs) that support this habitat are the following: (1) Nearshore waters directly off the highest density nesting beaches and their adjacent beaches as identified in 50 CFR 17.95(c) to 1.6 km (1 mile) offshore; (2) Waters sufficiently free of obstructions or artificial lighting to allow transit through the surf zone and outward toward open water; and, (3) Waters with minimal manmade structures that could promote predators (i.e., nearshore predator concentration caused by submerged and emergent offshore structures), disrupt wave patterns necessary for orientation, and/or create excessive longshore currents.

The occasional project vessel transits that may occur within the designated nearshore reproductive habitat will have no effect on nearshore reproductive habitat for the following reasons: waters would remain free of obstructions or artificial lighting that would affect the transit of turtles through the surf zone and outward toward open water; and, vessel transits would not promote predators or disrupt wave patterns necessary for orientation or create excessive longshore currents.

Winter
The PBF of winter habitat is described 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. PCEs that support this habitat are the following: (1) Water temperatures above 10°C from November through April; (2) Continental shelf waters in proximity to the western boundary of the Gulf Stream; and, (3) Water depths between 20 and 100 m.

The occasional project vessel transits that may occur within the designated winter habitat will have no effect on this habitat because they will not: affect or change water temperatures above 10°C from November through April; affect habitat in continental shelf waters in proximity to the western boundary of the Gulf Stream; or, affect or change water depths between 20 and 100 m.

Breeding
The PBFs of concentrated breeding habitat are sites with high densities of both male and female adult individuals during the breeding season. PCEs that support this habitat are the following: (1) High densities of reproductive male and female loggerheads; (2) Proximity to primary Florida migratory corridor; and, (3) Proximity to Florida nesting grounds.

The project vessel transits that may occur within the designated breeding habitat will have no effect on this habitat because they will not: affect the density of reproductive male or female loggerheads or result in any alterations of habitat in proximity to the primary Florida migratory corridor or Florida nesting grounds.

Constricted Migratory Corridors
The PBF of constricted migratory habitat is high use migratory corridors that are constricted (limited in width) by land on one side and the edge of the continental shelf and Gulf Stream on the other side. PCEs that support this habitat are the following: (1) Constricted continental shelf area relative to nearby continental shelf waters that concentrate migratory pathways; and, (2) Passage conditions to allow for migration to and from nesting, breeding, and/or foraging areas.

The project vessel transits that may occur within the designated winter habitat will have no effect on this habitat because they will not result in any alterations of habitat in the constricted continental shelf area and will not affect passage conditions in this area.

Sargassum
The PBF of loggerhead Sargassum habitat is developmental and foraging habitat for young loggerheads where surface waters form accumulations of floating material, especially Sargassum. PCEs that support this habitat are the following: (i) 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; (ii) Sargassum in concentrations that support adequate prey abundance and cover; (iii) Available prey and other material associated with Sargassum habitat including, but not limited to, plants and cyanobacteria and animals native to the Sargassum community such as hydroids and copepods; and, (iv) Sufficient water depth and proximity to available currents to ensure offshore transport (out of the surf zone), and foraging and cover requirements by Sargassum for post-hatchling loggerheads, i.e., >10 m depth.

The project vessel transits that may occur within the designated Sargassum habitat will have no effect on: 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; the concentration of Sargassum; the availability of prey within Sargassum; or the depth of water in any area.

Summary of Effects to Critical Habitat
We have determined that because the proposed action will have no effect on any of the PBFs, the proposed action will have no effect on the critical habitat designated for the Northwest Atlantic DPS of loggerhead sea turtles.

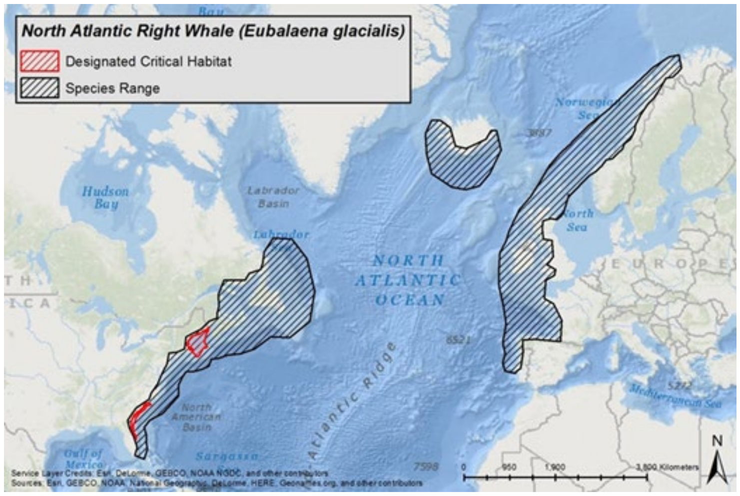
5.0 STATUS OF THE SPECIES

5.1 Marine Mammals

5.1.1 North Atlantic Right Whale (Eubalaena glacialis)
There are three species classified as right whales (genus *Eubalaena*): North Pacific (*E. japonica*), Southern (*E. australis*), and North Atlantic (*E. glacialis*). The North Atlantic right whale is the only species of right whale that occurs in the North Atlantic Ocean (Figure 5.1.1) and, therefore, is the only species of right whale that may occur in the action area.

North Atlantic right whales occur primarily in the western North Atlantic Ocean. However, there have been acoustic detections, reports, and/or sightings of North Atlantic right whales in waters off Greenland (east/southeast), Newfoundland, northern Norway, and Iceland, as well as within Labrador Basin (Hamilton et al. 1998, Jacobsen et al. 2004, Knowlton et al. 1992, Mellinger et al. 2011). These latter sightings/detections are consistent with historic records documenting North Atlantic right whales south of Greenland, in the Denmark straits, and in eastern North Atlantic waters (Kraus et al. 2007). There is also evidence of possible historic North Atlantic right whale calving grounds in the Mediterranean Sea (Rodrigues et al. 2018), an area not currently considered as part of this species' historical range.

Figure 5.1.1. Approximate historic range and currently designated U.S. critical habitat of the North Atlantic right whale



The North Atlantic right whale is distinguished by its stocky body and lack of a dorsal fin. The species was listed as endangered on December 2, 1970. We used information available in the most recent five-year review for North Atlantic right whales (NMFS 2022), the most recent stock assessment report (Hayes et al. 2022 and Hayes et al. 2023 *draft*[13]), and the scientific literature to summarize the status of the species, as follows.

Life History

The maximum lifespan of North Atlantic right whales is unknown, but one individual reached at least 70 years of age (Hamilton et al. 1998, Kenney 2009). Previous modeling efforts suggest that in 1980, females had a life expectancy of approximately 51.8 years of age, which was twice that of males at the time (Fujiwara and Caswell 2001); however, by 1995, female life expectancy was estimated to have declined to approximately 14.5 years (Fujiwara and Caswell 2001). Most recent estimates indicate that North Atlantic right whale females are only living to 45 and males to age 65 (https://www.fisheries.noaa.gov/species/north-atlantic-right-whale). Females, ages 5+, have reduced survival relative to males, ages 5+, resulting in a decrease in female abundance relative to male abundance (Pace et al. 2017). Specifically, state-space mark-recapture model estimates show that from 2010-2015, males declined just under 4.0%, and females declined approximately 7% (Pace et al. 2017).

Gestation is estimated to be between 12 and 14 months, after which calves typically nurse for around one year (Cole et al. 2013, Kenney 2009, Kraus and Hatch 2001, Lockyer 1984). After weaning a calf, females typically undergo a 'resting' period before becoming pregnant again, presumably because they need time to recover from the energy deficit experienced during lactation (Fortune et al. 2013, Fortune et al. 2012, Pettis et al. 2017). From 1983 to 2005, annual

[13] NMFS considers the population estimate for North Atlantic right whales published in the draft Stock Assessment Report (Hayes et al. 2023 draft) to be part of the best available data; this is because the population estimate is developed using a peer-reviewed model and the population estimate and accompanying text has been reviewed by the Atlantic Scientific Review Group (ASRG). See, generally, https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-stock-assessments and imbedded link to the Scientific Review Groups.

average calving intervals ranged from 3 to 5.8 years (overall average of 4.23 years) (Kraus et al. 2007). Between 2006 and 2015, annual average calving intervals continued to vary within this range, but in 2016 and 2017 longer calving intervals were reported (6.3 to 6.6 years in 2016 and 10.2 years in 2017) (Hayes et al. 2018a, Pettis and Hamilton 2015, Pettis and Hamilton 2016, Pettis et al. 2018a, Pettis et al. 2018b, Pettis et al. 2020). There were no calves recorded in 2018. Annual average calving interval between 2019 and 2022 ranged from a low of 7 in 2019 to a high of 9.2 in 2021 (Pettis et al. 2022). The calving index is the annual percentage of reproductive females assumed alive and available to calve that was observed to produce a calf. This index averaged 47% from 2003 to 2010 but has dropped to an average of 17% since 2010 (Moore et al. 2021). The percentage of available females that had calves ranged from 11.9% to 30.5% from 2019-2022 (Pettis et al. 2022). Females have been known to give birth as young as five years old, but the mean age of a female first giving birth is 10.2 years old (n=76, range 5 to 23, SD 3.3) (Moore et al. 2021). Taken together, changes to inter-birth interval and age to first reproduction suggest that both parous (having given birth) and nulliparous (not having given birth) females are experiencing delays in calving. These calving delays correspond with the recent distribution shifts. The low reproductive rate of right whales is likely the result of several factors including nutrition (Fortune et al. 2013, Moore et al. 2021). Evidence also indicates that North Atlantic right whales are growing to shorter adult lengths than in earlier decades (Stewart et al. 2021) and are in poor body condition compared to southern right whales (Christiansen et al. 2020). As stated in the draft 2023 SAR, all these changes may result from a combination of documented regime shifts in primary feeding habitats (Meyer-Gutbrod and Greene 2014; Meyer-Gutbrod et al. 2021; Record et al. 2019), and increased energy expenditures related to non-lethal entanglements (Rolland et al. 2016; Pettis et al. 2017; van der Hoop 2017). As noted in the 2022 Five-Year Review (NMFS 2022), poor body condition, arrested growth, and maternal body length have led to reduced reproductive success and are contributors to low birth rates for the population over the past decade (Christiansen et al. 2020; Reed et al. 2022; Stewart et al. 2021; Stewart et al. 2022).

Pregnant North Atlantic right whales migrate south, through the mid-Atlantic region of the U.S., to low latitudes during late fall where they overwinter and give birth in shallow, coastal waters (Kenney 2009, Krzystan et al. 2018). During spring, these females and new calves migrate to high latitude foraging grounds where they feed on large concentrations of copepods, primarily *C. finmarchicus* (Mayo et al. 2018, NMFS 2017). Some non-reproductive North Atlantic right whales (males, juveniles, non-reproducing females) also migrate south, although at more variable times throughout the winter. Others appear to not migrate south and remain in the northern feeding grounds year round or go elsewhere (Bort et al. 2015, Mayo et al. 2018, Morano et al. 2012, NMFS 2017, Stone et al. 2017). Nonetheless, calving females arrive to the southern calving grounds earlier and stay in the area more than twice as long as other demographics (Krzystan et al. 2018). Little is known about North Atlantic right whale habitat use in the mid-Atlantic, but recent acoustic data indicate near year round presence of at least some whales off the coasts of New Jersey, Virginia, and North Carolina (Davis et al. 2017, Hodge et al. 2015, Salisbury et al. 2016, Whitt et al. 2013). While it is generally not known where North Atlantic right whales mate, some evidence suggests that mating may occur in the northern feeding grounds (Cole et al. 2013, Matthews et al. 2014).

Population Dynamics
Today, North Atlantic right whales are primarily found in the western North Atlantic, from their calving grounds in lower latitudes off the coast of the southeastern United States to their feeding grounds in higher latitudes off the coast of New England and Nova Scotia (Hayes et al. 2018a). Beginning in 2010, a change in seasonal residency patterns has been documented through visual and acoustic monitoring with declines in presence in the Bay of Fundy, Gulf of Maine, and Great South Channel, and more animals being observed in Cape Cod Bay, the Gulf of Saint Lawrence, the mid-Atlantic, and south of Nantucket, Massachusetts (Daoust et al. 2018, Davies et al. 2019, Davis et al. 2017, Hayes et al. 2018a, Hayes et al. 2019, Meyer-Gutbrod et al. 2018, Moore et al. 2021, Pace et al. 2017, Quintana-Rizzo et al. 2021). Right whales have been observed nearly year round in the area south of Martha's Vineyard and Nantucket, with highest sightings rates between December and May (Leiter et al., 2017, Stone et al. 2017, Quintana-Rizzo et al. 2021, O'Brien et al. 2022). Increased detections of right whales in the Gulf of St. Lawrence have been documented from late spring through the fall (Cole et al. 2016, Simard et al. 2019, DFO 2020).

There are two recognized populations of North Atlantic right whales, an eastern, and a western population. Very few individuals likely make up the population in the eastern Atlantic, which is thought to be functionally extinct (Best et al. 2001). However, in recent years, a few known individuals from the western population have been seen in the eastern Atlantic, suggesting some individuals may have wider ranges than previously thought (Kenney 2009). Specifically, there have been acoustic detections, reports, and/or sightings of North Atlantic right whales in waters off Greenland (east/southeast), Newfoundland, northern Norway, and Iceland, as well as within Labrador Basin (Jacobsen et al. 2004, Knowlton et al. 1992, Mellinger et al. 2011). It is estimated that the North Atlantic historically (i.e., pre-whaling) supported between 9,000 and 21,000 right whales (Monsarrat et al. 2016). The western population may have numbered fewer than 100 individuals by 1935, when international protection for right whales came into effect (Kenney et al. 1995).

Genetic analyses, based upon mitochondrial and nuclear DNA analyses, have consistently revealed an extremely low level of genetic diversity in the North Atlantic right whale population (Hayes et al. 2018a, Malik et al. 2000, McLeod and White 2010, Schaeff et al. 1997). Waldick et al. (2002) concluded that the principal loss of genetic diversity occurred prior to the 18th century, with more recent studies hypothesizing that the loss of genetic diversity may have occurred prior to the onset of Basque whaling during the 16th and 17th century (Mcleod et al. 2008, Rastogi et al. 2004, Reeves et al. 2007, Waldick et al. 2002). The persistence of low genetic diversity in the North Atlantic right whale population might indicate inbreeding; however, based on available data, no definitive conclusions can be reached at this time (Hayes et al. 2019, Radvan 2019, Schaeff et al. 1997). By combining 25 years of field data (1980-2005) with high-resolution genetic data, Frasier et al. (2013) found that North Atlantic right whale calves born between 1980 and 2005 had higher levels of microsatellite (nuclear) heterozygosity than would be expected from this species' gene pool. The authors concluded that this level of heterozygosity is due to postcopulatory selection of genetically dissimilar gametes and that this mechanism is a natural means to mitigate the loss of genetic diversity, over time, in small populations (Frasier et al. 2013).

In the western North Atlantic, North Atlantic right whale abundance was estimated to be 270 animals in 1990 (Pace et al. 2017). From 1990 to 2011, right whale abundance increased by approximately 2.8% per year, despite a decline in 1993 and no growth between 1997 and 2000 (Pace et al. 2017). However, since 2011, when the abundance peaked at 481 animals, the population has been in decline, with a 99.99% probability of a decline of just under 1% per year (Pace et al. 2017). Between 1990 and 2015, survival rates appeared relatively stable, but differed between the sexes, with males having higher survivorship than females (males: 0.985 ± 0.0038; females: 0.968 ± 0.0073) leading to a male-biased sex ratio (approximately 1.46 males per female) (Pace et al. 2017).

As reported in the most recent final SAR (Hayes et al. 2022), the western North Atlantic right whale stock size is estimated based on a published state-space model of the sighting histories of individual whales identified using photo-identification techniques (Pace et al. 2017; Pace 2021). Sightings histories were constructed from the photo-ID recapture database as it existed in January 2021, and included photographic information up through November 2019. Using a hierarchical, state-space Bayesian open population model of these histories produced a median abundance value (N_{est}) as of November 30, 2019 of 368 individuals (95% Credible Interval (CI): 356–378). The draft 2022 SAR (Hayes et al. 2023 draft) uses data from the photo-ID database as it existed in December 2021 and included photographic information up through November 2020. Using the hierarchical, state-space Bayesian open population model of these histories produced a median abundance value (N_{est}) as of November 30, 2020 of 338 individuals (95%CI: 325–350) and a minimum population estimate of 332.

Each year, scientists at NMFS' Northeast Fisheries Science Center estimate the right whale population abundance and share that estimate at the North Atlantic Right Whale Consortium's annual meeting in a "Report Card." This estimate is considered preliminary and undergoes further review before being included in the draft North Atlantic Right Whale Stock Assessment Report. Each draft stock assessment report is peer-reviewed by one of three regional Scientific Review Groups, revised after a public comment period, and published. The 2022 "Report Card" (Pettis et al. 2022) data reports a preliminary population estimate for 2021 using data as of August 30, 2022 is 340 (+/- 7). Pettis et al. (2022) also report that fifteen mother calf pairs were sighted in 2022, down from 18 in 2021. There were no first time mothers sighted in 2022. Initial analyses detected at least 16 new entanglements in 2022: five whales seen with gear and 11 with new scarring from entanglements. Additionally, there was one non-fatal vessel strike detected. No carcasses were detected. Of the 15 calves born in 2022, one is known to have died and another is thought likely to have died.

In addition to finding an overall decline in the North Atlantic right whale population, Pace et al. (2017) also found that between 1990 and 2015, the survival of age 5+ females relative to 5+ males has been reduced; this has resulted in diverging trajectories for male and female abundance. Specifically, there was an estimated 142 males (95% CI=143-152) and 123 females (95% CI=116-128) in 1990; however, by 2015, model estimates show the species was comprised of 272 males (95% CI=261-282) and 186 females (95% CI=174-195; Pace et al. 2017). Calving rates also varied substantially between 1990 and 2015 (i.e., 0.3% to 9.5%), with low calving rates coinciding with three periods (1993-1995, 1998-2000, and 2012-2015) of decline or no growth (Pace et al. 2017). Using generalized linear models, Corkeron et al. (2018) found that between 1992 and 2016, North Atlantic right whale calf counts increased at a rate of 1.98% per year. Using the highest annual estimates of survival recorded over the time series from Pace et al. (2017), and an assumed calving interval of approximately four years, Corkeron et al. (2018) suggests that the North Atlantic right whale population could potentially increase at a rate of at least 4% per year if there was no anthropogenic mortality.[14] This rate is approximately twice that observed, and the analysis indicates that adult female mortality is the main factor influencing this rate (Corkeron et al. 2018). Right whale births remain significantly below what is expected and the average inter-birth interval remains high (Pettis et al. 2022). Additionally, there were no first-time mothers in 2022, underscoring recent research findings that fewer adult, nulliparous females are becoming reproductively active (Reed et al., 2022).

Status
The North Atlantic right whale is listed under the ESA as endangered. Anthropogenic mortality and sub-lethal stressors (i.e., entanglement) that affect reproductive success are currently affecting the ability of the species to recover (Corkeron et al. 2018, Stewart et al. 2021), currently, none of the species recovery goals (see below) have been met. With whaling now prohibited, the two major known human causes of mortality are vessel strikes and entanglement in fishing gear (Hayes et al. 2018a). Estimates of total annual anthropogenic mortality (i.e., ship strike and entanglement in fishing gear), as well as the number of undetected anthropogenic mortalities for North Atlantic right whales are presented in the annual stock assessment reports. These anthropogenic threats appear to be worsening (Hayes et al. 2018a).

On June 7, 2017, NMFS declared an Unusual Mortality Event (UME) for the North Atlantic right whale, as a result of 17 observed right whale mortalities in the U.S. and Canada. Under the Marine Mammal Protection Act, a UME is defined as "a stranding that is unexpected; involves a significant die-off of any marine mammal population; and demands immediate response." As of February 2023, there are 35 confirmed mortalities for the UME, 22 serious injuries, and 36 sublethal injuries or illness (for more information on UMEs, see https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-unusual-mortality-events). Mortalities are recorded as vessel strike (11), entanglement (9), perinatal (2), unknown/undetermined (3), or not examined (10).[15]

The North Atlantic right whale population continues to decline. As noted above, between 1990 to 2011, right whale abundance increased by approximately 2.8% per year; however, since 2011 the population has been in decline (Pace et al. 2017). The draft 2023 SAR reports an overall abundance decline between 2011 and 2020 of 29.7% (Hayes et al. 2023 draft). Recent modeling efforts indicate that low female survival, a male biased sex ratio, and low calving success are contributing to the population's current decline (Pace et al. 2017). For instance, five new calves were documented in 2017 calving season, zero in 2018, and seven in 2019 (Pettis et al. 2018a,

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[14] Based on information in the North Atlantic Right Whale Catalog, the mean calving interval is 4.69 years (P. Hamilton 2018, unpublished, in Corkeron et al. 2018). Corkeron et al. (2018) assumed a 4 year calving interval as the approximate mid-point between the North Atlantic Right Whale Catalog calving interval and observed calving intervals for southern right whales (i.e., 3.16 years for South Africa, 3.42 years for Argentina, 3.31 years for Auckland Islands, and 3.3 years for Australia).

[15] https://www.fisheries.noaa.gov/national/marine-life-distress/2017-2023-north-atlantic-right-whale-unusual-mortality-event; last accessed February 12, 2023

Pettis et al. 2018b, Pettis et al. 2020), these numbers of births are well below the number needed to compensate for expected mortalities. More recently, there were 10 calves in the 2020 calving season, 18 calves in 2021, and 15 in 2022. Two of the 2020 calves and one of the 2021 calves died or were seriously injured due to vessel strikes. Two additional calves were reported in the 2021 season, but were not seen as a mother/calf pair. One animal stranded dead with no evidence of human interaction and initial results suggest the calf died during birth or shortly thereafter. The second animal was an anecdotal report of a calf off the Canary Islands. Two calves in 2022 are suspected to have died, with the causes of death unknown. As of March 26, 2023, 11 mother-calf pairs have been sighted in the 2022-2023 calving season[16].

Long-term photographic identification data indicate new calves rarely go undetected (Kraus et al. 2007, Pace et al. 2017). While there are likely a multitude of factors involved, low calving has been linked to poor female health (Rolland et al. 2016) and reduced prey availability (Devine et al. 2017, Johnson et al. 2017, Meyer-Gutbrod and Green 2014, Meyer-Gutbrod and Greene 2018, Meyer-Gutbrod et al. 2018). A recent study comparing North Atlantic right whales to other right whale species found that juvenile, adult, and lactating female North Atlantic right whales all had lower body condition scores compared to the southern right whale populations, with lactating females showing the largest difference; however, North Atlantic right whale calves were in good condition (Christiansen et al. 2020). While some of the difference could be the result of genetic isolation and adaptations to local environmental conditions, the authors suggest that the magnitude indicates that North Atlantic right whale females are in poor condition, which could be suppressing their growth, survival, age of sexual maturation and calving rates. In addition, they conclude that the observed differences are most likely a result of differences in the exposure to anthropogenic factors (Christiansen et al. 2020). Furthermore, entanglement in fishing gear appears to have substantial health and energetic costs that affect both survival and reproduction (Hayes et al. 2018a, Hunt et al. 2016, Lysiak et al. 2018, Pettis et al. 2017, Robbins et al. 2015, Rolland et al. 2017, van der Hoop et al. 2017).

Kenney et al. (2018) projected that if all other known or suspected impacts (e.g., vessel strikes, calving declines, climate change, resource limitation, sublethal entanglement effects, disease, predation, and ocean noise) on the population remained the same between 1990 and 2016, and none of the observed fishery related mortality and serious injury occurred, the projected population in 2016 would be 12.2% higher (506 individuals). Furthermore, if the actual mortality resulting from fishing gear is double the observed rate (as estimated in Pace et al. 2017), eliminating all mortalities (observed and unobserved) could have resulted in a 2016 population increase of 24.6% (562 individuals) and possibly over 600 in 2018 (Kenney 2018).

Given the above information, North Atlantic right whales' resilience to future perturbations affecting health, reproduction, and survival is expected to be very low (Hayes et al. 2018a). The observed (and clearly biased low) human-caused mortality and serious injury was 7.7 right whales per year from 2015 through 2019 (Hayes et al. 2022). Using the refined methods of Pace et al. (2021), the estimated annual rate of total mortality for the period 2014–2018 was 27.4, which is 3.4 times larger than the 8.15 total derived from reported mortality and serious injury for the same period (Hayes et al. 2022). The 2023 draft SAR reports the observed human-caused

[16] https://www.fisheries.noaa.gov/national/endangered-species-conservation/north-atlantic-right-whale-calving-season-2023

mortality and serious injury was 8.1 right whales per year from 2016 through 2020 (Hayes et al. 2023 draft). Using the refined methods of Pace et al. (2021), the estimated annual rate of total mortality for the period 2015–2019was 31.2, which is 4.1 times larger than the 7.7 total derived from reported mortality and serious injury for the same period. Using a matrix population projection model, it is estimated that by 2029 the population will decline from 160 females to the 1990 estimate of 123 females if the current rate of decline is not altered (Hayes et al. 2018a).

Climate change poses a significant threat to the recovery of North Atlantic right whales. The information presented here is summarized from a more complete description of this threat in the 2022 5-Year Review (NMFS 2022). The documented shift in North Atlantic right whale summer habitat from the Gulf of Maine to waters further north in the Gulf of St. Lawrence in the early 2010s is considered to be related to an oceanographic regime shift in Gulf of Maine waters linked to a northward shift of the Gulf Stream which caused the availability of the primary North Atlantic right whale prey, the copepod *Calanus finmarchicus*, to decline locally, forcing North Atlantic right whales to forage in areas further north (Meyer-Gutbrod et al. 2021; Record et al. 2019; Sorochan et al. 2019). The shift of North Atlantic right whale distribution into waters further north also created policy challenges for the Canadian government, which had to implement new regulations in areas that were not protected because they were not documented as right whale habitat in the past (Davies and Brillant 2019; Meyer-Gutbrod et al. 2018; Record et al. 2019).

When prey availability is low, North Atlantic right whale calving rates decline, a well-documented phenomenon through periods of low prey availability in the 1990s and the 2010s; without increased prey availability in the future, low population growth is predicted (Meyer-Gutbrod and Greene 2018). Prey densities in the Gulf of St. Lawrence have fluctuated irregularly in the past decade, limiting suitable foraging habitat for North Atlantic right whales in some years and further limiting reproductive rates (Bishop et al. 2022; Gavrilchuck et al. 2020; Gavrilchuck et al. 2021; Lehoux et al. 2020).

Recent studies have investigated the spatial and temporal role of oceanography on copepod availability and distribution and resulting effects on foraging North Atlantic right whales. Changes in seasonal current patterns have an effect on the density of *Calanus* species in the Gulf of St. Lawrence, which may lead to further temporal variations over time (Sorochan et al. 2021a). Brennan et al. (2019) developed a model to estimate seasonal fluctuations in C. finmarchicus availability in the Gulf of St. Lawrence, which is highest in summer and fall, aligning with North Atlantic right whale distribution during those seasons. Pendleton et al. (2022) found that the date of maximum occupancy of North Atlantic right whales in Cape Cod Bay shifted 18.1 days later between 1998 and 2018 and was inversely related to the spring thermal transition date, when the regional ocean temperature surpasses the mean annual temperature for that location, which has trended towards moving earlier each year as an effect of climate change. This inverse relationship may be due to a ‘waiting room’ effect, where North Atlantic right whales wait and forage on adequate prey in the waters of Cape Cod Bay while richer prey develops in the Gulf of St. Lawrence, and then migrate directly there rather than following migratory pathways used previously (Pendleton et al. 2022; Ganley et al. 2022). Although the date of maximum occupancy in Cape Cod Bay has shifted to later in the spring, initial sightings of individual North Atlantic right whales have started earlier, indicating that they may be using regional water temperature as a cue for migratory movements between habitats (Ganley et al. 2022).

North Atlantic right whales rely on late stage or diapause copepods, which are more energy-rich, for prey; diving behavior is highly reliant on where in the vertical strata *C. finmarchicus* is distributed (Baumgartner et al. 2017). There is evidence that *C. finmarchicus* are reaching the diapause phase at deeper depths to account for warming water on the Newfoundland Slope and Scotian Shelf, forcing North Atlantic right whales to forage deeper and further from shore (Krumhansl et al. 2018; Sorochan et al. 2021a).

Several studies have already used the link between *Calanus* distribution and North Atlantic right whale distribution to determine suitable habitat, both currently and in the future (Gavrilchuk et al. 2020; Pershing et al. 2021; Silber et al. 2017; Sorochan et al. 2021b). Plourde et al. (2019) used suitable habitat modeling using *Calanus* density to confirm new North Atlantic right whale hot spots for summer feeding in Roseway Basin and Grand Manan and identified other potential aggregation areas further out on the Scotian Shelf. Gavrilchuk et al. (2021) determined suitable habitat for reproductive females in the Gulf of St. Lawrence, finding declines in foraging habitat over a 12- year period and indicating that the prey biomass in the area may become insufficient to sustain successful reproduction over time. Ross et al. (2021) used suitable habitat modeling to predict that the Gulf of Maine habitat would continue to decline in suitability until 2050 under a range of climate change scenarios. Similarly, models of future copepod density in the Gulf of Maine have predicted declines of up to 50 percent under high greenhouse gas emission scenarios by 2080- 2100 (Grieve et al. 2017). It is clear that climate change does and will continue to have an impact on the availability, supply, aggregation, and distribution of *C. finmarchicus*, and North Atlantic right whale abundance and distribution will continue to vary based on those impacts; however, more research must be done to better understand these factors and associated impacts (Sorochan et al. 2021b). Climate change will likely have other secondary effects on North Atlantic right whales, such as an increase in harmful algal blooms of the toxic dinoflagellate *Alexandrium catenella* due to warming waters, increasing the risk of North Atlantic right whale exposure to neurotoxins (Boivin-Rioux et al. 2021; Pershing et al. 2021).

Factors Outside the Action Area Affecting the Status of the Right Whale: Fishery Interactions and Vessel Strikes in Canadian Waters

In Canada, right whales are protected under the Species at Risk Act (SARA) and the Fisheries Act. The right whale was considered a single species and designated as endangered in 1980. SARA includes provisions against the killing, harming, harassing, capturing, taking, possessing, collecting, buying, selling, or trading of individuals or its parts (SARA section 32) and damage or destruction of its residence (SARA section 33). In 2003, the species was split to allow separate designation of the North Atlantic right whale, which was listed as endangered under SARA in May 2003. All marine mammals are subject to the provisions of the marine mammal regulations under the Fisheries Act. These include requirements related to approach, disturbance, and reporting. In the St. Lawrence estuary and the Saguenay River, the maximum approach distance for threatened or endangered whales is 1,312 ft. (400 m).

North Atlantic right whales have died or been seriously injured in Canadian waters by vessel strikes and entanglement in fishing gear (DFO 2014). Serious injury and mortality events are rarely observed where the initial entanglement occurs. After an event, live whales or carcasses may travel hundreds of miles before ever being observed, including into U.S. waters given prevailing currents. It is unknown exactly how many serious injuries and mortalities have occurred in Canadian waters historically. However, at least 14 right whale carcasses and 20 injured right whales were sighted in Canadian waters between 1988 and 2014 (Davies and Brillant 2019); 25 right whale carcasses were first sighted in Canadian waters or attributed to Canadian fishing gear from 2015 through 2019. In the sections to follow, information is provided on the fishing and shipping industry in Canadian waters, as well as measures the Canadian government is taking (or will be taking) to reduce the level of serious injuries and mortalities to North Atlantic rights resulting from incidental entanglement in fishing gear or vessel strikes.

Fishery Interactions in Canadian Waters

There are numerous fisheries operating in Canadian waters. Rock and toad crab fisheries, as well as fixed gear fisheries for cod, Atlantic halibut, Greenland halibut, winter flounder, and herring have historically had few interactions. While these fisheries deploy gear that pose some risk, this analysis focuses on fisheries that have demonstrated interactions with ESA-listed species (i.e., lobster, snow crab, mackerel, and whelk). Based on information provided by the Department of Fisheries and Oceans Canada (DFO), a brief summary of these fisheries is provided below.

The American lobster fishery is DFO's largest fishery, by landings. It is managed under regional management plans with 41 Lobster Fisheries Areas (Figure 5.1.2); in which 10,000 licensed harvesters across Atlantic Canada and Quebec participate.[17] In addition to the one permanent closure in Lobster Fishery Area 40 (Figure 5.1.2), fisheries are generally closed during the summer to protect molts. Lobster fishing is most active in the Gulf of Maine, Bay of Fundy, Southern Gulf of St. Lawrence, and coastal Nova Scotia. Most fisheries take place in shallow waters less than 130 ft. (40 m) deep and within 8 nmi (15 km) of shore, although some fisheries will fish much farther out and in waters up to 660 ft. (200 m) deep. Management measures are tailored to each Area and include limits on the number of licenses issued, limits on the number of traps, limited and staggered fishing seasons, limits on minimum and maximum carapace size (which differs depending on the Area), protection of egg-bearing females (females must be notched and released alive), and ongoing monitoring and enforcement of fishing regulations and license conditions. The Canadian lobster fisheries use trap/pot gear consistent with the gear used in the American lobster fishery in the U.S. While both Canada and the U.S. lobster fisheries employ similar gears, the two nations employ different management strategies that result in divergent prosecution of the fisheries.

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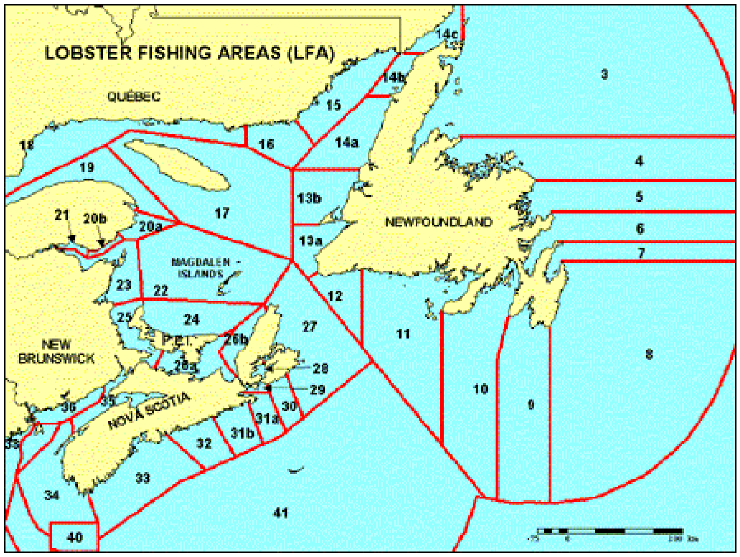
[17] Of the 41 Lobster Fisheries Areas, one is for the offshore fishery, and one is closed for conservation.

Figure 5.1.2. Lobster fishing areas in Atlantic Canada (https://www.dfo-mpo.gc.ca/fisheries-peches/commercial-commerciale/atl-arc/lobster-homard-eng.html)



The snow crab fishery is DFO's second largest fishery, by landings. It is managed under regional management plans with approximately 60 Snow Crab Management Areas in Canada spanning four regions (Scotia-Fundy, Southern Gulf of St. Lawrence, Northern Gulf of St. Lawrence, and Newfoundland and Labrador). Approximately 4,000 crab fishery licenses are issued annually[18]. The management of the snow crab fishery is based on annual total allowable catch, individual quotas, trap and mesh restrictions, minimum legal size, mandatory release of female crabs, minimum mesh size of traps, limited seasons, and areas. Protocols are in place to close grids when a percentage of soft-shell crabs in catches is reached. Harvesters use baited conical traps and pots set on muddy or sand-mud bottoms usually at depths of 230-460 ft. (70-140 m). Annual permit conditions have been used since 2017 to minimize the impacts to North Atlantic right whales, as described below.

DFO manages the Atlantic mackerel fishery under one Atlantic management plan, established in 2007. Management measures include fishing seasons, total allowable catch, gear, Safety at Sea fishing areas, licensing, minimum size, fishing gear restrictions, and monitoring. The plan allows the use of the following gear: gillnet, handline, trap net, seine, and weir. When established, the DFO issued 17,182 licenses across four regions, with over 50% of these licenses using gillnet gear. In 2020, DFO issued 7,812 licenses; no gear information was available. Commercial harvest is timed with the migration of mackerel into and out of Canadian waters. In Nova Scotia, the gillnet and trap fisheries for mackerel take place primarily in June and July. Mackerel generally arrive in southwestern Nova Scotia in May and Cape Breton in June. Migration out of the Gulf of St. Lawrence begins in September, and the fishery can continue into October or early November. They may enter the Gulf of St. Lawrence, depending on temperature conditions. The gillnet fishery in the Gulf of St. Lawrence also occurs in June and

[18] https://www.dfo-mpo.gc.ca/stats/commercial/licences-permis/licences-permis-atl-eng.htm#Species; Last accessed February 12, 2023

July. Most nets are fixed, except for a drift fishery in Chaleurs Bay and the part of the Gulf between New Brunswick, Prince Edward Island, and the Magdalen Islands.

Conservation harvesting plans are used to manage waved whelk in Canadian waters, which are harvested in the Gulf of St. Lawrence, Quebec, Maritimes, and Newfoundland and Labrador regions. The fishery is managed using quotas, fishing gear requirements, dockside monitoring, traps limits, seasons, tagging, and area requirements. In 2017, there were 240 whelk license holders in Quebec; however, only 81 of them were active. Whelk traps are typically weighted at the bottom with cement or other means and a rope or other mechanism is positioned in the center of the trap to secure the bait. Between 50 and 175 traps are authorized per license. The total number of authorized traps for all licenses in each fishing area varies between 550 and 6,400 traps, while the number of used or active traps is lower, with 200 to 1,700 traps per fishing area. Since 2017, the Government of Canada has implemented measures to protect right whales from entanglement. These measures have included seasonal and dynamic closures for fixed gear fisheries, changes to the fishing season for snow crab, reductions in traps in the mid-shore fishery in Crab Fishing Area 12, and license conditions to reduce the amount of rope in the water. Measures to better track gear, require reporting of gear loss, require reporting of interactions with marine mammals, and increased surveillance for right whales have also been implemented. Measures to reduce interactions with fishing gear are adjusted annually. In 2021, mandatory closures for non-tended fixed gear fisheries, including lobster and crab, will be put in place for 15 days when right whales are sighted. If a whale is detected in days 9-15 of the closure, the closure will be extended. In the Bay of Fundy and the critical habitats in the Roseway and Grand Manan basins, this extension will be for an additional 15 days. If a right whale is detected in the Gulf of St. Lawrence, the closure will be season-long (until November 15, 2021). Outside the dynamic area, closures are considered on a case-by-case basis. There are also gear marking and reporting requirements for all fixed gear fisheries. The Government of Canada will also continue to support industry trials of innovative fishing technologies and methods to prevent and mitigate whale entanglement. This includes authorizing ropeless gear trials in closed areas in 2021. Measures to implement weak rope or weak-breaking points were delayed and will be implemented by 2024. Measures related to maximum rope diameters, sinking rope between traps and reductions in vertical and floating rope will be implemented after 2022. More information on these measures is available at https://www.dfo-mpo.gc.ca/fisheries-peches/commercial-commerciale/atl-arc/narw-bnan/management-gestion-eng.html.

In August 2016, NMFS published the MMPA Import Provisions Rule (81 FR 54389, August 15, 2016), which established criteria for evaluating a harvesting nation's regulatory program for reducing marine mammal bycatch and the procedures for obtaining authorization to import fish and fish products into the United States. Specifically, to continue in the international trade of seafood products with the United States, other nations must demonstrate that their marine mammal mitigation measures for commercial fisheries are, at a minimum, equivalent to those in place in the United States. A five-year exemption period (beginning January 1, 2017) was created in this process to allow foreign harvesting nations time to develop, as appropriate, regulatory programs comparable in effectiveness to U.S. programs at reducing marine mammal bycatch. To comply with its requirements, it is essential that these interactions are reported, documented, and quantified. To guarantee that fish products have access to the U.S. markets, DFO must implement procedures to reliably certify that the level of mortality caused by fisheries does not exceed U.S. standards. DFO must also demonstrate that the regulations in place to reduce accidental death of marine mammals are comparable to those of the United States.

Vessel Strikes in Canadian Waters
Vessel strikes are a threat to right whales throughout their range. In Canadian waters where rights whales are present, vessels include recreational and commercial vessels, small and large vessels, and sail, and power vessels. Vessel categories include oil and gas exploration, fishing and aquaculture, cruise ships, offshore excursions (whale and bird watching), tug/tow, dredge, cargo, and military vessels. At the time of development of the Gulf of St. Lawrence management plan, approximately 6,400 commercial vessels transited the Cabot Strait and the Strait of Belle Isle annually. This represents a subset of the vessels in this area as it only includes commercial vessels (DFO 2013). To address vessel strikes in Canadian waters, the International Maritime Organization (IMO) amended the Traffic Separation Scheme in the Bay of Fundy to reroute vessels around high use areas. In 2007, IMO adopted and Canada implemented a voluntary seasonal Area to Be Avoided (ATBA) in Roseway Basin to further reduce the risk of vessel strike (DFO 2020). In addition, Canada has implemented seasonal speed restrictions and developed a proposed action plan to identify specific measures needed to address threats and achieve recovery (DFO 2020).

The Government of Canada has also implemented measures to mitigate vessel strikes in Canadian waters. Each year since August 2017, the Government has implemented seasonal speed restrictions (maximum 10 knots) for vessels 20 meters or longer in the western Gulf of St. Lawrence. In 2019, the area was adjusted and the restriction was expanded to apply to vessels greater than 13 m. Smaller vessels are encouraged to respect the limit. Dynamic area management has also been used in recent years. Currently, there are two shipping lanes, south and north of Anticosti Island, where dynamic speed restrictions (mandatory slowdown to 10 knots) can be activated when right whales are present. In 2020 and 2021, the Government of Canada also implemented a trial voluntary speed restriction zone from Cabot Strait to the eastern edge of the dynamic shipping zone at the beginning and end of the season and a mandatory restricted area in or near Shediac Valley mid-season. More information is available at https://www.tc.gc.ca/en/services/marine/navigation-marine-conditions/protecting-north-atlantic-right-whales-collisions-ships-gulf-st-lawrence.html. Modifications to measures in 2021 include refining the size, location, and duration of the mandatory restricted area in and near Shediac Valley and expanding the speed limit exemption in waters less than 20 fathoms to all commercial fishing vessels. In 2022, a variety of measures were in place to reduce the risk of vessel strike including vessel speed limits and restricted access areas.

Critical Habitat
Critical habitat for North Atlantic right whales has been designated in U.S. waters as described in section 4.0 of this Opinion.

Recovery Goals
Recovery is the process of restoring endangered and threatened species to the point where they no longer require the safeguards of the Endangered Species Act. A recovery plan serves as a road map for species recovery—the plan outlines the path and tasks required to restore and secure self-sustaining wild populations. It is a non-regulatory document that describes, justifies,

and schedules the research and management actions necessary to support recovery of a species. The goal of the 2005 Recovery Plan for the North Atlantic right whale (NMFS, 2005) is to promote the recovery of North Atlantic right whales to a level sufficient to warrant their removal from the List of Endangered and Threatened Wildlife and Plants under the ESA. The intermediate recovery goal is to reclassify the species from endangered to threatened. The recovery strategy identified in the Recovery Plan focuses on reducing or eliminating deaths and injuries from anthropogenic activities, namely shipping and commercial fishing operations; developing demographically-based recovery criteria; the characterization, monitoring, and protection of important habitat; identification and monitoring of the status, trends, distribution and health of the species; conducting studies on the effects of other potential threats and ensuring that they are addressed, and conducting genetic studies to assess population structure and diversity. The plan also recognizes the need to work closely with State, other Federal, international and private entities to ensure that research and recovery efforts are coordinated. The recovery plan includes the following downlisting criteria, the achievement of which would demonstrate significant progress toward full recovery:

> North Atlantic right whales may be considered for reclassifying to threatened when all of the following have been met: 1) The population ecology (range, distribution, age structure, and gender ratios, etc.) and vital rates (age-specific survival, age-specific reproduction, and lifetime reproductive success) of right whales are indicative of an increasing population; 2) The population has increased for a period of 35 years at an average rate of increase equal to or greater than 2% per year; 3) None of the known threats to North Atlantic right whales (summarized in the five listing factors) are known to limit the population's growth rate; and 4) Given current and projected threats and environmental conditions, the right whale population has no more than a 1% chance of quasi-extinction in 100 years.

Specific criteria for delisting North Atlantic right whales are not included in the recovery plan; as described in the recovery plan, conditions related to delisting are too distant and hypothetical to realistically develop specific criteria. The current abundance of North Atlantic right whales is currently an order of magnitude less than an abundance at which NMFS would even consider delisting the species. The current dynamics indicate that the North Atlantic right whale population is in decline, rather than recovering, and decades of population growth at rates considered typical for large whales would be required before the population could attain an abundance that may suggest that delisting was appropriate to consider. Specific criteria for delisting North Atlantic right whales will be included in a future revision of the recovery plan well before the population is at a level when delisting becomes a reasonable decision (NMFS 2005).

The most recent five-year review for right whales was completed in 2022 (NMFS 2022). The recommendation in that plan was for the status to remain as endangered. As described in the report, the North Atlantic right whale faces continued threat of human-caused mortality due to lethal interactions with commercial fisheries and vessel traffic. As stated in the 5-Year Review, there is also uncertainty regarding the effect of long-term sublethal entanglements, emerging environmental stressors including climate change, and the compounding effects of multiple continuous stressors that may be limiting North Atlantic right whale calving and recovery. In addition, the North Atlantic right whale population has been in a state of decline since 2010. Management measures in the United States have been in place for an extended period of time and continued modifications are underway/anticipated, and measures in Canada since 2017 also suggest continued progress toward implementing conservation regulations. Despite these efforts to reduce the decline and promote recovery, progress toward right whale recovery has continued to regress.

5.1.2 Fin Whale (Balaenoptera physalus)

Globally there is one species of fin whale, *Balaenoptera physalus*. Fin whales occur in all major oceans of the Northern and Southern Hemispheres (NMFS 2010a) (Figure 5.1.3). Within this range, three subspecies of fin whales are recognized: *B. p. physalus* in the Northern Hemisphere, and *B. p. quoyi* and *B. p. patachonica* (a pygmy form) in the Southern Hemisphere (NMFS 2010a). For management purposes in the northern Hemisphere, the United States divides, *B. p. physalus,* into four stocks: Hawaii, California/Oregon/Washington, Alaska (Northeast Pacific), and Western North Atlantic (Hayes et al. 2019, NMFS 2010a).

Figure 5.1.3. Range of the fin whale

Fin whales are distinguishable from other whales by a sleek, streamlined body, with a V-shaped head, a tall hooked dorsal fin, and a distinctive color pattern of a black or dark brownish-gray body and sides with a white ventral surface. The lower jaw is gray or black on the left side and creamy white on the right side. The fin whale was listed as endangered on December 2, 1970 (35 FR 18319).

Information available from the recovery plan (NMFS 2010a), recent stock assessment reports (Carretta et al. 2019a, Hayes et al. 2022, Muto et al. 2019a), the five-year status review (NMFS 2019b), as well as the recent International Union for the Conservation of Nature's (IUCN) fin whale assessment (Cooke 2018b) were used to summarize the life history, population dynamics and status of the species as follows.

Life History

Fin whales can live, on average, 80 to 90 years. They have a gestation period of less than one year, and calves nurse for six to seven months. Sexual maturity is reached between 6 and 10 years of age with an average calving interval of two to three years. They mostly inhabit deep, offshore waters of all major oceans. They winter at low latitudes, where they calve and nurse, and summer at high latitudes, where they feed, although some fin whales appear to be residential to certain areas.

Population Dynamics
The pre-exploitation estimate for the fin whale population in the entire North Atlantic was approximately 30,000-50,000 animals (NMFS 2010a), and for the entire North Pacific Ocean, approximately 42,000 to 45,000 animals (Ohsumi and Wada 1974). In the Southern Hemisphere, prior to exploitation, the fin whale population was approximately 40,000 whales (Mizroch et al. 1984b). In the North Atlantic Ocean, fin whales were heavily exploited from 1864 to the 1980s; over this timeframe, approximately 98,000 to 115,000 fin whales were killed (IWC 2017). Between 1910-1975, approximately 76,000 fin whales were recorded taken by modern whaling in the North Pacific; this number is likely higher as many whales killed were not identified to species or while killed, were not successfully landed (Allison 2017). Over 725,000 fin whales were killed in the Southern Hemisphere from 1905 to 1976 (Allison 2017).

In the North Atlantic Ocean, the IWC has defined seven management stocks of fin whales: (1) North Norway (2) East Greenland and West Iceland (EGI); (3) West Norway and the Faroes; (4) British Isles, Spain and Portugal; (5) West Greenland and (6) Nova Scotia, (7) Newfoundland and Labrador (Donovan 1991, NMFS 2010a). Based on three decades of survey data in various portions of the North Atlantic, the IWC estimates that there are approximately 79,000 fin whales in this region. Under the present IWC scheme, fin whales off the eastern United States, Nova Scotia and the southeastern coast of Newfoundland are believed to constitute a single stock; in U.S. waters, NMFS classifies these fin whales as the Western North Atlantic stock (Donovan 1991, Hayes et al. 2019, NMFS 2010a). NMFS' best estimate of abundance for the Western North Atlantic Stock of fin whales is 6,802 individuals (N_{min}=5,573); this estimate is the sum of the 2016 NOAA shipboard and aerial surveys and the 2016 Canadian Northwest Atlantic International Sightings Survey (Hayes et al. 2022). Currently, there is no population estimate for the entire fin whale population in the North Pacific (Cooke 2018b). However, abundance estimates for three stocks in U.S. Pacific Ocean waters do exist: Northeast Pacific (N= 3,168; N_{min}=2,554), Hawaii (N=154; N_{min}=75), and California/Oregon/Washington (N= 9,029; N_{min}=8,127) (Nadeem et al. 2016). Abundance data for the Southern Hemisphere stock remain highly uncertain; however, available information suggests a substantial increase in the population has occurred (Thomas et al. 2016).

In the North Atlantic, estimates of annual growth rate for the entire fin whale population in this region is not available (Cooke 2018b). However, in U.S. Atlantic waters NMFS has determined that until additional data are available, the cetacean maximum theoretical net productivity rate of 4.0% will be used for the Western North Atlantic stock (Hayes et al. 2019). In the North Pacific, estimates of annual growth rate for the entire fin whale population in this region is not available (Cooke 2018b). However, in U.S. Pacific waters, NMFS has determined that until additional data are available, the cetacean maximum theoretical net productivity rate of 4.0% will be used for the Northeast Pacific stock (Muto et al. 2019b, NMFS 2016b). Overall population growth rates and total abundance estimates for the Hawaii stock of fin whales are not available at this time (Carretta et al. 2018). Based on line transect studies between 1991-2014, there was estimated a 7.5% increase in mean annual abundance in fin whales occurring in waters off California, Oregon, and Washington; to date, this represents the best available information on the current population trend for the overall California/Oregon/Washington stock of fin whales (Carretta et al. 2019a, Nadeem et al. 2016).[19] For Southern Hemisphere fin whales, as noted above, overall information suggests a substantial increase in the population; however, the rate of increase remains poorly quantified (Cooke 2018b).

Archer et al. (2013) examined the genetic structure and diversity of fin whales globally. Full sequencing of the mitochondrial DNA genome for 154 fin whales sampled in the North Atlantic Ocean, North Pacific Ocean, and Southern Hemisphere, resulted in 136 haplotypes, none of which were shared among ocean basins suggesting differentiation at least at this geographic scale. However, North Atlantic fin whales appear to be more closely related to the Southern Hemisphere population, as compared to fin whales in the North Pacific Ocean, which may indicate a revision of the subspecies delineations is warranted. Generally, haplotype diversity was found to be high both within and across ocean basins (Archer et al. 2013). Such high genetic diversity and lack of differentiation within ocean basins may indicate that despite some populations having small abundance estimates, the species may persist long-term and be somewhat protected from substantial environmental variance and catastrophes. Archer et al. 2019 suggests that within the Northern Hemisphere, populations in the North Pacific and North Atlantic oceans can be considered at least different subspecies, if not different species.

Status

The fin whale is endangered because of past commercial whaling. Prior to commercial whaling, hundreds of thousands of fin whales existed. Fin whales may be killed under “aboriginal subsistence whaling” in Greenland, under Japan’s scientific whaling program, and Iceland’s formal objection to the IWC’s ban on commercial whaling. Additional threats include vessel strikes, reduced prey availability due to overfishing or climate change, and sound. The species’ overall large population size may provide some resilience to current threats, but trends are largely unknown. The total annual estimated average human-caused mortality and serious injury for the western North Atlantic fin whale for the period 2015−2019 is 1.85 (1.45 incidental fishery interactions and 0.40 vessel collisions) (Henry et al. 2022). Hayes et al. 2022 notes that these represent a minimum estimate of human-caused mortality, which is, almost certainly biased low.

Critical Habitat

No critical habitat has been designated for the fin whale.

Recovery Goals

The goal of the 2010 Recovery Plan for the fin whale (NMFS 2010a) is to promote the recovery of fin whales to the point at which they can be downlisted from endangered to threatened status, and ultimately to remove them from the list of Endangered and Threatened Wildlife and Plants, under the provisions of the ESA. The intermediate goal is to reclassify the species from endangered to threatened. The recovery plan also includes downlisting and delisting criteria. Key elements for the recovery program for fin whales are:

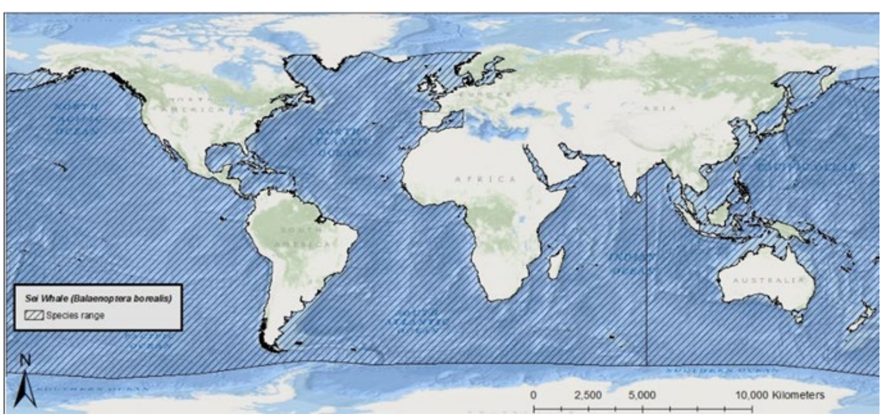
[19] Since 2005, the fin whale abundance increase has been driven by increases off northern California, Oregon, and Washington; numbers off Central and Southern California have remained stable (Carretta et al. 2020, Nadeem et al. 2016).

1. Coordinate state, federal, and international actions to implement recovery actions and maintain international regulation of whaling for fin whales;
2. Determine population discreteness and population structure of fin whales;
3. Develop and apply methods to estimate population size and monitor trends in abundance;
4. Conduct risk analysis;
5. Identify, characterize, protect, and monitor habitat important to fin whale populations in U.S. waters and elsewhere;
6. Investigate causes and reduce the frequency and severity of human-caused injury and mortality;
7. Determine and minimize any detrimental effects of anthropogenic noise in the oceans;
8. Maximize efforts to acquire scientific information from dead, stranded, and/or entrapped fin whales; and,
9. Develop post-delisting monitoring plan.

In February 2019, NMFS published a Five-Year Review for fin whales. This 5-year review indicates that, based on a review of the best available scientific and commercial information, that the fin whale should be downlisted from endangered to threatened. The review also recommended that NMFS consider whether listing at the subspecies or distinct population segment level is appropriate in terms of potential conservation benefits and the use of limited agency resources (NMFS 2019). To date, no changes to the listing for fin whales have been proposed.

5.1.3 Sei Whale (Balaenoptera borealis)
Globally there is one species of sei whale, *Balaenoptera borealis borealis*. Sei whales occur in subtropical, temperate, and subpolar marine waters across the Northern and Southern Hemispheres (Figure 5.1.4) (Cooke 2018a, NMFS 2011a). For management purposes, in the Northern Hemisphere, the United States recognizes four sei whale stocks: Hawaii, Eastern North Pacific, and Nova Scotia (NMFS 2011a).

Figure 5.1.4. Range of the sei whale



Sei whales are distinguishable from other whales by a long, sleek body that is dark bluish-gray to black in color and pale underneath, and a single ridge located on their rostrum. The sei whale was listed as endangered on December 2, 1970 (35 FR 18319).

Information available from the recovery plan (NMFS 2011a), recent stock assessment reports (Carretta et al. 2019a, Hayes et al. 2022, Hayes et al. 2017), 5-Year Review (NMFS 2021), as well as the recent IUCN sei whale assessment (Cooke 2018a) were used to summarize the life history, population dynamics and status of the species as follows.

Life History
Sei whales can live, on average, between 50 and 70 years. They have a gestation period of 10 to 12 months, and calves nurse for six to nine months. Sexual maturity is reached between 6 and 12 years of age with an average calving interval of two to three years. Sei whales mostly inhabit continental shelf and slope waters far from the coastline. They winter at low latitudes, where they calve and nurse, and summer at high latitudes, where they feed on a range of prey types, including: plankton (copepods and krill), small schooling fishes, and cephalopods.

Population Dynamics
There are no estimates of pre-exploitation sei whale abundance in the entire North Atlantic Ocean; however, approximately 17,000 sei whales were documented caught by modern whaling in the North Atlantic (Allison 2017). In the North Pacific, the pre-whaling sei abundance was estimated to be approximately 42,000 (Tillman 1977 as cited in (NMFS 2011a)). In the Southern Hemisphere, approximately 63,100 to 65,000 occurred in the Southern Hemisphere prior to exploitation (Mizroch et al. 1984a, NMFS 2011a).

In 1989, the entire North Atlantic sei whale population was estimated to be 10,300 whales (Cattanach et al. 1993 as cited in (NMFS 2011a). While other surveys have been completed in portions of the North Atlantic since 1989, the survey coverage levels in these studies are not as complete as those done in Cattanach et al. (1993) (Cooke 2018a). As a result, to date, updated abundance estimates for the entire North Atlantic population of sei whales are not available. However, in the western North Atlantic, Palka et al. (2017) has provided a recent abundance estimate for the Nova Scotia stock of sei whales. Based on survey data collected from Halifax, Nova Scotia, to Florida between 2010 and 2013, it is estimated that there are approximately 6,292 sei whales (N_{min}=3,098) (Palka et al. 2017); this estimate is considered the best available scientific information for the Nova Scotia stock (NMFS 2021). In the North Pacific, an abundance estimate for the entire North Pacific population of sei whales is not available. However, in the western North Pacific, it is estimated that there are 35,000 sei whales (Cooke 2018a). In the eastern North Pacific (considered east of longitude 180º), two stocks of sei whales occur in U.S. waters: Hawaii and Eastern North Pacific. Abundance estimates for the Hawaii stock are 391 sei whales (N_{min}=204), and for Eastern North Pacific stock, 519 sei whales (N_{min}=374) (Carretta et al. 2019a). In the Southern Hemisphere, recent abundance of sei whales is estimated at 9,800 to 12,000 whales. Population growth rates for sei whales are not available at this time as there are little to no systematic survey efforts to study sei whales; however, in U.S. waters, NMFS has determined that until additional data is available, the cetacean maximum theoretical net productivity rate of 4.0% will be used for the Hawaii, Eastern North Pacific, and Hawaii stocks of sei whales (Hayes 2019).

Based on genetic analyses, there appears to be some differentiation between sei whale populations in different ocean basins. In an early analysis of genetic variation in sei whales, some differences between Southern Ocean and the North Pacific sei whales were detected (Wada and Numachi 1991). However, more recent analyses of mtDNA control region variation show no significant differentiation between Southern Ocean and the North Pacific sei whales, though both appear to be genetically distinct from sei whales in the North Atlantic (Huijser et al. 2018). Within each ocean basin, there appears to be intermediate to high genetic diversity and little genetic differentiation despite there being different managed stocks (Danielsdottir et al. 1991, Kanda et al. 2011, Kanda et al. 2006, Kanda et al. 2013, Kanda et al. 2015).

Status

The sei whale is endangered because of past commercial whaling. Now, only a few individuals are taken each year by Japan. Current threats include vessel strikes, fisheries interactions (including entanglement), climate change (habitat loss and reduced prey availability), and anthropogenic sound. Given the species' overall abundance, they may be somewhat resilient to current threats. However, trends are largely unknown, especially for individual stocks, many of which have relatively low abundance estimates. The most recent 5-year average human-caused mortality and serious injury rate for sei whales in the North Atlantic is 0.80 (0.4 incidental fishery interactions, 0.2 vessel collisions, 0.2 other human-caused mortality; Hayes et al. 2022). These represent a minimum estimate of human-caused mortality, which is almost certainly biased low.

Critical Habitat

No critical habitat has been designated for the sei whale.

Recovery Goals

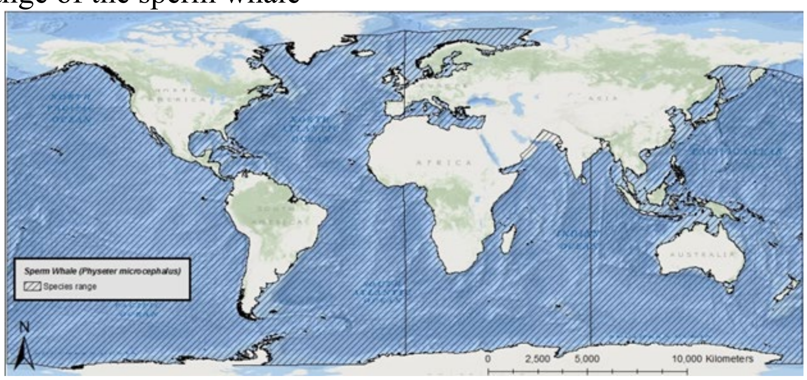
The 2011 Recovery Plan for the sei whale (NMFS 2011b) indicates that, "because the current population status of sei whales is unknown, the primary purpose of this Recovery Plan is to provide a research strategy to obtain data necessary to estimate population abundance, trends, and structure and to identify factors that may be limiting sei whale recovery." The goal of the Recovery Plan is to promote the recovery of sei whales to the point at which they can be downlisted from Endangered to Threatened status, and ultimately to remove them from the list of Endangered and Threatened Wildlife and Plants, under the provisions of the ESA. The intermediate goal is to reclassify the species from endangered to threatened. The recovery plan incorporates an adaptive management strategy that divides recovery actions into three tiers. Tier I involves: 1) continued international regulation of whaling (i.e., a moratorium on commercial sei whaling); 2) determining population size, trends, and structure using opportunistic data collection in conjunction with passive acoustic monitoring, if determined to be feasible; and 3) continued stranding response and associated data collection.

NMFS completed the most recent five-year review for sei whales in 2021 (NMFS 2021). In that review, NMFS concluded that the listing status should remain unchanged. They also concluded that recovery criteria outlined in the sei whale recovery plan (NMFS 2011b) do not reflect the best available and most up-to date information on the biology of the species. The 5-Year review states that currently, there is insufficient data to undertake an assessment of the sei whale's present status due to a number of uncertainties and unknowns for this species: (1) lack of scientifically reliable population estimates for the North Atlantic and Southern Hemisphere; (2) lack of comprehensive information on status and trends; (3) existence of critical knowledge gaps; and (4) emergence of potential new threats. Thus, further research is needed to fill critical knowledge gaps.

5.1.4 Sperm Whale (Physter macrocephalus)

Globally there is one species of sperm whale, *Physeter macrocephalus*. Sperm whales occur in all major oceans of the Northern and Southern Hemispheres (NMFS 2010b)(Figure 5.1.5). For management purposes, in the Northern Hemisphere, the United States recognizes six sperm whale stocks: California/Oregon/Washington, Hawaii, North Pacific, North Atlantic, Northern Gulf of Mexico, and Puerto Rico and the U.S. Virgin Islands (NMFS 2010b); see NMFS Marine Mammal Stock Assessment Reports: https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-stock-assessment-reports-species-stock).

Figure 5.1.5. Range of the sperm whale



The sperm whale is the largest toothed whale and distinguishable from other whales by its extremely large head, which takes up 25 to 35% of its total body length and a single blowhole asymmetrically situated on the left side of the head near the tip. The sperm whale was originally listed as endangered on December 2, 1970 (35 FR 18319).

Information available from the recovery plan (NMFS 2010b), recent stock assessment reports (Carretta et al. 2018, Hayes et al. 2020, Muto et al. 2018), status review (NMFS 2015b), as well as the recent IUCN sperm whale assessment (Taylor et al. 2019) were used to summarize the life history, population dynamics and status of the species as follows.

Life History

The average lifespan of sperm whales is estimated to be at least 50 years (Whitehead 2009). They have a gestation period of one to one and a half years, and calves nurse for approximately two years, though they may begin to forage for themselves within the first year of life (Tønnesen et al. 2018). Sexual maturity is reached between 7 and 13 years of age for females with an average calving interval of four to six years. Male sperm whales reach full sexual maturity in their 20s. Sperm whales mostly inhabit areas with a water depth of 600 m or more, and are uncommon in waters less than 300 m deep. They winter at low latitudes, where they calve and nurse, and summer at high latitudes, where they feed primarily on squid; other prey includes octopus and demersal fish (including teleosts and elasmobranchs).

Population Dynamics
Pre-whaling, the global population of sperm whales was estimated to be approximately 1,100,000 animals (Taylor et al. 2019, Whitehead 2002). By 1880, due to whaling, the population was approximately 71% of its original level (Whitehead 2002). In 1999, ten years after the end of large-scale whaling, the population was estimated to be about 32% of its original level (Whitehead 2002).

The most recent global sperm whale population estimate is 360,000 whales (Whitehead 2009). There are no reliable estimates for sperm whale abundance across the entire (North and South) Atlantic Ocean. However, estimates are available for two of three U.S. stocks in the western North Atlantic Ocean; the Northern Gulf of Mexico stock is estimated to consist of 763 individuals (N_{min}=560) (Waring et al. 2016) and the North Atlantic stock is estimated to consist of 4,349 individuals (N_{min}=3,451) (Hayes 2019). There are insufficient data to estimate abundance for the Puerto Rico and U.S. Virgin Islands stock. Similar to the Atlantic Ocean, there are no reliable estimates for sperm whale abundance across the entire (North and South) Pacific Ocean. However, estimates are available for two of three U.S. stocks that occur in the eastern Pacific; the California/Oregon/ Washington stock is estimated to consist of 1,997 individuals (N_{min}=1,270; Carretta et al. 2019b), and the Hawaii stock is estimated to consist of 4,559 individuals (N_{min}=3,478) (Carretta et al. 2019a). We are aware of no reliable abundance estimates for sperm whales in other major oceans in the Northern and Southern Hemispheres. Although maximum net productivity rates for sperm whales have not been clearly defined, population growth rates for sperm whale populations are expected to be low (i.e., no more than 1.1% per year) (Whitehead 2002). In U.S. waters, NMFS determined that, until additional data is available, the cetacean maximum theoretical net productivity rate of 4.0% will be used for, among others, the North Atlantic, Northern Gulf of Mexico, and Puerto Rico and the U.S. Virgin Islands stocks of sperm whales (Carretta et al. 2019a, Carretta et al. 2019b, Hayes 2019, Muto et al. 2019a, Muto et al. 2019b, Waring et al. 2010, Waring et al. 2016).

Ocean-wide genetic studies indicate sperm whales have low genetic diversity, suggesting a recent bottleneck, but strong differentiation between matrilineally related groups (Lyrholm and Gyllensten 1998). Consistent with this, two studies of sperm whales in the Pacific Ocean indicate low genetic diversity (Mesnick et al. 2011, Rendell et al. 2012). Furthermore, sperm whales from the Gulf of Mexico, the western North Atlantic Ocean, the North Sea, and the Mediterranean Sea all have been shown to have low levels of genetic diversity (Engelhaupt et al. 2009). As none of the stocks for which data are available have high levels of genetic diversity, the species may be at some risk to inbreeding and 'allee' effects[20], although the extent to which is currently unknown. Sperm whales have a global distribution and can be found in relatively deep waters in all ocean basins. While both males and females can be found in latitudes less than 40 degrees, only adult males venture into the higher latitudes near the poles.

Status
The sperm whale is endangered as a result of past commercial whaling. Although the aggregate abundance worldwide is probably at least several hundred thousand individuals, the extent of

[20] Allee effects are broadly characterized as a decline in individual fitness in populations with a small size or density.

depletion and degree of recovery of populations are uncertain. Commercial whaling is no longer allowed, however, illegal hunting may occur. Continued threats to sperm whale populations include vessel strikes, entanglement in fishing gear, competition for resources due to overfishing, loss of prey and habitat due to climate change, and sound. The Deepwater Horizon Natural Resource Damage Assessment Trustees assessed effects of oil exposure on sea turtles and marine mammals. Sperm whales in the Gulf of Mexico were impacted by the oil spill with 3% of the stock estimated to have died (DWH NRDA Trustees 2016). The most recent SAR for sperm whales in the North Atlantic notes that there were no documented reports of fishery-related mortality or serious injury to the North Atlantic stock in the U.S. EEZ during 2013–2017 (Hayes et al. 2020); there are also no reports in NMFS records from 2018-2023. The species' large population size shows that it is somewhat resilient to current threats.

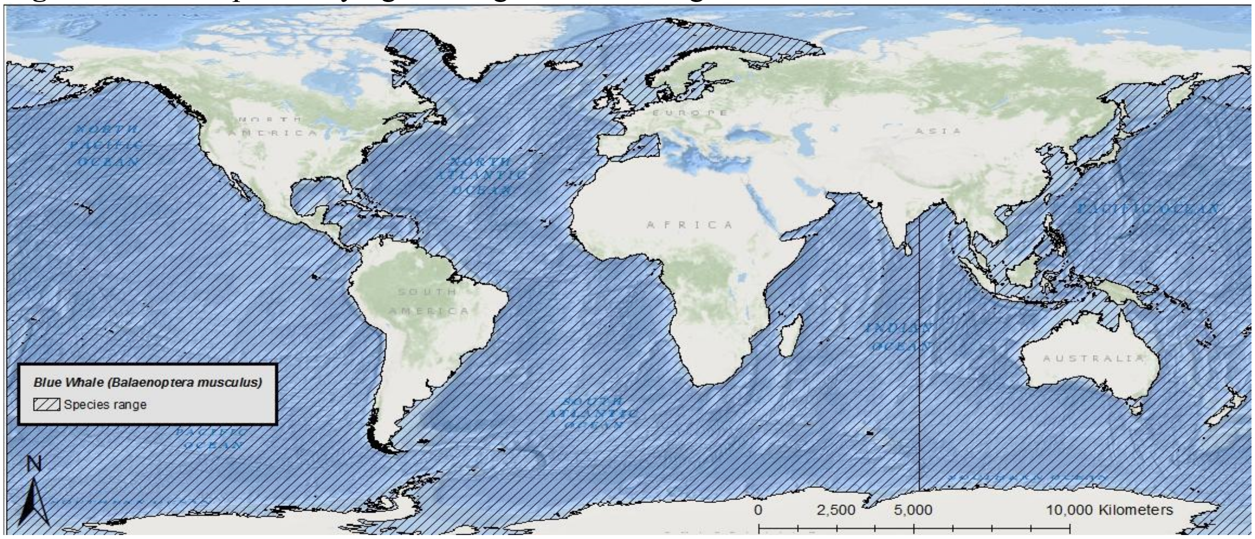
Critical Habitat
No critical habitat has been designated for the sperm whale.

Recovery Goals
The goal of the Recovery Plan is to promote recovery of sperm whales to a point at which they can be downlisted from endangered to threatened status, and ultimately to remove them from the list of Endangered and Threatened Wildlife and Plants, under the provisions of the ESA. The primary purpose of the Recovery Plan is to identify and take actions that will minimize or eliminate effects of human activities that are detrimental to the recovery of sperm whale populations. Immediate objectives are to identify factors that may be limiting abundance, recovery, and/or productivity, and cite actions necessary to allow the populations to increase. The Recovery Plan includes downlisting and delisting criteria (NMFS 2010).

The most recent Five-Year Review for sperm whales was completed in 2015 (NMFS 2015). In that review, NMFS concluded that no change to the listing status was recommended.

5.1.5 Blue Whale (Balaenoptera musculus)
Blue whales are the largest animal on earth and distinguishable from other whales by a long-body and comparatively slender shape, a broad, flat "rostrum" when viewed from above, proportionally smaller dorsal fin, and are a mottled gray color that appears light blue when seen through the water (Figure 2). Most experts recognize at least three subspecies of blue whale, *B. m. musculus*, which occurs in the Northern Hemisphere, *B. m. intermedia*, which occurs in the Southern Ocean, and *B. m. brevicauda*, a pygmy species found in the Indian Ocean and South Pacific. The blue whale was originally listed as endangered on December 2, 1970 (35 FR 18319) (Table 1).

Figure 5.1.6. Map identifying the range of the endangered blue whale.



Information available from the recovery plan (NMFS 2020a), recent stock assessment reports (Caretta et al. 2022, Hayes et al. 2020, Muto et al. 2018), and status review (NMFS 2020b) were used to summarize the life history, population dynamics and status of the species as follows.

Life History

The average life span of blue whales is eighty to ninety years. They have a gestation period of ten to twelve months, and calves nurse for six to seven months. Blue whales reach sexual maturity between five and fifteen years of age with an average calving interval of two to three years. They winter at low latitudes, where they mate, calve and nurse, and summer at high latitudes, where they feed. Blue whales forage almost exclusively on krill and can eat approximately 3,600 kilograms daily. Feeding aggregations are often found at the continental shelf edge, where upwelling produces concentrations of krill at depths of 90 to 120 meters.

Population Dynamics

The following is a discussion of the species' population and its variance over time. This section includes abundance, population growth rate, genetic diversity, and spatial distribution as it relates to the blue whale.

The global, pre-exploitation estimate for blue whales is approximately 181,200 (IWC 2007). Current estimates indicate approximately 5,000 to 12,000 blue whales globally (IWC 2007). Blue whales are separated into populations by ocean basin in the North Atlantic, North Pacific, and Southern Hemisphere. There are three stocks of blue whales designated in U.S. waters: the eastern North Pacific (current best estimate N = 1,647 N_{min} = 1,551; (Calambokidis and Barlow 2013)) central North Pacific (N = 81 N_{min} = 38), and western North Atlantic (N = 400 to 600 N_{min} = 440). The Southern Hemisphere ocean basins have approximately 2,000 individual blue whales.

Current estimates indicate a growth rate of just under three percent per year for the eastern North Pacific stock (Calambokidis et al. 2009). An overall population growth rate for the species or growth rates for the two other individual U.S. stocks are not available at this time.

Little genetic data exist on blue whales globally. Data from Australia indicates that at least populations in this region experienced a recent genetic bottleneck, likely the result of commercial whaling, although genetic diversity levels appear to be similar to other, non-threatened mammal species (Attard et al. 2010). Consistent with this, data from Antarctica also demonstrate this bottleneck but high haplotype diversity, which may be a consequence of the recent timing of the bottleneck and blue whales long lifespan (Sremba et al. 2012). Data on genetic diversity of blue whales in the Northern Hemisphere are currently unavailable. However, genetic diversity information for similar cetacean population sizes can be applied. Stocks that have a total population size of 2,000 to 2,500 individuals or greater provide for maintenance of genetic diversity resulting in long-term persistence and protection from substantial environmental variance and catastrophes. Stocks that have a total population 500 individuals or less may be at a greater risk of extinction due to genetic risks resulting from inbreeding. Stock populations at low densities (<100) are more likely to suffer from the 'Allee' effect, where inbreeding and the heightened difficulty of finding mates reduces the population growth rate in proportion with reducing density.

In general, distribution is driven largely by food requirements; blue whales are more likely to occur in waters with dense concentrations of their primary food source, krill. While they can be found in coastal waters, they are thought to prefer waters further offshore (Figure 1). In the North Atlantic Ocean, the blue whale range extends from the subtropics to the Greenland Sea. They are most frequently sighted in waters off eastern Canada with a majority of sightings taking place in the Gulf of St. Lawrence. In the North Pacific Ocean, blue whales range from Kamchatka to southern Japan in the west and from the Gulf of Alaska and California to Costa Rica in the east. They primarily occur off the Aleutian Islands and the Bering Sea. In the northern Indian Ocean, there is a "resident" population of blue whales with sightings being reported from the Gulf of Aden, Persian Gulf, Arabian Sea, and across the Bay of Bengal to Burma and the Strait of Malacca. In the Southern Hemisphere, distributions of subspecies (*B. m. intermedia* and *B. m. brevicauda*) seem to be segregated. The subspecies *B. m. intermedia* occurs in relatively high latitudes south of the "Antarctic Convergence" (located between 48°S and 61°S latitude) and close to the ice edge. The subspecies *B. m. brevicauda* is typically distributed north of the Antarctic Convergence.

Status

The blue whale is endangered as a result of past commercial whaling. In the North Atlantic, at least 11,000 blue whales were taken from the late nineteenth to mid-twentieth centuries. In the North Pacific, at least 9,500 whales were killed between 1910 and 1965. Commercial whaling no longer occurs; potential threats to blue whales identified in the 2020 Recovery Plan include ship strikes, entanglement in fishing gear and marine debris, anthropogenic noise, and loss of prey base due to climate and ecosystem change (NMFS 2020). There are no recent confirmed records of anthropogenic mortality or serious injury to blue whales in the U.S. Atlantic EEZ or in Atlantic Canadian waters (Henry et al. 2020). The total level of human caused mortality and serious injury is unknown, but it is believed to be insignificant and approaching a zero mortality and serious injury rate (Hayes et al. 2020). Because populations appear to be increasing in size, the species appears to be somewhat resilient to current threats; however, the species has not recovered to pre-exploitation levels.

The 2020 5-Year Review for Blue Whales states that there is insufficient data to undertake an assessment of the blue whale's current status on a global scale. As none of the recovery criteria outlined in the Revised Recovery Plan have been met and given the existing data gaps, the recommendation was for blue whales to remain classified as endangered.

Critical Habitat
No critical habitat has been designated for the blue whale.

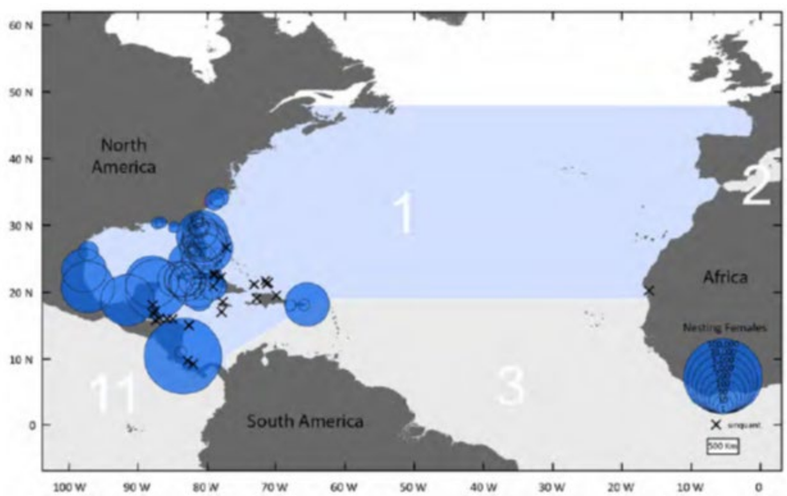
Recovery Goals
The goal of the 2020 Revised Recovery Plan is to promote the recovery of blue whales to the point at which they can be removed from the List of Endangered and Threatened Wildlife and Plants under the provisions of the ESA. The intermediate goal is to reach a sufficient recovery status to reclassify the species from endangered to threatened. The two main objectives for blue whales are to 1) increase blue whale resiliency and ensure geographic and ecological representation by achieving sufficient and viable populations in all ocean basins and in each recognized subspecies, and 2) increase blue whale resiliency by managing or eliminating significant anthropogenic threats. The Recovery Plan includes recovery criteria that address minimum abundance in each of the nine management units (abundance of 500 or 2,000 whales depending on the unit); stable or increasing trend in each of the nine management units; and criteria related to threat identification and minimization (NMFS 2020). The Recovery Plan also includes delisting criteria that address abundance, trends, and threat minimization/elimination (NMFS 2020).

5.2 Sea Turtles
Kemp's ridley and leatherback sea turtles are currently listed under the ESA at the species level; green and loggerhead sea turtles are listed at the DPS level. Therefore, we include information on the range-wide status of Kemp's ridley and leatherback sea turtles to provide the overall status of each species. Information on the status of loggerhead and green sea turtles is for the DPS affected by this action.

5.2.1 Green Sea Turtle (Chelonia mydas, North Atlantic DPS)
The green sea turtle has a circumglobal distribution, occurring throughout tropical, subtropical and, to a lesser extent, temperate waters. They commonly inhabit nearshore and inshore waters. It is the largest of the hardshell marine turtles, growing to a weight of approximately 350 lbs. (159 kg) and a straight carapace length of greater than 3.3 ft. (1 m). The species was listed under the ESA on July 28, 1978 (43 FR 32800) as endangered for breeding populations in Florida and the Pacific coast of Mexico and threatened in all other areas throughout its range. On April 6, 2016, NMFS listed 11 DPSs of green sea turtles as threatened or endangered under the ESA (81 FR 20057). The North Atlantic DPS of green turtle is found in the North Atlantic Ocean and Gulf of Mexico (Figure 5.2.1) and is listed as threatened. Green turtles from the North Atlantic DPS range from the boundary of South and Central America (7.5° N, 77° W) in the south, throughout the Caribbean, the Gulf of Mexico, and the U.S. Atlantic coast to New Brunswick,

Canada (48° N, 77° W) in the north. The range of the DPS then extends due east along latitudes 48° N and 19° N to the western coasts of Europe and Africa.

Figure 5.2.1. Range of the North Atlantic distinct population segment green turtle (1), with location and abundance of nesting females (Seminoff et al. 2015).



We used information available in the 2015 Status Review (Seminoff et al. 2015), relevant literature, and recent nesting data from the Florida Fish and Wildlife Conservation Commission's Fish and Wildlife Research Institute (FWRI) to summarize the life history, population dynamics and status of the species, as follows.

Life History

Costa Rica (Tortuguero), Mexico (Campeche, Yucatan, Quintana Roo), United States (Florida) and Cuba support nesting concentrations of particular interest in the North Atlantic DPS (Seminoff et al. 2015). The largest nesting site in the North Atlantic DPS is in Tortuguero, Costa Rica, which hosts 79% of nesting females for the DPS (Seminoff et al. 2015). In the southeastern United States, females generally nest between May and September (Seminoff et al. 2015, Witherington et al. 2006). Green sea turtles lay an average of three nests per season with an average of one hundred eggs per nest (Hirth 1997, Seminoff et al. 2015). The remigration interval (period between nesting seasons) is two to five years (Hirth 1997, Seminoff et al. 2015). Nesting occurs primarily on beaches with intact dune structure, native vegetation, and appropriate incubation temperatures during the summer months.

Sea turtles are long-lived animals. Size and age at sexual maturity have been estimated using several methods, including mark-recapture, skeletochronology, and marked known-aged individuals. Skeletochronology analyzes growth marks in bones to obtain growth rates and age at sexual maturity estimates. Estimates vary widely among studies and populations, and methods continue to be developed and refined (Avens and Snover 2013). Early mark-recapture studies in Florida estimated the age at sexual maturity 18-30 years (Frazer and Ehrhart 1985, Goshe et al. 2010, Mendonça 1981). More recent estimates of age at sexual maturity are as high as 35–50 years (Avens and Snover 2013, Goshe et al. 2010), with lower ranges reported from known age

(15–19 years) turtles from the Cayman Islands (Bell et al. 2005) and Caribbean Mexico (12–20 years) (Zurita et al. 2012). A study of green turtles that use waters of the southeastern United States as developmental habitat found the age at sexual maturity likely ranges from 30 to 44 years (Goshe et al. 2010). Green turtles in the Northwestern Atlantic mature at 2.8-33+ ft. (85–100+ cm) straight carapace lengths (SCL) (Avens and Snover 2013).

Adult turtles exhibit site fidelity and migrate hundreds to thousands of kilometers from nesting beaches to foraging areas. Green sea turtles spend the majority of their lives in coastal foraging grounds, which include open coastlines and protected bays and lagoons. Adult green turtles feed primarily on seagrasses and algae, although they also eat other invertebrate prey (Seminoff et al. 2015).

Population Dynamics
The North Atlantic DPS has a globally unique haplotype, which was a factor in defining the discreteness of the DPS. Evidence from mitochondrial DNA studies indicates that there are at least four independent nesting subpopulations in Florida, Cuba, Mexico, and Costa Rica (Seminoff et al. 2015). More recent genetic analysis indicates that designating a new western Gulf of Mexico management unit might be appropriate (Shamblin et al. 2016).

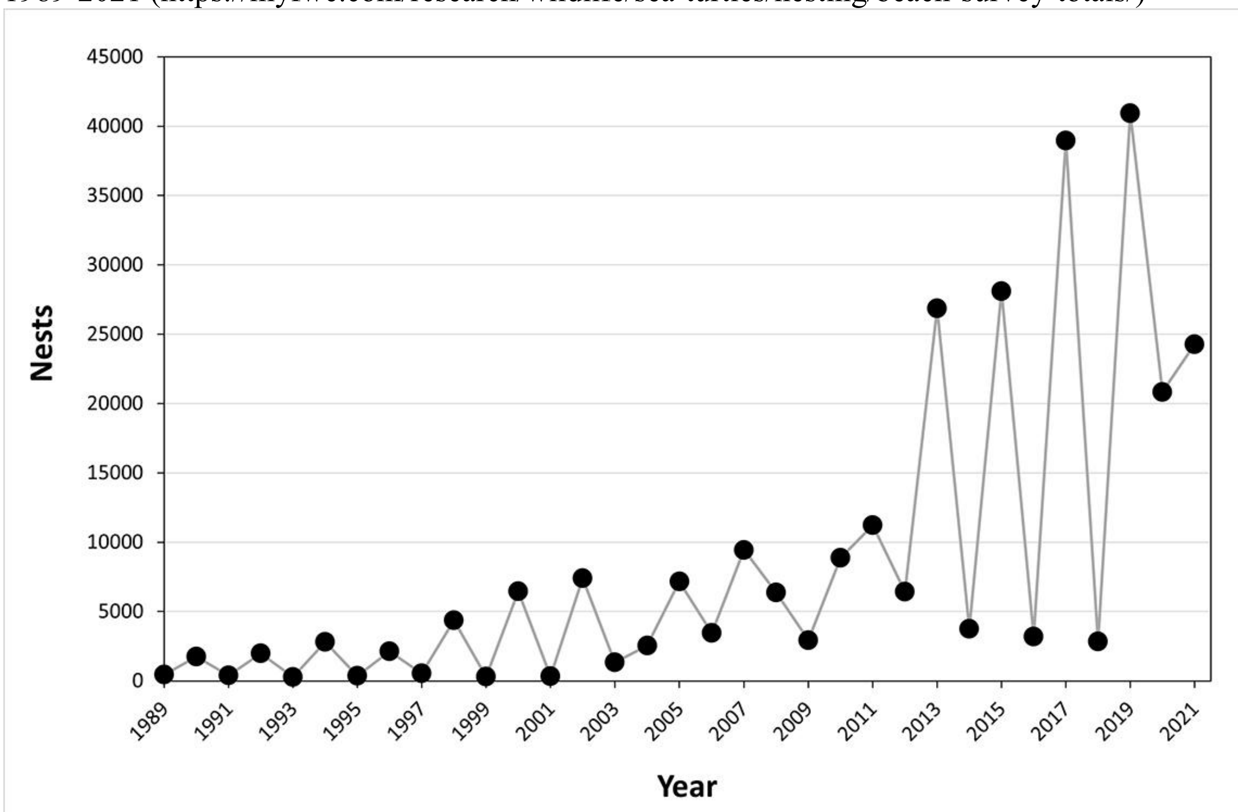
Compared to other DPSs, the North Atlantic DPS exhibits the highest nester abundance, with approximately 167,424 females at seventy-three nesting sites (using data through 2012), and available data indicated an increasing trend in nesting (Seminoff et al. 2015). Counts of nests and nesting females are commonly used as an index of abundance and population trends, even though there are doubts about the ability to estimate the overall population size.

There are no reliable estimates of population growth rate for the DPS as a whole, but estimates have been developed at a localized level. The status review for green sea turtles assessed population trends for seven nesting sites with more than10 years of data collection in the North Atlantic DPS. The results were variable with some sites showing no trend and others increasing. However, all major nesting populations (using data through 2011-2012) demonstrated increases in abundance (Seminoff et al. 2015)).

Recent data is available for the southeastern United States. The FWRI monitors sea turtle nesting through the Statewide Nesting Beach Survey (SNBS) and Index Nesting Beach Survey (INBS). Since 1979, the SNBS has surveyed approximately 215 beaches to collect information on the distribution, seasonality, and abundance of sea turtle nesting in Florida. Since 1989, the INBS has been conducted on a subset of SNBS beaches to monitor trends through consistent effort and specialized training of surveyors. The INBS data uses a standardized data-collection protocol to allow for comparisons between years and is presented for green, loggerhead, and leatherback sea turtles. The index counts represent 27 core index beaches and do not represent Florida's total annual nest counts because they are collected only on a subset of Florida's beaches (27 out of 224 beaches) and only during a 109-day time window (15 May through 31 August). The index nest counts represent approximately 67% of known green turtle nesting in Florida (https://myfwc.com/research/wildlife/sea-turtles/nesting/beach-survey-totals/).

Green turtle nest counts have increased eightyfold since standardized nest counts began in 1989. In 2021, green turtle nest counts on the 27-core index beaches reached more than 24,000 nests recorded. Nesting green turtles tend to follow a two-year reproductive cycle and, typically, there are wide year-to-year fluctuations in the number of nests recorded. Green turtles set record highs in 2011, 2013, 2015, 2017, and 2019. The nest count in 2021 did not set another record high but was only marginally higher than 2020, an unusually high "low year." FWRI reports that changes in the typical two-year cycle have been documented in the past as well (e.g., 2010-2011) and are not reason of concern.

Figure 5.2.2. Number of green sea turtle nests counted on core index beaches in Florida from 1989-2021 (https://myfwc.com/research/wildlife/sea-turtles/nesting/beach-survey-totals/)



Status
Historically, green sea turtles in the North Atlantic DPS were hunted for food, which was the principal cause of the population's decline. Apparent increases in nester abundance for the North Atlantic DPS in recent years are encouraging but must be viewed cautiously, as the datasets represent a fraction of a green sea turtle generation, which is between 30 and 40 years (Seminoff et al. 2015). While the threats of pollution, habitat loss through coastal development, beachfront lighting, and fisheries bycatch continue, the North Atlantic DPS appears to be somewhat resilient to future perturbations.

Critical Habitat
Critical habitat for the North Atlantic DPS of green sea turtles surrounds Culebra Island, Puerto Rico (66 FR 20058, April 6, 2016), which is outside the action area.

Recovery Goals
The most recent Recovery Plan for the U.S. population of green sea turtles in the Atlantic was published in 1991. The goal of the 1991 Recovery Plan is to delist the species once the recovery criteria are met (NMFS and U.S.FWS 1991). The recovery plan includes criteria for delisting related to nesting activity, nesting habitat protection, and reduction in mortality.

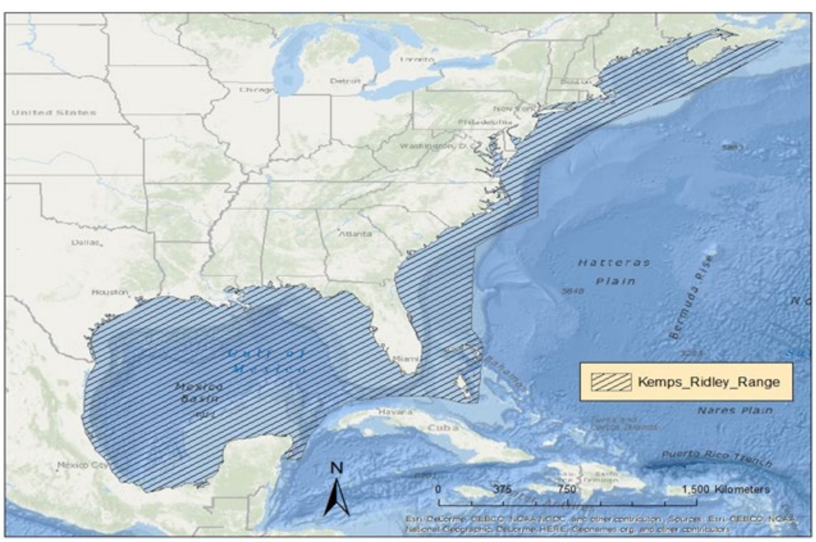
Priority actions to meet the recovery goals include:

1. Providing long-term protection to important nesting beaches.
2. Ensuring at least a 60% hatch rate success on major nesting beaches.
3. Implementing effective lighting ordinances/plans on nesting beaches.
4. Determining distribution and seasonal movements of all life stages in the marine environment.
5. Minimizing commercial fishing mortality.
6. Reducing threat to the population and foraging habitat from marine pollution.

5.2.2 Kemp's Ridley Sea Turtle (Lepidochelys kempii)
The range of Kemp's ridley sea turtles extends from the Gulf of Mexico to the Atlantic coast (Figure 5.2.3). They have occasionally been found in the Mediterranean Sea, which may be due to migration expansion or increased hatchling production (Tomás and Raga 2008). They are the smallest of all sea turtle species, with a nearly circular top shell and a pale yellowish bottom shell. The species was first listed under the Endangered Species Conservation Act (35 FR 18319, December 2, 1970) in 1970. The species has been listed as endangered under the ESA since 1973.

We used information available in the revised recovery plan (NMFS et al. 2011), the five-year review (NMFS and USFWS 2015), and published literature to summarize the life history, population dynamics and status of the species, as follows.

Figure 5.2.3. Range of the Kemp's ridley sea turtle



Life History
Kemp's ridley nesting is essentially limited to the western Gulf of Mexico. Approximately 97% of the global population's nesting activity occurs on a 90-mile (146-km) stretch of beach that includes Rancho Nuevo in Mexico (Wibbels and Bevan 2019). In the United States, nesting occurs primarily in Texas and occasionally in Florida, Alabama, Georgia, South Carolina, and North Carolina (NMFS and USFWS 2015). Nesting occurs from April to July in large arribadas (synchronized large-scale nesting). The average remigration interval is two years, although intervals of 1 and 3 years are not uncommon (NMFS et al. 2011, TEWG 1998, 2000). Females lay an average of 2.5 clutches per season (NMFS et al. 2011). The annual average clutch size is 95 to 112 eggs per nest (NMFS and USFWS 2015). The nesting location may be particularly important because hatchlings can more easily migrate to foraging grounds in deeper oceanic waters, where they remain for approximately two years before returning to nearshore coastal habitats (Epperly et al. 2013, NMFS and USFWS 2015, Snover et al. 2007). Modeling indicates that oceanic-stage Kemp's ridley turtles are likely distributed throughout the Gulf of Mexico into the northwestern Atlantic (Putman et al. 2013). Kemp's ridley nearing the age when recruitment to nearshore waters occurs are more likely to be distributed in the northern Gulf of Mexico, eastern Gulf of Mexico, and the western Atlantic (Putman et al. 2013).

Several studies, including those of captive turtles, recaptured turtles of known age, mark-recapture data, and skeletochronology, have estimated the average age at sexual maturity for Kemp's ridleys between 5 to 12 years (captive only) (Bjorndal et al. 2014), 10 to 16 years (Chaloupka and Zug 1997, Schmid and Witzell 1997, Schmid and Woodhead 2000, Zug et al. 1997), 9.9 to 16.7 years (Snover et al. 2007), 10 and 18 years (Shaver and Wibbels 2007), 6.8 to 21.8 years (mean 12.9 years) (Avens et al. 2017).

During spring and summer, juvenile Kemp's ridleys generally occur in the shallow coastal waters of the northern Gulf of Mexico from south Texas to north Florida and along the U.S. Atlantic coast from southern Florida to the Mid-Atlantic and New England. The NEFSC caught a juvenile Kemp's ridley during a research project in deep water south of Georges Bank (NEFSC, unpublished data). In the fall, most Kemp's ridleys migrate to deeper or more southern, warmer waters and remain there through the winter. As adults, many turtles remain in the Gulf of Mexico, with only occasional occurrence in the Atlantic Ocean (NMFS et al. 2011). Adult habitat largely consists of sandy and muddy areas in shallow, nearshore waters less than 120 feet (37 meters) deep (Seney and Landry 2008, Shaver et al. 2005, Shaver and Rubio 2008), although they can also be found in deeper offshore waters. As larger juveniles and adults, Kemp's ridleys forage on swimming crabs, fish, mollusks, and tunicates (NMFS et al. 2011).

Population Dynamics
Of the sea turtles species in the world, the Kemp's ridley has declined to the lowest population level. Nesting aggregations at a single location (Rancho Nuevo, Mexico) were estimated at 40,000 females in 1947. By the mid-1980s, the population had declined to an estimated 300 nesting females. From 1980 to 2003, the number of nests at three primary nesting beaches (Rancho Nuevo, Tepehuajes, and Playa Dos) increased at 15% annually (Heppell et al. 2005). However, due to recent declines in nest counts, decreased survival of immature and adult sea turtles, and updated population modeling, this rate is not expected to continue and the overall trend is unclear (Caillouet et al. 2018, NMFS and USFWS 2015). In 2019, there were 11,090

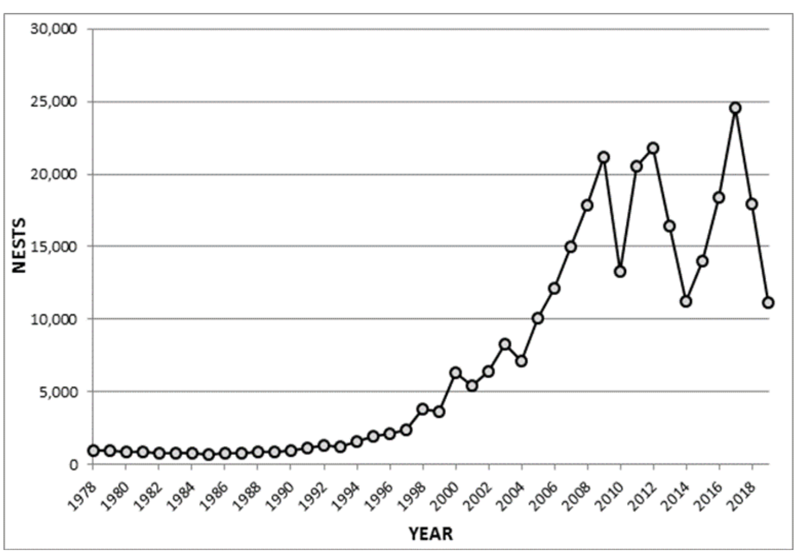
nests, a 37.61% decrease from 2018, and a 54.89% decrease from 2017, which had the highest number (24,587) of nests (Figure 5.2.4; unpublished data). The reason for this recent decline is uncertain. In 2021, 198 Kemp's ridley nests were found in Texas – the largest number recorded in Texas since 1978 was in 2017, when 353 nests were documented.

Using the standard IUCN protocol for sea turtle assessments, the number of mature individuals was recently estimated at 22,341 (Wibbels and Bevan 2019). The calculation took into account the average annual nests from 2016-2018 (21,156), a clutch frequency of 2.5 per year, a remigration interval of 2 years, and a sex ratio of 3.17 females: 1 male. Based on the data in their analysis, the assessment concluded the current population trend is unknown (Wibbels and Bevan 2019). Genetic variability in Kemp's ridley turtles is considered to be high, as measured by nuclear DNA analyses (i.e., microsatellites) (NMFS et al. 2011). If this holds true, rapid increases in population over one or two generations would likely prevent any negative consequences in the genetic variability of the species (NMFS et al. 2011). Additional analysis of the mtDNA taken from samples of Kemp's ridley turtles at Padre Island, Texas, showed six distinct haplotypes, with one found at both Padre Island and Rancho Nuevo (Dutton et al. 2006).

Status

The Kemp's ridley was listed as endangered in response to a severe population decline, primarily the result of egg collection. In 1973, legal ordinances in Mexico prohibited the harvest of sea turtles from May to August, and in 1990, the harvest of all sea turtles was prohibited by presidential decree. In 2002, Rancho Nuevo was declared a Sanctuary. Nesting beaches in Texas have been re-established. Fishery interactions are the main threat to the species. Other threats include habitat destruction, oil spills, dredging, disease, cold stunning, and climate change. The current population trend is uncertain. While the population has increased, recent nesting numbers have been variable. In addition, the species' limited range and low global abundance make it vulnerable to new sources of mortality as well as demographic and environmental randomness, all of which are often difficult to predict with any certainty. Therefore, its resilience to future perturbation affecting survival and nesting success is low.

Figure 5.2.4. Kemp's ridley nest totals from Mexican beaches (Gladys Porter Zoo nesting database 2019)



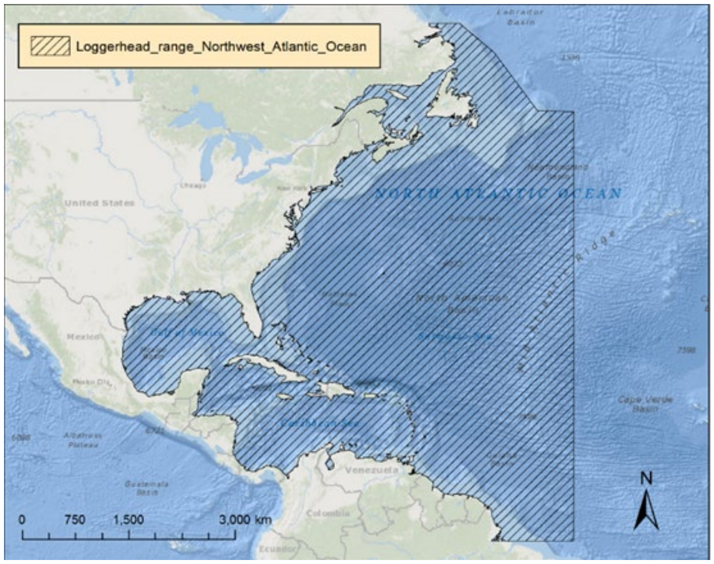
Critical Habitat
Critical habitat has not been designated for Kemp's ridley sea turtles.

Recovery Goals
As with other recovery plans, the goal of the 2011 Kemp's ridley recovery plan (NMFS, USFWS, and SEMARNAT 2011) is to conserve and protect the species so that the listing is no longer necessary. The recovery criteria relate to the number of nesting females, hatchling recruitment, habitat protection, social and/or economic initiatives compatible with conservation, reduction of predation, TED or other protective measures in trawl gear, and improved information available to ensure recovery. In 2015, the bi-national recovery team published a number of recommendations including four critical actions (NMFS and USFWS 2015). These include: (a) continue funding by the major funding institutions at a level of support needed to run the successful turtle camps in the State of Tamaulipas, Mexico, in order to continue the high level of hatchling production and nesting female protection; (b) increase turtle excluder device (TED) compliance in U.S. and MX shrimp fisheries; 3 (c) require TEDs in U.S. skimmer trawl fisheries and other trawl fisheries in coastal waters where fishing overlaps with the distribution of Kemp's ridleys; (d) assess bycatch in gillnets in the Northern Gulf of Mexico and State of Tamaulipas, Mexico, to determine whether modifications to gear or fishing practices are needed.

The most recent Five-Year Review was completed in 2015 (NMFS and USFWS 2015) with a recommendation that the status of Kemp's ridley sea turtles should remain as endangered. In the Plan, the Services recommend that efforts continue towards achieving the major recovery actions in the 2015 plan with a priority for actions to address recent declines in the annual number of nests.

5.2.3 Loggerhead Sea Turtle (Caretta caretta, Northwest Atlantic Ocean DPS)
Loggerhead sea turtles are circumglobal and are found in the temperate and tropical regions of the Indian, Pacific, and Atlantic Oceans. The loggerhead sea turtle is distinguished from other turtles by its reddish-brown carapace, large head and powerful jaws. The species was first listed as threatened under the Endangered Species Act in 1978 (43 FR 32800, July 28, 1978). On September 22, 2011, the NMFS and USFWS designated nine distinct population segments of loggerhead sea turtles, with the Northwest Atlantic Ocean DPS listed as threatened (76 FR 58868). The Northwest Atlantic Ocean DPS of loggerheads is found along eastern North America, Central America, and northern South America (Figure 5.2.5).

Figure 5.2.5. Range of the Northwest Atlantic Ocean DPS of loggerhead sea turtles



We used information available in the 2009 Status Review (Conant et al. 2009), the final listing rule (76 FR 58868, September 22, 2011), the relevant literature, and recent nesting data from the FWRI to summarize the life history, population dynamics and status of the species, as follows.

Life History
Nesting occurs on beaches where warm, humid sand temperatures incubate the eggs. Northwest Atlantic females lay an average of five clutches per year. The annual average clutch size is 115 eggs per nest. Females do not nest every year. The average remigration interval is three years. There is a 54% emergence success rate (Conant et al. 2009). As with other sea turtles, temperature determines the sex of the turtle during the middle of the incubation period. Turtles spend the post-hatchling stage in pelagic waters. The juvenile stage is spent first in the oceanic zone and later in coastal waters. Some juveniles may periodically move between the oceanic zone and coastal waters (Bolten 2003, Conant et al. 2009, Mansfield 2006, Morreale and Standora 2005, Witzell 2002). Coastal waters provide important foraging, inter-nesting, and migratory habitats for adult loggerheads. In both the oceanic zone and coastal waters, loggerheads are primarily carnivorous, although they do consume some plant matter as well (Conant et al. 2009). Loggerheads have been documented to feed on crustaceans, mollusks, jellyfish and salps, and algae (Bjorndal 1997, Donaton et al. 2019, Seney and Musick 2007). Avens et al. (2015) used three approaches to estimate age at maturation. Mean age predictions associated with minimum and mean maturation straight carapace lengths were 22.5-25 and 36-38 years for females and 26-28 and 37-42 years for males. Male and female sea turtles have similar post-maturation longevity, ranging from 4 to 46 (mean 19) years (Avens et al. 2015).

Loggerhead hatchlings from the western Atlantic disperse widely, most likely using the Gulf Stream to drift throughout the Atlantic Ocean. MtDNA evidence demonstrates that juvenile loggerheads from southern Florida nesting beaches comprise the vast majority (71%-88%) of individuals found in foraging grounds throughout the western and eastern Atlantic: Nicaragua, Panama, Azores and Madeira, Canary Islands and Andalusia, Gulf of Mexico, and Brazil (Masuda 2010). LaCasalla et al. (2013) found that loggerheads, primarily juveniles, caught within the Northeast Distant (NED) waters of the North Atlantic mostly originated from nesting populations in the southeast United States and, in particular, Florida. They found that nearly all loggerheads caught in the NED came from the Northwest Atlantic DPS (mean = 99.2%), primarily from the large eastern Florida rookeries. There was little evidence of contributions from the South Atlantic, Northeast Atlantic, or Mediterranean DPSs (LaCasella et al. 2013). A more recent analysis assessed sea turtles captured in fisheries in the Northwest Atlantic and included samples from 850 (including 24 turtles caught during fisheries research) turtles caught from 2000-2013 in coastal and oceanic habitats (Stewart et al. 2019). The turtles were primarily captured in pelagic longline and bottom otter trawls. Other gears included bottom longline, hook and line, gillnet, dredge, and dip net. Turtles were identified from 19 distinct management units; the western Atlantic nesting populations were the main contributors with little representation from the Northeast Atlantic, Mediterranean, or South Atlantic DPSs (Stewart et al. 2019). There was a significant split in the distribution of small (≤ 2 ft. (63 cm) SCL) and large (> 2 ft. (63 cm) SCL) loggerheads north and south of Cape Hatteras, North Carolina. North of Cape Hatteras, large turtles came mainly from southeast Florida (44%±15%) and the northern United States management units (33%±16%); small turtles came from central east Florida (64%±14%). South of Cape Hatteras, large turtles came mainly from central east Florida (52%±20%) and southeast Florida (41%±20%); small turtles came from southeast Florida (56%±25%). The authors concluded that bycatch in the western North Atlantic would affect the Northwest Atlantic DPS almost exclusively (Stewart et al. 2019).

Population Dynamics

A number of stock assessments and similar reviews (Conant et al. 2009, Heppell et al. 2005, NMFS SEFSC 2001, 2009, Richards et al. 2011, TEWG 1998, 2000, 2009) have examined the stock status of loggerheads in the Atlantic Ocean, but none has been able to develop a reliable estimate of absolute population size. As with other species, counts of nests and nesting females are commonly used as an index of abundance and population trends, even though there are doubts about the ability to estimate the overall population size.

Based on genetic analysis of nesting subpopulations, the Northwest Atlantic Ocean DPS is divided into five recovery units: Northern, Peninsular Florida, Dry Tortugas, Northern Gulf of Mexico, and Greater Caribbean (Conant et al. 2009). A more recent analysis using expanded mtDNA sequences revealed that rookeries from the Gulf and Atlantic coasts of Florida are genetically distinct (Shamblin et al. 2014). The recent genetic analyses suggest that the Northwest Atlantic Ocean DPS should be considered as ten management units: (1) South Carolina and Georgia, (2) central eastern Florida, (3) southeastern Florida, (4) Cay Sal, Bahamas, (5) Dry Tortugas, Florida, (6) southwestern Cuba, (7) Quintana Roo, Mexico, (8) southwestern Florida, (9) central western Florida, and (10) northwestern Florida (Shamblin et al. 2012). The Northwest Atlantic Ocean's loggerhead nesting aggregation is considered the largest in the world (Casale and Tucker 2017). Using data from 2004-2008, the adult female population size of the DPS was estimated at 20,000 to 40,000 females (NMFS SEFSC 2009). More recently, Ceriani and Meylan (2017) reported a 5-year average (2009-2013) of more than 83,717 nests per year in the southeast United States and Mexico (excluding Cancun (Quintana Roo, Mexico). These estimates included sites without long-term (≥10 years) datasets. When they used data from 86 index sites (representing 63.4% of the estimated nests for the whole DPS with long-term datasets, they reported 53,043 nests per year. Trends at the different index nesting beaches ranged from negative to positive. In a trend analysis of the 86 index sites, the overall trend for the Northwest Atlantic DPS was positive (+2%) (Ceriani and Meylan 2017). Uncertainties in this analysis include, among others, using nesting females as proxies for overall population abundance and trends, demographic parameters, monitoring methodologies, and evaluation methods involving simple comparisons of early and later 5-year average annual nest counts. However, the authors concluded that the subpopulation is well monitored and the data evaluated represents 63.4 % of the total estimated annual nests of the subpopulation and, therefore, are representative of the overall trend (Ceriani and Meylan 2017).

About 80% of loggerhead nesting in the southeast United States occurs in six Florida counties (NMFS and USFWS 2008). The Peninsula Florida Recovery Unit and the Northern Recovery Unit represent approximately 87% and 10%, respectively of all nesting effort in the Northwest Atlantic DPS (Ceriani and Meylan 2017, NMFS and USFWS 2008). As described above, FWRI's INBS collects standardized nesting data. The index nest counts for loggerheads represent approximately 53% of known nesting in Florida. There have been three distinct intervals observed: increasing (1989-1998), decreasing (1998-2007), and increasing (2007-2021). At core index beaches in Florida, nesting totaled a minimum of 28,876 nests in 2007 and a maximum of 65,807 nests in 2016 (https://myfwc.com/research/wildlife/sea-turtles/nesting/beach-survey-totals/). In 2019, more than 53,000 nests were documented. In 2020, loggerhead turtles had another successful nesting season with more than 49,100 nests documented. The nest counts in Figure 5.2.6 represent peninsular Florida and do not include an additional set of beaches in the Florida Panhandle and southwest coast that were added to the program in 1997. Nest counts at these Florida Panhandle index beaches have an upward trend since 2010 (Figure 5.2.7).

Figure 5.2.6. Annual nest counts of loggerhead sea turtles on Florida core index beaches in peninsular Florida, 1989-2021 (https://myfwc.com/research/wildlife/sea-turtles/nesting/beach-survey-totals/)

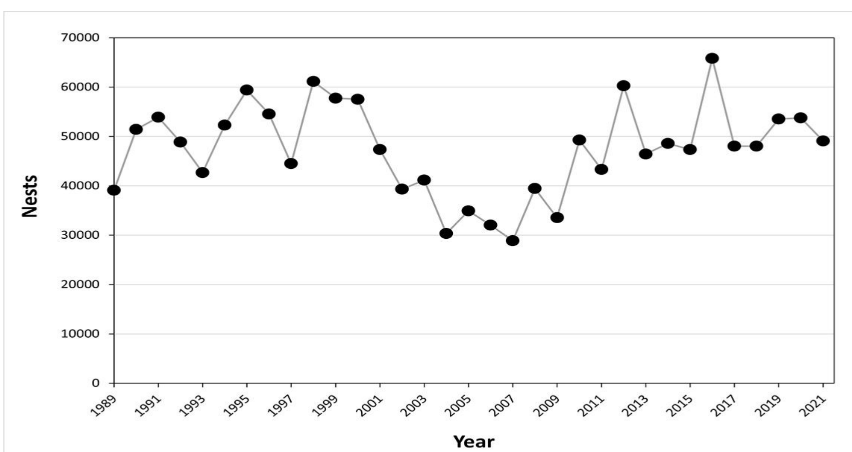
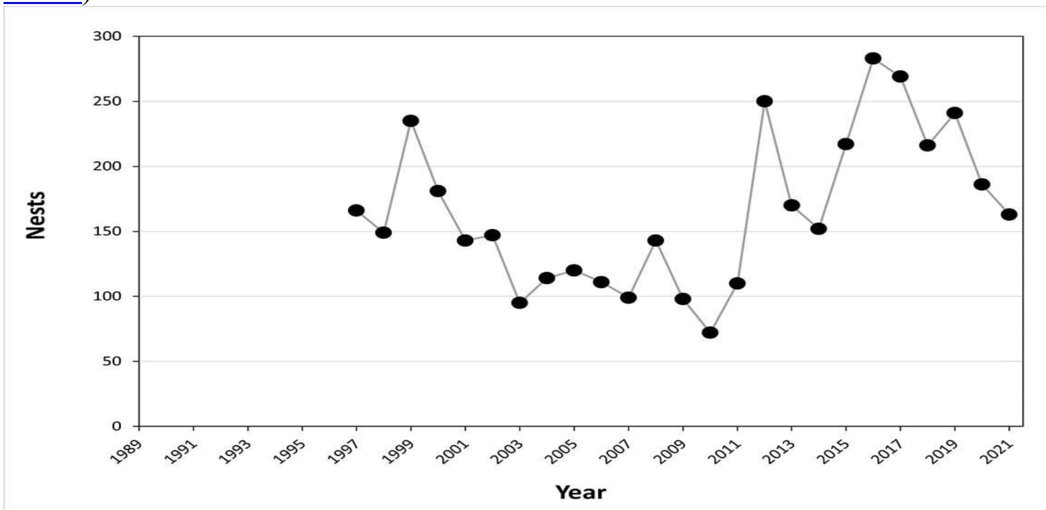


Figure 5.2.7. Annual nest counts of loggerhead sea turtles on index beaches in the Florida Panhandle, 1997-2021 (https://myfwc.com/research/wildlife/sea-turtles/nesting/beach-survey-totals/)



The annual nest counts on Florida's index beaches fluctuate widely, and we do not fully understand what drives these fluctuations. In assessing the population, Ceriani and Meylan (2017) and Bolten et al. (2019) looked at trends by recovery unit. Trends by recovery unit were variable.

The Peninsular Florida Recovery Unit extends from the Georgia-Florida border south and then north (excluding the islands west of Key West, Florida) through Pinellas County on the west coast of Florida. Annual nest counts from 1989 to 2018 ranged from a low of 28,876 in 2007 to a high of 65,807 in 1998 (Bolten et al. 2019). More recently (2008-2018), counts have ranged from 33,532 in 2009 to 65,807 in 2016 (Bolten et al. 2019). Nest counts taken at index beaches in Peninsular Florida showed a significant decline in loggerhead nesting from 1989 to 2007, most likely attributed to mortality of oceanic-stage loggerheads caused by fisheries bycatch (Witherington et al. 2009). Trend analyses have been completed for various periods. From 2009 through 2013, a 2% decrease for this recovery unit was reported (Ceriani and Meylan 2017). Using a longer time series from 1989-2018, there was no significant change in the number of annual nests (Bolten et al. 2019). It is important to recognize that an increase in the number of nests has been observed since 2007. The recovery team cautions that using short term trends in nesting abundance can be misleading and trends should be considered in the context of one generation (50 years for loggerheads) (Bolten et al. 2019).

The Northern Recovery Unit, ranging from the Florida-Georgia border through southern Virginia, is the second largest nesting aggregation in the DPS. Annual nest totals for this recovery unit from 1983 to 2019 have ranged from a low of 520 in 2004 to a high of 5,555 in 2019 (Bolten et al. 2019). From 2008 to 2019, counts have ranged from 1,289 nests in 2014 to 5,555 nests in 2019 (Bolten et al. 2019). Nest counts at loggerhead nesting beaches in North Carolina, South Carolina, and Georgia declined at 1.9% annually from 1983 to 2005 (NMFS and USFWS 2008). Recently, the trend has been increasing. Ceriani and Meylan (2017) reported a

35% increase for this recovery unit from 2009 through 2013. A longer-term trend analysis based on data from 1983 to 2019 indicates that the annual rate of increase is 1.3% (Bolten et al. 2019). The Dry Tortugas Recovery Unit includes all islands west of Key West, Florida. A census on Key West from 1995 to 2004 (excluding 2002) estimated a mean of 246 nests per year, or about 60 nesting females (NMFS and USFWS 2008). No trend analysis is available because there was not an adequate time series to evaluate the Dry Tortugas recovery unit (Ceriani et al. 2019, Ceriani and Meylan 2017), which accounts for less than 1% of the Northwest Atlantic DPS (Ceriani and Meylan 2017).

The Northern Gulf of Mexico Recovery Unit is defined as loggerheads originating from beaches in Franklin County on the northwest Gulf coast of Florida through Texas. From 1995 to 2007, there were an average of 906 nests per year on approximately 300 km of beach in Alabama and Florida, which equates to about 221 females nesting per year (NMFS and USFWS 2008). Annual nest totals for this recovery unit from 1997-2018 have ranged from a low of 72 in 2010 to a high of 283 in 2016 (Bolten et al. 2019). Evaluation of long-term nesting trends for the Northern Gulf of Mexico Recovery Unit is difficult because of changed and expanded beach coverage. However, there are now over 20 years of Florida index nesting beach survey data. A number of trend analyses have been conducted. From 1995 to 2005, the recovery unit exhibited a significant declining trend (Conant et al. 2009, NMFS, and USFWS 2008). Nest numbers have increased in recent years (Bolten et al. 2019) (see https://myfwc.com/research/wildlife/sea-turtles/nesting/beach-survey-totals/). In the 2009-2013 trend analysis by Ceriani and Meylan (2017), a 1% decrease for this recovery unit was reported, likely due to diminished nesting on beaches in Alabama, Mississippi, Louisiana, and Texas. A longer-term analysis from 1997-2018 found that there has been a non-significant increase of 1.7% (Bolten et al. 2019).

The Greater Caribbean Recovery Unit encompasses nesting subpopulations in Mexico to French Guiana, the Bahamas, and the lesser and Greater Antilles. The majority of nesting for this recovery unit occurs on the Yucatán Peninsula, in Quintana Roo, Mexico, with 903 to 2,331 nests annually (Zurita et al. 2003). Other significant nesting sites are found throughout the Caribbean, including Cuba, with approximately 250 to 300 nests annually (Ehrhart et al. 2003), and over 100 nests annually in Cay Sal in the Bahamas (NMFS and USFWS 2008). In the trend analysis by Ceriani and Meylan (2017), a 53% increase for this Recovery Unit was reported from 2009 through 2013.

Status

Fisheries bycatch is the highest threat to the Northwest Atlantic DPS of loggerhead sea turtles (Conant et al. 2009). Other threats include boat strikes, marine debris, coastal development, habitat loss, contaminants, disease, and climate change. Nesting trends for each of the loggerhead sea turtle recovery units in the Northwest Atlantic Ocean DPS are variable. Overall, short-term trends have shown increases, however, over the long-term the DPS is considered stable.

Critical Habitat

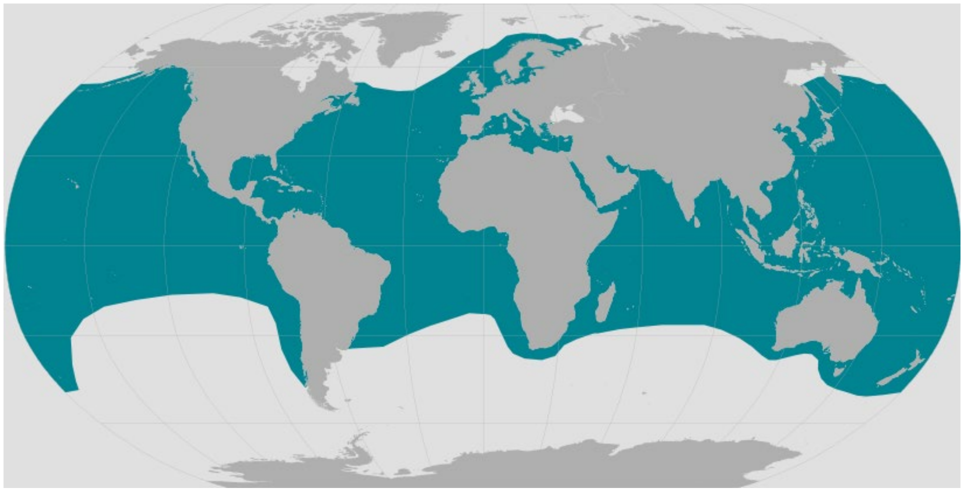
Critical habitat for the Northwest Atlantic DPS was designated in 2014 (see section 4).

Recovery Goals
The recovery goal for the Northwest Atlantic loggerhead is to ensure that each recovery unit meets its recovery criteria, alleviating threats to the species so that protection under the ESA is not needed. The recovery criteria relate to the number of nests and nesting females, trends in abundance on the foraging grounds, and trends in neritic strandings relative to in-water abundance. The 2008 Final Recovery Plan for the Northwest Atlantic Population of Loggerheads includes the complete downlisting/delisting criteria (NMFS and U.S. FWS 2008). The recovery objectives to meet these goals include:

1. Ensure that the number of nests in each recovery unit is increasing and that this increase corresponds to an increase in the number of nesting females.
2. Ensure the in-water abundance of juveniles in both neritic and oceanic habitats is increasing and is increasing at a greater rate than strandings of similar age classes.
3. Manage sufficient nesting beach habitat to ensure successful nesting.
4. Manage sufficient feeding, migratory and internesting marine habitats to ensure successful growth and reproduction.
5. Eliminate legal harvest.
6. Implement scientifically based nest management plans.
7. Minimize nest predation.
8. Recognize and respond to mass/unusual mortality or disease events appropriately.
9. Develop and implement local, state, federal and international legislation to ensure long-term protection of loggerheads and their terrestrial and marine habitats.
10. Minimize bycatch in domestic and international commercial and artisanal fisheries.
11. Minimize trophic changes from fishery harvest and habitat alteration.
12. Minimize marine debris ingestion and entanglement.
13. Minimize vessel strike mortality.

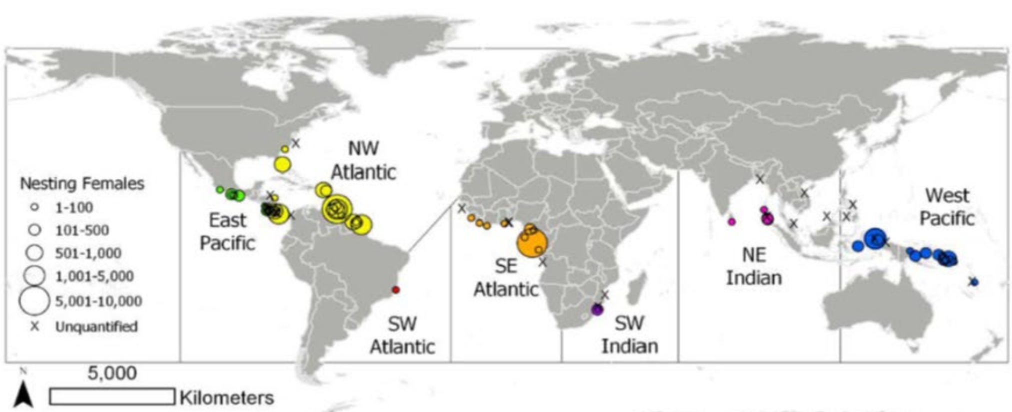
5.2.4 Leatherback Sea Turtle (Deromchelys coriacea)
The leatherback sea turtle is unique among sea turtles for its large size, wide distribution (due to thermoregulatory systems and behavior), and lack of a hard, bony carapace. It ranges from tropical to subpolar latitudes, worldwide (Figure 5.2.8).

Figure 5.2.8. Range of the leatherback sea turtle



Leatherbacks are the largest living turtle, reaching lengths of six feet long, and weighing up to one ton. Leatherback sea turtles have a distinct black leathery skin covering their carapace with pinkish white skin on their plastron. The species was first listed under the Endangered Species Conservation Act (35 FR 8491, June 2, 1970) and has been listed as endangered under the ESA since 1973. In 2020, seven leatherback populations that met the discreteness and significance criteria of the distinct population segment policy were identified (NMFS and USFWS 2020). The population found within the action area is the Northwest Atlantic population segment (NW Atlantic) (Figure 5.2.9). NMFS and USFWS concluded that the seven populations, which met the criteria for DPSs, all met the definition of an endangered species. However, NMFS and USFWS determined that the listing of DPSs was not warranted; leatherbacks continue to be listed at the global level (85 FR 48332, August 10, 2020). Therefore, information is presented on the range-wide status. We used information available in the five-year review (NMFS and USFWS 2013), the critical habitat designation (44 FR 17710, March 23, 1979), the most recent status review (NMFS and USFWS 2020), relevant literature, and recent nesting data from the Florida FWRI to summarize the life history, population dynamics and status of the species, as follows.

Figure 5.2.9. Leatherback sea turtle DPSs and nesting beaches (NMFS and USFWS 2020)



Life History
Leatherbacks are a long-lived species. Preferred nesting grounds are in the tropics; though, nests span latitudes from 34 °S in western Cape, South Africa to 38 °N in Maryland (Eckert et al. 2012, Eckert et al. 2015). Females lay an average of five to seven clutches (range: 1-14 clutches) per season, with 20 to over 100 eggs per clutch (Eckert et al. 2012, Reina et al. 2002, Wallace et al. 2007). The average clutch frequency for the NW Atlantic population segment is 5.5 clutches per season (NMFS and USFWS 2020). In the western Atlantic, leatherbacks lay about 82 eggs per clutch (Sotherland et al. 2015). Remigration intervals are 2-4 years for most populations (range 1-11 years) (Eckert et al. 2015, NMFS and USFWS 2020); the remigration interval for the NW Atlantic population segment is approximately 3 years (NMFS and USFWS 2020). The number of leatherback hatchlings that make it out of the nest on to the beach (i.e., emergence success) is approximately 50% worldwide (Eckert et al. 2012).

Age at sexual maturity has been challenging to obtain given the species physiology and habitat use (Avens et al. 2019). Past estimates ranged from 5-29 years (Avens et al. 2009, Spotila et al. 1996). More recently, Avens et al. (2020) used refined skeletochronology to assess the age at sexual maturity for leatherback sea turtles in the Atlantic and the Pacific. In the Atlantic, the mean age at sexual maturity was 19 years (range 13-28) and the mean size at sexual maturity was 4.2 ft. (129.2 cm) CCL (range (3.7-5 ft. (112.8-153.8 cm)). In the Pacific, the mean age at sexual maturity was 17 years (range 12-28) and the mean size at sexual maturity was 4.2 ft. (129.3 cm) CCL (range 3.6- 5 ft. (110.7-152.3 cm)) (Avens et al. 2019).

Leatherbacks have a greater tolerance for colder waters compared to all other sea turtle species due to their thermoregulatory capabilities (Paladino et al. 1990, Shoop and Kenney 1992, Wallace and Jones 2008). Evidence from tag returns, satellite telemetry, and strandings in the western Atlantic suggests that adult leatherback sea turtles engage in routine migrations between temperate/boreal and tropical waters (Bond and James 2017, Dodge et al. 2015, Eckert et al. 2006, Fossette et al. 2014, James et al. 2005a, James et al. 2005b, James et al. 2005c, NMFS and USFWS 1992). Tagging studies collectively show a clear separation of leatherback movements between the North and South Atlantic Oceans (NMFS and USFWS 2020).

Leatherback sea turtles migrate long, transoceanic distances between their tropical nesting beaches and the highly productive temperate waters where they forage, primarily on jellyfish and tunicates. These gelatinous prey are relatively nutrient-poor, such that leatherbacks must consume large quantities to support their body weight. Leatherbacks weigh about 33% more on their foraging grounds than at nesting, indicating that they probably catabolize fat reserves to fuel migration and subsequent reproduction (James et al. 2005c, Wallace et al. 2006). Studies on the foraging ecology of leatherbacks in the North Atlantic show that leatherbacks off Massachusetts primarily consumed lion's mane, sea nettles, and ctenophores (Dodge et al. 2011). Juvenile and small sub-adult leatherbacks may spend more time in oligotrophic (relatively low plant nutrient usually accompanied by high dissolved oxygen) open ocean waters where prey is more difficult to find (Dodge et al. 2011). Sea turtles must meet an energy threshold before returning to nesting beaches. Therefore, their remigration intervals are dependent upon foraging success and duration (Hays 2000, Price et al. 2004).

Population Dynamics
The distribution is global, with nesting beaches in the Pacific, Atlantic, and Indian Oceans. Leatherbacks occur throughout marine waters, from nearshore habitats to oceanic environments (NMFS and USFWS 2020, Shoop and Kenney 1992). Movements are largely dependent upon reproductive and feeding cycles and the oceanographic features that concentrate prey, such as frontal systems, eddy features, current boundaries, and coastal retention areas (Benson et al. 2011).

Analyses of mtDNA from leatherback sea turtles indicates a low level of genetic diversity (Dutton et al. 1999). Further analysis of samples taken from individuals from rookeries in the Atlantic and Indian Oceans suggest that each of the rookeries represent demographically independent populations (NMFS and USFWS 2013). Using genetic data,, combined with nesting, tagging, and tracking data, researchers identified seven global regional management units (RMU) or subpopulations: Northwest Atlantic, Southeast Atlantic, Southwest Atlantic, Northwest Indian, Southwest Indian, East Pacific, and West Pacific (Wallace et al. 2010). The status review concluded that the RMUs identified by Wallace et al. (2010) are discrete populations and, then, evaluated whether any other populations exhibit this level of genetic discontinuity (NMFS and USFWS 2020).

To evaluate the RMUs and fine-scale structure in the Atlantic, Dutton et al. (2013) conducted a comprehensive genetic re-analysis of rookery stock structure. Samples from eight nesting sites in the Atlantic and one in the southwest Indian Ocean identified seven management units in the Atlantic and revealed fine scale genetic differentiation among neighboring populations. The mtDNA analysis failed to find significant differentiation between Florida and Costa Rica or between Trinidad and French Guiana/Suriname (Dutton et al. 2013). While Dutton et al. (2013) identified fine-scale genetic partitioning in the Atlantic Ocean, the differences did not rise to the level of marked separation or discreteness (NMFS and USFWS 2020). Other genetic analyses corroborate the conclusions of Dutton et al. (2013). These studies analyzed nesting sites in French Guiana (Molfetti et al. 2013), nesting and foraging areas in Brazil (Vargas et al. 2019), and nesting beaches in the Caribbean (Carreras et al. 2013). These studies all support three discrete populations in the Atlantic (NMFS and USFWS 2020). While these studies detected fine-scale genetic differentiation in the NW, SW, and SE Atlantic populations, the status review team determined that none indicated that the genetic differences were sufficient to be considered marked separation (NMFS and USFWS 2020).

Population growth rates for leatherback sea turtles vary by ocean basin. An assessment of leatherback populations through 2010 found a global decline overall (Wallace et al. 2013). Using datasets with abundance data series that are 10 years or greater, they estimated that leatherback populations have declined from 90,599 nests per year to 54,262 nests per year over three generations ending in 2010 (Wallace et al. 2013).

Several more recent assessments have been conducted. The Northwest Atlantic Leatherback Working Group was formed to compile nesting abundance data, analyze regional trends, and provide conservation recommendations. The most recent, published IUCN Red List assessment for the NW Atlantic Ocean subpopulation estimated 20,000 mature individuals and approximately 23,000 nests per year (estimate to 2017) (Northwest Atlantic Leatherback

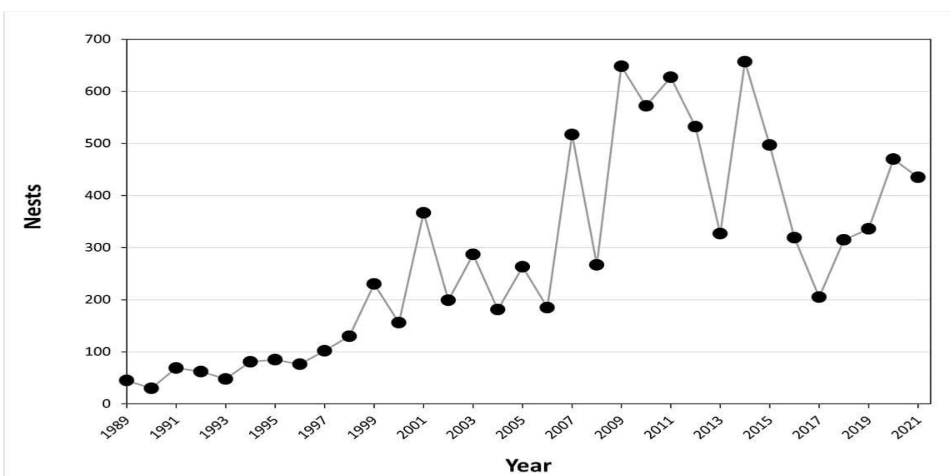
Working Group 2019). Annual nest counts show high inter-annual variability within and across nesting sites (Northwest Atlantic Leatherback Working Group 2018). Using data from 24 nesting sites in 10 nations within the NW Atlantic population segment, the leatherback status review estimated that the total index of nesting female abundance for the NW Atlantic population segment is 20,659 females (NMFS and USFWS 2020). This estimate only includes nesting data from recently and consistently monitored nesting beaches. An index (rather than a census) was developed given that the estimate is based on the number of nests on main nesting beaches with recent and consistent data and assumes a 3-year remigration interval. This index provides a minimum estimate of nesting female abundance (NMFS and USFWS 2020). This index of nesting female abundance is similar to other estimates. The TEWG estimated approximately 18,700 (range 10,000 to 31,000) adult females using nesting data from 2004 and 2005 (TEWG 2007). As described above, the IUCN Red List Assessment estimated 20,000 mature individuals (male and female). The estimate in the status review is higher than the estimate for the IUCN Red List assessment, likely due to a different remigration interval, which has been increasing in recent years (NMFS and USFWS 2020).

Previous assessments of leatherbacks concluded that the Northwest Atlantic population was stable or increasing (TEWG 2007, Tiwari et al. 2013b). However, based on more recent analyses, leatherback nesting in the Northwest Atlantic is showing an overall negative trend, with the most notable decrease occurring during the most recent period of 2008-2017 (Northwest Atlantic Leatherback Working Group 2018). The analyses for the IUCN Red List assessment indicate that the overall regional, abundance-weighted trends are negative (Northwest Atlantic Leatherback Working Group 2018, 2019). The dataset for trend analyses included 23 sites across 14 countries/territories. Three periods were used for the trend analysis: long-term (1990-2017), intermediate (1998-2017), and recent (2008-2017) trends. Overall, regional, abundance-weighted trends were negative across the periods and became more negative as the time-series became shorter. At the stock level, the Working Group evaluated the NW Atlantic – Guianas-Trinidad, Florida, Northern Caribbean, and the Western Caribbean. The NW Atlantic – Guianas-Trinidad stock is the largest stock and declined significantly across all periods, which was attributed to an exponential decline in abundance at Awala-Yalimapo, French Guiana as well as declines in Guyana, Suriname, Cayenne, and Matura. Declines in Awala-Yalimapo were attributed, in part, due to beach erosion and a loss of nesting habitat (Northwest Atlantic Leatherback Working Group 2018). The Florida stock increased significantly over the long-term, but declined from 2008-2017. The Northern Caribbean and Western Caribbean stocks also declined over all three periods. The Working Group report also includes trends at the site-level, which varied depending on the site and time period, but were generally negative especially in the recent time period. The Working Group identified anthropogenic sources (fishery bycatch, vessel strikes), habitat loss, and changes in life history parameters as possible drivers of nesting abundance declines (Northwest Atlantic Leatherback Working Group 2018). Fisheries bycatch is a well-documented threat to leatherback turtles. The Working Group discussed entanglement in vertical line fisheries off New England and Canada as potentially important mortality sinks. They also noted that vessel strikes result in mortality annually in feeding habitats off New England. Off nesting beaches in Trinidad and the Guianas, net fisheries take leatherbacks in high numbers (~3,000/yr.) (Eckert 2013, Lum 2006, Northwest Atlantic Leatherback Working Group 2018).

Similarly, the leatherback status review concluded that the NW Atlantic population segment exhibits decreasing nest trends at nesting aggregations with the greatest indices of nesting female abundance. Significant declines have been observed at nesting beaches with the greatest historical or current nesting female abundance, most notably in Trinidad and Tobago, Suriname, and French Guiana. Though some nesting aggregations (see status review document for information on specific nesting aggregations) indicated increasing trends, most of the largest ones are declining. The declining trend is considered to be representative of the population segment (NMFS and USFWS 2020). The status review found that fisheries bycatch is the primary threat to the NW Atlantic population (NMFS and USFWS 2020).

Leatherback sea turtles nest in the southeastern United States. From 1989-2019, leatherback nests at core index beaches in Florida have varied from a minimum of 30 nests in 1990 to a maximum of 657 in 2014 (https://myfwc.com/research/wildlife/sea-turtles/nesting/beach-survey-totals/). Leatherback nest numbers reached a peak in 2014 followed by a steep decline (2015-2017) and a promising increase (2018-2021) (https://myfwc.com/research/wildlife/sea-turtles/nesting/beach-survey-totals/) (Figure 5.2.10). The status review found that the median trend for Florida from 2008-2017 was a decrease of 2.1% annually (NMFS and USFWS 2020). Surveyors counted 435 leatherback nests on the 27 core index beaches in 2021. These counts do not include leatherback nesting at the beginning of the season (before May 15), nor do they represent all the beaches in Florida where leatherbacks nest; however, the index provided by these counts remains a representative reflection of trends. However, while green turtle nest numbers on Florida's index beaches continue to rise, Florida hosts only a few hundred nests annually and leatherbacks can lay as many as 11 clutches during a nesting season. Thus, fluctuations in nest count may be the result of a small change in number of females. More years of standardized nest counts are needed to understand whether the fluctuation is natural or warrants concern.

Figure 5.2.10. Number of leatherback sea turtle nests on core index beaches in Florida from 1989-2021 (https://myfwc.com/research/wildlife/sea-turtles/nesting/)



For the SW Atlantic population segment, the status review estimates the total index of nesting female abundance at approximately 27 females (NMFS and USFWS 2020). This is similar to the IUCN Red List assessment that estimated 35 mature individuals (male and female) using nesting data since 2010. Nesting has increased since 2010 overall, though the 2014-2017 estimates were lower than the previous three years. The trend is increasing, though variable (NMFS and USFWS 2020). The SE Atlantic population segment has an index of nesting female abundance of 9,198 females and demonstrates a declining nest trend at the largest nesting aggregation (NMFS and USFWS 2020). The SE population segment exhibits a declining nest trend (NMFS and USFWS 2020).

Populations in the Pacific have shown dramatic declines at many nesting sites (Mazaris et al. 2017, Santidrián Tomillo et al. 2017, Santidrián Tomillo et al. 2007, Sarti Martínez et al. 2007, Tapilatu et al. 2013). For an IUCN Red List evaluation, datasets for nesting at all index beaches for the West Pacific population were compiled (Tiwari et al. 2013a). This assessment estimated the number of total mature individuals (males and females) at Jamursba-Medi and Wermon beaches to be 1,438 turtles (Tiwari et al. 2013a). Counts of leatherbacks at nesting beaches in the western Pacific indicate that the subpopulation declined at a rate of almost 6% per year from 1984 to 2011 (Tapilatu et al. 2013). More recently, the leatherback status review estimated the total index of nesting female abundance of the West Pacific population segment at 1,277 females, and the population exhibits low hatchling success (NMFS and USFWS 2020). The total index of nesting female abundance for the East Pacific population segment is 755 nesting females. It has exhibited a decreasing trend since monitoring began with a 97.4% decline since the 1980s or 1990s, depending on nesting beach (Wallace et al. 2013). The low productivity parameters, drastic reductions in nesting female abundance, and current declines in nesting place the population segment at risk (NMFS and USFWS 2020).

Population abundance in the Indian Ocean is difficult to assess due to lack of data and inconsistent reporting. Available data from southern Mozambique show that approximately 10 females nest per year from 1994 to 2004, and about 296 nests per year were counted in South Africa (NMFS and USFWS 2013). A 5-year status review in 2013 found that, in the southwest Indian Ocean, populations in South Africa are stable (NMFS and USFWS 2013). More recently, the 2020 status review estimated that the total index of nesting female abundance for the SW Indian population segment is 149 females and that the population is exhibiting a slight decreasing nest trend (NMFS and USFWS 2020). While data on nesting in the NE Indian Ocean populations segment is limited, the poulation is estimated at 109 females. This population has exhibited a drastic population decline with extirpation of the largest nesting aggregation in Malaysia (NMFS and USFWS 2020).

Status

The leatherback sea turtle is an endangered species whose once large nesting populations have experienced steep declines in recent decades. There has been a global decline overall. For all population segments, including the NW Atlantic population, fisheries bycatch is the primary threat to the species (NMFS and USFWS 2020). Leatherback turtle nesting in the Northwest Atlantic showed an overall negative trend through 2017, with the most notable decrease occurring during the most recent time frame of 2008 to 2017 (Northwest Atlantic Leatherback Working Group 2018). Though some nesting aggregations indicated increasing trends, most of the largest ones are declining. Therefore, the leatherback status review in 2020 concluded that the NW Atlantic population exhibits an overall decreasing trend in annual nesting activity (NMFS and USFWS 2020). Threats to leatherback sea turtles include loss of nesting habitat, fisheries bycatch, vessel strikes, harvest of eggs, and marine debris, among others (Northwest Atlantic Leatherback Working Group 2018). Because of the threats, once large nesting areas in the Indian and Pacific Oceans are now functionally extinct (Tiwari et al. 2013a) and there have been range-wide reductions in population abundance. The species' resilience to additional perturbation both within the NW Atlantic and worldwide is low.

Critical Habitat
Critical habitat has been designated for leatherback sea turtles in the waters adjacent to Sandy Point, St. Croix, U.S. Virgin Islands (44 FR 17710, March 23, 1979) and along the U.S. West Coast (77 FR 4170, January 26, 2012), both of which are outside the action area.

Recovery Goals
There are separate recovery plans for the U.S. Caribbean, Gulf of Mexico, and Atlantic (NMFS and USFWS 1992) and the U.S. Pacific (NMFS and USFWS 1998) populations of leatherback sea turtles. Neither plan has been recently updated. As with other sea turtle species, the recovery plans for leatherbacks include criteria for considering delisting. These criteria relate to increases in the populations, nesting trends, nesting beach and habitat protection, and implementation of priority actions. Criteria for delisting in the recovery plan for the U.S. Caribbean, Gulf of Mexico, and Atlantic are described here.

Delisting criteria

1. Adult female population increases for 25 years after publication of the recovery plan, as evidenced by a statistically significant trend in nest numbers at Culebra, Puerto Rico; St. Croix, U.S. Virgin Islands; and the east coast of Florida.
2. Nesting habitat encompassing at least 75% of nesting activity in the U.S. Virgin Islands, Puerto Rico, and Florida is in public ownership.
3. All priority-one tasks have been successfully implemented (see the recovery plan for a list of priority one tasks).

Major recovery actions in the U.S. Caribbean, Gulf of Mexico, and Atlantic include actions to:

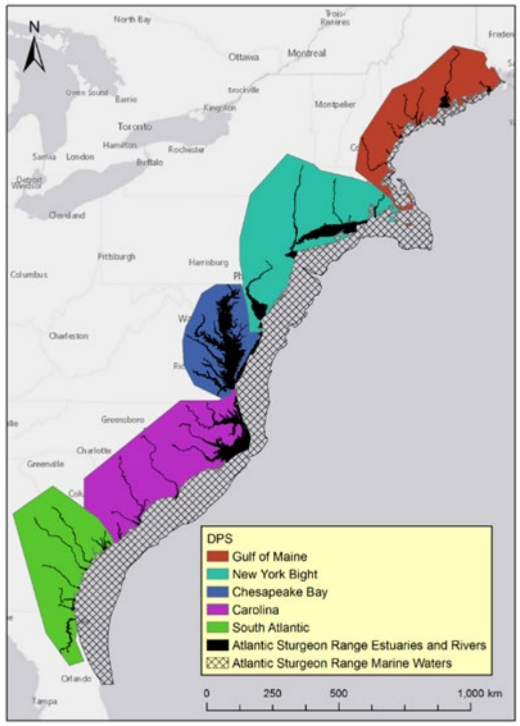
1. Protect and manage terrestrial and marine habitats.
2. Protect and manage the population.
3. Inform and educate the public.
4. Develop and implement international agreements.

The 2013 Five-Year Review (NMFS and USFWS 2013) concluded that the leatherback turtle should not be delisted or reclassified and notes that the 1991 and 1998 recovery plans are dated and do not address the major, emerging threat of climate change.

5.3 Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*)
An estuarine-dependent anadromous species, Atlantic sturgeon occupy ocean and estuarine waters, including sounds, bays, and tidal-affected rivers from Hamilton Inlet, Labrador, Canada, to Cape Canaveral, Florida (ASSRT 2007) (Figure 5.3.1). On February 6, 2012, NMFS listed

five DPSs of Atlantic sturgeon under the ESA: Gulf of Maine (GOM), New York Bight (NYB), Chesapeake Bay (CB), Carolina, and South Atlantic (77 FR 5880 and 77 FR 5914). The Gulf of Maine DPS is listed as threatened, and the New York Bight, Chesapeake Bay, Carolina, and South Atlantic DPSs are listed as endangered.

Figure 5.3.1. U.S. range of Atlantic sturgeon DPSs



Information available from the 2007 Atlantic sturgeon status review (ASSRT 2007), 2017 ASMFC benchmark stock assessment (ASMFC 2017), final listing rules (77 FR 5880 and 77 FR 5914; February 6, 2012), material supporting the designation of Atlantic sturgeon critical habitat (NMFS 2017a), and Five-Year Reviews completed for the Gulf of Maine, New York Bight, and Chesapeake Bay DPSs (NMFS 2022a, b, c) were used to summarize the life history, population dynamics, and status of the species.

Life History

Atlantic sturgeon are a late maturing, anadromous species (ASSRT 2007, Balazik et al. 2010, Hilton et al. 2016, Sulak and Randall 2002). Sexual maturity is reached between the ages of 5 to 34 years. Sturgeon originating from rivers in lower latitudes (e.g., South Carolina rivers) mature faster than those originating from rivers located in higher latitudes (e.g., Saint Lawrence River) (NMFS 2017a).

Atlantic sturgeon spawn in freshwater (ASSRT 2007, NMFS 2017b) at sites with flowing water and hard bottom substrate (Bain et al. 2000, Balazik et al. 2012b, Gilbert 1989, Greene et al. 2009, Hatin et al. 2002, Mohler 2003, Smith and Clugston 1997, Vladykov and Greeley 1963).

Water depths of spawning sites are highly variable, but may be up to 88.5 ft. (27 m) (Bain et al. 2000, Crance 1987, Leland 1968, Scott and Crossman 1973). Based on tagging records, Atlantic sturgeon return to their natal rivers to spawn (ASSRT 2007), with spawning intervals ranging from one to five years in males (Caron et al. 2002, Collins et al. 2000b, Smith 1985) and two to five years in females (Stevenson and Secor 1999, Van Eenennaam et al. 1996, Vladykov and Greeley 1963). Some Atlantic sturgeon river populations may have up to two spawning seasons comprised of different spawning adults (Balazik and Musick 2015, Collins et al. 2000b), although the majority likely have just one, either in the spring or fall.[21] There is evidence of spring and fall spawning for the South Atlantic DPS (77 FR 5914, February 6, 2012, Collins et al. 2000b, NMFS and USFWS 1998b) (Collins et al. 2000b, NMFS and USFWS 1998), spring spawning for the Gulf of Maine and New York Bight DPSs (NMFS 2017a), and fall spawning for the Chesapeake and Carolina DPSs (Balazik et al. 2012a, Smith et al. 1984). While spawning has not been confirmed in the James River (Chesapeake Bay DPS), telemetry and empirical data suggest that there may be two potential spawning runs: a spring run from late March to early May and a fall run around September after an extended staging period in the lower river (Balazik et al. 2012a, Balazik and Musick 2015).

Following spawning, males move downriver to the lower estuary and remain there until outmigration in the fall (Bain 1997, Bain et al. 2000, Balazik et al. 2012a, Breece et al. 2013, Dovel and Berggren 1983a, Greene et al. 2009, Hatin et al. 2002, Ingram et al. 2019, Smith 1985, Smith et al. 1982). Females move downriver and may leave the estuary and travel to other coastal estuaries until outmigration to marine waters in the fall (Bain 1997, Bain et al. 2000, Balazik et al. 2012a, Breece et al. 2013, Dovel and Berggren 1983a, Greene et al. 2009, Hatin et al. 2002, NMFS 2017a, Smith 1985, Smith et al. 1982). Atlantic sturgeon deposit eggs on hard bottom substrate. They hatch into the yolk sac larval stage approximately 94 to 140 hours after deposition (Mohler 2003, Murawski and Pacheco 1977, Smith et al. 1980, Van Den Avyle 1984, Vladykov and Greeley 1963). Once the yolk sac is absorbed (eight to twelve days post-hatching), sturgeon are larvae. Shortly after, they become young of year and then juveniles. The juvenile stage can last months to years in the brackish waters of the natal estuary (ASSRT 2007, Calvo et al. 2010, Collins et al. 2000a, Dadswell 2006, Dovel and Berggren 1983b, Greene et al. 2009, Hatin et al. 2007, Holland and Yelverton 1973, Kynard and Horgan 2002, Mohler 2003, Schueller and Peterson 2010, Secor et al. 2000, Waldman et al. 1996). Upon reaching the sub-adult phase, individuals enter the marine environment, mixing with adults and sub-adults from other river systems (Bain 1997, Dovel and Berggren 1983a, Hatin et al. 2007, McCord et al. 2007) (NMFS 2017a). Once sub-adult Atlantic sturgeon have reached maturity/the adult stage, they will remain in marine or estuarine waters, only returning far upstream to the spawning areas when they are ready to spawn (ASSRT 2007, Bain 1997, Breece et al. 2016, Dunton et al. 2012, Dunton et al. 2015, Savoy and Pacileo 2003).

The life history of Atlantic sturgeon can be divided up into seven general categories as described in Table 5.3.1 below (adapted from ASSRT 2007).

Table 5.3.1. Descriptions of Atlantic sturgeon life history stages

[21] Although referred to as spring spawning and fall spawning, the actual time of Atlantic sturgeon spawning may not occur during the astronomical spring or fall season (Balazik and Musick 2015).

Age Class	Size	Duration	Description
Egg	~2 mm – 3 mm diameter (Van Eenennaam et al. 1996)(p. 773)	Hatching occurs ~3-6 days after egg deposition and fertilization (ASSRT 2007)(p. 4))	Fertilized or unfertilized
Yolk-sac larvae (YSL)	~6mm – 14 mm (Bath et al. 1981)(pp. 714-715))	8-12 days post hatch (ASSRT 2007)(p. 4))	Negative photo-taxic, nourished by yolk sac
Post yolk-sac larvae (PYSL)	~14mm – 37mm (Bath et al. 1981)(pp. 714-715))	12-40 days post hatch	Free swimming; feeding; Silt/sand bottom, deep channel; fresh water
Young of Year (YOY)	0.3 grams <410mm TL	From 40 days to 1 year	Fish that are > 40 days and < one year; capable of capturing and consuming live food
Juveniles	>410mm and <760mm TL	1 year to time at which first coastal migration is made	Fish that are at least age 1 and are not sexually mature and do not make coastal migrations.
Subadults	>760 mm and <1500 mm TL	From first coastal migration to sexual maturity	Fish that are not sexually mature but make coastal migrations
Adults	>1500 mm TL	Post-maturation	Sexually mature fish

Population Dynamics
A population estimate was derived from the NEAMAP trawl surveys.[22] For this Opinion, we are relying on the population estimates derived from the NEAMAP swept area biomass assuming a 50% catchability (i.e., net efficiency x availability) rate. We consider that the NEAMAP surveys sample an area utilized by Atlantic sturgeon but do not sample all the locations and times where Atlantic sturgeon are present. We also consider that the trawl net captures some, but likely not all, of the Atlantic sturgeon present in the sampling area. Therefore, we assume that net efficiency and the fraction of the population exposed to the NEAMAP surveys in combination result in a 50% catchability (NMFS 2013). The 50% catchability assumption reasonably accounts for the robust, yet not complete, sampling of the Atlantic sturgeon oceanic temporal and spatial ranges and the documented high rates of encounter with NEAMAP survey gear. As these estimates are derived directly from empirical data with fewer assumptions than have been required to model Atlantic sturgeon populations to date, we believe these estimates continue to serve as the best available information. Based on the above approach, the overall abundance of Atlantic sturgeon in U.S. Atlantic waters is estimated to be 67,776 fish (see table16 in Kocik et al. 2013). Based on genetic frequencies of occurrence in the sampled area, this overall population estimate was subsequently partitioned by DPS (Table 5.3.2). Given the proportion of adults to sub-adults in the NMFS NEFSC observer data (approximate ratio of 1:3), we have also estimated the number of adults and sub-adults originating from each DPS. However, this cannot be considered an estimate of the total number of sub-adults because it only considers those sub-adults that are of a size that are present and vulnerable to capture in commercial trawl and gillnet gear in the marine environment.

It is important to note, the NEAMAP-based estimates do not include young-of-the-year (YOY) fish and juveniles in the rivers; therefore, the NEAMAP-based estimates underestimate the total population size as they do not account for multiple year classes of Atlantic sturgeon that do not occur in the marine environment where the NEAMAP surveys take place. The NEAMAP surveys are conducted in waters that include the preferred depth ranges of sub-adult and adult Atlantic sturgeon and take place during seasons that coincide with known Atlantic sturgeon coastal migration patterns in the ocean. However, the estimated number of sub-adults in marine waters is a minimum count because it only considers those sub-adults that are captured in a portion of the action area and are present in the marine environment, which is only a fraction of the total number of sub-adults. In regards to adult Atlantic sturgeon, the estimated population in marine waters is also a minimum count as the NEAMAP surveys sample only a portion of the action area, and therefore a portion of the Atlantic sturgeon's range.

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[22] Since fall 2007, NEAMAP trawl surveys (spring and fall) have been conducted from Cape Cod, Massachusetts to Cape Hatteras, North Carolina in nearshore waters at depths up to 60 ft. (18.3 m). Each survey employs a spatially stratified random design with a total of 35 strata and 150 stations.

Table 5.3.2. Calculated population estimates based upon the NEAMAP survey swept area model, assuming 50% efficiency

DPS	Estimated Ocean Population Abundance	Estimated Ocean Population of Adults	Estimated Ocean Population of Sub-adults (of size vulnerable to capture in fisheries)
GOM	7,455	1,864	5,591
NYB	34,566	8,642	25,925
CB	8,811	2,203	6,608
Carolina	1,356	339	1,017
SA	14,911	3,728	11,183
Canada	678	170	509

Precise estimates of population growth rate (intrinsic rates) are unknown for the five listed DPSs of Atlantic sturgeon due to a lack of long-term abundance data. The Commission's 2017 stock assessment referenced a population viability assessment (PVA) that was done to determine population growth rates for the five DPSs based on a few long-term survey programs, but most results were statistically insignificant or utilized a model for which the available did not or poorly fit. In any event, the population growth rates reported from that PVA ranged from -1.8% to 4.9% (ASMFC 2017).

The genetic diversity of Atlantic sturgeon throughout its range has been well-documented (ASSRT 2007, Bowen and Avise 1990, O'Leary et al. 2014, Ong et al. 1996, Waldman et al. 1996, Waldman and Wirgin 1998). Overall, these studies have consistently found populations to be genetically diverse, and the majority can be readily differentiated. Relatively low rates of gene flow reported in population genetic studies (Fritts et al. 2016, Savoy et al. 2017, Wirgin et al. 2002) indicate that Atlantic sturgeon return to their natal river to spawn, despite extensive mixing in coastal waters.

The marine range of U.S. Atlantic sturgeon extends from Labrador, Canada, to Cape Canaveral, Florida. As Atlantic sturgeon travel long distances in these waters, all five DPSs of Atlantic sturgeon have the potential to be anywhere in this marine range. Based on a recent genetic mixed stock analysis (Kazyak et al. 2021; the Ocean Wind project area falls within the "MID Offshore" area described in that paper.), we expect Atlantic sturgeon in the portions of the action area north of Cape Hatteras to originate from the five DPSs at the following frequencies: New York Bight (55.3%), Chesapeake (22.9%), South Atlantic (13.6%), Carolina (5.8%), Gulf of Maine (1.6%), and Gulf of Maine (1.6%) DPSs. It is possible that a small fraction (0.7%) of Atlantic sturgeon in the area may be Canadian origin (Kazyak et al. 2021); Canadian-origin Atlantic sturgeon are not listed under the ESA. This represents the best available information on the likely genetic makeup of individuals occurring in the lease area, the cable routes and vessel transit routes north of Cape Hatteras. The portion of the action area south of Cape Hatteras falls with the "SOUTH" region described in Kazyak et al. 2021; Atlantic sturgeon in this portion of the action area are expected to be nearly all from the South Atlantic DPS (91.2%) and the Carolina DPS (6.2%), with few individuals from the Chesapeake Bay and New York Bight

DPSs.

Based on fishery-independent, fishery dependent, tracking, and tagging data, Atlantic sturgeon appear to primarily occur inshore of the 164 ft. (50 m) depth contour (Dunton et al. 2012, Dunton et al. 2010, Erickson et al. 2011, Laney et al. 2007, O'Leary et al. 2014, Stein et al. 2004a, b, Waldman et al. 2013, Wirgin et al. 2015a, Wirgin et al. 2015b). However, they are not restricted to these depths and excursions into deeper (e.g., 250 ft. (75 m)) continental shelf waters have been documented (Colette and Klein-MacPhee 2002, Collins and Smith 1997, Erickson et al. 2011, Stein et al. 2004b, Timoshkin 1968). Data from fishery-independent surveys and tagging and tracking studies also indicate that some Atlantic sturgeon may undertake seasonal movements along the coast (Dunton et al. 2010, Erickson et al. 2011, Hilton et al. 2016, Oliver et al. 2013, Post et al. 2014, Wippelhauser 2012). For instance, studies found that satellite-tagged adult sturgeon from the Hudson River concentrated in the southern part of the Mid-Atlantic Bight, at depths greater than 66 ft. (20 m), during winter and spring; while, in the summer and fall, Atlantic sturgeon concentrations shifted to the northern portion of the Mid-Atlantic Bight at depths less than 66 ft. (20 m) (Erickson et al. 2011).

In the marine range, several marine aggregation areas occur adjacent to estuaries and/or coastal features formed by bay mouths and inlets along the U.S. eastern seaboard (i.e., waters off North Carolina; Chesapeake Bay; Delaware Bay; New York Bight; Massachusetts Bay; Long Island Sound; and Connecticut and Kennebec River Estuaries). Depths in these areas are generally no greater than 82 ft. (25 m) (Bain et al. 2000, Dunton et al. 2010, Erickson et al. 2011, Laney et al. 2007, O'Leary et al. 2014, Oliver et al. 2013, Savoy and Pacileo 2003, Stein et al. 2004b, Waldman et al. 2013, Wippelhauser 2012, Wippelhauser and Squiers 2015). Although additional studies are still needed to clarify why Atlantic sturgeon aggregate at these sites, there is some indication that they may serve as thermal refugia, wintering sites, or marine foraging areas (Dunton et al. 2010, Erickson et al. 2011, Stein et al. 2004b).

Status

Atlantic sturgeon were once present in 38 river systems and, of these, spawned in 35 (ASSRT 2007). They are currently present in 36 rivers and are probably present in additional rivers that provide sufficient forage base, depth, and access (ASSRT 2007). The benchmark stock assessment evaluated evidence for spawning tributaries and sub-populations of U.S. Atlantic sturgeon in 39 rivers. They confirmed (eggs, embryo, larvae, or YOY observed) spawning in ten rivers, considered spawning highly likely (adults expressing gametes, discrete genetic composition) in nine rivers, and suspected (adults observed in upper reaches of tributaries, historical accounts, presence of resident juveniles) spawning in six rivers. Spawning in the remaining rivers was unknown (ten) or suspected historical (four) (ASMFC 2017). The decline in abundance of Atlantic sturgeon has been attributed primarily to the large U.S. commercial fishery, which existed for the Atlantic sturgeon through the mid-1990s. Based on management recommendations in the ISFMP, adopted by the Commission in 1990, commercial harvest in Atlantic coastal states was severely restricted and ultimately eliminated from most coastal states (ASMFC 1998a). In 1998, the Commission placed a 20-40 year moratorium on all Atlantic sturgeon fisheries until the spawning stocked could be restored to a level where 20 subsequent year classes of adult females were protected (ASMFC 1998a, b). In 1999, NMFS closed the U.S. EEZ to Atlantic sturgeon retention, pursuant to the ACA (64 FR 9449; February 26, 1999). However, many state fisheries for sturgeon were closed prior to this.

The most significant threats to Atlantic sturgeon are incidental catch, dams that block access to spawning habitat in southern rivers, poor water quality, dredging of spawning areas, water withdrawals from rivers, and vessel strikes. Climate change related impacts on water quality (e.g., temperature, salinity, dissolved oxygen, contaminants) also have the potential to affect Atlantic sturgeon populations using impacted river systems.

The Atlantic States Marine Fisheries Commission released a new benchmark stock assessment for Atlantic sturgeon in October 2017 (ASMFC 2017). Based on historic removals and estimated effective population size, the 2017 stock assessment concluded that all five Atlantic sturgeon DPSs are depleted relative to historical levels. However, the 2017 stock assessment does provide some evidence of population recovery at the coastwide scale, and mixed population recovery at the DPS scale (ASMFC 2017). The 2017 stock assessment also concluded that a variety of factors (i.e., bycatch, habitat loss, and ship strikes) continue to impede the recovery rate of Atlantic sturgeon (ASMFC 2017).

Despite the depleted status, the Commission's assessment did include signs that the coastwide index is above the 1998 value (95% probability). Total mortality from the tagging model was very low at the coastwide level. Small sample sizes made mortality estimates at the DPS level more difficult. By DPS, the assessment concluded that there was a 51% probability that the Gulf of Maine DPS abundance has increased since 1998 but a 74% probability that mortality for this DPS exceeds the mortality threshold used for the assessment. There is a relatively high (75%) probability that the New York Bight DPS abundance has increased since 1998, and a 31% probability that mortality exceeds the mortality threshold used for the assessment. There is also a relatively high (67%) probability that the Carolina DPS abundance has increased since 1998, and a relatively high probability (75%) that mortality for this DPS exceeds the mortality threshold used in the assessment. However, the index from the Chesapeake Bay DPS (highlighted red) only had a 36% chance of being above the 1998 value and a 30% probability that the mortality for this DPS exceeds the mortality threshold for the assessment. There was not enough information available to assess the abundance for the South Atlantic DPS relative to the 1998 moratorium, but the assessment did conclude that there was 40% probability that the mortality for this DPS exceeds the mortality threshold used in the assessment (ASMFC 2017).

5.3.1 Gulf of Maine DPS

The Gulf of Maine DPS includes the following: all anadromous Atlantic sturgeons that are spawned in the watersheds from the Maine/Canadian border and, extending southward, all watersheds draining into the Gulf of Maine as far south as Chatham, MA. Within this range, Atlantic sturgeon historically spawned in the Androscoggin, Kennebec, Merrimack, Penobscot, and Sheepscot Rivers (ASSRT, 2007). Spawning occurs in the Kennebec River. The capture of a larval Atlantic sturgeon in the Androscoggin River below the Brunswick Dam in the spring of 2011 indicates spawning may also occur in that river. Despite the presence of suitable spawning habitat in a number of other rivers, there is no evidence of recent spawning in the remaining rivers. Atlantic sturgeons that are spawned elsewhere continue to use habitats within all of these rivers as part of their overall marine range (ASSRT, 2007). The movement of subadult and adult sturgeon between rivers, including to and from the Kennebec River and the Penobscot River, demonstrates that coastal and marine migrations are key elements of Atlantic sturgeon life history for the Gulf of Maine DPS (ASSRT, 2007; Fernandes, *et al.*, 2010).

The current status of the Gulf of Maine DPS is affected by historical and modern fisheries dating as far back as the 1800s (Squiers *et al.*, 1979; Stein *et al.*, 2004; ASMFC 2007). Incidental capture of Atlantic sturgeon in state and Federal fisheries continues today. As explained above, we have estimates of the number of subadults and adults that are killed as a result of bycatch in fisheries authorized under Northeast Fishery Management Plans. At this time, we are not able to quantify the impacts from other threats or estimate the number of individuals killed as a result of other anthropogenic threats. Habitat disturbance and direct mortality from anthropogenic sources are the primary concerns.

Some of the impacts from the threats that contributed to the decline of the Gulf of Maine DPS have been removed (e.g., directed fishing), or reduced as a result of improvements in water quality and removal of dams (e.g., the Edwards Dam on the Kennebec River in 1999, the Veazie Dam on the Penobscot River). There are strict regulations on the use of fishing gear in Maine state waters that incidentally catch sturgeon. In addition, there have been reductions in fishing effort in state and federal waters, which most likely would result in a reduction in bycatch mortality of Atlantic sturgeon. A significant amount of fishing in the Gulf of Maine is conducted using trawl gear, which is known to have a much lower mortality rate for Atlantic sturgeon caught in the gear compared to sink gillnet gear (ASMFC, 2007). Atlantic sturgeon from the GOM DPS are not commonly taken as bycatch in areas south of Chatham, MA, with only 8% (e.g., 7 of the 84 fish) of interactions observed in the Mid Atlantic/Carolina region being assigned to the Gulf of Maine DPS (Wirgin and King, 2011). Tagging results also indicate that Gulf of Maine DPS fish tend to remain within the waters of the Gulf of Maine and only occasionally venture to points south. However, data on Atlantic sturgeon incidentally caught in trawls and intertidal fish weirs fished in the Minas Basin area of the Bay of Fundy (Canada) indicate that approximately 35 percent originated from the Gulf of Maine DPS (Wirgin *et al.*, in draft).

As noted previously, studies have shown that in order to rebuild, Atlantic sturgeon can only sustain low levels of bycatch and other anthropogenic mortality (Boreman, 1997; ASMFC, 2007; Kahnle *et al.*, 2007; Brown and Murphy, 2010). NMFS has determined that the Gulf of Maine DPS is at risk of becoming endangered in the foreseeable future throughout all of its range (i.e., is a threatened species) based on the following: (1) significant declines in population sizes and the protracted period during which sturgeon populations have been depressed; (2) the limited amount of current spawning; and, (3) the impacts and threats that have and will continue to affect recovery.

In 2018, we announced the initiation of a 5-year review for the Gulf of Maine DPS. We reviewed and considered new information for the Gulf of Maine DPS that has become available since this DPS was listed as threatened in February 2012. We completed the 5-year review for the Gulf of Maine DPS in February 2022 (NMFS 2022a). Based on the best scientific and commercial data available at the time of the review, we concluded that no change to the listing status is warranted.

5.3.2 New York Bight DPS

The New York Bight DPS includes the following: all anadromous Atlantic sturgeon spawned in the watersheds that drain into coastal waters from Chatham, MA to the Delaware-Maryland border on Fenwick Island. Within this range, Atlantic sturgeon historically spawned in the Connecticut, Delaware, Hudson, and Taunton Rivers (Murawski and Pacheco, 1977; Secor, 2002; ASSRT, 2007). Spawning still occurs in the Delaware and Hudson Rivers. There is no recent evidence (within the last 15 years) of spawning in the Taunton River (ASSRT, 2007). Atlantic sturgeon that are spawned elsewhere continue to use habitats within the Connecticut and Taunton Rivers as part of their overall marine range (ASSRT, 2007; Savoy, 2007; Wirgin and King, 2011).

In 2014, several presumed age-0 Atlantic sturgeon were captured in the Connecticut River; the available information indicates that successful spawning took place in 2013 by a small number of adults. Genetic analysis of the juveniles indicates that the adults were likely migrants from the South Atlantic DPS (Savoy et al. 2017). As noted by the authors, this conclusion is counter to prevailing information regarding straying of adult Atlantic sturgeon. As these captures represent the only contemporary records of possible natal Atlantic sturgeon in the Connecticut River and the genetic analysis is unexpected, more information is needed to establish the frequency of spawning in the Connecticut River and whether there is a unique Connecticut River population of Atlantic sturgeon.

The abundance of the Hudson River Atlantic sturgeon riverine population prior to the onset of expanded exploitation in the 1800s is unknown but has been conservatively estimated at 10,000 adult females (Secor, 2002). Current abundance is likely at least one order of magnitude smaller than historical levels (Secor, 2002; ASSRT, 2007; Kahnle *et al.*, 2007). As described above, an estimate of the mean annual number of mature adults (863 total; 596 males and 267 females) was calculated for the Hudson River riverine population based on fishery-dependent data collected from 1985-1995 (Kahnle *et al.*, 2007). Kahnle *et al.* (1998; 2007) also showed that the level of fishing mortality from the Hudson River Atlantic sturgeon fishery during the period of 1985-1995 exceeded the estimated sustainable level of fishing mortality for the riverine population and may have led to reduced recruitment. A decline in the abundance of young Atlantic sturgeon appeared to occur in the mid to late 1970s followed by a secondary drop in the late 1980s (Kahnle *et al.*, 1998; Sweka *et al.*, 2007; ASMFC, 2010). At the time of listing, catch-per-unit-effort (CPUE) data suggested that recruitment remained depressed relative to catches of juvenile Atlantic sturgeon in the estuary during the mid-late 1980s (Sweka *et al.*, 2007; ASMFC, 2010). In examining the CPUE data from 1985-2007, there are significant fluctuations during this time. There appears to be a decline in the number of juveniles between the late 1980s and early 1990s while the CPUE is generally higher in the 2000s as compared to the 1990s. Given the significant annual fluctuation, it is difficult to discern any trend. Despite the CPUEs from 2000-2007 being generally higher than those from 1990-1999, they are low compared to the late 1980s. Standardized mean catch per net set from the NYSDEC juvenile Atlantic sturgeon survey have had a general increasing trend from 2006 – 2015, with the exception of a dip in 2013.

In addition to capture in fisheries operating in Federal waters, bycatch and mortality also occur in state fisheries; however, the primary fishery (shad) that impacted juvenile sturgeon in the Hudson River, has now been closed and there is no indication that it will reopen soon. In the Hudson River, sources of potential mortality include vessel strikes and entrainment in dredges. Impingement at water intakes, including the Danskammer, Roseton, and Indian Point power plants has been documented in the past; all three of these facilities have recently shut down. Recent information from surveys of juveniles (see above) indicates that the number of young Atlantic sturgeon in the Hudson River is increasing compared to recent years, but is still low compared to the 1970s. There is currently not enough information regarding any life stage to establish a trend for the entire Hudson River population.

There is no abundance estimate for the Delaware River population of Atlantic sturgeon. Harvest records from the 1800s indicate that this was historically a large population with an estimated 180,000 adult females prior to 1890 (Secor and Waldman, 1999; Secor, 2002). Sampling in 2009 to target young-of- the year (YOY) Atlantic sturgeon in the Delaware River (i.e., natal sturgeon) resulted in the capture of 34 YOY, ranging in size from 178 to 349 mm TL (Fisher, 2009) and the collection of 32 YOY Atlantic sturgeon in a separate study (Brundage and O'Herron in Calvo *et al.*, 2010). Genetics information collected from 33 of the 2009-year class YOY indicates that at least three females successfully contributed to the 2009-year class (Fisher, 2011). Therefore, while the capture of YOY in 2009 provides evidence that successful spawning is still occurring in the Delaware River, the relatively low numbers suggest the existing riverine population is limited in size.

Some of the impact from the threats that contributed to the decline of the New York Bight DPS have been removed (e.g., directed fishing) or reduced as a result of improvements in water quality since passage of the Clean Water Act (CWA). In addition, there have been reductions in fishing effort in state and federal waters, which may result in a reduction in bycatch mortality of Atlantic sturgeon. Nevertheless, areas with persistent, degraded water quality, habitat impacts from dredging, continued bycatch in state and federally managed fisheries, and vessel strikes remain significant threats to the New York Bight DPS.

In the marine range, New York Bight DPS Atlantic sturgeon are incidentally captured in federal and state managed fisheries, reducing survivorship of subadult and adult Atlantic sturgeon (Stein *et al.*, 2004; ASMFC 2007). As explained above, currently available estimates indicate that at least 4% of adults may be killed as a result of bycatch in fisheries authorized under federal Northeast FMPs. Based on mixed stock analysis results presented by Wirgin and King (2011), over 40 percent of the Atlantic sturgeon bycatch interactions in the Mid Atlantic Bight region were sturgeon from the New York Bight DPS. Individual-based assignment and mixed stock analysis of samples collected from sturgeon captured in Canadian fisheries in the Bay of Fundy indicated that approximately 1-2% were from the New York Bight DPS. At this time, we are not able to quantify the impacts from other threats or estimate the number of individuals killed as a result of other anthropogenic threats.

Riverine habitat may be impacted by dredging and other in-water activities, disturbing spawning habitat, and altering the benthic forage base. Both the Hudson and Delaware rivers have navigation channels that are maintained by dredging. Dredging is also used to maintain channels in the nearshore marine environment. Dredging outside of Federal channels and in-water construction occurs throughout the New York Bight region. While some dredging projects operate with observers present to document fish mortalities many do not. We have reports of one Atlantic sturgeon entrained during hopper dredging operations in Ambrose Channel, New Jersey, and a number of Atlantic sturgeon have been killed during Delaware River channel maintenance and deepening activities.

In the Hudson and Delaware Rivers, dams do not block access to historical habitat. The Holyoke Dam on the Connecticut River blocks further upstream passage; however, the extent that Atlantic sturgeon would historically have used habitat upstream of Holyoke is unknown. Connectivity may be disrupted by the presence of dams on several smaller rivers in the New York Bight region. Because no Atlantic sturgeon occur upstream of any hydroelectric projects in the New York Bight region, passage over hydroelectric dams or through hydroelectric turbines is not a source of injury or mortality in this area.

New York Bight DPS Atlantic sturgeon may also be affected by degraded water quality. In general, water quality has improved in the Hudson and Delaware over the past decades (Lichter *et al.* 2006; EPA, 2008). Both the Hudson and Delaware rivers, as well as other rivers in the New York Bight region, were heavily polluted in the past from industrial and sanitary sewer discharges. While water quality has improved and most discharges are limited through regulations, many pollutants persist in the benthic environment. This can be particularly problematic if pollutants are present on spawning and nursery grounds as developing eggs and larvae are particularly susceptible to exposure to contaminants.

Vessel strikes occur in the Delaware and Hudson rivers. Delaware State University (DSU) collaborated with the Delaware Division of Fish and Wildlife (DDFW) in an effort to document vessel strikes in 2005. Approximately 200 reported carcasses with over half being attributed to vessel strikes based on a gross examination of wounds have been documented through 2019 (DiJohnson 2019). One hundred thirty-eight (138) sturgeon carcasses were observed on the Hudson River and reported to the NYSDEC between 2007 and 2015. Of these, 69 are suspected of having been killed by vessel strike. Genetic analysis has not been completed on any of these individuals to date, given that the majority of Atlantic sturgeon in the Hudson River belong to the New York Bight DPS; we assume that the majority of the dead sturgeon reported to NYSDEC belonged to the New York Bight DPS. Given the time of year in which the fish were observed (predominantly May through July), it is likely that many of the adults were migrating through the river to the spawning grounds.

Studies have shown that to rebuild, Atlantic sturgeon can only sustain low levels of anthropogenic mortality (Boreman, 1997; ASMFC, 2007; Kahnle *et al.*, 2007; Brown and Murphy, 2010). There are no empirical abundance estimates of the number of Atlantic sturgeon in the New York Bight DPS. We determined that the New York Bight DPS is currently at risk of extinction due to: (1) precipitous declines in population sizes and the protracted period in which sturgeon populations have been depressed; (2) the limited amount of current spawning; and (3) the impacts and threats that have and will continue to affect population recovery.

In 2018, we announced the initiation of a 5-year review for the New York Bight DPS. We reviewed and considered new information for the New York Bight DPS that has become available since this DPS was listed as endangered in February 2012. We completed the 5-year review for the DPS in February 2022 (NMFS 2022b). Based on the best scientific and commercial data available at the time of the review, we concluded that no change to the listing status is warranted.

5.3.3 Chesapeake Bay DPS

The Chesapeake Bay (CB) DPS includes the following: all anadromous Atlantic sturgeon that spawn or are spawned in the watersheds that drain into the Chesapeake Bay and into coastal waters from the Delaware-Maryland border on Fenwick Island to Cape Henry, Virginia. The marine range of Atlantic sturgeon from the CB DPS extends from Hamilton Inlet, Labrador, Canada, to Cape Canaveral, Florida. The riverine range of the CB DPS and the adjacent portion of the marine range are shown in Figure 5.3.1. Within this range, Atlantic sturgeon historically spawned in the Susquehanna, Potomac, James, York, Rappahannock, and Nottoway Rivers (ASSRT 2007). Based on the review by Oakley (2003), 100% of Atlantic sturgeon habitat is currently accessible in these rivers since most of the barriers to passage (i.e., dams) are located upriver of where spawning is expected to have historically occurred (ASSRT 2007).

At the time of listing, the James River was the only known spawning river for the Chesapeake Bay DPS (ASSRT, 2007; Hager, 2011; Balazik et al., 2012). Since the listing, evidence has been provided of both spring and fall spawning populations for the James River, as well as fall spawning in the Pamunkey River, a tributary of the York River, and fall spawning in Marshyhope Creek, a tributary of the Nanticoke River (Hager et al., 2014; Kahn et al., 2014; Balazik and Musick, 2015; Richardson and Secor, 2016). Detections of acoustically-tagged adult Atlantic sturgeon along with historical evidence suggests that Atlantic sturgeon belonging to the Chesapeake Bay DPS may be spawning in the Mattaponi and Rappahannock rivers as well (Hilton et al. 2016; ASMFC 2017a; Kahn et al. 2019). However, information for these populations is limited and the research is ongoing.

Several threats play a role in shaping the current status of CB DPS Atlantic sturgeon. Historical records provide evidence of the large-scale commercial exploitation of Atlantic sturgeon from the James River and Chesapeake Bay in the 19th century (Hildebrand and Schroeder 1928; Vladykov and Greeley 1963; ASMFC 1998b; Secor 2002; Bushnoe *et al.* 2005; ASSRT 2007) as well as subsistence fishing and attempts at commercial fisheries as early as the 17th century (Secor 2002; Bushnoe *et al.* 2005; ASSRT 2007; Balazik *et al.* 2010). Habitat disturbance caused by in-river work, such as dredging for navigational purposes, is thought to have reduced available spawning habitat in the James River (Holton and Walsh 1995; Bushnoe *et al.* 2005; ASSRT 2007). At this time, we do not have information to quantify this loss of spawning habitat.

Decreased water quality also threatens Atlantic sturgeon of the CB DPS, especially since the Chesapeake Bay system is vulnerable to the effects of nutrient enrichment due to a relatively low tidal exchange and flushing rate, large surface-to-volume ratio, and strong stratification during the spring and summer months (Pyzik *et al.* 2004; ASMFC 1998a; ASSRT 2007; EPA 2008). These conditions contribute to reductions in dissolved oxygen levels throughout the Bay. The availability of nursery habitat, in particular, may be limited given the recurrent hypoxia (low dissolved oxygen) conditions within the Bay (Niklitschek and Secor 2005, 2010). Heavy industrial development during the 20th century in rivers inhabited by sturgeon impaired water quality and impeded these species' recovery.

Although there have been improvements in some areas of the Bay's health, the ecosystem remains in poor condition. At this time, we do not have sufficient information to quantify the extent that degraded water quality affects habitat or individuals in the Chesapeake Bay watershed.

More than 100 Atlantic sturgeon carcasses have been salvaged in the James River since 2007 and additional carcasses were reported but could not be salvaged (Greenlee et al. 2019). Many of the salvaged carcasses had evidence of a fatal vessel strike. In addition, vessel struck Atlantic sturgeon have been found in other parts of the Chesapeake Bay DPS's range including in the York and Nanticoke river estuaries, within Chesapeake Bay, and near the mouth of the Bay since the DPS was listed as endangered (NMFS Sturgeon Salvage Permit Reporting; Secor et al. 2021).

In the marine and coastal range of the CB DPS from Canada to Florida, fisheries bycatch in federally and state-managed fisheries poses a threat to the DPS, reducing survivorship of subadults and adults and potentially causing an overall reduction in the spawning population (Stein *et al.* 2004b; ASMFC TC 2007; ASSRT 2007).

Areas with persistent, degraded water quality, habitat impacts from dredging, continued bycatch in U.S. state and federally managed fisheries, Canadian fisheries, and vessel strikes remain significant threats to the CB DPS of Atlantic sturgeon. Of the 35% of Atlantic sturgeon incidentally caught in the Bay of Fundy, about 1% were CB DPS fish (Wirgin *et al.* 2012). Studies have shown that Atlantic sturgeon can only sustain low levels of bycatch mortality (Boreman 1997; ASMFC TC 2007; Kahnle *et al.* 2007). The CB DPS is currently at risk of extinction given (1) precipitous declines in population sizes and the protracted period in which sturgeon populations have been depressed; (2) the limited amount of current spawning; and, (3) the impacts and threats that have and will continue to affect the potential for population recovery.

In 2018, we announced the initiation of a 5-year review for the Chesapeake Bay DPS. We reviewed and considered new information for the Chesapeake Bay DPS that has become available since this DPS was listed as endangered in February 2012. We completed the 5-year review for the Chesapeake Bay DPS in February 2022 (NMFS 2022c). Based on the best scientific and commercial data available at the time of the review, we concluded that no change to the listing status is warranted.

5.3.4 Carolina DPS

The Carolina DPS includes all Atlantic sturgeon that spawn or are spawned in the watersheds (including all rivers and tributaries) from Albemarle Sound southward along the southern Virginia, North Carolina, and South Carolina coastal areas to Charleston Harbor. The marine range of Atlantic sturgeon from the Carolina DPS extends from the Hamilton Inlet, Labrador, Canada, to Cape Canaveral, Florida.

Rivers in the Carolina DPS considered to be spawning rivers include the Neuse, Roanoke, Tar-Pamlico, Cape Fear, and Northeast Cape Fear rivers, and the Santee-Cooper and Pee Dee river (Waccamaw and Pee Dee rivers) systems. Historically, both the Sampit and Ashley Rivers were documented to have spawning populations at one time. However, the spawning population in the Sampit River is believed to be extirpated and the current status of the spawning population in the Ashley River is unknown. We have no information, current or historical, of Atlantic sturgeon using the Chowan and New Rivers in North Carolina. Recent telemetry work by Post et al. (2014) indicates that Atlantic sturgeon do not use the Sampit, Ashley, Ashepoo, and Broad-Coosawhatchie Rivers in South Carolina. These rivers are short, coastal plains rivers that most likely do not contain suitable habitat for Atlantic sturgeon. Fish from the Carolina DPS likely use other river systems than those listed here for their specific life functions.

Historical landings data indicate that between 7,000 and 10,500 adult female Atlantic sturgeon were present in North Carolina prior to 1890 (Armstrong and Hightower 2002, Secor 2002). Secor (2002) estimates that 8,000 adult females were present in South Carolina during that same period. Reductions from the commercial fishery and ongoing threats have drastically reduced the numbers of Atlantic sturgeon within the Carolina DPS. Currently, the Atlantic sturgeon spawning population in at least one river system within the Carolina DPS has been extirpated, with a potential extirpation in an additional system. The ASSRT estimated the remaining river populations within the DPS to have fewer than 300 spawning adults; this is thought to be a small fraction of historic population sizes (ASSRT 2007).

The Carolina DPS was listed as endangered under the ESA as a result of a combination of habitat curtailment and modification, overutilization (i.e., being taken as bycatch) in commercial fisheries, and the inadequacy of regulatory mechanisms in ameliorating these impacts and threats.

The modification and curtailment of Atlantic sturgeon habitat resulting from dams, dredging, and degraded water quality is contributing to the status of the Carolina DPS. Dams have curtailed Atlantic sturgeon spawning and juvenile developmental habitat by blocking over 60 percent of the historical sturgeon habitat upstream of the dams in the Cape Fear and Santee-Cooper River systems. Water quality (velocity, temperature, and dissolved oxygen (DO)) downstream of these dams, as well as on the Roanoke River, has been reduced, which modifies and curtails the extent of spawning and nursery habitat for the Carolina DPS. Dredging in spawning and nursery grounds modifies the quality of the habitat and is further curtailing the extent of available habitat in the Cape Fear and Cooper Rivers, where Atlantic sturgeon habitat has already been modified and curtailed by the presence of dams. Reductions in water quality from terrestrial activities have modified habitat utilized by the Carolina DPS. In the Pamlico and Neuse systems, nutrient-loading and seasonal anoxia are occurring, associated in part with concentrated animal feeding operations (CAFOs). Heavy industrial development and CAFOs have degraded water quality in the Cape Fear River. Water quality in the Waccamaw and Pee Dee rivers have been affected by industrialization and riverine sediment samples contain high levels of various toxins, including dioxins. Additional stressors arising from water allocation and climate change threaten to exacerbate water quality problems that are already present throughout the range of the Carolina DPS. The removal of large amounts of water from the system will alter flows, temperature, and

DO. Existing water allocation issues will likely be compounded by population growth and potentially, by climate change. Climate change is also predicted to elevate water temperatures and exacerbate nutrient-loading, pollution inputs, and lower DO, all of which are current stressors to the Carolina DPS.

Overutilization of Atlantic sturgeon from directed fishing caused initial severe declines in Atlantic sturgeon populations in the Southeast, from which they have never rebounded. Further, continued overutilization of Atlantic sturgeon as bycatch in commercial fisheries is an ongoing impact to the Carolina DPS. Little data exists on bycatch in the Southeast and high levels of bycatch underreporting are suspected. Stress or injury to Atlantic sturgeon taken as bycatch but released alive may result in increased susceptibility to other threats, such as poor water quality (e.g., exposure to toxins and low DO). This may result in reduced ability to perform major life functions, such as foraging and spawning, or even post-capture mortality.

As a wide-ranging anadromous species, Carolina DPS Atlantic sturgeon are subject to numerous Federal (U.S. and Canadian), state and provincial, and inter-jurisdictional laws, regulations, and agency activities. While these mechanisms have addressed impacts to Atlantic sturgeon through directed fisheries, there are currently no mechanisms in place to address the significant risk posed to Atlantic sturgeon from commercial bycatch. Though statutory and regulatory mechanisms exist that authorize reducing the impact of dams on riverine and anadromous species, such as Atlantic sturgeon, and their habitat, these mechanisms have proven inadequate for preventing dams from blocking access to habitat upstream and degrading habitat downstream. Further, water quality continues to be a problem in the Carolina DPS, even with existing controls on some pollution sources. Current regulatory regimes are not necessarily effective in controlling water allocation issues (e.g., no restrictions on interbasin water transfers in South Carolina, the lack of ability to regulate non-point source pollution, etc.)

5.3.5 South Atlantic DPS

The South Atlantic DPS includes all Atlantic sturgeon that spawn or are spawned in the watersheds (including all rivers and tributaries) of the Ashepoo, Combahee, and Edisto Rivers (ACE) Basin southward along the South Carolina, Georgia, and Florida coastal areas to the St. Johns River, Florida.

Rivers known to have current spawning populations within the range of the South Atlantic DPS include the Combahee, Edisto, Savannah, Ogeechee, Altamaha, St. Marys, and Satilla Rivers. Recent telemetry work by Post et al. (2014) indicates that Atlantic sturgeon do not use the Sampit, Ashley, Ashepoo, and Broad-Coosawhatchie Rivers in South Carolina. These rivers are short, coastal plains rivers that most likely do not contain suitable habitat for Atlantic sturgeon. Post et al. (2014) also found Atlantic sturgeon only use the portion of the Waccamaw River downstream of Bull Creek. Due to manmade structures and alterations, spawning areas in the St. Johns River are not accessible and therefore do not support a reproducing population.

Secor (2002) estimates that 8,000 adult females were present in South Carolina prior to 1890. Prior to the collapse of the fishery in the late 1800s, the sturgeon fishery was the third largest fishery in Georgia. Secor (2002) estimated from U.S. Fish Commission landing reports that approximately 11,000 spawning females were likely present in the state prior to 1890.

Reductions from the commercial fishery and ongoing threats have drastically reduced the numbers of Atlantic sturgeon within the South Atlantic DPS. Currently, the Atlantic sturgeon spawning population in at least one river system within the South Atlantic DPS has been extirpated. The Altamaha River population of Atlantic sturgeon, with an estimated 343 adults spawning annually, is believed to be the largest population in the Southeast, yet is estimated to be only 6 percent of its historical population size. The ASSRT estimated the abundances of the remaining river populations within the DPS, each estimated to have fewer than 300 spawning adults, to be less than 1 percent of what they were historically (ASSRT 2007).

The South Atlantic DPS was listed as endangered under the ESA as a result of a combination of habitat curtailment and modification, overutilization (i.e., being taken as bycatch) in commercial fisheries, and the inadequacy of regulatory mechanisms in ameliorating these impacts and threats.

The modification and curtailment of Atlantic sturgeon habitat resulting from dredging and degraded water quality is contributing to the status of the South Atlantic DPS. Maintenance dredging is currently modifying Atlantic sturgeon nursery habitat in the Savannah River and modeling indicates that the proposed deepening of the navigation channel will result in reduced DO and upriver movement of the salt wedge, curtailing spawning habitat. Dredging is also modifying nursery and foraging habitat in the St. Johns River. Reductions in water quality from terrestrial activities have modified habitat utilized by the South Atlantic DPS Non-point source inputs are causing low DO in the Ogeechee River and in the St. Marys River, which completely eliminates juvenile nursery habitat in summer. Low DO has also been observed in the St. Johns River in the summer. Sturgeon are more sensitive to low DO and the negative (metabolic, growth, and feeding) effects caused by low DO increase when water temperatures are concurrently high, as they are within the range of the South Atlantic DPS. Additional stressors arising from water allocation and climate change threaten to exacerbate water quality problems that are already present throughout the range of the South Atlantic DPS. Large withdrawals of over 240 million gallons per day (mgd) of water occur in the Savannah River for power generation and municipal uses. However, users withdrawing less than 100,000 gallons per day (gpd) are not required to get permits, so actual water withdrawals from the Savannah and other rivers within the range of the South Atlantic DPS are likely much higher. The removal of large amounts of water from the system will alter flows, temperature, and DO. Water shortages and "water wars" are already occurring in the rivers occupied by the South Atlantic DPS and will likely be compounded in the future by population growth and potentially by climate change. Climate change is also predicted to elevate water temperatures and exacerbate nutrient-loading, pollution inputs, and lower DO, all of which are current stressors to the South Atlantic DPS.

Overutilization of Atlantic sturgeon from directed fishing caused initial severe declines in Atlantic sturgeon populations in the Southeast, from which they have never rebounded. Further, continued overutilization of Atlantic sturgeon as bycatch in commercial fisheries is an ongoing impact to the South Atlantic DPS. The loss of large subadults and adults as a result of bycatch impacts Atlantic sturgeon populations because they are a long-lived species, have an older age at maturity, have lower maximum fecundity values, and a large percentage of egg production occurs later in life. Little data exist on bycatch in the Southeast and high levels of bycatch underreporting are suspected. Further, a total population abundance for the DPS is not available, and it is therefore not possible to calculate the percentage of the DPS subject to bycatch mortality based on the available bycatch mortality rates for individual fisheries. However, fisheries known to incidentally catch Atlantic sturgeon occur throughout the marine range of the species and in some riverine waters as well. Because Atlantic sturgeon mix extensively in marine waters and may access multiple river systems, they are subject to being caught in multiple fisheries throughout their range. In addition, stress or injury to Atlantic sturgeon taken as bycatch but released alive may result in increased susceptibility to other threats, such as poor water quality (e.g., exposure to toxins and low DO). This may result in reduced ability to perform major life functions, such as foraging and spawning, or even post-capture mortality.

As a wide-ranging anadromous species, Atlantic sturgeon are subject to numerous Federal (U.S. and Canadian), state and provincial, and inter-jurisdictional laws, regulations, and agency activities. While these mechanisms have addressed impacts to Atlantic sturgeon through directed fisheries, there are currently no mechanisms in place to address the significant risk posed to Atlantic sturgeon from commercial bycatch. Though statutory and regulatory mechanisms exist that authorize reducing the impact of dams on riverine and anadromous species, such as Atlantic sturgeon, and their habitat, these mechanisms have proven inadequate for preventing dams from blocking access to habitat upstream and degrading habitat downstream. Further, water quality continues to be a problem in the South Atlantic DPS, even with existing controls on some pollution sources. Current regulatory regimes are not necessarily effective in controlling water allocation issues (e.g., no permit requirements for water withdrawals under 100,000 gpd in Georgia, no restrictions on interbasin water transfers in South Carolina, the lack of ability to regulate non-point source pollution.)

5.3.6 Critical Habitat

Critical habitat has been designated for the five DPSs of Atlantic sturgeon (82 FR 39160, August 17, 2017) in rivers of the eastern United States. Critical habitat designated in the Delaware River for the New York Bight DPS of Atlantic sturgeon is the only critical habitat that may be affected by the proposed action. The February 25, 2022 NJWP Biological Opinion discusses the status of Atlantic sturgeon critical habitat in the Delaware River in sections 5.3 and 6.2.3 and is incorporated here by reference.

Recovery Goals

A Recovery Plan has not been completed for any DPS of Atlantic sturgeon. In 2018, NMFS published a Recovery Outline[23] to serve as an initial recovery-planning document. In this, the recovery vision is stated, "Subpopulations of all five Atlantic sturgeon DPSs must be present across the historical range. These subpopulations must be of sufficient size and genetic diversity to support successful reproduction and recovery from mortality events. The recruitment of juveniles to the sub-adult and adult life stages must also increase and that increased recruitment must be maintained over many years. Recovery of these DPSs will require conservation of the riverine and marine habitats used for spawning, development, foraging, and growth by abating threats to ensure a high probability of survival into the future." The Outline also includes steps that are expected to serve as an initial recovery action plan. These include protecting extant subpopulations and the species' habitat through reduction of threats; gathering information through research and monitoring on current distribution and abundance; and addressing vessel

[23] https://media.fisheries.noaa.gov/dam-migration/ats_recovery_outline.pdf; last accessed March 26, 2023.

strikes in rivers, the effects of climate change and bycatch.

5.4 Shortnose Sturgeon (*Acipenser brevirostrum*)

The only activity considered in this Opinion that may adversely affect shortnose sturgeon is vessel traffic in the Delaware River. Shortnose sturgeon are fish that occur in rivers and estuaries along the East Coast of the U.S. and Canada (SSSRT, 2010). They have a head covered in bony plates, as well as protective armor called scutes extending from the base of the skull to the caudal peduncle. Other distinctive features include a subterminal, protractile tube-like mouth and chemosensory barbels for benthic foraging (SSSRT, 2010). Sturgeon have been present in North America since the Upper Cretaceous period, more than 66 million years ago. The information below is a summary of available information on the species. More thorough discussions can be found in the cited references as well as the Shortnose Sturgeon Status Review Team's (SSSRT) Biological Assessment (2010).

Life History and General Habitat Use

There are differences in life history, behavior, and habitat use across the range of the species. Current research indicates that these differences are adaptations to unique features of the rivers where these populations occur. For example, there are differences in larval dispersal patterns in the Connecticut River (MA) and Savannah River (GA) (Parker, 2007). There are also morphological and behavioral differences. Growth and maturation occurs more quickly in southern rivers but fish in northern rivers grow larger and live longer. We provide general life history attributes in Table 10.

Table 1. Shortnose sturgeon general life history for the species throughout its range

Stage	Size (mm)	Duration	Behaviors/Habitat Used
Egg	3-4	13 days postspawn	stationary on bottom; Cobble and rock, fresh, fast flowing water (0.4-0.8 m/s)
Yolk Sac Larvae	7-15	8-12 days post hatch	Photonegative; swim up and drift behavior; form aggregations with other YSL; Cobble and rock, stay at bottom near spawning site
Post Yolk Sac Larvae	15 - 57	12-40 days post hatch	Free swimming; feeding; Silt bottom, deep channel; fresh water
Young of Year	57 – 140 (north); 57-300 (south)	From 40 days post-hatch to one year	Deep, muddy areas upstream of the salt wedge
Juvenile	140 to 450-550 (north); 300 to 450-550 (south)	1 year to maturation	Increasing salinity tolerance with age; same habitat patterns as adults
Adult	450-1100 average; (max recorded 1400)	Post-maturation	Freshwater to estuary with some individuals making nearshore coastal migrations

Shortnose sturgeon live on average for 30-40 years (Dadswell et al., 1984). Males mature at approximately 5-10 years and females mature between age 7 and 13, with later maturation occurring in more northern populations (Dadswell et al., 1984). Females typically spawn for the first time 5 years post-maturation (age 12-18; Dadswell, 1979; Dadswell et al., 1984) and then spawn every 3-5 years (Dadswell, 1979; Dadswell et al., 1984;). Males spawn for the first time approximately 1-2 years after maturity with spawning typically occurring every 1-2 years (Kieffer and Kynard, 1996; NMFS, 1998; Dadswell et al., 1984). Shortnose sturgeon are iteroparous (spawning more than once during their life) and females release eggs in multiple "batches" during a 24 to 36-hour period (total of 30,000-200,000 eggs). Multiple males are likely to fertilize the eggs of a single female.

Cues for spawning are thought to include water temperature, day length and river flow (Kynard et al, 2012, Kynard et al. 2016). Shortnose sturgeon spawn in freshwater reaches of their natal rivers when water temperatures reach 9–15°C in the spring (Dadswell, 1979; Taubert, 1980a and b; Kynard, 1997). Spawning occurs over gravel, rubble, and/or cobble substrate (Dadswell, 1979, Taubert, 1980a and b; Buckley and Kynard, 1985b; Kynard, 1997) in areas with average bottom velocities between 0.4 and 0.8 m/s. Depths at spawning sites are variable, ranging from 1.2 - 27 m (multiple references in SSSRT (2010)). Eggs are small and demersal and stick to the rocky substrate where spawning occurs.

Shortnose sturgeon occur in waters between 0-34°C (Dadswell et al., 1984; Heidt & Gilbert, 1978); with temperatures above 28°C considered to be stressful. Depths used are highly variable, ranging from shallow mudflats while foraging to deep channels up to 30 m (Dadswell et al., 1984; Dadswell, 1979). Salinity tolerance increases with age; while young of the year must remain in freshwater, adults have been documented in the ocean with salinities of up 30 parts-per-thousand (ppt) (Holland and Yeverton, 1973; Saunders and Smith, 1978). Dissolved oxygen affects distribution, with preference for DO levels at or above 5mg/l and adverse effects anticipated for prolonged exposure to DO less than 3.2mg/L (Secor and Niklitschek 2001).

Shortnose sturgeon feed on benthic insects, crustaceans, mollusks, and polychaetes (Dadswell et al., 1984). Both juvenile and adult shortnose sturgeon primarily forage over sandy-mud bottoms, which support benthic invertebrates (Carlson and Simpson, 1987; Kynard, 1997). Shortnose sturgeon have also been observed feeding off plant surfaces (Dadswell et al., 1984).

Following spawning, adult shortnose sturgeon disperse quickly down river to summer foraging grounds areas and remain in areas downstream of their spawning grounds throughout the remainder of the year (Buckley and Kynard, 1985a, Dadswell et al., 1984; Buckley and Kynard, 1985b; O'Herron et al., 1993).

In northern rivers, shortnose aggregate during the winter months in discrete, deep (3-10m) freshwater areas with minimal movement and foraging (Kynard et al., 2012; Buckley and Kynard, 1985a; Dadswell, 1979, Li et al., 2007; Dovel et al., 1992; Bain et al., 1998a and b). In the winter, adults in southern rivers spend much of their time in the slower moving waters downstream near the salt-wedge and forage widely throughout the estuary (Collins and Smith, 1993, Weber et al., 1998). Prespawning sturgeon in some northern and southern systems migrate into an area in the upper tidal portion of the river in the fall and complete their migration in the spring (Rogers and Weber, 1995). Older juveniles typically occur in the same overwintering areas as adults while young of the year remain in freshwater (Jenkins et al*.,* 1993; Jarvis et al. 2001).

Listing History
Shortnose sturgeon were listed as endangered in 1967 (32 FR 4001), and the species remained on the endangered species list with the enactment of the ESA in 1973. Shortnose sturgeon are thought to have been abundant in nearly every large East Coast river prior to the 1880s (see McDonald, 1887; Smith and Clugston, 1997). Pollution and overfishing, including bycatch in the shad fishery, were listed as principal reasons for the species' decline. The species remains listed as endangered throughout its range. While the 1998 Recovery Plan refers to Distinct Population Segments (DPS), the process to designate DPSs for this species has not been undertaken. The SSSRT published a Biological Assessment for shortnose sturgeon in 2010. The report summarized the status of shortnose sturgeon within each river and identified stressors that continue to affect the abundance and stability of these populations.

Current Status
There is no current total population estimate for shortnose sturgeon rangewide. Information on populations and metapopulations is presented below. In general, populations in the Northeast are larger and more stable than those in the Southeast (SSSRT, 2010). Population size throughout the species' range is considered to be stable; however, most riverine populations are below the historic population sizes and most likely are below the carrying capacity of the river (Kynard, 1996).

Population Structure
There are 19 documented populations of shortnose sturgeon ranging from the St. Johns River, Florida (possibly extirpated from this system) to the Saint John River in New Brunswick, Canada. There is a large gap in the middle of the species range with individuals present in the Chesapeake Bay separated from populations in the Carolinas by a distance of more than 400 km. Currently, there are significantly more shortnose sturgeon in the northern portion of the range.

Developments in genetic research as well as differences in life history support the grouping of shortnose sturgeon into five genetically distinct groups, all of which have unique geographic adaptations (see Grunwald et al., 2008; Grunwald et al., 2002; King et al., 2001; Waldman et al., 2002b; Walsh et al., 2001; Wirgin et al., 2009; Wirgin et al., 2002; SSSRT, 2010). These groups are: 1) Gulf of Maine; 2) Connecticut and Housatonic Rivers; 3) Hudson River; 4) Delaware River and Chesapeake Bay; and 5) Southeast. The Gulf of Maine, Delaware/Chesapeake Bay and Southeast groups function as metapopulations[24]. The other two groups (Connecticut/Housatonic and the Hudson River) function as independent populations.

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[24] A metapopulation is a group of populations in which distinct populations occupy separate patches of habitat separated by unoccupied areas (Levins 1969). Low rates of connectivity through dispersal, with little to no effective movement, allow individual populations to remain distinct as the rate of migration between local populations is low enough not to have an impact on local dynamics or evolutionary lineages (Hastings and Harrison 1994). This interbreeding between populations, while limited, is consistent, and distinguishes metapopulations from other patchy populations.

While there is migration within each metapopulation (i.e., between rivers in the Gulf of Maine and between rivers in the Southeast) and occasional migration between populations (e.g., Connecticut and Hudson), interbreeding between river populations is limited to very few individuals per generation; this results in morphological and genetic variation between most river populations (see Walsh et al., 2001; Grunwald et al., 2002; Waldman et al., 2002; Wirgin et al., 2005). Indirect gene flow estimates from mtDNA indicate an effective migration rate of less than two individuals per generation. This means that while individual shortnose sturgeon may move between rivers, very few sturgeon are spawning outside their natal river; it is important to remember that the result of physical movement of individuals is rarely genetic exchange.

Summary of Status of Northeast Rivers
In NMFS' Greater Atlantic Region, shortnose sturgeon are known to spawn in the Kennebec, Androscoggin, Merrimack, Connecticut, Hudson, and Delaware Rivers. Shortnose sturgeon are also known to occur in the Penobscot and Potomac Rivers; although it is unclear if spawning is currently occurring in those systems.

Gulf of Maine Metapopulation
Tagging and telemetry studies indicate that shortnose sturgeon are present in the Penobscot, Kennebec, Androscoggin, Sheepscot, and Saco Rivers. Individuals have also been documented in smaller coastal rivers; however, the duration of presence has been limited to hours or days and the smaller coastal rivers are thought to be only used occasionally (Zydlewski et al., 2011).

Since the removal of the Veazie and Great Works Dams (2013 and 2012, respectively), in the Penobscot River, shortnose sturgeon range from the Bay to the Milford Dam. Shortnose sturgeon now are presumed to have access to their full historical range. Adult and large juvenile sturgeon have been documented to use the river. While potential spawning sites have been identified, no spawning has been documented. Foraging and overwintering are known to occur in the river. Nearly all prespawn females and males detected in the Penobscot River have been documented to return to the Kennebec or Androscoggin Rivers. Robust design analysis with closed periods in the summer and late fall estimated seasonal adult abundance ranging from 636-1285 (weighted mean), with a low estimate of 602 (95% CI: 409.6-910.8) and a high of 1306 (95% CI: 795.6-2176.4) (Fernandes, 2008; Fernandes et al., 2010; Dionne, 2010 in Maine DMR (2010)).

Delaware River-Chesapeake Bay Metapopulation
Shortnose sturgeon range from Delaware Bay up to at least Scudders Falls (river kilometer 223); there are no dams within the species' range on this river. The population is considered stable (comparing 1981-1984 to 1999-2003) at around 12,000 adults (Hastings et al., 1987 and ERC, 2006b). Spawning occurs primarily between Scudders Falls and the Trenton rapids. Overwintering and foraging also occur in the river. Shortnose sturgeon have been documented to use the Chesapeake-Delaware Canal to move from the Chesapeake Bay to the Delaware River. In Chesapeake Bay, shortnose sturgeon have most often been found in Maryland waters of the mainstem bay and tidal tributaries such as the Susquehanna, Potomac, and Rappahannock Rivers (Kynard et al., 2016; SSSRT, 2010). Spells (1998), Skjeveland et al. (2000), and Welsh et al. (2002) all reported one capture each of adult shortnose sturgeon in the Rappahannock River. Recent documented use of Virginia waters of Chesapeake Bay is currently limited to two

individual shortnose sturgeon: one captured in 2016 (Balazik, 2017) and a second sturgeon (a confirmed gravid female) caught in 2018 in the James River (Balazik, pers. comm. 2018). Spawning has not been documented in any tributary to the Bay although suitable spawning habitat and two prespawn females with late stage eggs have been documented in the Potomac River. Current information indicates that shortnose sturgeon are present year round in the Potomac River with foraging and overwintering taking place there. Shortnose sturgeon captured in the Chesapeake Bay are not genetically distinct from the Delaware River population.

Southeast Metapopulation

There are no shortnose sturgeon between Maryland waters of the Chesapeake Bay and the Carolinas. Shortnose sturgeon are only thought to occur in the Cape Fear River and Yadkin-Pee Dee River in North Carolina and are thought to be present in very small numbers.

The Altamaha River supports the largest known population in the Southeast with successful self-sustaining recruitment. The most recent population estimate for this river was 6,320 individuals (95% CI = 4,387-9,249; DeVries, 2006). The population contains more juveniles than expected. Comparisons to previous population estimates suggest that the population is increasing; however, there is high mortality between the juvenile and adult stages in this river. This mortality is thought to result from incidental capture in the shad fishery, which occurs at the same time as the spawning period (DeVries, 2006).

The only available estimate for the Cooper River is of 300 spawning adults at the Pinoplis Dam spawning site (based on 1996-1998 sampling; Cooke et al., 2004). This is likely an underestimate of the total number of adults as it would not include non-spawning adults. Estimates for the Ogeechee River were 266 (95%CI=236-300) in 1993 (Weber, 1996; Weber et al., 1998); a more recent estimate (sampling from 1999-2004; Fleming et al., 2003) indicates a population size of 147 (95% CI = 104-249). While the more recent estimate is lower, it is not significantly different from the previous estimate. Available information indicates the Ogeechee River population may be experiencing juvenile mortality rates greater than other southeastern rivers.

Spawning is also occurring in the Savannah River, the Congaree River, and the Yadkin-Pee Dee River. There are no population estimates available for these rivers. Occurrence in other southern rivers is limited, with capture in most other rivers limited to fewer than five individuals. They are thought to be extremely rare or possibly extirpated from the St. Johns River in Florida as only a single specimen was found by the Florida Fish and Wildlife Conservation Commission during extensive sampling of the river in 2002/2003. In these river systems, shortnose sturgeon occur in nearshore marine, estuarine, and riverine habitat.

Threats

Because sturgeon are long-lived and slow growing, stock productivity is relatively low; this can make the species vulnerable to rapid decline and slow recovery (Musick, 1999). In well studied rivers (e.g., Hudson, upper Connecticut), researchers have documented significant year to year recruitment variability (up to 10 fold over 20 years in the Hudson and years with no recruitment in the CT). However, this pattern is not unexpected given the life history characteristics of the species and natural variability in hydrogeologic cues relied on for spawning.

The small amount of effective movement between populations means recolonization of currently extirpated river populations is expected to be very slow and any future recolonization of any rivers that experience significant losses of individuals would also be expected to be very slow. Despite the significant decline in population sizes over the last century, gene diversity in shortnose sturgeon is moderately high in both mtDNA (Quattro et al., 2002; Wirgin et al., 2005; Wirgin et al., 2000) and nDNA (King et al., 2001) genomes.

A population of sturgeon can go extinct as a consequence of demographic stochasticity (fluctuations in population size due to random demographic events); the smaller the metapopulation (or population), the more prone it is to extinction. Anthropogenic impacts acting on top of demographic stochasticity further increase the risk of extinction.

All shortnose sturgeon populations are highly sensitive to increases in juvenile mortality that would result in reductions in the number of adult spawners (Anders et al., 2002; Gross et al., 2002; Secor, 2002). Populations of shortnose sturgeon that do not have reliable natural recruitment are at increased risk of experiencing population decline leading to extinction (Secor et al., 2002). Elasticity studies of shortnose sturgeon indicate that the highest potential for increased population size and stability comes from YOY and juveniles as compared to adults (Gross et al., 2002); that is, increasing the number of YOY and juveniles has a more significant long term impact to the population than does increasing the number of adults or the fecundity of adults.

The Shortnose Sturgeon Recovery Plan (NMFS, 1998) and the Shortnose Sturgeon Status Review Team's Biological Assessment of shortnose sturgeon (2010) identify habitat degradation or loss and direct mortality as principal threats to the species' survival. Natural and anthropogenic factors continue to threaten the recovery of shortnose sturgeon and include: poaching, bycatch in riverine fisheries, habitat alteration resulting from the presence of dams, in-water and shoreline construction, including dredging; degraded water quality which can impact habitat suitability and result in physiological effects to individuals including impacts on reproductive success; direct mortality resulting from dredging as well as impingement and entrainment at water intakes; and, loss of historical range due to the presence of dams. Shortnose sturgeon are also occasionally killed as a result of research activities. The total number of sturgeon affected by these various threats is not known. Climate change, particularly shifts in seasonal temperature regimes and changes in the location of the salt wedge, may impact shortnose sturgeon in the future (more information on Climate Change is presented in Section 5.0). More information on threats experienced in the action area is presented in the Environmental Baseline section of this Opinion.

Recovery Plan

The 1998 Recovery Plan (NMFS, 1998) outlines the steps necessary for recovery and indicates that each population may be a candidate for downlisting (i.e., to threatened) when it reaches a minimum population size that is large enough to prevent extinction and will make the loss of genetic diversity unlikely; the minimum population size for each population has not yet been determined. The Recovery Outline contains three major tasks: (1) establish delisting criteria; (2) protect shortnose sturgeon populations and habitats; and, (3) rehabilitate habitats and population segments. We know that in general, to recover, a listed species must have a sustained positive trend of increasing population over time. To allow that to happen for sturgeon, individuals must have access to enough habitat in suitable condition for foraging, resting and spawning. In many rivers, particularly in the Southeast, habitat is compromised and continues to impact the ability of sturgeon populations to recover. Conditions must be suitable for the successful development of early life stages. Mortality rates must be low enough to allow for recruitment to all age classes so that successful spawning can continue over time and over generations. There must be enough suitable habitat for spawning, foraging, resting and migrations of all individuals. Habitat connectivity must also be maintained so that individuals can migrate between important habitats without delays that impact their fitness. The loss of any population or metapopulation would result in the loss of biodiversity and would create (or widen) a gap in the species' range.

6.0 ENVIRONMENTAL BASELINE

The "environmental baseline" refers to the condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process. (50 C.F.R. §402.02).

There are a number of existing activities that regularly occur in various portions of the action area, including operation of vessels and federal and state authorized fisheries. Other activities that occur occasionally or intermittently include scientific research, military activities, and geophysical and geotechnical surveys. There are also environmental conditions caused or exacerbated by human activities (i.e., water quality and noise) that may affect listed species in the action area. Some of these stressors result in mortality or serious injury to individual animals (e.g., vessel strike, fisheries), whereas others result in non-lethal impacts or impacts that are indirect. For all of the listed species considered here, given their extensive movements in and out of the action area and throughout their range as well as the similarities of stressors throughout the action area and other parts of their range the status of the species in the action area is the same as the rangewide status presented in the *Status of the Species* section of this Opinion. Below, we describe the conditions of the action area, present a summary of the best available information on the use of the action area by listed species, and address the impacts to listed species of federal, state, and private activities in the action area that meet the definition of "environmental baseline." Future offshore wind projects, as well as activities caused by aspects of their development and operation, that are not the subjects of a completed consultation are not in the Environmental Baseline for the Ocean Wind 1 project. Rather, as a Section 7 consultation is completed on a wind project, the effects of the action associated with that project would be considered in the Environmental Baseline for the next one in line for consultation.

As described above in Section 3.4, the action area includes the Wind Farm Area (WFA) and the two offshore export cable route corridors, project-related vessel routes (including to/from Europe) and the geographic extent of effects caused by project-related activities in those areas. The Ocean Wind 1 project area is located within multiple defined marine areas. The broadest area, the U.S. Northeast Shelf Large Marine Ecosystem, extends from the Gulf of Maine to Cape

Hatteras, North Carolina (Kaplan 2011). The WFA and export cable routes are located within the Southern Mid-Atlantic Bight sub-region of the U.S. Northeast Shelf Ecosystem, which is distinct from other regions based on differences in productivity, species assemblages and structure, and habitat features (Cook and Auster 2007). The physical oceanography of this region is influenced by the seafloor, freshwater input from multiple rivers and estuaries, large-scale weather patterns, and tropical or winter coastal storm events. Weather-driven surface currents, tidal mixing, and estuarine outflow all contribute to driving water movement through the area (Kaplan 2011).

In areas off the coast of southern New Jersey, including the lease area, sea surface temperatures vary seasonally from 36°F (2°C) in winter to 79°F (26°C) in summer (NJDEP 2010, BOEM 2022). Seasonally, the Mid-Atlantic region experiences one of the largest transitions in stratification in any part of the ocean around the world, from the cold, well-mixed conditions in winter months to one of the largest top-to-bottom temperature differences in the summer (Castelao et al. 2010, Houghton et al. 1982, Miles et al. 2021). From spring through early summer, a strong thermocline develops across the length of the Mid-Atlantic Bight, isolating a continuous mid-shelf “cold pool” of water that extends from Nantucket to Cape Hatteras (Houghton et al. 1982, Kaplan 2011, Miles 2021). Through summer, the thermocline strengthens and the cold pool becomes more stable as a result of surface heating and freshwater runoff (Castelao et al. 2010). The stable summer cold pool is a relatively slow-moving feature, which moves back and forth between the coast and shelf in response to surface wind forcing during periods of upwelling and downwelling. During the fall, more frequent strong wind events and decreasing surface heat over increasingly shorter daily daylight hours shifts the balance between heat input and vertical mixing. This results in reduced stratification, which ultimately breaks down the cold pool (Bigelow 1933, Castelao et al 2010, Gong et al 2010, Lentz 2017, Lentz et al 2003, Miles et al 2021). These cold pool “seasons” of spring setup, summer stability, and fall breakdown are associated with and drivers of important biological and ecological processes, such as foraging and migration amongst marine vertebrates (Scales et al 2014).

Shelf currents in the Ocean Wind I project area generally flow in a southerly direction (WHOI 2016). These bottom currents are influenced by local bathymetry and regional density gradients. Prominent bottom features of the Mid-Atlantic Bight include a series of ridges and troughs. On the OCS off the coast of New Jersey, the largest slopes are associated with sand ridges that are generally parallel to the shoreline and are actively modified by ocean currents (Goff et al 2005). While the WFA is a generally flat expanse of soft sediments with seafloor slopes that are typically less than 1°, geophysical surveys in and near portions of the lease area identified ridges of up to 15m (49 ft.) above the surrounding seabed (Guida et al 2017, Ocean Wind 2022). From the coastline to the WFA along the export cable routes, there is a shallow slope with an average gradient of less than 1°.

Troughs are characterized by fine sediments and high organic matter, while ridges are characterized by coarse sediments. Site-specific benthic surveys conducted in the WFA describe a habitat that is dominated by medium to coarse grained sand and muddy sand interspersed with areas of coarse sediment (e.g., gravelly sand or gravel deposits) and coarse substrate (e.g., pebbles or cobbles)(Fugro 2017, Alpine 2017, Inspire 2021) Small areas of low-density boulders are also documented in the WFA. Increasing mud and sandy mud habitats near the shore define the substrate along the export cable routes. The estuarine portion of the Oyster Creek export cable route is primarily mud and sandy mud with SAV on the shorelines of the route and a small area of low-density boulders. The estuarine portion of the BL England export cable route consists of a 150m (492 ft.) crossing of Peck Bay at the Roosevelt Bridge. Sediment types along the corridor through the northern end of Peck Bay/Southern end of Great Egg Harbor Bay are sand and muddy sand or mud and sandy mud.

Water depths range from 15-38 m in the WFA. From the coastline to the WFA along the export cable routes, water depths vary from 15-30 m. In the back bays, water depths are predominantly shallow (0.3-3 m) except in existing channels. Water depths along the bay-to-shore portion of the Oyster Creek corridor route at Barnegat Bay are an average of 1.1 m (3.6 ft.). The estuarine portion of the Oyster Creek cable route is poorly flushed (25 to 30 days) and is therefore a highly eutrophic estuary (Kennish et al 2007, Gilbert et al 2010, BOEM 2022).

6.1 Summary of Information on Listed Large Whale Presence in the Action Area

North Atlantic right whale (Eubalaena glacialis)
North Atlantic right whale presence and behavior in the action area is best understood in the context of their range. North Atlantic right whales occur in the Northwest Atlantic Ocean from calving grounds in coastal waters of the southeastern United States to feeding grounds in New England waters into Canadian waters and the Canadian Bay of Fundy, Scotian Shelf, and Gulf of St. Lawrence (Hayes et al. 2021). In the late fall months (e.g., October), pregnant female right whales move south to their calving grounds off Georgia and Florida, while the majority of the population likely remains on the feeding grounds or disperses along the eastern seaboard. There is at least one case of a calf apparently being born in the Gulf of Maine (Patrician et al. 2009), and another newborn was detected in Cape Cod Bay in 2013 (CCS, unpublished data, as cited in Hayes et al. 2020). A review of visual and passive acoustic monitoring data in the western North Atlantic demonstrated nearly continuous year-round presence across their entire habitat range (for at least some individuals), including in waters previously thought to be used only seasonally by individuals migrating along the coast (e.g., off New Jersey and Virginia). This suggests that not all of the population undergoes a consistent annual migration (Bort et al. 2015, Cole et al. 2013, Davis et al. 2017, Hayes et al. 2020, Leiter et al. 2017, Morano et al. 2012, Whitt et al. 2013). Several recent studies (Meyer-Gutbrod et al. 2015, 2021, Davis et al. 2017, Davies et al. 2019, Gowan et al. 2019, Simard et al. 2019) suggest spatiotemporal habitat-use patterns are in flux both with regards to a shift northward (Meyer-Gutbrod et al. 2021), changing migration patterns (Gowan et al. 2019), as well as changing numbers in existing known high-use areas e.g., Davis et al. (2017, 2019, 2020) suggest increased distribution in waters of the mid-Atlantic.

North Atlantic right whales have been observed in or near state and federal waters off New Jersey during all four seasons; however, they are most common in spring when they are migrating north and in fall during their southbound migration (Kenney and Vigness-Raposa 2010, Roberts et al. 2016). These seasonal occurrence observations are aligned with more recent findings from aerial survey data collected between 2017-2020, where North Atlantic right whales were seen in adjacent state and federal waters off New York (up to 120 nm from the coast) during all seasons except summer (Zoidis et al. 2021). A single North Atlantic right whale sighting occurred in the Study Corridor during Ocean Wind's Geotechnical 1A Survey in winter

2017-2018 (Smultea Environmental Sciences 2018), but no North Atlantic right whales were observed during the Ocean Wind Offshore Wind Farm Survey in summer 2017 in the Study Corridor (Alpine 2017). Three North Atlantic right whale sightings within the Ocean Wind survey area were reported between 13 and 14 December 2018 (NOAA Right Whale Sighting and Advisory System 2019).

In the past, occurrences of North Atlantic right whales in or near state and federal waters off New Jersey were known only from broader regional studies, opportunistic sightings, stranding records, and fine-scale studies in adjacent waters (e.g., CETAP 1982, Bowman et al. 2001, Knowlton et al. 2002, Biedron et al. 2009). Whitt et al. (2013) presents findings from the United States' first Ecological Baseline Study (EBS) specific to offshore wind planning for the New Jersey Department of Environmental Protection (NJDEP; GMI 2010); vessel and aerial surveys were carried out from the coast to 37km offshore between January 2008 and December 2009. The area surveyed included in the Ocean Wind WDA. Whitt et al. (2013) reports on the North Atlantic right whale sighting and aerial survey data collected in that study. In the two-year study period, four individual or pairs of North Atlantic right whales were observed, including one cow-calf pair. North Atlantic right whales were sighted in January (two juveniles), May (cow/calf pair), November, and December. Acoustic detections were also recorded during the study period. Sightings occurred in water depths ranging from 17 to 26 m (mean: 22.5 m) and distances from shore ranged from 19.9 to 31.9 km (mean: 23.7 km; the survey transects went out to 37 km from shore). Initial sightings of females in November and December, and subsequent confirmations of these same individuals in southern calving grounds, illustrate that these waters are used for migration (Whitt et al. 2013). Whitt et al. (2013) reported behaviors for two juveniles that were sighted together exhibiting skim-feeding behavior (for approximately 1.5 hours) offshore of Barnegat Bay in January. Although feeding could not be confirmed as there was no evidence of prey patches and no prey sampling was conducted, the authors suggest that this observation indicates that at least occasional foraging in or near the WDA may occur when suitable prey in suitable densities is present. However, the WDA is not known to support aggregations of foraging right whales or sustained foraging over extended periods (i.e., days or weeks).

The Ecosystems and Passive Acoustic Monitoring (ECO-PAM) Project, a partnership between Orsted North America, Rutgers University, Woods Hole Oceanographic Institution (WHOI), and the University of Rhode Island, has deployed digital acoustic monitoring (DMON) moored buoys and autonomous underwater gliders in the Ocean Wind lease area (Orsted 2021). Since July 2020, WHOI has deployed DMON moored buoys 20 miles southeast of Atlantic City to monitor the presence of baleen whales in near real-time by automatically detecting and identifying their calls (WHOI 2021). Rutgers University has deployed autonomous underwater gliders in the WFA off New Jersey (Rutgers University 2021). These buoys and gliders have detected North Atlantic right whale calls in the vicinity of Ocean Wind's WFA (WHOI 2021); no estimate of the number of individuals are available from this data but the acoustic detections confirm the presence of right whales in the action area.

As described in Appendix A of the BA, the best available information regarding marine mammal densities in the portion of the action area encompassing the project area is provided by habitat-based density models produced by the Duke University Marine Geospatial Ecology Laboratory

(Roberts et al., 2016, 2017, 2018, 2021a, 2021b)(Table 6.1 and 6.2). The updated North Atlantic right whale density model includes new abundance estimates for Cape Cod Bay in December. This data was used to develop mean monthly density estimates for North Atlantic right whales in different parts of the action area; the mean density for each month was determined by calculating the unweighted mean of all 5- by 5-km grid cells partially or fully within the analysis polygon (Küsel et al. 2022).

Table 6.1. Mean Monthly Density Estimates for North Atlantic right whales within a 50 km Buffer around the Lease Area

Species	Monthly Densities (animals per 100 km^2)												Annual Mean Density
	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec	
North Atlantic right whale	0.335	0.396	0.464	0.444	0.054	0.004	0.002	0.001	0.002	0.004	0.021	0.161	0.157

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

Table 6.2. Density Estimate Ranges for North Atlantic right whales along vessel transit routes to and from the lease area.

Species/Port	Monthly Densities (animals per 100 km^2)											
North Atlantic right whale	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec
Port Elizabeth, NJ	0.068-0.68	0.046-0.46	0-0.68	0-0.68	0-0.046	<0.01	<0.01	<0.01	<0.01	<0.01	0-0.022	0.015-0.46
Norfolk, VA	0-1.0	0-1.0	0-1.0	0-0.68	0-0.046	<0.01	<0.01	<0.01	<0.01	<0.01	0-0.046	0-0.68
Charleston, SC	0-1.0	0-1.0	0-1.0	0-1.0	0-0.068	<0.01	<0.01	<0.01	<0.01	<0.01	0-0.046	0.01-0.68

Source: Roberts et al. 2018

Density estimates indicate that March is the month with the highest density of right whales in the WDA and along the anticipated vessel transit routes to and from ports in NJ, VA, and SC and that overall, North Atlantic right whales are most likely to occur in and around the lease area and along these vessel transit routes from December through May, with the highest probability of occurrence extending from January through April.

Outside of the U.S. EEZ, we expect right whales to be rare along the vessel transit routes to Europe. While right whales used to be common and wide ranging along coastal waters on both sides of the North Atlantic (Kraus and Rolland 2007, Silva et al. 2012), the species was severely depleted by centuries of exploitation and at present, the eastern population is presumed functionally extinct (Silva et al. 2012). In the Northeast Atlantic, sightings of right whales in former whaling grounds off the coast of Europe remain limited to sporadic individuals. Knowlton et al. (1992) and Jacobsen et al. (2004) report eight individual sightings in European waters since 1964. Based on the paucity of sightings in the eastern Atlantic, it is reasonable to expect that North Atlantic right whales will not co-occur with project vessels as they transit outside of the U.S. EEZ between Europe and the WDA.

In summary, we anticipate individual North Atlantic right whales to occur year round in the coastal U.S. portion of the action area in both coastal, shallower waters as well as offshore, deeper waters. We expect these individuals to be moving throughout this portion of the action area, making seasonal migrations, and possibly foraging when copepod patches of sufficient density to trigger feeding behavior are present. The presence of North Atlantic right whales along the vessel transit routes to and from Europe outside the Southern Mid-Atlantic Bight is expected to be rare and limited to occasional, sporadic individuals (Silva et al. 2012).

Nova Scotia Stock of Sei whale (Balaenoptera borealis)
In the action area, sei whales are expected to be present in the WDA, most likely in the deeper areas furthest from the coast, and may be present along the oceanic portions of all potential vessel transit routes. The presence and behavior of sei whales in the action area is best understood in the context of their range in the Atlantic, which extends from southern Europe/northwestern Africa to Norway in the east, and from the southeastern United States (or occasionally the Gulf of Mexico and Caribbean Sea; Mead 1977) to West Greenland in the west (Gambell 1977; Gambell 1985b; Horwood 1987). The southern portion of the species' range during spring and summer includes the northern portions of the U.S. EEZ, the Gulf of Maine, Georges Bank, and south of New England (Halpin et al. 2009, Hayes et al. 2017, Hayes et al. 2020).

Sei whales occurring in the Mid-Atlantic Bight belong to the Nova Scotia stock (Hayes et al. 2020). Sei whales can be found in deeper waters of the continental shelf edge waters of the northeastern United States and northeastward to south of Newfoundland (Hain et al. 1985, Prieto et al., 2014). Sei whale sightings in U.S. Atlantic waters are typically centered on mid-shelf and the shelf edge and slope (Olsen et al. 2009). In the New York Bight, Zoidis et al. (2021) recorded a lone individual in the shelf zone (54 m water depth) and a group of 6 individuals in the slope zone (380 m water depth). AMAPPS acoustic data (NEFSC and SEFSC, 2019) similarly reported most detections in shelf waters. Sei whales occasionally occur in shallower waters during certain years when oceanographic conditions force planktonic prey to shelf and inshore waters (Payne et al. 1990, Schilling et al. 1993, Waring et al. 2004).

Documented sei whale sightings along the U.S. Atlantic Coast south of Cape Cod are relatively uncommon compared to other baleen whales (CETAP 1982; Lagueux et al. 2010; Hayes et al. 2020).Within the Mid-Atlantic Region, sei whales are infrequently sighted in the New York Bight. No sei whales were sighted in the New York Bight during the AMAPPS II 2018 or 2019 aerial surveys (NEFSC and SEFSC, 2019, 2020). However, Estabrook et al. (2019, 2020) detected sei whales acoustically every month except July when detections from both years were combined. There have been no recorded strandings of sei whales in New Jersey since 2008 (Henry et al. 2020); however, in the summer of 2017, a sei whale carcass was found on the bow of a ship in the Hudson River, Newark, New Jersey (Hayes et al. 2020).

As noted above, sei whales often occur along the shelf edge to feed, but also use shallower shelf waters. Although known to eat fish in other oceans, sei whales off the northeastern U.S. are largely planktivorous, feeding primarily on euphausiids and copepods (Flinn et al. 2002, Hayes et al. 2017). These aggregations of prey are largely influenced by the dynamic oceanographic processes in the region. While LaBrecque et al. (2015) defined a Biologically Important Area (BIA) for May to November feeding for sei whales that extends from the 82-foot (25-m) contour off coastal Maine and Massachusetts east to the 656-foot (200-m) contour in the central Gulf of Maine, foraging activity has been reported as far south as the New York Bight (USDOI FWS 1997, Kaplan 2011).

Sei whales may be present in the general vicinity of the WDA year-round but are most commonly present in the spring and summer (Hayes et al. 2020). No sei whales were recorded during EBS surveys, but a fin or sei whale (could not be identified to species) was documented in the waters off New Jersey within a survey area that spanned from the coastline to approximately the 2,000 m depth contour during the summer 2016 and 2017 AMAPPS surveys (NJDEP 2010; NEFSC and SEFSC 2016, 2018). Sei whales were observed on the shelf and slope in the spring during aerial line-transect surveys in the New York Bight from 2017 to 2020 (Zoidis et al. 2021). This data from nearby areas informs our consideration of the presence of sei whales in the WDA.

Mean monthly density estimates of sei whales in and around the WDA were derived using the Duke University Marine Geospatial Ecology Laboratory model results (Roberts et al. 2016a, 2016b, 2017, 2018, 2021a, 2021b). Model results indicate that sei whale density in the lease area plus a 50 km buffer in all directions is generally low, peaking in April and May at densities ranging from 0.010 to 0.012 individuals per 100 km^2 (HDR 2022). Based on the information presented here, we expect sei whales to be at least occasionally present in the deeper water portions of the WDA and in the offshore portions of vessel routes between the WDA and ports in NJ, VA, and SC.

We have considered whether vessels transiting to and from the WDA from ports in Europe could potentially encounter sei whales. While sei whales may occur along trans-Atlantic vessel routes, occurrence in European waters is scarce (e.g., Hammond et al. 2013, 2017, Leonard & Øien 2020a,b, Pike et al. 2019a, Rogan et al. 2018). Only a few sightings have been made in Norwegian waters in recent years. Most recently, a single individual was sighted in each of the years 2006, 2014 and 2018 (Øien et al. 2009, Prieto et al. 2012, Leonard et al. 2019). Additionally, sei whales have been detected on rare occasions during acoustic surveys in Irish waters (Berrow et al. 2018). Based on the paucity of sightings in European waters, it is reasonable to expect that the presence of sei whales along vessel transit routes to and from Europe outside the Southern Mid-Atlantic Bight is rare.

In summary, we anticipate individual or small groups of sei whales to occur in the offshore portions of the action area year round, with presence in more shallow, inshore waters and shelf portions of the action area, including the lease area, cable corridors, and vessel transit routes primarily in the spring and summer months. We expect individuals in the action area to be making seasonal migrations, and to be foraging when krill are present.

North Atlantic Stock of Sperm whale (Physeter macrocephalus)

In the action area, sperm whales are present in the more offshore portion of the WDA and may be present along the oceanic portions of all potential vessel transit routes. Sperm whale presence and behavior in the action area is best understood in the context of their range. Sperm whales are widely distributed throughout the deep waters of the North Atlantic, primarily along the continental shelf edge, over the continental slope, and into mid-ocean regions (Hayes et al., 2020). They are found at higher densities in areas such as the Bay of Biscay, to the west of Iceland, and towards northern Norway (Rogan et al. 2017) as well as around the Azores. This offshore distribution is more commonly associated with the Gulf Stream edge and other features (Waring et al. 1993, Waring et al. 2001). Calving for the species occurs in low latitude waters outside of the action area. Most sperm whales that are seen at higher latitudes are solitary males, with females generally remaining further south. Sperm whales occurring in the Mid-Atlantic Bight belong to the North Atlantic stock (Hayes et al. 2020).

In the U.S. Atlantic EEZ waters, there appears to be a distinct seasonal distribution pattern (CETAP 1982, Scott and Sadove 1997). In spring, the center of distribution shifts northward to east of Delaware and Virginia and is widespread throughout the central portion of the Mid-Atlantic Bight and the southern portion of Georges Bank. In summer, the distribution of sperm whales includes the area east and north of Georges Bank and into the Northeast Channel region, as well as the continental shelf (inshore of the 100-m isobath) south of New England. In the fall, sperm whale occurrence south of New England on the continental shelf is at its highest level. In winter, sperm whales are concentrated east and northeast of Cape Hatteras.

The average depth of sperm whale sightings observed during the CeTAP surveys was 5,880 ft. (1,792 m) (CETAP 1982). This is consistent with the findings in Zoidis et al. (2021) as authors observed 72 individual sperm whales during 32 sightings in the plain zone (>1,000 m water depth). Female sperm whales and young males usually inhabit waters deeper than 3,280 ft. (1,000 m) and at latitudes less than 40° N (Whitehead 2002). Sperm whales feed on larger organisms that inhabit the deeper ocean regions including large- and medium-sized squid, octopus, and medium-and large-sized demersal fish, such as rays, sharks, and many teleosts (NMFS 2018; Whitehead 2002).

Although primarily a deep-water species, sperm whales are known to visit shallow coastal regions when there are sharp increases in bottom depth where upwelling occurs resulting in areas of high planktonic biomass (Clarke 1956, Best 1969, Clarke et al. 1978, Jaquet 1996). As such, sperm whales may be present in the general vicinity of the WDA. Nevertheless, sperm whales are considered uncommon year-round visitors near the Ocean Wind 1 WDA. During the summer 2017 AMAPPS aerial survey, a sperm whale was documented in the waters off New Jersey, in the deeper portion of the shelf edge (NEFSC and SEFSC 2018). During the Northern leg of the 2021 AMAPPS shipboard survey, sperm whales were among the most common large whale species detected during acoustic monitoring efforts in the survey area which ranged from south of Massachusetts to east of Virginia in waters beyond the 100 m depth contour, including potential vessel transit routes to and from ports in Europe outside of the Southern Mid-Atlantic.

Until recently, there had been no recorded strandings of sperm whales in New Jersey since 2008 (Henry et al. 2020). There were four sperm whale strandings along the New Jersey/New York coastline in 2022, three of which occurred in December (MMSC 2023). No evidence of human interactions was detected for these strandings.

Mean monthly density estimates of sperm whales in the WDA were derived using the Duke University Marine Geospatial Ecology Laboratory model results (Roberts et al. 2016a, 2016b, 2017, 2018, 2021a, 2021b). Model results indicate that sperm whale density in and around the lease area is generally low, peaking from July through September at densities ranging from 0.012 to 0.018 individuals per 100 km^2.

Given the deep-water offshore routes that will be transited by project vessels going to and from Europe, we expect trans-Atlantic vessel routes to overlap with the distribution of sperm whales. We also expect sperm whales to occasionally be present in the WDA, likely in the deeper portions furthest from the coast.

In summary, individual adult sperm whales are anticipated to occur infrequently in deeper, offshore waters of the Southern Mid-Atlantic Bight portion of the action area primarily in summer and fall months, with a small number of individuals potentially present year round. These individuals are expected to be moving in or near the WDA as they make seasonal migrations, and to be foraging along the shelf break. As sperm whales typically forage at deep depths (500-1,000 m) (NMFS 2018) well beyond that of the WDA, foraging is not expected to occur in the WFA or along the cable corridor. Sperm whales may occur along vessel transit routes used by project vessels transiting to and from ports in the South Atlantic and Europe year round.

Western North Atlantic stock of fin whales (Balaenoptera physalus)
In the action area, fin whales are present in the WDA and may be present along the oceanic portions of a majority of vessel transit routes. Fin whale presence and behavior in the action area is best understood in the context of their range. Fin whale presence in the North Atlantic is limited to waters north of Cape Hatteras, NC. In general, fin whales in the central and eastern Atlantic tend to occur most abundantly over the continental slope and on the shelf seaward of the 200-m isobath (Rørvik et al. 1976 in NMFS 2010). In contrast, off the eastern United States they are centered along the 100-m isobath but with sightings well spread out over shallower and deeper water, including submarine canyons along the shelf break (Kenney and Winn 1987; Hain et al. 1992).

Fin whales occurring in the Mid-Atlantic belong to the western North Atlantic stock (Hayes et al. 2019). They are typically found along the 328-foot (100-meter) isobath but also in shallower and deeper water, including submarine canyons along the shelf break (Kenney and Winn 1986). Fin whales are migratory, moving seasonally into and out of feeding areas, but the overall migration pattern is complex and specific routes are unknown (NMFS 2018a). Fin whales are believed to use the North Atlantic water primarily for feeding and more southern waters for calving. Movement of fin whales from the Labrador/Newfoundland region south into the West Indies during the fall have been reported (Clark 1995). Neonate strandings along the U.S. Mid-Atlantic coast from October through January indicate a possible offshore calving area (Hain et al. 1992). The species occur year-round in a wide range of latitudes and longitudes, but the density of individuals in any one area changes seasonally. Thus, their movements overall are patterned and consistent, but distribution of individuals in a given year may vary according to their energetic and reproductive condition, and climatic factors (NMFS 2010).

The northern Mid-Atlantic Bight represents a major feeding ground for fin whales as the physical and biological oceanographic structure of the area aggregates prey. This feeding area extends in a zone east from Montauk, Long Island, New York, to south of Nantucket (LaBrecque et al. 2015, Kenney and Vigness-Raposa 2010; NMFS 2010a) and is a location where fin whales congregate in dense aggregations and sightings frequently occur (Kenney and Vigness-Raposa 2010). This known foraging area is outside of the WDA but overlaps the area that may be transited by some project vessels transiting to/from Europe. Fin whales in this area feed on krill (*Meganyctiphanes norvegica* and *Thysanoessa inermis*) and schooling fish such as capelin (*Mallotus villosus*), herring (*Clupea harengus*), and sand lance (*Ammodytes* spp.) (Borobia et al. 1995) by skimming the water or lunge feeding. This area is used extensively by feeding fin whales from March to October. Several studies suggest that distribution and movements of fin whales along the east coast of the United States is influenced by the availability of sand lance (Kenney and Winn 1986, Payne 1990).

Acoustic studies in Estabrook et al. (2019, 2020) detected fin whales in the New York Bight every month of the year in their study period from 2017 to 2019. The results of these acoustic studies are consistent with the observations in Zoidis et al. (2021) where fin whales were sighted at least once in each month of the calendar year across the 3 years and in each survey season, throughout the study area across all habitat zones. While these studies were north of the WDA, given the geographic proximity to the WDA they are informative of potential presence of fin whales in the WDA. Based on the occurrence of a cow-calf pair observed in August 2008, results from the EBS provide support for the possibility of nearshore waters off New Jersey serving as nursery habitat (NJDEP 2010, Whitt et al. 2015). Ten fin whales are reported to have stranded along the New Jersey coast from 2008 to 2017 (Hayes et al. 2020; Henry et al. 2020). Of these, nine were determined to be the result of vessel strikes and one ruled an entanglement.

Sightings data from the EBS (NJDEP 2010, Whitt et al. 2015) in state and federal waters off New Jersey indicate that fin whales are common in and near the Ocean Wind 1 WDA during all seasons. AMAPPS surveys detected fin whales in the Wind Energy Areas in the fall 2012 aerial, spring 2013 aerial, spring 2014 aerial, spring and summer 2017 aerial, winter 2018 aerial, and summer 2016 shipboard surveys (NEFSC and SEFSC 2012, 2013, 2014, 2016, 2018, 2019, 2022). Fin whales were also recorded in the WDA during the summer 2017 HRG survey (Alpine 2017b) and during the Geotechnical 1A Survey in winter 2017–2018 (Smultea Environmental Sciences 2018).

Mean monthly density estimates of fin whales in the project area were derived using the Duke University Marine Geospatial Ecology Laboratory model results (Roberts et al. 2016a, 2016b, 2017, 2018, 2021a, 2021b). Model results indicate that fin whale density in the lease area is considerably variable between months with peaks in June and September with densities ranging from 0.088 to 0.257 individuals per 100 km^2 throughout the year. Seasonal estimates calculated for fin whales in the NJ WEA in Palka et al. (2017) contradict these results as the authors described low numbers during the spring, summer, and fall, with peaks in cooler months.

Because fin whales have a worldwide distribution and are largely open-ocean dwellers, we expect trans-Atlantic vessel routes to overlap with the distribution of fin whales. Additionally, we expect fin whales to occur along all portions of the oceanic vessel transit route to Norfolk, VA and along only a portion of the vessel transit route to Charleston, SC. This is because fin whales are common in state and federal waters principally from Cape Hatteras, NC northward.

In summary, we anticipate individual fin whales to occur in the WDA year-round, with the possibility that monthly density peaks will vary inter-annually. We expect these individuals to be making seasonal coastal migrations, and to be foraging during spring and summer months. Fin whales occur year-round in a wide range of latitudes and longitudes, thus they may be present along the vessel transit routes north of Cape Hatteras, NC year round.

Western North Atlantic Stock of Blue whales (Balaenoptera musculus)
In the action area, blue whales are present along the oceanic portions of all potential vessel transit routes and are expected to occasionally occur in the more offshore portions of the WDA. Blue whale presence and behavior in the action area is best understood in the context of their range. In the North Atlantic Ocean, the range of blue whales extends from the subtropics to the Greenland Sea. As described in Hayes et al. (2020; the most recent stock assessment report for blue whales), blue whales have been detected and tracked acoustically in much of the North Atlantic with most of the acoustic detections around the Grand Banks area of Newfoundland and west of the British Isles. Photo-identification in eastern Canadian waters indicates that blue whales from the St. Lawrence, Newfoundland, Nova Scotia, New England, and Greenland all belong to the same stock, while blue whales photographed off Iceland and the Azores appear to be part of a separate population (CETAP 1982; Wenzel et al. 1988; Sears and Calambokidis 2002; Sears and Larsen 2002).

Based on their distribution, blue whales could occur along all vessel transit routes between European ports and the WDA. Migration patterns for blue whales in the eastern North Atlantic Ocean are poorly understood. However, blue whales have been documented in winter months off Mauritania in northwest Africa (Baines & Reichelt 2014); in the Azores, where their arrival is linked to secondary production generated by the North Atlantic spring phytoplankton bloom (Visser et al. 2011); and traveling through deep-water areas near the shelf break west of the British Isles (Charif & Clark 2009). Blue whale calls have been detected in winter on hydrophones along the mid-Atlantic ridge south of the Azores (Nieukirk et al. 2004). Given the deep-water offshore routes that will be transited by project vessels going to and from Europe, we expect trans-Atlantic vessel routes to overlap with the distribution of blue whales.

Blue whales do not regularly occur within the U.S. EEZ and typically occur further offshore in areas with depths of 100 m or more (Waring et al. 2010), which is outside of the WDA. Passive acoustic recording devices deployed in the New York Bight yielded detections of blue whales about 20 nm southeast of the entrance to New York Harbor during the months of January, February, and March (Muirhead et al. 2018). During aerial line-transect surveys in the New York Bight from 2017 to 2020, blue whales were observed in offshore waters in the fall and winter (Zoidis et al. 2021). While these areas are north of the WDA, these detections provide a reasonable indication of potential blue whale presence in the WDA. There have been no recorded strandings of blue whales in New Jersey since 2008 (Hayes et al. 2020; Henry et al.

2021). No blue whales were observed in the Ocean Wind 1 WDA during the EBS or AMAPPS. Sightings have been recently recorded off the coast of Virginia include a vessel sighting of a juvenile in April 2018 (Engelhaupt et al. 2019), and a sighting of an adult whale made in February 2019 during a systematic aerial survey (Cotter 2019). The aerial sighting was recorded in deep waters beyond the shelf break, but the vessel sighting was over the shelf near the 50-m isobath. Both sightings are considered extremely rare and constitute the southernmost sightings of blue whales off the U.S. east coast in the U.S. EEZ. Based on the available information, we expect blue whales to be rare in the WDA with presence limited to transient individuals or small groups in the offshore most areas of the WDA. Density estimates for blue whales within 10 km of the WDA were 0.00001 animal/km2 (Table 6-3 in HDR 2022). Based on the paucity of sightings in nearshore waters, it is reasonable to expect that the presence of blue whales along vessel transit routes to and from ports in New Jersey, Norfolk, and Charleston is rare.

In summary, individual blue whales are anticipated to occur infrequently in deeper, offshore waters of the Southern Mid-Atlantic Bight portion of the action area, with a small number of individuals potentially present in the fall and winter. These individuals are expected to be moving near the WDA as they make seasonal migrations, and to be foraging along the shelf break. Blue whales may occur along vessel transit routes used by project vessels transiting to and from ports Europe year round. The presence of blue whales along the vessel transit routes to and from ports in the South Atlantic inside the Southern Mid-Atlantic Bight is expected to be rare.

6.2 Summary of Information on Listed Sea Turtles in the Action Area

Four ESA-listed species of sea turtles (Leatherback sea turtles, North Atlantic DPS of green sea turtles, Northwest Atlantic Ocean DPS of loggerhead sea turtles, Kemp's ridley sea turtles) make seasonal migrations into the U.S. Mid-Atlantic. Individuals from all four species are seasonally present in the WDA, typically from late spring/early summer through the fall; these species are also seasonally present in the coastal and oceanic waters that may be transited by project vessels traveling to ports in New Jersey, including lower Delaware Bay. Sea turtles are present year round in the South Atlantic and their range overlaps with the coastal and oceanic waters that may be transited by project vessels traveling to/from Charleston, SC. In the open ocean area where vessels from Europe will be transiting, all four species may be present with seasonal distribution limited by water temperature (see species-specific sections below for more information).

The four species of sea turtles considered here are highly migratory. One of the main factors influencing sea turtle presence in mid-Atlantic waters and north is seasonal temperature patterns (Ruben and Morreale 1999) as waters in these areas are not warm enough to support sea turtle presence year round. In general, sea turtles move up the U.S. Atlantic coast from southern wintering areas to foraging grounds as water temperatures warm in the spring. The trend is reversed in the fall as water temperatures cool. By December, sea turtles have passed Cape Hatteras, returning to more southern waters for the winter (Braun-McNeill and Epperly 2002, Ceriani et al. 2012, Griffin et al. 2013, James et al. 2005b, Mansfield et al. 2009, Morreale and Standora 2005, Morreale and Standora 1998, NEFSC and SEFSC 2011, Shoop and Kenney 1992, TEWG 2009, Winton et al. 2018). Water temperatures too low or too high may affect feeding rates and physiological functioning (Milton and Lutz 2003); metabolic rates may be suppressed when a sea turtle is exposed for a prolonged period to temperatures below 8-10°C

(George 1997, Milton and Lutz 2003, Morreale et al. 1992). That said, loggerhead sea turtles have been found in waters as low as 7.1-8°C (Braun-McNeill et al. 2008, Smolowitz et al. 2015, Weeks et al. 2010). However, in assessing critical habitat for loggerhead sea turtles, the review team considered the water-temperature habitat range for loggerheads to be above 10° C (NMFS 2013). Sea turtles are most likely to occur in the action area when water temperatures are above this temperature, although depending on seasonal weather patterns and prey availability, they could be also present in months when water temperatures are cooler (as evidenced by fall and winter cold stunning records as well as year round stranding records). Given the warmer water temperatures, sea turtles are present in waters off the U.S. south Atlantic year round.

AMAPPS aerial abundance surveys in summer 2021 indicate that loggerhead and leatherback turtles are relatively common in waters of the southern Mid-Atlantic Bight while Kemp's ridley turtles and green turtles are less common (NEFSC and SEFSC 2022). Sea turtle nesting does not occur in New Jersey, and there are no nesting beaches or other critical habitats in the vicinity of the project area (GARFO 2021). For this reason, sea turtles in the lease area are adults or juveniles; due to the distance from any nesting beaches, no hatchlings occur in the lease area.

Sea turtles feed on a variety of both pelagic and benthic prey, and change diets through different life stages. Adult loggerhead and Kemp's ridley sea turtles are carnivores that feed on crustaceans, mollusks, and occasionally fish, green sea turtles are herbivores and feed primarily on algae, seagrass, and seaweed, and leatherback sea turtles are pelagic feeders that forage throughout the water column primarily on gelatinivores. As juveniles, loggerhead and green sea turtles are omnivores (Wallace et al. 2009, Dodge et al. 2011, BA - Eckert et al. 2012, https://www.seeturtles.org/sea-turtle-diet, Murray et al 2013, Patel et al. 2016). The distribution of pelagic and benthic prey resources is primarily associated with dynamic oceanographic processes, which ultimately affect where sea turtles forage (Polovina et al. 2006). During late-spring, summer, and early-fall months when water temperatures are suitable, the physical and biological structure of both the pelagic and benthic environment in the lease area and cable corridor provide habitat for both the four species of sea turtles in the region as well as their prey.

Additional species-specific information is presented below. It is important to note that most of these data sources report sightings data that is not corrected for the percentage of sea turtles that were unobservable due to being under the surface. As such, many of these sources represent a minimum estimate of sea turtles in the area.

Leatherback sea turtles
Leatherbacks are a predominantly pelagic species that ranges into cooler waters at higher latitudes than other sea turtles, and their large body size makes the species easier to observe in aerial and shipboard surveys. The CETAP regularly documented leatherback sea turtles on the OCS between Cape Hatteras and Nova Scotia during summer months in aerial and shipboard surveys conducted from 1978 through 1988. The greatest concentrations were observed between Long Island and the Gulf of Maine (Shoop and Kenney 1992). AMAPPS surveys conducted from 2010 through 2021 routinely documented leatherbacks in the NJ WEA and surrounding areas during summer months (NEFSC and SEFSC 2018, 2022; Palka 2021).

During NJDEP (2010) aerial and shipboard surveys for marine mammals and sea turtles, sightings included a total of 12 leatherback sea turtles in waters ranging from 59 to 98 feet (18 to 30 meters) deep, with a mean depth of 79 feet (24 meters). Sightings were recorded from 6.4 to 22.5 miles (5.6 to 19.6 nm, 10.3 to 36.2 km) from shore, with a mean distance of 17.8 miles (15.5 nm, 28.6 km). The sea surface temperatures associated with leatherback sea turtle sightings ranged from 64.6 to 68.5°F (18.1 to 20.3°C), with a mean temperature of 66.2°F (19.0°C). Migrating leatherback sea turtles usually start arriving along the New Jersey coast in late spring/early summer (Shoop and Kenney 1992; James et al. 2006). Density of leatherback sea turtles in the project area during summer, the season with the highest density, ranges from 1.889 to 4.135 animals per 38.6 mi^2 (100 km^2) (U.S. Navy 2007), which equates to an instantaneous estimate of approximately 5.2 to 11.5 leatherback sea turtles within the 68,450-acre (277 km^2) Wind Farm Area.

Key foraging destinations include, among others, the eastern coast of the United States (Eckert et al. 1998, 2012). Satellite tagging studies provide information on leatherback sea turtle behavior and movement in the action area. These studies show that leatherback sea turtles move throughout most of the North Atlantic from the equator to high latitudes. Based on tracking data for leatherbacks tagged off North Carolina (n=21), many of the tagged leatherbacks spent time in shelf waters from North Carolina, up the Mid-Atlantic shelf and into southern New England and the Gulf of Maine. After coastal residency, some leatherbacks undertook long migrations while tagged. Some migrated far offshore of the Mid-Atlantic, past Bermuda, even as far as the Mid-Atlantic Trench region. Others went towards Florida, the Caribbean, or Central America (Palka et al. 2021). This data indicates that leatherbacks are present throughout the action area at all depths of the water column and may be present along the vessel transit routes from Europe and the South Atlantic.

The Marine Mammal Stranding Center (MMSC) in New Jersey rescued 177 leatherback turtles between 1995 and 2005 and another 10 between 2013 and 2018 (MMSC 2023). Of the turtles rescued in this time interval, 14 percent had been struck by boat propellers, 8 percent had an interaction with fishing gear, and 2 percent had been struck by a boat (Schoelkopf 2006). From 2010 through 2020, the Sea Turtle Stranding and Salvage Network (STSSN) reported 12 offshore and 6 inshore leatherback sea turtle strandings within Zone 39, which encompasses southern New Jersey (NMFS 2021b).

As described in Appendix A of the BA, the best available information regarding densities for sea turtles in the WDA were derived from at-sea densities of sea turtles using data from a multi-year series of seasonal aerial surveys conducted in the adjacent New York Bight region (Normandeau Associates and APEM 2018a, 2018b, 2019a, 2019b, 2020). Abundance estimates were corrected to represent the abundance in the entire offshore planning area and then scaled by the full offshore planning area to obtain a density in units of animals per km^2. Model results indicate that leatherback sea turtle density in the offshore project area is highest in the fall (.789 animals/100 km^2), followed by summer (0.331 animals/100 km^2), and no leatherback sea turtles expected in spring or winter.

Based on the information presented here, we anticipate leatherback sea turtles to occur in the WDA (i.e., the lease area and cable corridors) during the warmer months, typically between May and November. Leatherbacks are also expected along the vessel transit routes used by project vessels transiting to and from ports in the South Atlantic and to Europe with seasonal presence dependent on latitude.

Northwest Atlantic DPS of Loggerhead sea turtles

The loggerhead sea turtle is commonly found throughout the North Atlantic including the Gulf of Mexico, the northern Caribbean, The Bahamas archipelago (Dow et al. 2007), and eastward to West Africa, the western Mediterranean, and the west coast of Europe (NMFS and USFWS 2008). The range of the Northwest Atlantic DPS is the Northwest Atlantic Ocean north of the equator, south of 60° N. Lat., and west of 40° W. Long. Northwest Atlantic DPS loggerheads occur in the oceanic portions of the action area west of 40°W, inclusive of the area of the Mid-Atlantic that may be used by vessels transiting to and from Europe.

Extensive tagging results suggest that tagged loggerheads occur on the continental shelf along the United States Atlantic from Florida to North Carolina year-round but also highlight the importance of summer foraging areas on the Mid-Atlantic shelf, which includes the WDA (Winton et al. 2018). In the shelf waters off of New Jersey, loggerhead sea turtles can be found seasonally, primarily in the summer and autumn months when surface temperatures range from 44.6ºF to 86ºF (7ºC to 30ºC) (Kenney and Vigness-Raposa 2010; Shoop and Kenney 1992). The NJDEP (2010) aerial and shipboard surveys recorded a total of 615 loggerhead sea turtle sightings between January 2008 and December 2009. The loggerhead sea turtle was the second most frequently sighted species during the survey, and the vast majority of sightings were during the summer (NJDEP 2010).

During the CETAP surveys, one of the largest observed aggregations of loggerheads was documented in shallow shelf waters northeast of Long Island (Shoop and Kenney 1992), north of the action area; however, this data is informative of loggerhead habitat use in the action area. Loggerheads were most frequently observed in areas ranging from 72 to 160 feet (22 and 49 m) deep. Over 80% of all sightings were in waters less than 262 feet (80 m), suggesting a preference for relatively shallow OCS habitats (Shoop and Kenney 1992). Juvenile loggerheads are prevalent in the nearshore waters of Long Island from July through mid-October (Morreale et al. 1992; Morreale and Standora 1998), accounting for more than 50% of live strandings and incidental captures (Morreale and Standora 1998).

In the summer of 2010, as part of the AMAPPS project, the NEFSC and SEFSC estimated the abundance of juvenile and adult loggerhead sea turtles in the portion of the northwestern Atlantic continental shelf between Cape Canaveral, Florida and the mouth of the Gulf of St. Lawrence, Canada (NMFS 2011b). The abundance estimates were based on data collected from an aerial line-transect sighting survey as well as satellite tagged loggerheads. The preliminary regional abundance estimate was about 588,000 individuals (approximate inter-quartile range of 382,000-817,000) based on only the positively identified loggerhead sightings, and about 801,000 individuals (approximate inter-quartile range of 521,000-1,111,000) when based on the positively identified loggerheads and a portion of the unidentified sea turtle sightings (NMFS 2011b). The loggerhead was the most frequently observed sea turtle species in 2010 to 2017 AMAPPS aerial surveys of the Atlantic continental shelf. Large concentrations were regularly observed in proximity to the NJ WEA (Palka et al. 2021).

Barco et al. (2018) estimated loggerhead sea turtle abundance and density in the southern portion of the Mid-Atlantic Bight and Chesapeake Bay using data from 2011-2012. During aerial surveys off Virginia and Maryland, loggerhead sea turtles were the most common turtle species detected, followed by greens and leatherbacks, with few Kemp's ridleys documented. Density varied both spatially and temporally. Loggerhead abundance and density estimates in the ocean were higher in the spring (May-June) than the summer (July-August) or fall (September-October). Ocean abundance estimates of loggerheads ranged from highs of 27,508-80,503 in the spring months of May-June to lows of 3,005-17,962 in the fall months of September-October (Barco et al. 2018).

AMAPPS data, along with other sources, have been used in recent modelling studies. Winton et al. (2018) modelled the spatial distribution of satellite-tagged loggerhead sea turtles in the Western North Atlantic. The Mid-Atlantic Bight was identified as an important summer foraging area and the results suggest that the area may support a larger proportion of the population, over 50% of the predicted relative density of loggerheads north of Cape Hatteras from June to October (NMFS 2019a, Winton et al. 2018). Using satellite telemetry observations from 271 large juvenile and adult sea turtles collected from 2004 to 2016, the models predicted that overall densities were greatest in the shelf waters of the U.S. Atlantic coast from Florida to North Carolina. Tagged loggerheads primarily occupied the continental shelf from Long Island, New York to Florida, with some moving offshore. Monthly variation in the Mid-Atlantic Bight indicated migration north to the foraging grounds from March to May and migration south from November to December. In late spring and summer, predicted densities were highest in the shelf waters from Maryland to New Jersey. In the cooler months, the predicted densities in the Mid-Atlantic Bight were higher offshore (Winton et al. 2018). South of Cape Hatteras, there was less seasonal variability and predicted densities were high in all months. Many of the individuals tagged in this area remained in the general vicinity of the tagging location. The authors did caution that the model was driven, at least in part, by the weighting scheme chosen, is reflective only of the tagged population, and has biases associated with the non-random tag deployment. Most loggerheads tagged in the Mid-Atlantic Bight were tagged in offshore shelf waters north of Chesapeake Bay in the spring. Thus, loggerheads in the nearshore areas of the Mid-Atlantic Bight may have been under-represented (Winton et al. 2018).

To better understand loggerhead behavior on the Mid-Atlantic foraging grounds, Patel et al. (2016) used a remotely operated vehicle (ROV) to document the feeding habitats (and prey availability), buoyancy control, and water column use of 73 loggerheads recorded from 2008-2014. When the mouth and face were in view, loggerheads spent 13% of the time feeding on non-gelatinous prey and 2% feeding on gelatinous prey. Feeding on gelatinous prey occurred near the surface to depths of 52.5 ft. (16 m). Non-gelatinous prey were consumed on the bottom. Turtles spent approximately 7% of their time on the surface (associated with breathing), 42% in the near surface region, 44% in the water column, 0.4% near bottom, and 6% on bottom. When diving to depth, turtles displayed negative buoyancy, making staying at the bottom easier (Patel et al. 2016).

Patel et al. (2018) evaluated temperature-depth data from 162 satellite tags deployed on loggerhead sea turtles from 2009 to 2017 when the water column is highly stratified (June 1 – October 4). Turtles arrived in the Mid-Atlantic Bight in late May as the Cold Pool formed and departed in early October when the Cold Pool started to dissipate. The Cold Pool is an oceanographic feature that forms annually in late May. During the highly stratified season, tagged turtles were documented throughout the water column from June through September. Fewer bottom dives occurred north of Hudson Canyon early (June) and late (September) in the foraging season (Patel et al. 2018).

The MMSC in New Jersey rescued an average of 47 loggerhead turtles each year between 1995 and 2005 and another 138 between 2013 and 2018 (MMSC 2023). Of the loggerhead turtles rescued between 1995 and 2005, 16 percent had been struck by propellers, 3.9 percent had evidence of boat collisions, and 3.7 percent had evidence of fisheries interactions (Schoelkopf 2006). From 2010 through 2020, STSSN reported 139 offshore and 74 inshore loggerhead sea turtle strandings within Zone 39, which encompasses southern New Jersey (NMFS 2021b). Loggerheads are stranded far more often than other sea turtles in New Jersey (NMFS 2021b), as they have a higher relative abundance.

The density of loggerhead sea turtles in the project area during summer, the season with the highest density, has been estimated to range from 1.631 to 9.881 animals per 38.6 mi^2 (100 km^2) (U.S. Navy 2007), which equates to an instantaneous estimate of approximately 4.5 to 27.4 loggerhead sea turtles within the 68,450-acre (277 km^2) Wind Farm Area. Density estimates of loggerhead sea turtles in the project area were also derived using at-sea-density data for sea turtles in the adjacent waters of the New York Bight (Normandeau Associates and APEM 2018a, 2018b, 2019a, 2019b, 2020). Model results indicate that loggerhead sea turtle density in the WDA is highest in the summer (26.799 animals/100 km^2), followed by spring (0.254 animals/100 km^2), then fall (0.19 animals/100 km^2), and winter (0.025 animals/100 km^2).

Based on the information presented here, we anticipate loggerheads from the Northwest Atlantic DPS to occur in the WDA (i.e., the lease area and cable corridors) during the warmer months, typically between May and November. Loggerheads are also expected along the vessel transit routes used by project vessels transiting to and from ports in the South Atlantic and to Europe with seasonal presence dependent on latitude.

Kemp's ridley sea turtles
Kemp's ridleys are distributed throughout the Gulf of Mexico and U.S. Atlantic coastal waters, from Florida to New England. A few records exist for Kemp's ridleys near the Azores, waters off Morocco, and within the Mediterranean Sea and they are occasionally found in other areas around the Atlantic Basin. As adults, many turtles remain in the Gulf of Mexico, with only occasional occurrence in the Atlantic Ocean (NMFS, USFWS, and SEAMARNAT 2011). Adult habitat largely consists of sandy and muddy areas in shallow, nearshore waters less than 120 feet (37 m) deep (Landry and Seney 2008; Shaver et al. 2005; Shaver and Rubio 2008), although they can also be found in deeper offshore waters.

Juvenile and subadult Kemp's ridley sea turtles are known to travel as far north as Long Island Sound and Cape Cod Bay during summer and autumn foraging (NMFS, USFWS and SEAMARNAT 2011); the range of these migrating turtles would overlap with the action area. Visual sighting data are limited because this small species is difficult to observe using aerial survey methods (Kraus et al. 2016), and most surveys do not cover its preferred shallow bay and estuary habitats. The MMSC in New Jersey rescued an average of 45 Kemp's ridley turtles each year between 1995 and 2005, of which 18% had become impinged on power plant grates, 4% had been struck by boat propellers, and 20% showed signs of other impacts (NJDEP 2006). From 2010 through 2020, the STSSN reported 11 offshore and 5 inshore Kemp's ridley sea turtle strandings within Zone 39, which encompasses southern New Jersey (NMFS 2021b).

The density of Kemp's ridley sea turtles in the project area during summer, the season with the highest density, ranges from 0 to 0.0186 animals per 38.6 mi^2 (100 km^2) (U.S. Navy 2007), which equates to an instantaneous estimate of approximately 0 to 1 Kemp's ridley sea turtles within the 68,450-acre (277 km^2) Wind Farm Area. Density estimates of Kemp's ridley sea turtles in the WDA were also derived using at-sea-density data for sea turtles in the adjacent waters of the New York Bight (Normandeau Associates and APEM 2018a, 2018b, 2019a, 2019b, 2020). Model results indicate that Kemp's ridley sea turtle density in the WDA is highest in the summer (0.991 animals/100 km^2), followed by fall (0.19 animals/100 km^2), then spring (0.05 animals/100 km^2), and no Kemp's ridley sea turtles expected in winter.

Based on the information presented here, we anticipate Kemp's ridley turtles to occur in the WDA (i.e., the lease area and cable corridors) during the warmer months, typically between May and November. We expect the highest likelihood of occurrence to be in coastal nearshore areas adjacent to Ocean City and Barnegat Bay, where the project's export cable system will make landfall, as Kemp's ridley sea turtles are known to seek protected shallow-water habitats. Kemp's ridleys are also expected along the vessel transit routes used by project vessels transiting to and from ports in the South Atlantic and to Europe with seasonal presence dependent on latitude.

North Atlantic DPS of Green sea turtles
Most green turtles spend the majority of their lives in coastal foraging grounds. These areas include fairly shallow waters both open coastline and protected bays and lagoons. In addition to coastal foraging areas, oceanic habitats are used by oceanic-stage juveniles, migrating adults, and, on some occasions, by green turtles that reside in the oceanic zone for foraging. Because of their association with warm waters, green sea turtles are only found in New Jersey waters during the summer, foraging on marine algae and marine grasses (CWFNJ 2021). While green sea turtles occur in the open Ocean, they are expected to be rare along the vessel transit routes from the project area to Europe due to their tendency to remain in coastal foraging grounds.

Five green turtle sightings were recorded off the Long Island shoreline in aerial surveys conducted from 2010 to 2013 (NEFSC and SEFSC 2018). Green sea turtles were also positively identified in 2010 to 2017 AMAPPS aerial surveys of the Atlantic continental shelf. Large concentrations were regularly observed in proximity to the NJ WEA, with most sightings occurring during summer between North Carolina and New York, along the continental shelf (Palka et al. 2021).

The STSSN rescued eight green sea turtles between 1995 and 2005, of which six had evidence of human interactions with fishing activities, boat strikes, and impingement on a power plant grate (NJDEP 2006). From 2010 to 2020, the STSSN reported seven offshore and two inshore green sea turtle strandings within Zone 39, which encompasses southern New Jersey (NMFS

2021b).These and other sources of information indicate that green sea turtles occur periodically in shallow nearshore waters of Mid-Atlantic Bight, but their presence offshore in the Lease Area is also possible.

The density of green sea turtles in the project area during summer, the season with the highest density, ranges from 0 to 2.338 animals per 38.6 mi^2 (100 km^2) (U.S. Navy 2007), which equates to an instantaneous estimate of approximately 0 to 6.5 green sea turtles within the 68,450-acre (277 km^2) Wind Farm Area. Density estimates of green sea turtles in the project area were also derived using at-sea-density data for sea turtles in the adjacent waters of the New York Bight (Normandeau Associates and APEM 2018a, 2018b, 2019a, 2019b, 2020). Model results indicate that green sea turtle density in the offshore project area is generally low and limited to the summer (0.038 animals/100 km^2), with no green sea turtles expected in spring, fall, or winter.

Based on the information presented here, we anticipate green sea turtles to occur in the project area (i.e., the lease area and cable corridors) during the warmer months, typically between May and November. Green sea turtles are also expected along the vessel transit routes used by project vessels transiting to and from ports in the South Atlantic and to Europe with seasonal presence dependent on latitude.

6.3 Summary of Information on Listed Marine Fish Presence in the Action Area

Atlantic sturgeon (Acipenser oxyrinchus oxyrinchus)
Adult and subadult (less than 150cm in total length, not sexually mature, but have left their natal rivers) Atlantic sturgeon from all five DPSs undertake seasonal, nearshore (i.e., typically depths less than 50 meters), coastal marine migrations along the United States eastern coastline including in waters of southern New England (Dunton et al. 2010, Erickson et al. 2011). Given their anticipated distribution in depths primarily 50 m and less, Atlantic sturgeon are not expected to occur in the deep, open-ocean portion of the action area that will be transited by project vessels carrying turbine components. In addition to at least occasional presence in the WDA, Atlantic sturgeon may occur along the transit routes to the Paulsboro Marine Terminal (transiting Delaware Bay and the lower Delaware River), the New Jersey Wind Port (NJ) (transiting Delaware Bay and the lower Delaware River), the Nexans facility at the Port of Charleston (SC) (transiting lower portions of the Cooper River), Pt. Elizabeth (transiting through lower Delaware Bay) and Norfolk International Terminal (VA) (transiting channels within the lower Chesapeake Bay).

Atlantic sturgeon demonstrate strong spawning habitat fidelity and extensive migratory behavior (Savoy et al. 2017). Adults and subadults migrate extensively along the Atlantic coastal shelf (Erickson et al. 2011; Savoy et al. 2017), and use the coastal nearshore zone to migrate between river systems (ASSRT 2007; Eyler et al. 2004). Erickson et al. (2011) found that adults remain in nearshore and shelf habitats ranging from 6 to 125 feet (2 to 38 m) in depth, preferring shallower waters in the summer and autumn and deeper waters in the winter and spring. Data from capture records, tagging studies, and other research efforts (Damon-Randall et al. 2013; Dunton et al. 2010; Stein et al. 2004a, 2004b; Zollett 2009) indicate the potential for occurrence in the action area during all months of the year. Individuals from every Atlantic sturgeon DPS have been captured in the Virginian marine ecoregion (Cook and Auster 2007; Wirgin et al.

2015a, 2015b), which extends from Cape Cod, Massachusetts, to Cape Lookout, North Carolina.

Based on tag data, sturgeon migrate to southern waters (e.g. off the coast of North Carolina and Virginia) during the fall, and migrate to more northern waters (e.g. off the coast of New York, southern New England, as far north as the Bay of Fundy) during the spring (Dunton et al. 2010, Erickson et al. 2011, Wippelhauser et al. 2017). In areas with gravel, sand and/or silt bottom habitats and relatively shallow depths (primarily <50 meters), sturgeon may also be foraging during these trips on prey including mollusks, gastropods, amphipods, annelids, decapods, isopods, and fish such as sand lance (Stein et al. 2004b, Dadswell 2006, Dunton et al. 2010, Erickson et al. 2011).

Atlantic sturgeon aggregate in several distinct areas along the Mid-Atlantic coastline; Atlantic sturgeon are most likely to occur in areas adjacent to estuaries and/or coastal features formed by bay mouths and inlets (Stein *et al.* 2004a; Laney *et. al* 2007; Erickson *et al*. 2011; Dunton *et al*. 2010). These aggregation areas are located within the coastal waters off North Carolina; waters between the Chesapeake Bay and Delaware Bay; the southern New Jersey coast near the mouth of Delaware Bay; and the southwest shores of Long Island (Laney *et. al* 2007; Erickson *et al*. 2011; Dunton *et al*. 2010). These aggregation areas are believed to be where Atlantic sturgeon overwinter and/or forage (Laney *et. al* 2007; Erickson *et al*. 2011; Dunton *et al*. 2010). With the exception of the area off Long Island (which is outside the action area), these waters are in the action area but are further inshore than the routes that will be transited by project vessels moving between U.S. ports and the WDA. Based on five fishery-independent surveys, Dunton *et al*. (2010) identified several "hotspots" for Atlantic sturgeon captures, all located in depths of less than 20 m adjacent to estuaries including the Hudson River/NY Bight, Delaware Bay, Chesapeake Bay, Cape Hatteras, and Kennebec River. , These "hotspots" are aggregation areas that are most often used during the spring, summer, and fall months (Erickson *et al*. 2011; Dunton *et al*. 2010). Areas between these sites are used by sturgeon migrating to and from these areas, as well as to spawning grounds found within natal rivers. Adult sturgeon return to their natal river to spawn in the spring. The nearest river to the lease area and the cable corridors that is known to regularly support Atlantic sturgeon spawning is the Delaware River. The nearest river to the vessel transit route to and from ports in the South Atlantic that is known to regularly support Atlantic sturgeon spawning is the Cooper River.

Dunton et al. (2015) caught sturgeon as bycatch in waters less than 50 feet deep during the New York summer flounder fishery, and Atlantic sturgeon occurred along eastern Long Island in all seasons except for the winter, with the highest frequency in the spring and fall. The species migrates along coastal New York from April to June and from October to November (Dunton et al. 2015). Ingram et al. (2019) studied Atlantic sturgeon distribution using acoustic tags and determined peak seasonal occurrence in the offshore waters of the OCS from November through January, whereas tagged individuals were uncommon or absent from July to September. The authors reported that the transition from coastal to offshore areas, predictably associated with photoperiod and river temperature, typically occurred in the autumn and winter months. Migratory adults and sub-adults have been collected in shallow nearshore areas of the continental shelf (32.9–164 feet [10–50 m]) on any variety of bottom types (silt, sand, gravel, or clay). Evidence suggests that Atlantic sturgeon orient to specific coastal features that provide foraging opportunities linked to depth-specific concentrations of fauna. Concentration areas of Atlantic sturgeon near Chesapeake Bay and North Carolina were strongly correlated with the coastal features formed by the bay mouth, inlets, and the physical and biological features produced by outflow plumes (Kingsford and Suthers 1994, as cited in Stein et al. 2004a). They are also known to commonly aggregate in areas that presumably provide optimal foraging opportunities, such as the Bay of Fundy, Massachusetts Bay, Rhode Island, New Jersey, and Delaware Bay (Dovel and Berggren 1983; Johnson et al. 1997; Rochard et al. 1997; Kynard et al. 2000; Eyler et al. 2004; Stein et al. 2004a; Dadswell 2006, as cited in ASSRT 2007).

Stein et al. (2004a, 2004b) reviewed 21 years of sturgeon bycatch records in the Mid-Atlantic OCS to identify regional patterns of habitat use and association with specific habitat types. Atlantic sturgeon were routinely captured in waters within and in immediate proximity to the action area, most commonly in waters ranging from 33 to 164 feet (10–50 m) deep. Sturgeon in this area were most frequently associated with coarse gravel substrates within a narrow depth range, presumably associated with depth-specific concentrations of preferred prey fauna.

Surveys specifically targeting Atlantic sturgeon have not been carried out in the WDA; however, a number of surveys occur regularly in the action area, including the WDA, that are designed to characterize the fish community and use sampling gear that is expected to collect Atlantic sturgeon if they were present in the area. One such survey is the Northeast Area Monitoring and Assessment Program (NEAMAP), which samples from Cape Cod, MA south to Cape Hatteras, NC and targets both juvenile and adult fishes; NEAMAP samples near shore water to a depth of 60 feet and includes the sounds to 120 feet. Atlantic sturgeon are regularly captured in this survey; however, there are few instances of collection in the WDA. The area is also sampled in the NEFSC bottom trawl surveys, which surveys from Cape Hatteras to the Western Scotian Shelf; few Atlantic sturgeon are collected in the WDA.

None of the scientific literature that has examined the distribution of Atlantic sturgeon in the marine environment has identified the lease area or cable corridor as a “hot spot” or an identified aggregation area (see above). However, given the depths (less than 50m) and the predominantly sandy substrate which are consistent habitat parameters with offshore areas where Atlantic sturgeon are known to occur, and the occasional collection of Atlantic sturgeon in this area in regional surveys and in commercial fisheries, at least some Atlantic sturgeon are likely to be present in the project area. Presence has been confirmed by the collection of Atlantic sturgeon in several sampling programs off the New Jersey coast (Stein et al. 2004b; Eyler et al. 2009; Dunton et al. 2010; Erickson et al. 2011). Dunton et al. (2010) analyzed data from surveys covering the northwest Atlantic Ocean from Cape Hatteras to the Gulf of Maine conducted by five agencies. The catch per unit of effort for Atlantic sturgeon off New Jersey, from New York Harbor south to the entrance of Delaware Bay (Delaware), was second only to catch per unit of effort from the entrance of New York Harbor to Montauk Point, New York. About 95% of all Atlantic sturgeon captured in the sampling off New Jersey occurred in depths less than 66 feet (20 meters) with the highest catch per unit of effort at depths of 33 to 49 feet (10 to 15 meters) (Dunton et al. 2010). Spawning, juvenile growth and development, and overwintering are not known to occur in the WDA. In the portion of the action area including the lease area and along the cable corridors, the majority of individuals will be from the New York Bight DPSs. Along vessel transit routes to and from ports in the South Atlantic, the majority of individuals will be from the South Atlantic DPS (Kazyak et al. 2021). Considering the action area as whole, individuals from all five DPSs may be present.

In summary, Atlantic sturgeon occur in most of the action area; with the exception being the waters transited by project vessels with depths greater than 50m. This means that in addition to the WDA and riverine/estuarine portions of the action area that will be transited by project vessels identified above, Atlantic sturgeon will only be present in the nearshore (less than 50 m depth) portion of the vessel transit routes and will not be present in the open ocean areas transited by vessels moving between the WDA and identified ports.

Critical Habitat for the New York Bight DPS of Atlantic sturgeon
Critical habitat has been designated for the five DPSs of Atlantic sturgeon (82 FR 39160, August 17, 2017) in rivers of the eastern United States. Critical habitat designated in the Delaware River for the New York Bight DPS of Atlantic sturgeon is the only critical habitat that may be affected by the proposed action. The February 25, 2022 NJWP Biological Opinion discusses the status of Atlantic sturgeon critical habitat in the Delaware River in sections 5.3 and 6.2.3 and is incorporated here by reference.

Shortnose sturgeon
The only portion of the action area that overlaps with the distribution of shortnose sturgeon is the Delaware River where vessels transiting to/from the Paulsboro Marine Terminal and New Jersey Wind Port will travel. The February 25, 2022 NJWP Biological Opinion discusses the status of shortnose sturgeon in the Delaware River in sections 5.2.1 and 6.2.1 and is incorporated here by reference.

6.4 Consideration of Federal, State, and Private Activities in the Action Area

Activities in the Coastal and Riverine Portions of the Action Area
Project vessels are expected to transit portions of Delaware Bay and a portion of the Delaware River (to/from Paulsboro, the New Jersey Wind Port, and Pt. Elizabeth), the Chesapeake Bay entrance channels and lower Chesapeake Bay (to/from Norfolk), and Charleston Harbor and the lower Cooper River (to/from the Nexans cable facility). In addition to fishing activity and vessel traffic, portions of these areas have navigation channels that are maintained by dredging, and are affected by routine in-water construction activities such as dock, pier, and wharf maintenance and construction.

Loggerhead, Kemp's ridley, and green sea turtles and Atlantic and shortnose sturgeon are vulnerable to serious injury and mortality in hopper dredges that are used to maintain federal navigation channels in the action area, including channels in New York Harbor, Chesapeake Bay, Charleston Harbor, and the Delaware River. NMFS has completed ESA section 7 consultations on these actions; measures are in place to avoid and minimize take and in all cases, NMFS has determined that the proposed actions are not likely to jeopardize the continued existence of any listed species. We expect that mortality of sturgeon and sea turtles as a result of maintenance dredging and channel deepening will continue in the action area over the life of the Ocean Wind 1 project.

As mentioned in section 4 of this Opinion, NMFS has completed ESA section 7 consultations on the construction and use of three of the ports that may be used by Ocean Wind 1 vessels. Please refer to information in that section for additional information on effects of those actions on Atlantic sturgeon.

Dredging of the Oyster Creek Federal Channel in Barnegat Bay
Maintenance dredging occurs in the action area to maintain navigational channels at safe depths. These activities are authorized by the U.S. Army Corps of Engineers and the State of New Jersey. Dredging typically occurs with a mechanical, cutterhead, or hydraulic hopper dredge, and the material is placed at an aquatic placement area known as Site 6 in Barnegat Bay west of previously (USACE 2020). Dredging results in the removal of bottom sediments and as such results in a temporary disruption of benthic resources; however, the dredged areas are expected to be recolonized from nearby undredged areas resulting in only a temporary reduction in the availability of potential sea turtle and sturgeon prey. The effects of these occasional, temporary reductions in the amount of prey in the action area are likely to be so small that they cannot be meaningfully measured, evaluated, or detected. There have been no reported interactions with sea turtles or Atlantic sturgeon during dredging in Barnegat Bay.

Fishing Activity in the Action Area
Commercial and recreational fishing occurs throughout the action area. The lease area and cable corridor occupies a portion of NMFS statistical area 614. The area that may be transited by vessels from Europe overlap with a number of offshore statistical areas, while transit routes to other ports, including those in New York, the Delaware River, South Carolina and Virginia overlap with a number of other statistical areas (see, https://www.fisheries.noaa.gov/resource/map/greater-atlantic-region-statistical-areas). Commercial fishing in the U.S. EEZ portion of the action area is authorized by the individual states or by NMFS under the Magnuson-Stevens Fishery Conservation and Management Act. Fisheries that operate pursuant to the MSFCMA have undergone consultation pursuant to section 7 of the ESA. These biological opinions are available online (available at: https://www.fisheries.noaa.gov/new-england-mid-atlantic/consultations/section-7-biological-opinions-greater-atlantic-region).

Given that fisheries occurring in the action area are known to interact with large whales, the past and ongoing risk of entanglement in the action area is considered here. The degree of risk in the future may change in association with fishing practices and accompanying regulations.
It is important to note that in nearly all cases, the location where a whale first encountered entangling gear is unknown and the location reported is the location where the entangled whale was first sighted. The risk of entanglement in fishing gear to fin, sei, blue, and sperm whales in the lease area appears to be low given the low interaction rates in the U.S. EEZ as a whole.

We have reviewed the most recent data available on reported entanglements for the ESA listed whale stocks that occur in the action area (Hayes et al. 2020, Hayes et al. 2022, Henry et al. 2022). As reported in Hayes et al. 2022, for the most recent 5-year period of review (2015-2019) in the U.S. Atlantic, the minimum rate of serious injury or mortality resulting from fishery interactions as 5.7/year for right whales, 1.45/year for fin whales, 0.4 for sei whales. The minimum rate of serious injury or mortality resulting from fishery interaction is zero for blue and sperm whales as reported in the most recent SAR for blue whales and sperm whales in the North Atlantic (Hayes et al. 2020). In all cases, the authors note that this is a minimum estimate of the amount of entanglement and resultant serious injury or mortality. These data represent only known mortalities and serious injuries; more, undocumented mortalities and serious injuries have likely occurred and gone undetected due to the offshore habitats where large whales occur. Hayes et al. (2020) notes that no confirmed fishery-related mortalities or serious injuries of sei whales have been reported in the NMFS Sea Sampling bycatch database and that a review of the records of stranded, floating, or injured sei whales for the period 2015 through 2019 on file at NMFS found 3 records with substantial evidence of fishery interaction causing serious injury or mortality, which results in the annual serious injury and mortality rate from fishery interactions noted above. Hayes et al. (2020), reports that sperm whales have not been documented as bycatch in the observed U.S. Atlantic commercial fisheries. No confirmed fishery-related mortalities or serious injuries of fin whales have been reported in the NMFS Sea Sampling bycatch database and a review of the records of stranded, floating, or injured fin whales for the period 2015 through 2019 with substantial evidence of fishery interactions causing injury or mortality are captured in the total observed incidental fishery interaction rate reported above (Hayes et al. 2022).

We also reviewed available data that post-dates the information presented in the most recent stock assessment reports. As explained in the Status of the Species section of this Opinion, there is an active UME for North Atlantic right whales[25]. Of the 95 right whales in the UME, 9 mortalities are attributed to entanglement as well as 20 serious injuries and 30 sublethal injuries. None of the whales recorded as part of the UME were first documented in the lease area or along the cable routes[26]. We reviewed information on serious injury and mortalities reported in Henry et al. 2022. Two live right whales were first documented as entangled in waters off the coast of New Jersey; right whale 3405 was documented as entangled in netting on December 4, 2016 approximately 3.5 nm east of Sandy Hook, right whale 4680 was documented as entangled in unknown gear on October 11, 2020 approximately 2.7 nm east of Sea Bright, NJ. It is unknown where either of these entanglements actually occurred. Henry et al. 2022 includes no records of entangled fin, sei, blue, or sperm whales first reported in waters off New Jersey.

Given the co-occurrence of fisheries and large whales in the action area, it is assumed that there have been entanglements in the action area in the past and that this risk will persist at some level throughout the life of the project. However, it is important to note that several significant actions have been taken to reduce the risk of entanglement in fisheries that operate in the action area including ongoing implementation of the Atlantic Large Whale Take Reduction Plan. The goal of the ALWTRP is to reduce injuries and deaths of large whales due to incidental entanglement in fishing gear. The ALWTRP is an evolving plan that changes as NMFS learns more about why whales become entangled and how fishing practices might be modified to reduce the risk of entanglement. It has several components including restrictions on where and how gear can be set; research into whale populations and whale behavior, as well as fishing gear interactions and

[25] Information in this paragraph related to the UME is available at: *https://www.fisheries.noaa.gov/national/marine-life-distress/2017-2021-north-atlantic-right-whale-unusual-mortality-event*; last accessed on February 13, 2023

[26] https://noaa.maps.arcgis.com/apps/webappviewer/index.html?id=e502f7daf4af43ffa9776c17c2aff3ea; last accessed February 13, 2023

modifications; outreach to inform and collaborate with fishermen and other stakeholders; and a large whale disentanglement program that seeks to safely remove entangling gear from large whales whenever possible. While there have been delays to implementation of some recently developed ALWTRP measures, the risk of entanglement within the action area is expected to decrease over the life of the action due to compliance of state and federal fisheries with new ALWTRP measures. All states that regulate fisheries in the U.S. portion of the action area codify the ALWTRP measures into their state fishery regulations.

Atlantic sturgeon are captured as bycatch in trawl and gillnet fisheries. An analysis of the NEFOP/ASM bycatch data from 2000-2015 (ASMFC 2017) found that most trips that encountered Atlantic sturgeon were in depths less than 20 meters and water temperatures between 45-60°F. Average mortality in bottom otter trawls was 4% and mortality averaged 30% in gillnets (ASMFC 2017). The most recent five years of data in the NMFS NEFOP and ASM database were queried for the number of reports of Atlantic sturgeon bycatch in the statistical area that overlaps with the lease area and cable routes (614[27]). The NEFOP program samples a percentage of trips from the Gulf of Maine to Cape Hatteras while the ASM program provides additive coverage for the New England ground fish fisheries, extending from Maine to New York. For the most recent five-year period that data are available (2016-2020), a total of 77 Atlantic sturgeon were reported as bycatch in statistical area 614, this represents approximately 5% of the total bycatch of Atlantic sturgeon in the Maine to Cape Hatteras area where the NEFOP, and Maine to New York area where the ASM program, operates. Incidental capture of Atlantic sturgeon is expected to continue in the action area at a similar rate over the life of the proposed action. While the rate of encounter is low and survival is relatively high (96% in otter trawls and 70% in gillnets), bycatch is expected to be the primary source of mortality of Atlantic sturgeon in the Atlantic Ocean portion of the action area. Given their coastal distribution is limited to depths of less than 50m, there are no anticipated interactions in fisheries beyond those considered here that may occur along the vessel transit routes to ports in Europe.

Sea turtles are vulnerable to capture in trawls as well as entanglement in gillnets and vertical lines. Using the same data source as for Atlantic sturgeon, from 2012-2020 there were a total of 4 incidents of observed sea turtle bycatch in fisheries in area 614 (3 loggerheads, 1 Kemp's ridley); the most recent record was from 2017 and all four turtles were captured in otter trawls. Leatherback sea turtles are particularly vulnerable to entanglement in vertical lines. Since 2005, 379 leatherbacks have been reported entangled in vertical lines in the Northeast Region. In response to high numbers of leatherback sea turtles found entangled in the vertical lines of fixed gear in the Northeast Region, NMFS established the Northeast Atlantic Coast Sea Turtle Disentanglement Network (STDN). Formally established in 2002, the STDN is an important component of the National Sea Turtle Stranding and Salvage Network. The STDN works to reduce serious injuries and mortalities caused by entanglements and is active throughout the action area responding to reports of entanglements. Where possible, turtles are disentangled and may be brought back to rehabilitation facilities for treatment and recovery. This helps to reduce the rate of death from entanglement. The Southeast STDN provides similar services in the South Atlantic and Gulf of Mexico. Sea turtles are also captured in fisheries operating in the Gulf of Mexico and in offshore areas where pelagic fisheries such as the Atlantic Highly Migratory

[27] Map available at:
https://www.greateratlantic.fisheries.noaa.gov/educational_resources/gis/gallery/gafostatisticalareas.html

Species (HMS) fishery occurs. Sea turtles are also vulnerable to interactions with fisheries occurring off the U.S. South Atlantic coast including the Atlantic shrimp trawl fishery. For all fisheries for which there is a fishery management plan (FMP) or for which any federal action is taken to manage that fishery, the impacts have been evaluated via section 7 consultation. Past consultations have addressed the effects of federally permitted fisheries on ESA-listed species, sought to minimize the adverse impacts of the action on ESA-listed species, and, when appropriate, have authorized the incidental taking of these species. Incidental capture and entanglement of sea turtles is expected to continue in the action area at a similar rate over the life of the proposed action. Safe release and disentanglement protocols help to reduce the severity of impacts of these interactions and these efforts are expected to continue over the life of the project.

Vessel Operations
The action area is used by a variety of vessels ranging from small recreational fishing vessels to large commercial cargo ships. Commercial vessel traffic in the action area includes research, tug/barge, liquid tankers, cargo, military and search-and-rescue vessels, and commercial fishing vessels. The open ocean portion of the action area that will be transited by vessels moving between the project site and ports in Europe is used primarily by large cargo and tanker vessels as well as some fishing and research vessels, cruise ships, and military vessels.

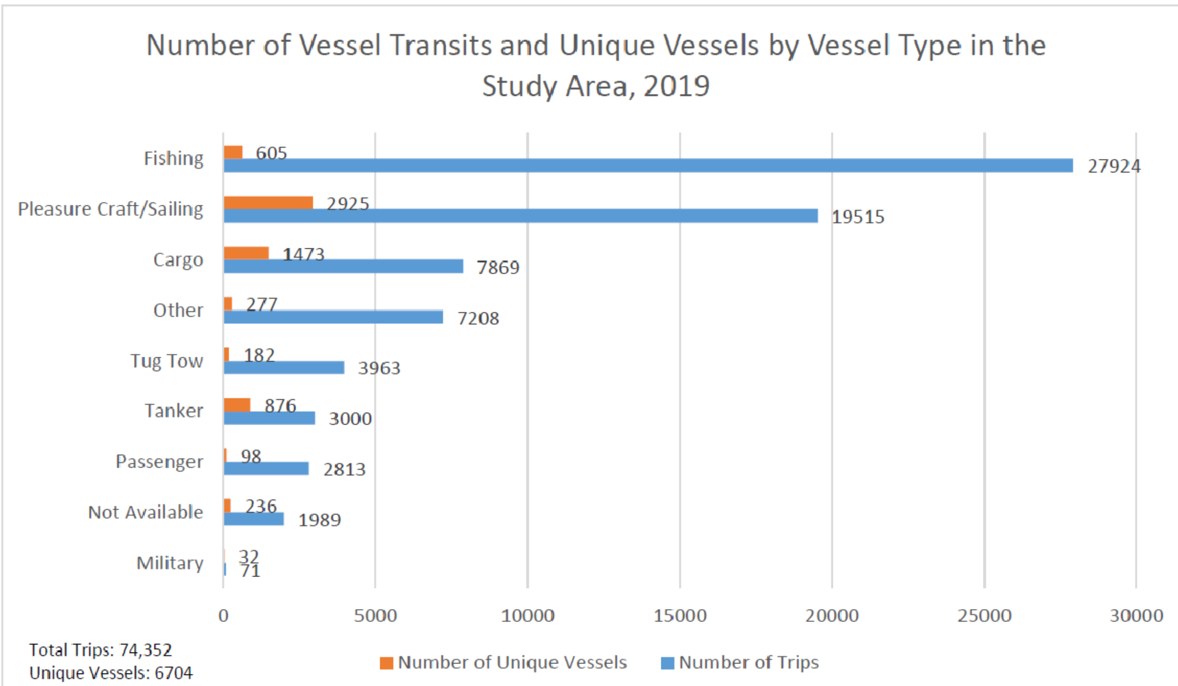
Vessel Traffic between the Lease Area and Foreign Ports (Europe)
Trans-Atlantic vessel traffic mainly consists of tankers, container ships, and passenger vessels. Commercial vessel traffic typically travels along the Nantucket to Ambrose Traffic Separation Scheme if going into ports in southern New England or New York or New Jersey and then transits through one of the TSSs mentioned above. There are thousands of trans-Atlantic vessel transits between Europe and the U.S. Atlantic Coast each year although few of these are likely to pass through the lease area as they are more likely to pass to the west or east as they move between the TSSs.

Vessel Traffic between the Lease Area and Ports to the South (Norfolk and Charleston)
Vessel traffic along the southern U.S. coast mainly consists of tug and barge, fishing vessels, tankers, container ships, and passenger vessels; military vessels also transit the area conducting training and operations. Vessels typically travel offshore before entering a traffic separation scheme heading into port. Traffic generally travels in a north to south or south to north direction. Throughout the Mid-Atlantic, commercial vessel traffic is significant throughout the year with a number of major U.S. ports located along the coast. These ports include ones in the Chesapeake Bay/Norfolk, VA and the Delaware Bay. Vessel traffic is heaviest in the nearshore waters, near major ports, in the shipping lanes. Recreational vessel traffic is high throughout these areas but is generally close to shore compared to commercial vessel travel.

Vessel Traffic in the Lease Area and Surrounding Waters
Information from a number of sources including the DEIS and the Navigational Safety Risk Assessment (NSRA) prepared to support the COP, and the USCG's Draft Port Access Route Study for the Seacoast of New Jersey (NJPARS) helps to establish the baseline vessel traffic in the WDA (i.e., the portion of the lease area where WTGs will be placed and the two cable corridors) and surrounding area. USCG's NJPARS analyzed Automatic Identification System

(AIS) data in the five BOEM OCS lease areas and the Hudson South Wind Planning Area along the seacoast of New Jersey including offshore approaches to the Delaware Bay and found 74,352 annual transits through the study area by 6,704 unique vessels in 2019 (Figure 2.2.1). The study concluded that vessel activity in the study area was largely commercial fishing. Commercial fishing fleets that currently transit the Lease Area primarily originate from Atlantic City, Sea Isle City, Wildwood, Lower Township, and Cape May.

Figure 2.2.1. Number of Vessel Transits and Unique Vessels by Vessel Type in the NJPARS Study Area, 2019



Source: 2020 Vessel Traffic Analysis for Port Access Route Study: Seacoast of New Jersey including the offshore approaches to the Delaware Bay, Delaware (NJ PARS)

Section 3 of the NSRA characterizes the baseline vessel traffic within a Marine Traffic Study Area, which is inclusive of the WDA, the remainder of the Lease Area, and offshore waters for more than 40 nm in any direction. The study describes baseline conditions according to identified vessel types, their characteristics, operating areas/routes, separation zones, traffic density, and seasonal traffic variability using AIS data for one year (March 1, 2019 – February 29, 2020), stakeholder outreach, 2014 – 2019 VMS data, Vessel Trip Report data, the draft NJPARS, and marine transportation/traffic Nationwide AIS data.

The NSRA included a comprehensive vessel traffic survey in the study area using automatic identification system (AIS) data from 2019 and 2020. AIS is required only for vessels 65’ or larger and is optional for smaller vessels. According to AIS data, the vicinity surrounding the lease area is heavily trafficked by vessels entering and exiting the Delaware Bay and transiting along the coast of the United States (DNV GL 2021). The data include eight vessel classes: cargo/carrier, fishing, other and unidentified, passenger, recreational, tanker, tanker – oil, and tug and service. Cargo/carrier, fishing, and recreational vessels accounted for more than 61% of vessel traffic in the area in 2019 through 2020 (DNV GL 2021). Average daily vessel transits were 18 for the entrance to Delaware Bay, 16 for Barnegat Inlet, and 11 for the east end of Delaware Bay (DNV GL 2021). The majority of vessel transits in the vicinity of the project area were between 197 and 262 feet (60 and 80 meters) in length (DNV GL 2021). Based on AIS data, the coastal traffic west of the WFA is predominantly comprised of tug transits, while the majority of the coastal traffic further south is predominantly pleasure and fishing vessels. Vessel traffic in the vicinity of the project is much less dense than near the coast. Traffic east of the WFA is predominantly deep draft commercial vessels. The data show that about 5 transits per day enter the WFA, 1,632 per year in total, including some minor double-counting (Marine Traffic 2020). Deep draft vessels and tugs are not expected to enter the WFA, except in emergency circumstances.

AIS data show that about five transits per day enter the WFA, 1,632 per year in total, including some minor double-counting (MarineTraffic 2020). The NSRA analyzed vessel traffic activity within the study area as transit counts per transect with transect locations selected to evaluate the areas of heaviest vessel traffic in the vicinity of the Lease Area. The study concluded that there were no high-density traffic areas within several miles of the WDA (Figure 2.2.2). Only three transects have more than 10 transits per day, according to the AIS data (3,650 transits per year):

- The entrance to Delaware Bay with an average of about 18 transits per day,
- Barnegat Inlet with an average of 16 transits per day, and,
- The eastern end of Delaware Bay with an average of 11 transits per day.

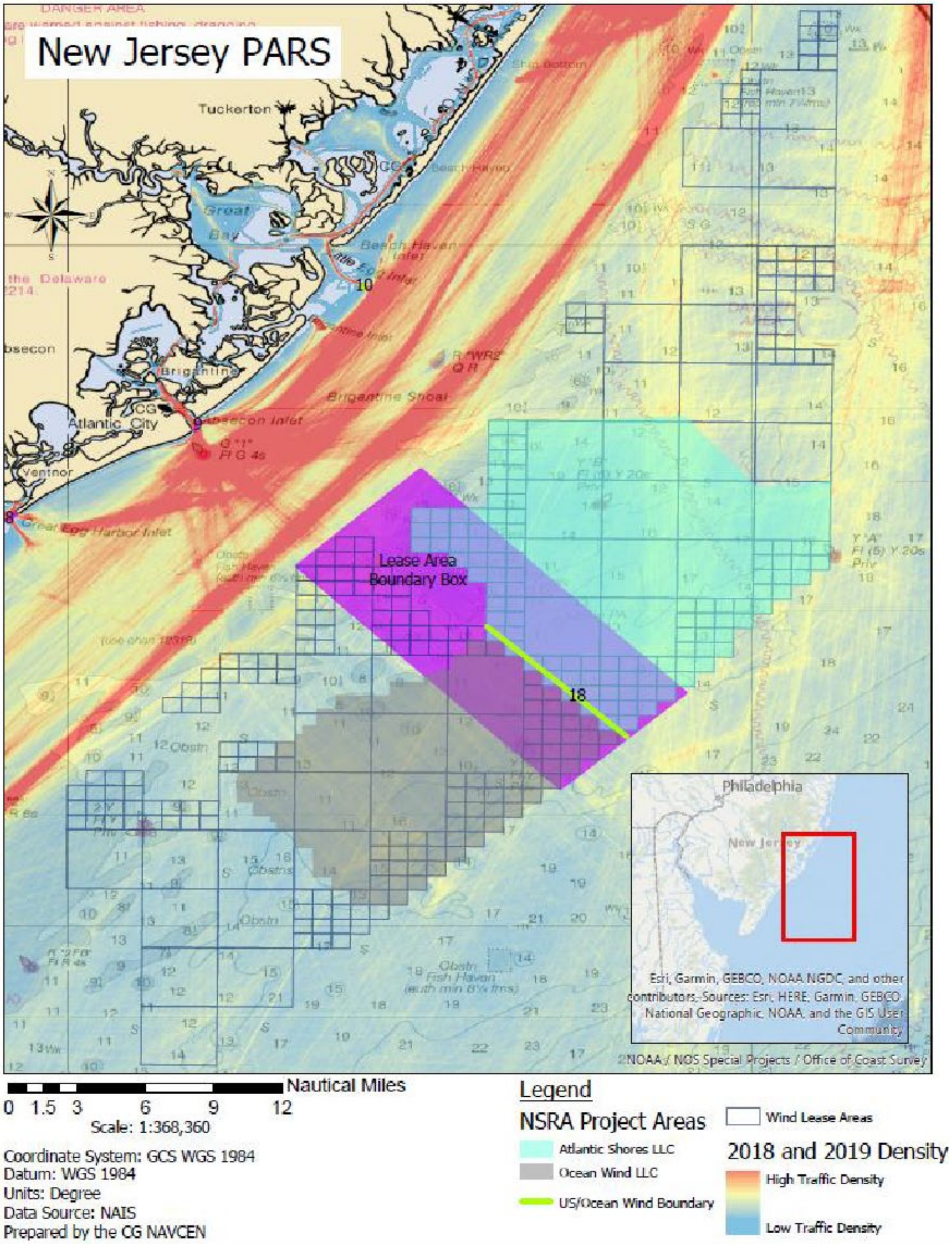
The coastal traffic west of the Lease Area is predominantly tug transits, while the coastal traffic farther south is predominantly pleasure and fishing vessels. Some deep-draft vessel traffic (cruise ships, cargo and carrier ships, and tankers) occurs within the Lease Area but most of the deep-draft vessels in the vicinity of the Lease Area pass to the east. No ferry routes are identified within the Lease Area with the closest ferry route (Cape May to Lewes) located 29 nm (54 kilometers) from the Lease Area. It should be noted that there are carriage requirements associated with AIS (self-propelled vessels of more than 1,600 gross tons with certain exceptions made for foreign vessels), thus certain vessel classes may be underestimated (i.e. fishing vessels, recreational vessels). The WDA receives increased vessel traffic in late spring and remains higher through early fall. Commercial fishing vessels that were equipped with AIS transited the WDA, primarily traveling in the north-northeast/south-southwest and northwest/southeast directions; some vessels also actively fish in the Lease Area.

The major commercial fishing ports closest to the WFA are Atlantic City, Sea Isle City, Wildwood, and Cape May. There are no significant commercial fishing fleets in Delaware that operate near the WFA. However, the Lease Area is used by 377 vessel monitoring system-enabled commercial fishing vessels (BOEM 2021). Fishing vessel tracks captured in the AIS data show the highest number of tracks adjacent to the coast (north and west of the WFA) (DNV GL 2021). The data also show transits to apparent fishing grounds approximately 22 nm (41 km) southeast of the WFA. Commercial fishing vessel activity is generally recognized as not fully captured in AIS data. A significant portion of commercial fishing vessels do not fall under the AIS carriage requirements. These smaller static and mobile-gear fishing vessels, like all vessels, will not be prohibited from fishing within the array.

AIS data suggests that despite there being countless recreational vessels located along the New Jersey Atlantic shore at marinas scattered along numerous inlets with ocean access, the majority of these recreational vessels operate west of the Lease Area with comparatively few tracks in the WFA. Recreational vessels cruising along the East Coast generally fall into two categories, dependent on their size and seakeeping ability. Smaller coastal cruisers, sail and especially motor, will cruise along the shore, usually within a few miles from the coast, taking advantage of the ability to visually navigate and often day cruising from port to port. These vessels will transit well inshore of any above water obstructions of the WFA. Vessels of greater seakeeping ability and underway on long distance transits may spend two or more days at sea between port calls. When traveling north-south along the East Coast of the United States, these vessels may travel a direct route, often further offshore, which could bring them near above water obstructions in the WFA.

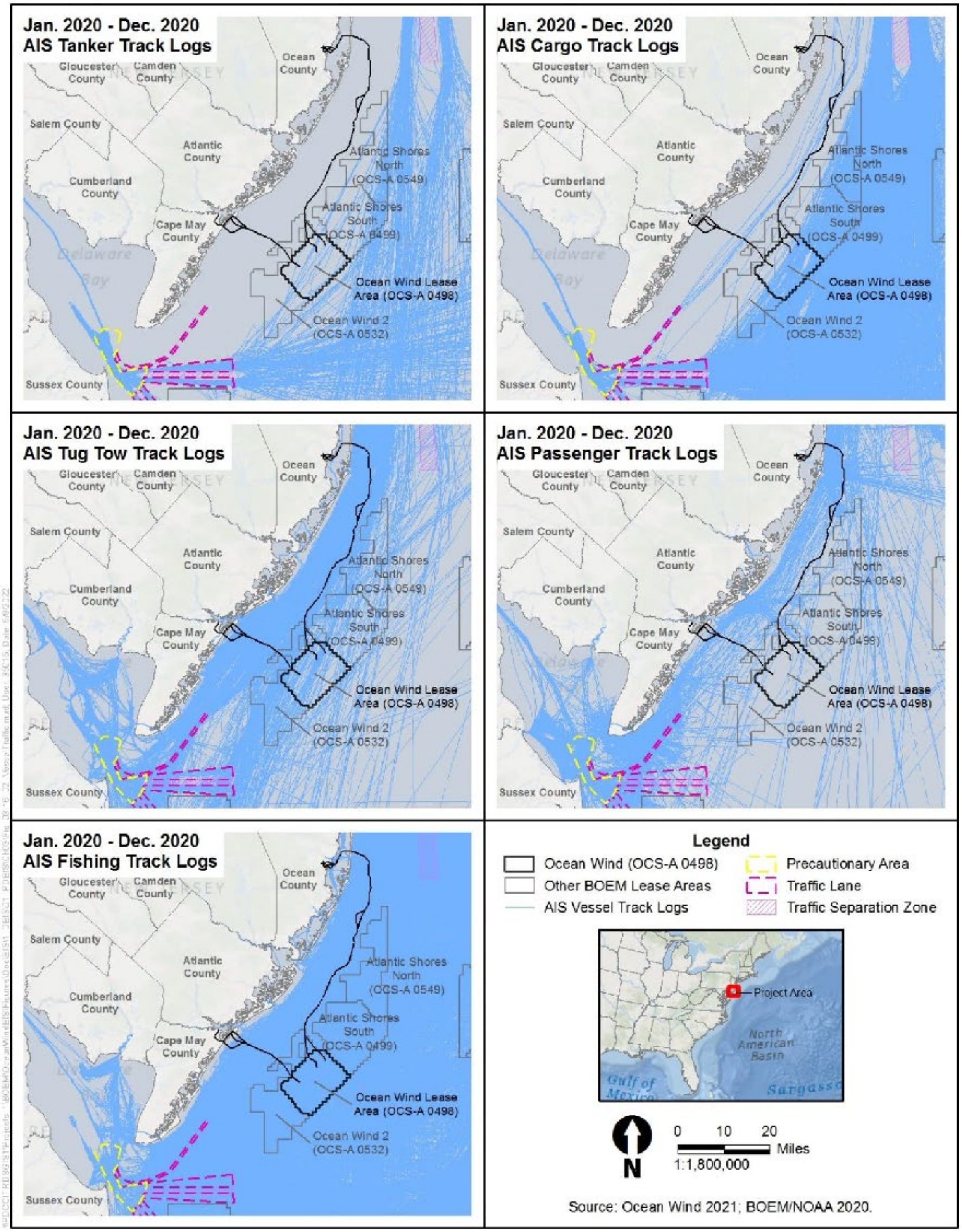
Large and medium sized passenger vessels (e.g., cruise ships, large ferries) generally transit well east of the WFA en route to and from the Ambrose/Barnegat Traffic lanes to the north. These vessels often were traveling between the Port of New York/New Jersey and foreign ports in the Caribbean or Bermuda.

Figure 2.2.2. Lease Area Boundary Box



Source: 2020 Vessel Traffic Analysis for Port Access Route Study: Seacoast of New Jersey including the offshore approaches to the Delaware Bay, Delaware (NJ PARS)

Figure 7.2.3. Vessel Traffic in the Vicinity of the Lease Area. Source: Ocean Wind 1 EIS 2022



Note: AIS track counts for fishing and pleasure vessels underrepresent these vessel types, as not all of these vessel types are required to have AIS on board per USCG regulations.

There are several routing measures that regulate vessel traffic to help ships avoid navigational hazards in the vicinity of the project area. Vessel traffic in and out of Delaware Bay is regulated by a Traffic Separation Scheme that is 17 miles (15 nm, 32 km) from the Project area. The Traffic Separation Scheme within the approach to Delaware Bay consists of four parts: an Eastern Approach, a Southwestern Approach, a Two-Way Traffic Route, and a Precautionary Area (33 CFR 167.170). The Inbound Five Fathom Bank to Cape Henlopen Traffic Lane, the Eastern Approach of the Traffic Separation Scheme, is 21 miles (18 nm, 33 km) south of the Lease Area and is primarily a shipping route for deep-draft vessels. The Two-Way Traffic Route (17 miles [15 nm, 28 km] from the Project area) is used primarily by tug and barge vessels entering and exiting Delaware Bay (Stahl et al. 2021). Based on AIS data, most towing vessel transits occurred west of the WFA while deep draft cargo and tanker vessel transits typically occurred east of the WFA. Most deep draft vessels that transited through the WFA in 2019 while transiting between the Ambrose to Barnegat Traffic Lane and the Five Fathom Bank to Cape Henlopen Traffic Lane appear to have cut the corner when entering or exiting the Delaware Bay Traffic Separation Scheme (DNV GL 2021).

Further to the north of the Project area (approximately 46 miles [40 nm, 74 km]) is a Traffic Separation Scheme that regulates vessel traffic in the approach to New York Harbor (NOAA 2021b, p. 361). There is a speed-restricted area for NARW seasonal management 16 miles (14 nm, 26 km) from the Project area (50 CFR 224.105).

To comply with the Ship Strike Reduction Rule (50 CFR 224.105), all vessels greater than or equal to 65 ft. (19.8 m) in overall length and subject to the jurisdiction of the United States and all vessels greater than or equal to 65 ft. in overall length entering or departing a port or place subject to the jurisdiction of the United States must slow to speeds of 10 knots or less in seasonal management areas (SMA). Mid-Atlantic SMAs in the vicinity of the project area include the ports of New York/New Jersey and the entrance to the Delaware Bay. All vessels 65 feet or longer that transit the SMAs from November 1 – April 30 each year (the period when right whale abundance is greatest) must operate at 10 knots or less. Mandatory speed restrictions of 10 knots or less are required in all of the SMAs along the U.S. East Coast during times when right whales are likely to be present; a number of these SMAs overlap with the portion of the action area that may be used by project vessels. The purpose of this regulation is to reduce the likelihood of deaths and serious injuries to these endangered whales that result from collisions with ships. On August 1, 2022, NMFS published proposed amendments to the North Atlantic vessel strike reduction rule (87 FR 46921). The proposed rule would: (1) modify the spatial and temporal boundaries of current speed restriction areas referred to as Seasonal Management Areas (SMAs), (2) include most vessels greater than or equal to 35 ft. (10.7 m) and less than 65 ft. (19.8 m) in length in the size class subject to speed restriction, (3) create a Dynamic Speed Zone framework to implement mandatory speed restrictions when whales are known to be present outside active SMAs, and (4) update the speed rule's safety deviation provision. Changes to the speed regulations are proposed to reduce vessel strike risk based on a coast-wide collision mortality risk assessment and updated information on right whale distribution, vessel traffic patterns, and vessel strike mortality and serious injury events. To date, the rule has not been finalized.

Restrictions are in place on how close vessels can approach right whales to reduce vessel-related impacts, including disturbance. NMFS rulemaking (62 FR 6729, February 13, 1997) restricts vessel approach to right whales to a distance of 500 yards. This rule is expected to reduce the potential for vessel collisions and other adverse vessel-related effects in the environmental baseline. The Mandatory Ship Reporting System (MSR) requires ships entering the northeast and southeast MSR boundaries to report the vessel identity, date, time, course, speed, destination, and other relevant information. In return, the vessel receives an automated reply with the most recent right whale sightings or management areas and information on precautionary measures to take while in the vicinity of right whales.

SMAs are supplemented by Dynamic Management Areas (DMAs) that are implemented for 15-day periods in areas in which right whales are sighted outside of SMA boundaries (73 FR 60173; October 10, 2008). DMAs can be designated anywhere along the U.S. eastern seaboard, including the action area, when NOAA aerial surveys or other reliable sources report aggregations of three or more right whales in a density that indicates the whales are likely to persist in the area. DMAs are put in place for two weeks in an area that encompass an area commensurate to the number of whales present. Mariners are notified of DMAs via email, the internet, Broadcast Notice to Mariners (BNM), NOAA Weather Radio, and the Mandatory Ship Reporting system (MSR). NOAA requests that mariners navigate around these zones or transit through them at 10 knots or less. In 2021, NMFS supplemented the DMA program with a new Slow Zone program, which identifies areas for recommended 10-knot speed reductions based on acoustic detection of right whales. Together, these zones are established around areas where right whales have been recently seen or heard, and the program provides maps and coordinates to vessel operators indicating areas where they have been detected. Compliance with these zones is voluntary.

Atlantic sturgeon, sea turtles, and ESA listed whales are all vulnerable to vessel strike, although the risk factors and areas of concern are different. Vessels have the potential to affect animals through strikes, sound, and disturbance by their physical presence.

As reported in Hayes et al. 2022, for the most recent 5-year period of review (2015-2019) in the North Atlantic, the minimum rate of serious injury or mortality resulting from vessel interactions is 2.0/year for right whales, 0.40/year for fin whales, 0.2 for sei whales. No vessel strikes for blue or sperm whales have been documented (Hayes et al. 2020). A review of available data on serious injury and mortality determinations for sei, fin, sperm, and right whales for 2000-2020 (Henry et al. 2022, UME website as cited above), includes one fin whale documented on the bow of a ship in Elberon, NJ (June 2020) and one sei whale documented on the bow of a ship in Newark, NJ (July 2016). While both individuals were reported as fresh dead, there is no indication of where the whales were actually hit. Hayes et al. (2021) reports three vessel struck sei whales first documented in the U.S. Northeast – all three were discovered on the bow of vessels entering port (two in the Hudson River and one in the Delaware River); no information on where the whales were hit is available. Hayes et al. (2020) reports only four recorded ship strikes of sperm whales. In May 1994, a ship-struck sperm whale was observed south of Nova Scotia (Reeves and Whitehead 1997), in May 2000, a merchant ship reported a strike in Block Canyon, and in 2001, and the U.S. Navy reported a ship strike within the EEZ (NMFS, unpublished data). In 2006, a sperm whale was found dead from ship-strike wounds off Portland, Maine. A similar rate of strike is expected to continue in the action area over the life of the project and we expect vessel strike will continue to be a source of mortality for right, sei, fin, and sperm whales in the action area. As outlined above, there are a number of measures that are in place to reduce the risk of vessel strikes to large whales that apply to vessels that operate in the action area.

NMFS' Sea Turtle Stranding and Salvage Network (STSSN) database provides information on records of stranded sea turtles in the region. The STSSN database was queried for records of stranded sea turtles with evidence of vessel strike throughout the waters of New Jersey to overlap with the area where the majority of project vessel traffic will occur. Out of the 747 recovered stranded sea turtles in New Jersey/Delaware waters from 2013 through 2022 (10 years), there were 210 definitely recorded sea turtle vessel strikes and 106 recorded blunt force traumas which are likely vessel strikes, primarily between the months of August and November. The majority of strikes and blunt force traumas were of loggerheads with a smaller number of leatherbacks, Kemp's ridleys, and green turtles. A similar rate of strike is expected to continue in the action area over the life of the project and that vessel strike will continue to be a source of mortality for sea turtles in the action area.

Atlantic sturgeon are struck and killed by vessels in at least some portions of their range. There are no records of vessel strike in the Atlantic Ocean. Atlantic sturgeon are known to be struck and killed in portions of the action area that will be transited by project vessels including Delaware Bay and the Delaware River. Risk is thought to be highest in areas with reduced opportunity for escape and from vessels operating at a high rate of speed or with propellers large enough to entrain sturgeon. A summary of information on vessel strikes of Atlantic sturgeon in the Delaware River and Bay is provided in the *Status of the Species* section of this Opinion. In addition, the effects of transits anticipated and analyzed in the 2022 Paulsboro Biological Opinion and 2022 NJWP Biological Opinion influence the environmental baseline for this action. In the February 25, 2022, Biological Opinion issued to USACE for the construction of the NJWP, NMFS concluded that the construction and subsequent use of the New Jersey Wind Port was likely to adversely affect but not likely to jeopardize shortnose sturgeon or any DPS of Atlantic sturgeon. NMFS determined that vessel traffic to and from the NJWP during 25 years of port operations will result in the mortality of 4 shortnose sturgeon and 35 Atlantic sturgeon (23 New York Bight DPS, 5 Chesapeake Bay DPS, 5 South Atlantic DPS, 2 Gulf of Maine DPS) as a result of vessel strike. The Opinion calculated these mortalities based on 1,280 vessel trips during the 25-year operational life of the port. In the BA for the Ocean Wind 1 project, BOEM estimates up to 99 trips to the NJWP (Table 3-24 in the BA). This is approximately 7.7% of the total trips considered in the NJWP Biological Opinion. Based on the available information, we expect that Ocean Wind vessels are similar to the vessels considered in this Opinion; we have not identified any features of the vessels or their operations that would make them more or less likely to strike an Atlantic sturgeon. As such, assuming that all vessels using the port are equally likely to strike an Atlantic sturgeon, we would expect that 7.7% of the total vessel strikes of Atlantic sturgeon could result from Ocean Wind 1 vessels. Calculating 7.7% of 35 Atlantic sturgeon results in an estimate of 2.7 vessel struck sturgeon. As such, we expect that vessels using the NJWP as part of the Ocean Wind 1 project will result in the strike of up to three Atlantic sturgeon. Considering the apportionment of take by DPS outlined in the February 2022 Opinion, we expect that two of these would be from the New York Bight DPS with one from the Chesapeake Bay, South Atlantic, or Gulf of Maine DPS. Calculating 7.7% of 4 shortnose sturgeon results in an estimate of 0.3 vessel struck sturgeon. As such, we expect that vessels using the NJWP as part of the Ocean Wind 1 project will result in the lethal strike of up to one shortnose sturgeon.

In the July 19, 2022, Biological Opinion issued to USACE for the construction of the Paulsboro Marine Terminal, NMFS concluded that the construction and subsequent use of the Paulsboro Marine Terminal was likely to adversely affect but not likely to jeopardize shortnose sturgeon or any DPS of Atlantic sturgeon. NMFS determined that vessel traffic transiting between the mouth of Delaware Bay to and from the Paulsboro Marine Terminal during 10 years of port operations will result in the mortality of one shortnose sturgeon and seven Atlantic sturgeon as a result of vessel strike (4 from the New York Bight DPS, 1 from the Chesapeake Bay DPS, 1 from the South Atlantic DPS, and 1 from the Gulf of Maine DPS). The Opinion calculated this mortality based on a maximum of 880 vessel trips during the 10-year operational life of the port. In the BA for the Ocean Wind 1 project, BOEM estimates up to 149 trips to the Paulsboro Marine Terminal (Table 3-24 in the BA). This is approximately 17% of the total trips considered in the Paulsboro Biological Opinion. Based on the available information, we expect that Ocean Wind vessels are similar to the vessels considered in this Opinion; we have not identified any features of the vessels or their operations that would make them more or less likely to strike an Atlantic sturgeon. Assuming that all vessels using the port are equally likely to strike an Atlantic sturgeon, we would expect that 17% of the total vessel strikes of Atlantic sturgeon could result from Ocean Wind 1 vessels. Calculating 17% of 7 Atlantic sturgeon results in an estimate of 1.19 vessel struck Atlantic sturgeon. As such, we expect that vessels using the Paulsboro Marine Terminal as part of the Ocean Wind 1 project will result in the strike of up to two Atlantic sturgeon. Based on the proportional assignment of take in the July 2022 Paulsboro Opinion, we expect that these are likely to be Atlantic sturgeon belonging to the New York Bight DPS. Calculating 17% of 1 shortnose sturgeon results in an estimate of 0.17 vessel struck shortnose sturgeon. As such, we expect that vessels using the Paulsboro Marine Terminal as part of the Ocean Wind 1 project will result in the lethal strike of up to 1 shortnose sturgeon.

In the July 19, 2022, Biological Opinion NMFS concluded that the construction and subsequent use of the Paulsboro Marine Terminal was not likely to adversely affect critical habitat designated for the New York Bight DPS of Atlantic sturgeon. In the February 25, 2022, Biological Opinion NMFS concluded that the construction and subsequent use of the New Jersey Wind Port was likely to adversely affect but not likely to destroy or adversely modify critical habitat designated for the New York Bight DPS of Atlantic sturgeon. As explained in that Opinion, NMFS determined that there would be temporary and permanent effects as a result of construction and mitigation activities and that the subsequent use of the NJWP channels by deep draft vessels and periodic maintenance dredging will continue to reduce the value of the habitat over the 25-year expected life-time of the NJWP operations. Based on the available information, we expect that Ocean Wind vessels are similar to the vessels considered in the NJWP Opinion; we have not identified any features of the vessels or their operations that would make them more or less likely to affect critical habitat. Due to the nature of the effects to critical habitat described in the NJWP Opinion (i.e., intermittent scouring and disturbance of river sediments), we are not able to determine the proportional effects of Ocean Wind 1 vessel use of these port facilities on critical habitat. However, based on the available information, including consideration of vessel type and number of trips, we determined the effects of the Ocean Wind 1 vessels are within the scope of effects considered in the NJWP Opinion. The effects of these vessel trips on critical habitat designated for the New York Bight DPS of Atlantic sturgeon are included in the Environmental Baseline for the Ocean Wind 1 project.

Offshore Wind Development

The action area includes a number of areas that have been leased by BOEM for offshore wind development or that are being considered for lease issuance. As noted above, in the *Environmental Baseline* section of an Opinion, we consider the past and present impacts of all federal, state, or private activities and the anticipated impacts of all proposed federal actions that have already undergone Section 7 consultation. In the context of offshore wind development, past and present impacts in the action area are limited to the effects of pre-construction surveys to support site characterization, site assessment, and data collection to support the development of Construction and Operations Plans (COPs). To date, we have not completed section 7 consultation to consider the effects of construction, operation, and decommissioning of any other commercial scale offshore wind project in the New Jersey Wind Energy Area. We have completed consultation on four projects along the Atlantic coast: Vineyard Wind 1, South Fork, Block Island Wind, and Dominions' Coastal Virginia Offshore Demonstration Project. The Vineyard Wind 1 and South Fork projects are in the construction phase while the other two are in the operations and maintenance phase.

Site Assessment, Site Characterization, and Surveys

A number of geotechnical and geophysical surveys to support wind farm siting have occurred and will continue to occur in the action area. Additionally, data collection buoys have been installed. Effects of these activities on ESA listed species in the action area are related to potential exposure to noise associated with survey equipment, survey vessels, and habitat impacts. Given the characteristics of the noise associated with survey equipment and the use of best management practices to limit exposure of listed species, including protected species observers, effects of survey noise on listed species have been determined to be extremely unlikely or insignificant. There is no information that indicates that the noise sources used for these surveys has the potential to result in injury, including hearing impairment, or mortality of any ESA listed species in the action area. Similarly, we have not anticipated any adverse effects to habitats or prey and do not anticipate any ESA listed species to be struck by survey vessels; risk is reduced by the slow speeds that survey vessels operate at, the use of lookouts, and incorporation of vessel strike avoidance measures.

Surveys to obtain data on fisheries resources have been undertaken in the larger action area to support OSW development. Some gear types used, including gillnet, trawl, and trap/pot, can entangle or capture ESA listed sea turtles, fish, and whales. Risk can be reduced through avoiding certain times/areas, minimizing soak and tow times, and using gear designed to limit entanglement or reduce the potential for serious injury or mortality.

Consideration of Construction, Operation, and Decommissioning of Other OSW Projects

We have completed ESA consultation for four OSW projects to date. Complete information on the assessment of effects of these three projects is found in their respective Biological Opinions (NMFS 2021a, NMFS 2021b, NMFS 2016, and NMFS 2014). It is possible that Ocean Wind 1 project vessels transiting to/from Norfolk may transit near the CVOW project. The Block Island, South Fork, and Vineyard Wind 1 lease areas and the geographic areas that may be affected by their project operations are outside of the Ocean Wind 1 action area. Also, the geographic extent of noise during construction of the Vineyard Wind 1 and South Fork projects will not extend into the Ocean Wind 1 lease area. The only portion of the South Fork and Vineyard Wind 1 action areas that overlap with the Ocean Wind 1 action area is a portion of the vessel transit routes. For South Fork, this includes vessel transit routes to ports in the U.S. Mid-Atlantic and the Gulf of Mexico as well as Europe; for Vineyard Wind 1, this is only vessel trips to Europe. In the Opinions for the South Fork and Vineyard Wind 1 projects, we did not anticipate any ESA listed species would be struck by vessels transiting to/from ports in Europe. In the South Fork Opinion, we did not anticipate that vessels transiting to ports in the U.S. Mid-Atlantic or the Gulf of Mexico would strike any ESA listed species.

Other Activities in the Action Area

Other activities that occur in the action area that may affect listed species include scientific research and geophysical and geotechnical surveys. Military operations in the action area are expected to be restricted to vessel transits, the effects of which are subsumed in the discussion of vessel strikes above.

Scientific Surveys

Numerous scientific surveys, including fisheries and ecosystem surveys carried out by NMFS operate in the action area. Regulations issued to implement section 10(a) (1)(A) of the ESA allow issuance of permits authorizing take of ESA-listed species for the purposes of scientific research. Prior to the issuance of such a permit, an ESA section 7 consultation must take place. No permit can be issued unless the proposed research is determined to be not likely to jeopardize the continued existence of any listed species. Scientific research permits are issued by NMFS for ESA listed whales and Atlantic sturgeon; the U.S. Fish and Wildlife Service is the permitting authority for ESA listed sea turtles.

Marine mammals, sea turtles, and Atlantic sturgeon have been the subject of field studies for decades. The primary objective of most of these field studies has generally been monitoring populations or gathering data for behavioral and ecological studies. Research on ESA listed whales, sea turtles, and Atlantic sturgeon has occurred in the action area in the past and is expected to continue over the life of the proposed action. Authorized research on ESA-listed whales includes close vessel and aerial approaches, photographic identification, photogrammetry, biopsy sampling, tagging, ultrasound, exposure to acoustic activities, breath sampling, behavioral observations, passive acoustic recording, and underwater observation. No lethal interactions are anticipated in association with any of the permitted research. ESA-listed sea turtle research includes approach, capture, handling, restraint, tagging, biopsy, blood or tissue sampling, lavage, ultrasound, imaging, antibiotic (tetracycline) injections, laparoscopy, and captive experiments. Most authorized take is sub-lethal with limited amounts of incidental mortality authorized in some permits (i.e., no more than one or two incidents per permit and only a few individuals overall). Authorized research for Atlantic sturgeon includes capture, collection, handling, restraint, internal and external tagging, blood or tissue sampling, gastric lavage, and collection of morphometric information. Most authorized take of Atlantic sturgeon for research activities is sub-lethal with small amounts of incidental mortality authorized (i.e., no more than one or two incidents per permit and only a few individuals overall).

Noise
The ESA-listed species that occur in the action area are regularly exposed to several sources of anthropogenic sounds in the action area. The major source of anthropogenic noise in the action area are vessels. Other sources are minor and temporary including short-term dredging, construction, and research activities. As described in the DEIS, typically, military training exercises occur in deeper offshore waters southeast of the lease area, though transit of military vessels may occur throughout the area; therefore, while military operations can be a significant source of underwater noise that is not the case in the action area. ESA-listed species may be impacted by either increased levels of anthropogenic-induced background sound or high intensity, short- term anthropogenic sounds.

The Ocean Wind WDA lies within a dynamic ambient noise environment, with natural background noise contributed by natural wind and wave action, a diverse community of vocalizing cetaceans, and other organisms. Anthropogenic noise sources, including commercial shipping traffic in high-use shipping lanes in proximity to the action area, also contribute ambient sound. While no ambient underwater noise measurements have been collected specifically for the Project area, Kraus et al. (2016) surveyed the ambient underwater noise environment in the RI/MA WEA, north of the WDA, as part of a broader study of large whale and sea turtle use of marine habitats in this wind energy development area. Acoustic monitoring sensor locations in and around the RI/MA WEA had water depths ranging from approximately 98 to 197 feet (30 to 60 meters), similar to the Project area, where water depths vary from 43 to 112 feet (13 to 34 meters). Figure 12 (in Kraus et al. 2016) displays 50th percentile power spectral density and cumulative percentile distribution of peak ambient sound levels measured between November 2011 and March 2015. Depending on location, ambient underwater sound levels within the RI/MA WEA varied from 96 to 103 dB in the 70.8- to 224-Hz frequency band at least 50% of the recording time, with peak ambient noise levels reaching as high as 125 dB in proximity to the Narraganset Bay and Buzzards Bay shipping lanes (Kraus et al. 2016). Low-frequency sound from large marine vessel traffic in these and other major shipping lanes to the east (Boston Harbor) and south (New York) were the dominant sources of underwater noise in the RI/MA WEA.

Short term increases in noise in the action area associated with vessel traffic and other activities, including geotechnical and geophysical surveys that have taken place in the past and will continue in the future in the portions of the action area that overlap with other offshore wind lease areas and/or potential cable routes. Exposure to these noise sources can result in temporary masking or temporary behavioral disturbance; however, in all cases, these effects are expected to be temporary and short term (e.g., the seconds to minutes it takes for a vessel to pass by) and not result in any injury or mortality in the action area. No acoustic surveys using seismic equipment or airguns have been proposed in the action area and none are anticipated to take place in the future, as that equipment is not necessary to support siting of future offshore wind development that is anticipated to occur in the action area. Noise associated with oil and gas exploration is addressed below.

Other Factors
Whales, sea turtles, and Atlantic sturgeon are exposed to a number of other stressors in the action area that are widespread and not unique to the action area which makes it difficult to determine

to what extent these species may be affected by past, present, and future exposure within the action area. These stressors include water quality and marine debris. Marine debris in some form is present in nearly all parts of the world's oceans, including the action area. While the action area is not known to aggregate marine debris as occurs in some parts of the world (e.g., The Great Pacific garbage patch, also described as the Pacific trash vortex, a gyre of marine debris particles in the north central Pacific Ocean), marine debris, including plastics that can be ingested and cause health problems in whales and sea turtles is expected to occur in the action area.

The Ocean Wind WFA and offshore export cables are located in offshore marine waters where available water quality data are limited. Broadly speaking, ambient water quality in these areas is expected to be generally representative of the regional ocean environment and subject to constant oceanic circulation that disperses, dilutes, and biodegrades anthropogenic pollutants from upland and shoreline sources (BOEM 2013).

A portion of the offshore export cable corridor is located in coastal New Jersey waters. The NJDEP conducts annual assessments of the state's waterways for water quality parameters. Five sampling sites within Barnegat Bay were in non-attainment for turbidity and considered impaired for this parameter as defined under the Clean Water Act Section 303(d) program. Water quality in Manahawkin Bay, Upper Little Egg Harbor, and Lower Little Egg Harbor Bay was designated as fully supporting recreation and shellfish but not supporting wildlife, due, in part, to increased turbidity (Ocean Wind 2022).

Ocean waters beyond 3 miles (4.8 km) offshore typically have low concentrations of suspended particles and low turbidity. Waters along the Northeast Coast average 5.6 milligrams per liter (mg/L) of TSS, which is considered low. There are notable exceptions, including estuaries that average 27.4 mg/L, although TSS sampling throughout nine assessment units in and around Barnegat Bay did not record TSS levels above 16 mg/L (EPA 2012; Ocean Wind 2022). While most ocean waters had TSS concentrations under 10 mg/L, which is the 90th percentile of all measured values, most estuarine waters (65.7% of the Northeast Coast area) had TSS concentrations above this level. Near-bottom TSS concentrations were similar to those near the water surface, averaging 6.9 mg/L. With the exception of the entrance to Delaware Bay, all other coastal ocean stations had near-bottom levels of TSS less than or equal to 16.3 mg/L (EPA 2012).

A study conducted by the EPA evaluated over 1,100 coastal locations in 2010, as reported in their National Coastal Condition Assessment (EPA, 2015). The EPA used a Water Quality Index (WQI) to determine the quality of various coastal areas including the northeast coast from Virginia to Maine and assigned three condition levels for a number of constituents: good, fair, and poor. A number of the sample locations overlap with the action area. Chlorophyll a concentrations, an indicator of primary productivity, levels in northeastern coastal waters were generally rated as fair (45%) to good (51%) condition, and stations in the action area were all also fair to good (EPA, 2015). Nitrogen and phosphorous levels in northeastern coastal waters generally rated as fair to good (13% fair and 82% good for nitrogen and 62% and 26% good for phosphorous); stations in the action area were all also fair to good (EPA 2015). Dissolved oxygen levels in northeastern coastal waters are generally rated as fair (14%) to good (80%)

condition, with consistent results for the sampling locations in the action area. Based on the available information, water quality in the action area appears to be consistent with surrounding areas. We are not aware of any discharges to the action area that would be expected to result in adverse effects to listed species or their prey. Outside of conditions related to climate change, discussed in section 7.10, water quality is not anticipated to negatively affect negative listed species that may occur in the action area.

7.0 EFFECTS OF THE ACTION

This section of the biological opinion assesses the effects of the proposed action on threatened or endangered species. Effects of the action are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (50 CFR §402.02 and § 402.17).

The main proposed action is BOEM's proposed COP approval with conditions, the effects of which will be analyzed in this section. The effects of the issuance of other permits and authorizations that are consequences of BOEM's proposed action are also evaluated in this section. For example, the ITA proposed by NMFS OPR to authorize incidental take of ESA-listed marine mammals under the MMPA and other permits proposed to be issued by USACE and EPA are considered effects of the action as they are consequences of BOEM's proposal to approve Ocean Wind's COP with conditions. In addition, the ITA proposed by NMFS OPR, as well as permits proposed by USACE and EPA, are also Federal actions that may affect ESA-listed species; therefore, they require Section 7 consultation in their own right. In this consultation, we have worked with NMFS OPR as the action agency proposing to authorize marine mammal takes under the MMPA through the ITA, as well as with other Federal action agencies aside from BOEM that are proposing to issue permits or other approvals, and we have analyzed the effects of those actions along with the effects of BOEM's proposed action to approve the COP with conditions. All effects of these collective actions on ESA-listed species and designated critical habitat are, therefore, comprehensively analyzed in this Opinion.[28]

The purpose of the Ocean Wind 1 project is to generate electricity. Electricity will travel from the WTGs to the OSSs and then by submarine cable to on-land cables in New Jersey. As described in the COP, from this point, electricity generated at the WTGs would be distributed to the regional electric transmission system operated by PJM Interconnection L.L.C. Power from the project is expected to displace the need to construct new fossil-fuel fired plants or transmission facilities and to compensate for the loss of electrical generation at the recently closed Oyster Creek nuclear facility and the BL England coal plant. All of the electricity generated will support existing uses.

Even if we assume the Ocean Wind 1 project will increase overall supply of electricity, we are not aware of any new actions demanding electricity that would not be developed but for the

[28] The term "proposed action" or "action" may be used to refer to all action agencies' actions related to the Ocean Wind 1 project, unless specific context reveals otherwise.

Ocean Wind 1 project specifically. Because the electricity generated by Ocean Wind 1 will be pooled with that of other sources in the power grid, we are unable to trace any particular new use of electricity to Ocean Wind's contribution to the grid and, therefore, we cannot identify any impacts, positive or negative, that would occur because of the Ocean Wind project's supply of electricity to the grid. As a result, there are no identifiable consequences of the proposed action analyzed in this Opinion that would not occur but for Ocean Wind's production of electricity and are reasonably certain to occur.

Here, we examine the activities associated with the proposed action and determine what the consequences of the proposed action are to listed species or critical habitat. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. In analyzing effects, we evaluate whether a source of impacts is "likely to adversely affect" listed species/critical habitat or "not likely to adversely affect" listed species/critical habitat. A "not likely to adversely affect" determination is appropriate when an effect is expected to be discountable, insignificant, or completely beneficial. As discussed in the FWS-NMFS Joint Section 7 Consultation Handbook (1998), "[b]eneficial effects are contemporaneous positive effects without any adverse effects to the species. Insignificant effects relate to the size of the impact and should never reach the scale where take occurs. Discountable effects are those extremely unlikely to occur. Based on best judgment, a person would not: (1) be able to meaningfully measure, detect, or evaluate insignificant effects; or (2) expect discountable effects to occur. If an effect is beneficial, discountable, or insignificant it is not considered adverse and thus cannot cause "take" of any listed species. "Take" means "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in any such conduct" (ESA §3(19)).

7.1 Underwater Noise

In this section, we provide background information on underwater noise and how it affects listed species, establish the underwater noise that listed species are likely to be exposed to, and then establish the expected response of the individuals exposed to that noise. This analysis considers all phases of the proposed action inclusive of construction, operations, and decommissioning.

7.1.1 Background on Noise

This section contains a brief technical background on sound, the characteristics of certain sound types, and metrics used in this consultation inasmuch as the information is relevant to the specified activity and to consideration of the potential effects of the specified activity on listed species found later in this document.

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

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

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

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

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

The sum of the various natural and anthropogenic sound sources that comprise ambient sound at any given location and time depends not only on the source levels (as determined by current weather conditions and levels of biological and human activity) but also on the ability of sound to propagate through the environment. In turn, sound propagation is dependent on the spatially and temporally varying properties of the water column and sea floor, and is frequency-dependent. As a result of the dependence on a large number of varying factors, ambient sound levels can be expected to vary widely over both coarse and fine spatial and temporal scales. Sound levels at a given frequency and location can vary by 10-20 decibels (dB) from day to day (Richardson *et al*., 1995). The result is that, depending on the source type and its intensity, sound from the specified activity may be a negligible addition to the local environment or could form a distinctive signal that may affect a particular species. As described in the BA, the Ocean Wind Development Area (WDA) lies within a dynamic ambient noise environment, with natural background noise contributed by natural wind and wave action, a diverse community of vocalizing cetaceans, and other organisms. Anthropogenic noise sources, including commercial shipping traffic in high-use shipping lanes in proximity to the Action Area, also contribute ambient sound.

Sounds are often considered to fall into one of two general types: pulsed and non-pulsed. The distinction between these two sound types is important because they have differing potential to cause physical effects, particularly with regard to hearing (*e.g.*, Ward, 1997 in Southall *et al*., 2007). Non-impulsive sounds can be tonal, narrowband, or broadband, brief or prolonged, and may be either continuous or intermittent (ANSI, 1995; NIOSH, 1998).

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

Non-pulsed sounds can be tonal, narrowband, or broadband, brief or prolonged, and may be either continuous or intermittent (ANSI, 1995; NIOSH, 1998). Some of these non-pulsed sounds can be transient signals of short duration but without the essential properties of pulses (*e.g.*, rapid rise time). Examples of non-pulsed sounds include those produced by vessels, aircraft, drilling or dredging, and vibratory pile driving.

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

7.1.2 Summary of Available Information on Sources of Increased Underwater Noise

During the construction phase of the project, sources of increased underwater noise include pile driving, vessel operations, and other underwater construction activities (cable laying, placement of scour protection) as well as HRG surveys. During the operations and maintenance phase of the project, sources of increased underwater noise are limited to WTG operations, vessel operations, and maintenance activities including occasional HRG surveys. During decommissioning, sources of increased underwater noise include removal of project components and associated surveys, as well as vessel operations. Here, we present a summary of available information on these noise sources. More detailed information is presented in the acoustic reports produced for the project (Küsel et al. 2022; Appendix R2, dated February 23, 2022), Ocean Wind's Application for an ITA and Revised Density and Take Estimate Memo[29], the Proposed Rule prepared for the ITA (87 FR 64868; October 26, 2022), and BOEM's BA.

Impact Pile Driving for Foundations

Impact pile driving for the Project involves two pile types: monopiles and pin piles. For the WTGs, a single vertical hollow steel monopile (26.2 feet [8 meters] in diameter at top, 36.1 feet [11 meters] in diameter at seafloor) with a 4-inch (10.3 cm) wall thickness will be installed for each location using an impact hammer (IHC-4000 kilojoule impact hammer or similar) to an expected penetration depth of 164 feet (50 meters). Installation of a single monopile is expected to take 9 hours (1 hour pre-clearance period, 4 hours for pile driving (based on the total number of strikes and strike/minutes, see Table 7.1.1), and 4 hours moving to the next location). Up to two monopiles are expected to be installed per 24-hour period. For the three offshore substations (OSS), a piled jacket or monopile foundation may be installed. A piled jacket would involve installing 52.5- by 8.0-foot (16 by 2.44-meter) diameter piles as a foundation for each OSS foundation using an impact hammer (IHC-S-2500 kilojoule impact hammer or similar) to an expected penetration depth of 230 feet (70 meters). Alternatively, a single monopile like the ones used for WTGs may be used for each OSS. Each pin pile takes approximately 4 hours of impact pile driving to install. A maximum of three pin piles will be installed per day, and installation of a single OSS foundation is expected to take 6 days.

A total of 98 monopiles will be installed for WTGs, and 48 pin piles (or three monopiles) would be installed for OSS, constituting about 584 hours of active pile driving (404 if monopiles are used, assuming OSS monopile installation is identical to that for WTGs) to install a total of up to 101 foundations. For installation of both the WTG and OSS monopile foundations, installation of more than one pile at a time (i.e., concurrent pile driving) is not planned or anticipated to occur. Therefore, the effects of concurrent pile driving are outside the scope of this Opinion. Reinitiation of consultation due to either a change in the action or new information may be appropriate if concurrent pile driving is considered in the future.

Two impact pile driving installation scenarios were modeled:

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[29] Available at: https://www.fisheries.noaa.gov/action/incidental-take-authorization-ocean-wind-lcc-construction-ocean-wind-1-wind-energy-facility; last accessed March 11, 2022.

1) Full monopile foundation scenario (see Table 1-7 in the Ocean Wind 1 ITA application) where there are 101 monopile foundations for the 98 WTGs and 3 OSSs; and,
2) A joint-monopile and jacket foundation scenario (see Table 1-15 in the Ocean Wind 1 ITA application) where there are 98 monopile foundations for WTGs and 3 pin-pile foundations for the three OSSs.

Representative hammering schedules of increasing hammer energy with increasing penetration depth were modeled, resulting in generally higher intensity sound fields as the hammer energy and penetration increases (Table 7.1.1).

Table 7.1.1. Estimated Impact Hammer Energy Schedules For Monopiles and Pin Piles.

Monopile foundations (8/11-m)			**Jacket Foundations (Pin piles; 2.44-m)**		
Hammer: IHC S-4000			Hammer: IHC S-2500		
Energy Level (kJ)[1]	Strike Count	Pile Penetration Depth (m)	Energy Level (kJ)	Strike Count	Pile Penetration Depth
500	763	7	500	554	3
2,000	980	6	200	5,373	29
1,000	375	3	750	1,402	8
3,000	385	2	1,000	1,604	8
4,000	5,006	16	1,500	1,310	6
3,000	1,135	6	2,500	1,026	6
4,000	2,202	10	1,500	1,922	10
Total:	10,846	50	Total:	13,191	70

For purposes of the modeling, monopiles and pin piles were assumed to be vertically aligned and driven to a maximum depth of 50 m for monopiles and 70 m for pin piles. While pile penetration depths may vary slightly, as described in the Notice of Proposed ITA, these values were chosen as reasonable penetration depths during modeling. All acoustic modeling was performed assuming that no concurrent pile driving of either monopiles or pin piles would occur. While multiple piles may be driven within any single 24-hour period, these installation activities would not occur simultaneously.

Modeling assumptions for the project are as follows:

- Two monopiles installed per day (4 hours per monopile with a 1 hour pre-clearance period; 9 hours of total with 8 hours of active pile driving time), although only one monopile may be installed on some days;

- No concurrent monopile and/or pin pile driving would occur;
- Monopiles would be 80 millimeters (mm) thick and consist of steel;
- Impact Pile driving: IHC S-4000 or IHC S-2500 kJ rated energy; 1,977.151 kilonewton (kN) ram weight);
- Helmet weight: 3,776.9 kN;
- Impact hammers would have a maximum power capacity of 6,000 kilowatts (KW).
- Up to three pin piles installed per day
- Pin piles would be 75 mm thick;
- Impact pile driving: IHC S-2,500 kJ rated energy; 1,227.32 kN ram weight);
- Helmet weight: 279 kN.

Ocean Wind is proposing to employ noise abatement systems, also known as noise mitigation systems (NMS), during all impact pile driving (monopiles and pin piles) to reduce the sound pressure levels that are transmitted through the water in an effort to reduce ranges to acoustic thresholds and minimize any acoustic impacts resulting from pile driving. Ocean Wind is proposing, and BOEM proposes to require through conditions of COP approval, the use of a noise attenuation system designed to minimize the sound radiated from piles by 10 dB. This requirement will be in place for all foundation piles to be installed. The noise mitigation system would be a combination of two devices that function together as a system to reduce noise propagation. The noise mitigation system ultimately selected for the Project would be tailored to and optimized for site-specific conditions, but the exact system to be used is not specified at this time. As noted below, this requirement is also in the proposed MMPA ITA; NMFS OPR is proposing that Ocean Wind must use a big bubble curtain (BBC), a hydro-sound damper (HSD), or an AdBm Helmholz resonator (Elzinga *et al.,* 2019). If a single system is used, it must be a double big bubble curtain (DBBC).

Bubbles create a local impedance change that acts as a barrier to sound transmission. The size of the bubbles determines their effective frequency band, with larger bubbles needed for lower frequencies. There are a variety of bubble curtain systems, confined or unconfined bubbles, and some with encapsulated bubbles or panels. Attenuation levels also vary by type of system, frequency band, and location. As described in the ITA proposed rule, if a bubble curtain is used (single or double), Orsted would be required to maintain the following operational parameters: The bubble curtain(s) must distribute air bubbles using a target air flow rate of at least 0.5 m^3 /(min*m), and must distribute bubbles around 100 percent of the piling perimeter for the full depth of the water column. The lowest bubble ring must be in contact with the seafloor for the full circumference of the ring, and the weights attached to the bottom ring must ensure 100-percent seafloor contact; no parts of the ring or other objects should prevent full seafloor contact. Ocean Wind must require that construction contractors train personnel in the proper balancing of airflow to the bubble ring, and must require that construction contractors submit an inspection/performance report for approval by Ocean Wind within 72 hours following the performance test. Corrections to the attenuation device to meet the performance standards must occur prior to impact driving of monopiles. If Ocean Wind uses a noise mitigation device in addition to a BBC, similar quality control measures will be required.

As described in the BA, BOEM considers an attenuation level of 10 dB achievable using a joint mitigation approach of a bubble curtain and another noise abatement system. Based on our independent review of the available information, we agree with that determination. It is also consistent with the findings in the Notice of Proposed ITA. Bellmann et al. (2020) found three noise abatement systems to have proven effectiveness and 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. *In situ* measurements during installation of large monopiles (approximately 8 m) for more than 150 WTGs in comparable water depths (greater than 25 m) and conditions in Europe indicate that attenuation levels of 10 dB are readily achieved (Bellmann, 2019; Bellmann *et al.*, 2020) using single BBCs as a noise abatement system. The Coastal Virginia Offshore Wind (CVOW) pilot project systematically measured noise resulting from the impact driven installation of two 7.8 m monopiles, one with a noise abatement system (double big bubble curtain (dBBC)) and one without (CVOW, unpublished data). Although many factors contributed to variability in received levels throughout the installation of the piles (*e.g.*, hammer energy, technical challenges during operation of the dBBC), reduction in broadband SEL using the dBBC (comparing measurements derived from the mitigated and the unmitigated monopiles) ranged from approximately 9 to 15 dB. The effectiveness of the dBBC as a noise mitigation measure was found to be frequency dependent, reaching a maximum around 1 kHz; this finding is consistent with other studies (*e.g.*, Bellman, 2014; Bellman *et al*., 2020).

As described in section 3.0 of this Opinion, in addition to seasonal restrictions on impact pile driving and requirements for use of a noise attenuation system, there are a number of other measures included as part of the proposed action that are designed to avoid or minimize exposure of ESA listed species to underwater noise. These measures are discussed in detail in the Effects Analysis below but generally include requirements for clearance and shutdown zones and time of day restrictions to ensure adequate visibility. At this time, BOEM is only proposing to authorize pile driving, and NMFS OPR is only proposing to authorize marine mammal takes from pile driving, that is initiated no more than 1 hour before civil sunrise and no later than 1.5 hours before civil sunset. These restrictions are to ensure that there is adequate daylight to allow for PSOs to visually monitor the clearance and shutdown zones. BOEM is proposing to condition the COP approval such that pile driving could be initiated outside of this window only if Ocean Wind can demonstrate through an Alternative Monitoring Plan (AMP) that their night vision devices (*e.g.*, mounted thermal/IR camera systems, hand-held or wearable night vision devices (NVDs), infrared (IR) spotlights) are proven to be able to detect sea turtles and protected marine mammals to the full extent of the established clearance and shutdown zones. NMFS OPR proposes to mirror this condition in its ITA for marine mammal take. If the plan does not include a full description of the proposed technology, monitoring methodology, and data supporting a determination that sea turtles and marine mammals can be reliably and effectively detected within the clearance and shutdown zones before and during impact pile driving, then nighttime pile driving will not be allowed (unless a pile was initiated 1.5 hours prior to civil sunset). The AMP will need to identify the efficacy of the technology at detecting sea turtles and marine mammals in the clearance and shutdowns under all the various conditions anticipated during construction, including varying weather conditions, sea states, and in consideration of the use of artificial lighting. The proposed conditions of COP approval and the MMPA ITA require both BOEM and NMFS approval of the AMP before any pile driving could be carried out outside the time of day requirements outlined here. Based on the requirement that the AMP will need to demonstrate the ability to detect sea turtles and large whales to the full extent of the established clearance and shutdown zones, we expect that it will need to demonstrate an ability for visual PSOs to reliably detect sea turtles at a distance of 500 m from the pile to be installed and for visual PSOs to reliably detect large whales throughout the minimum visibility zone (1,650 m May – November and 2,500 m in December).

Vibratory Pile Driving
The proposed action includes installation of up to seven temporary cofferdams at four locations to connect the cables to shore:

1. Oyster Creek horizontal directional drilling (HDD), two cofferdams (Atlantic Ocean to Island Beach State Park; sea-to-shore);
2. Island Beach State Park Barnegat Bay HDD, two cofferdams (Barnegat Bay onshore; bay-to-shore);
3. Farm Property HDD, two cofferdams (bayside of Oyster Creek; shore-to-bay); and
4. BL England HDD, one cofferdam (sea-to-shore).

The cofferdams may be installed either as sheet pile structures driven into the seafloor or a gravity cell structure placed on the floor using ballast weight. Installation and removal of sheet piles would require the use of a vibratory hammer/extractor. Cofferdam installation would primarily occur between October through March, although some removal of cofferdams may occur during the months of April or May. Installation of each cofferdam would require a maximum of 12 hours via vibratory driving while removal using a vibratory extractor would require 18 hours. All seven cofferdams would necessitate two days for installation and two days for removal (four days total) with only 12 hours of vibratory removal occurring per day. Installation and removal may occur over a total of 28 non-consecutive days. Ocean Wind has determined a source level of 165 dB re 1mPa for installation. Ocean Wind did not separately analyze the removal of the cofferdams using a vibratory extractor but has assumed that the removal would be acoustically comparable to the installation. Based on available pile driving data (Caltrans, 2020), this is a conservative, yet reasonable, assumption.

UXO Detonations
During construction, Ocean Wind may encounter Unexploded Ordnance/Munitions and Explosives of Concern (UXO/MEC) on the seabed in the Lease Area and along export cable routes. These include explosive munitions such as bombs, shells, mines, torpedoes, etc., that did not explode when they were originally deployed or were intentionally discarded to avoid land-based detonations. While avoidance is the preferred approach for UXO/MEC mitigation, BOEM and Ocean Wind indicate there may be instances when confirmed UXO/MEC avoidance is not possible due to layout restrictions, presence of archaeological resources, or other factors that preclude micro-siting. In such situations, confirmed UXO/MEC may be removed through physical relocation or *in situ* disposal. In situ disposal of the UXO/MEC could include low-order methods (deflagration) or high-order removal (detonation), or cutting the UXO/MEC up to extract the explosive components.

BOEM and Ocean Wind are currently assuming that up to 10 UXOs with 454-kg (1,000 pounds) charges, which is the largest charge that is reasonably expected to be present, may have to be detonated in place. The proposed action considered here includes detonation of no more than 10 UXOs. As described by BOEM, Ocean Wind, and NMFS OPR, although it is highly unlikely that all ten charges would consist of this 454 kg charge, it was determined to be the most reasonably conservative assumption to adopt when analyzing the potential effects of the activity. If necessary, these detonations would occur on up to 10 different days (*i.e.*, only one detonation would occur per day). In the event that high-order removal (detonation) is determined to be the preferred and safest method of disposal, all detonations would occur during daylight hours. Time of year restrictions that are proposed for COP approval and/or the proposed MMPA ITA will limit detonations to only occur between May 1 and December 31 in state waters (i.e., along the cable corridor within 3 nm of the New Jersey coast) and between May 1 and October 31 in federal waters (i.e., along the cable corridor beyond 3 nm of the New Jersey coast and within the lease area).

Ocean Wind conducted modeling of acoustic fields for UXO detonations, which included three sound pressure metrics (peak pressure level, SEL, and acoustic impulse), four different depths at four different sites, and five charge weight bins ranging from 5 pounds (2.3 kg) (bin E4) up to 1,000 pounds (454 kg) (bin E12). The depths were selected to be representative of the lease area and cable route and ranged from 39 to 148 feet (12 to 45 meters). The modeling of acoustic fields was performed using a combination of semi-empirical and physics-based computational models. The modeling assumed that the full weights of UXO explosive charges are detonated together with their donor charges and that no shielding by sediments occurs. It also assumed that only one UXO would be detonated within a 24-hour period. Modeling of mitigated (10 dB attenuation) and unmitigated scenarios were conducted; however, mitigation will be required for all detonation events (10 dB attenuation will be required as a condition of COP approval and the proposed MMPA ITA). The locations for the modeling presented in Hannay and Zykov (2022) were selected to be representative of three projects. The specific locations modeled were chosen inside the Revolution Wind project area off the coast of Massachusetts. The key influencing parameter for these results is water depth; however, small variances of water depth (<33 feet [10 meters]) are not expected to generate significant differences to the sound fields, so BOEM and NMFS OPR determined that the propagation results will be relevant for each project area, including Ocean Wind, at sites with similar water depth as the sites modeled.

Ocean Wind is committing to the use of a dual noise-mitigation system during all detonations. Based on previous experience, 10 dB minimum of attenuation is possible with the use of a noise mitigation system (review provided in Hannay and Zykov 2022), and Ocean Wind has committed to attaining a 10 dB attenuation for all UXO detonation events. As described in section 3.0 of this Opinion, in addition to seasonal and time of day restrictions as well as requirements for use of a noise attenuation system, there are a number of other measures included as part of the proposed action that are designed to avoid or minimize exposure of ESA listed species to UXO detonations, including clearance and shutdown zones. These are discussed in detail in the Effects Analysis below.

Vessel Noise

Vessel noise is considered a continuous noise source that will occur intermittently. Vessels transmit noise through water primarily through propeller cavitation, although other ancillary noises may be produced. The intensity of noise from vessels is roughly related to ship size and speed. Large ships tend to be noisier than small ones, and ships underway with a full load (or towing or pushing a load) produce more noise than unladen vessels. Radiated noise from ships varies depending on the nature, size, and speed of the ship. McKenna et al. (2012b) determined that container ships produced broadband source levels around 177 to 188 dB re 1 μPa and a typical fishing vessel radiates noise at a source level of about 158 dB re 1 μPa (Mintz and Filadelfo 2011c; Richardson et al. 1995b; Urick 1983b). Noise levels generated by larger construction and installation and O&M would have an approximate *L*rms source level of 170 dB re 1 μPa-m (Denes et al. 2020). Smaller construction and installation and O&M vessels, such as CTVs, are expected to have source levels of approximately 160 dB re 1 μPa-m, based on observed noise levels generated by working commercial vessels of similar size and class (Kipple and Gabriele 2003; Takahashi et al. 2019).

Typical large vessel ship-radiated noise is dominated by tonals related to blade and shaft sources at frequencies below about 50 Hz and by broadband components related to cavitation and flow noise at higher frequencies (approximately around the one-third octave band centered at 100 Hz) (Mintz and Filadelfo 2011c; Richardson et al. 1995b; Urick 1983b). The acoustic signature produced by a vessel varies based on the type of vessel (e.g., tanker, bulk carrier, tug, container ship) and vessel characteristics (e.g., engine specifications, propeller dimensions and number, length, draft, hull shape, gross tonnage, speed). Bulk carrier noise is predominantly near 100 Hz while container ship and tanker noise is predominantly below 40 Hz (McKenna et al. 2012b). Small craft types will emit higher-frequency noise (between 1 kHz and 50 kHz) than larger ships (below 1 kHz). Large shipping vessels and tankers produce lower frequency noise with a primary energy near 40 Hz and underwater SLs for these commercial vessels generally range from 177 to 188 decibels referenced to 1 micropascal at 1 meter (dB re 1 μPa m) (McKenna et al., 2012). Smaller vessels typically produce higher frequency sound (1,000 to 5,000 Hz) at SLs of 150 to 180 dB re 1 μPa m (Kipple and Gabriele, 2003; Kipple and Gabriele, 2004).

As part of various construction related activities, including cable laying and construction material delivery, dynamic positioning thrusters may be utilized to hold vessels in position or move slowly. Sound produced through use of dynamic positioning thrusters is similar to that produced by transiting vessels, and dynamic positioning thrusters are typically operated either in a similarly predictable manner or used for short durations around stationary activities. Dynamically positioned (DP) vessels use thrusters to maneuver and maintain station, and generate substantial underwater noise with apparent SLs ranging from SPL 150 to 180 dB re 1 μPa depending on operations and thruster use (BOEM 2014, McPherson et al., 2016). Acoustic propagation modeling calculations for DP vessel operations were completed by JASCO Applied Sciences, Inc. for two representative locations for pile foundation construction at the South Fork Wind Farm SFWF based on a 107 m DP vessel equipped with six thrusters (Denes et al., 2021a). Unweighted root-mean square sound pressure levels (SPLrms) ranged from 166 dB re one μPa at 50 m from the vessel (CSA 2021). Noise from vessels used for the Ocean Wind project are expected to be similar in frequency and source level.

Cable Installation
Noise produced during cable laying includes dynamic positioning (DP) thruster use. Nedwell et al. (2003) reports a sound source level for cable trenching operations in the marine environment of 178 dB re 1µPa at a distance of 1m from the source. Hale (2018) reports on unpublished information for cable jetting operations indicating a comparable sound source level, concentrated in the frequency range of 1 kHz to 15 kHz and notes that the sounds of cable burial were attributed to cavitation bubbles as the water jets passed through the leading edge of the burial plow.

WTG Operations
As described in BOEM's BA, once operational, offshore wind turbines produce continuous, non-impulsive underwater noise, primarily in the lower-frequency bands (below 1 kHz; Thomsen et al. 2006); vibrations from the WTG drivetrain and power generator would be transmitted into the steel monopile foundation generating underwater noise. Most of the currently available information on operational noise from turbines is based on monitoring of existing windfarms in Europe. Although useful for characterizing the general range of WTG operational noise effects, this information is drawn from studies of older generation WTGs that operate with gearboxes and is not necessarily representative of current generation direct-drive systems (Elliot et al. 2019; Tougaard et al. 2020). Studies indicate that the typical noise levels produced by older-generation WTGs with gearboxes range from 110 to 130 dB RMS with 1/3-octave bands in the 12.5- to 500-Hz range, sometimes louder under extreme operating conditions such as higher wind conditions (Betke et al. 2004; Jansen and de Jong 2016; Madsen et al. 2006; Marmo et al. 2013; Nedwell and Howell 2004; Tougaard et al. 2009). Operational noise increases concurrently with ambient noise (from wind and waves), meaning that noise levels usually remain indistinguishable from background within a short distance from the source under typical operating conditions.

Tougaard et al. (2020) concluded that operational noise from multiple WTGs could elevate noise levels within a few kilometers of large windfarm operations under very low ambient noise conditions. Tougaard et al. (2020) caution that their analysis is based on monitoring data for older generation WTG designs that are not necessarily representative of the noise levels produced by modern direct-drive systems, which are considerably quieter. However, even with these louder systems, Tougaard further stated that the operational noise produced from WTGs is static in nature and is lower than noise produced from passing ships; operational noise levels are likely lower than those ambient levels already present in active shipping lanes, meaning that any operational noise levels would likely only be detected at a very close proximity to the WTG (Thomsen et al., 2006; Tougaard et al., 2020).

Stober and Thomsen (2021) summarized data on operational noise from offshore wind farms with 0.45 – 6.15 MW turbines based on published measurements and simulations from gray literature then used modeling to predict underwater operational noise levels associated with a theoretical 10 MW turbine. Using generic transmission loss calculations, they then predicted distances to various noise levels including 120 dB re 1uPa RMS. The authors note that there is unresolved uncertainty in their methods because the measurements were carried out at different water depths and using different methods that might have an effect on the recorded sound levels. Given this uncertainty, it is questionable how reliably this model predicts actual underwater noise levels for any operating wind turbines. The authors did not do any in-field measurements to validate their predictions. Additionally, the authors noted that all impact ranges (i.e., the predicted distance to thresholds) come with very high uncertainties. Using this methodology, they used the sound levels reported for the Block Island Wind Farm turbines in Elliot et al. 2019 and estimated the noise that would be produced by a theoretical 10 MW direct-drive WTG would be above the 120 dB re 1uPa RMS at a distance of up to 1.4 km from the turbine. However, it is important to note that this desktop calculation, using values reported from different windfarms under different conditions, is not based on in situ evaluation of underwater noise of a 10 MW direct-drive turbine. Further, we note that context is critical to the reported noise levels evaluated in this study as well as for any resulting predictions. Without information on soundscape, water depth, sediment type, wind speed, and other factors, it is not possible to determine the reliability of any predictions from the Stober and Thomsen paper to the Ocean Wind project or any other 10 MW turbine. Further, as noted by Tougaard et al. (2020), as the turbines also become higher with larger capacity, the distance from the noise source in the nacelle to the water becomes larger too, and with the mechanical resonances of the tower and foundation likely to change with size as well, it is not straightforward to predict changes to the noise with increasing sizes of the turbines. Therefore, for the reasons provided above, Stober and Thomsen (2021) is not considered the best available scientific information. We also note that Tougaard et al. (2020) and Stober and Thomsen (2021) both note that operational noise is less than shipping noise; this suggests that in areas with consistent vessel traffic, such as the Ocean Wind lease area, operational noise may not be detectable above ambient noise.

Elliot et al. (2019) summarized findings from hydroacoustic monitoring of operational noise from the Block Island Wind Farm (BIWF). The BIWF is composed of five GE Haliade 150 6-MW direct-drive WTGs on jacketed foundations located approximately 300 km northeast of the proposed Ocean Wind 1 WFA. We note that Tougaard (2020) reported that in situ assessments have not revealed any systematic differences between noise from turbines with different foundation types (Madsen et al., 2006); thus, the difference in foundation type is not expected to influence underwater noise from operations. Underwater noise monitoring took place from December 20, 2016 – January 7, 2017 and July 15 – November 3, 2017. Elliot et al. (2019) also presents measurements comparing underwater noise associated with operations of the direct-drive turbines at the BIWF to underwater noise reported at wind farms in Europe using older WTGs with gearboxes and conclude that absent the noise from the gears, the direct-drive models are quieter.

The WTGs proposed for Ocean Wind 1 will use the newer, direct-drive technology. Elliot et al. (2019) is the only available data on in-situ measurements of underwater noise from operational direct-drive turbines. As such, and given the issues with modeled predictions outlined above, it represents the best available data on operational noise that can be expected from the operation of the Ocean Wind 1 turbines. We acknowledge that as the Ocean Wind turbines will have a greater capacity (up to 12 MW) than the turbines at Block Island there is some uncertainty in operational noise levels. However, we note that even the papers that predict greater operational noise note that operational noise is less than shipping noise; this suggests that in areas with consistent vessel traffic, such as the Ocean Wind lease area, operational noise may not be detectable above ambient noise and, therefore, would be unlikely to result in any behavioral response by any whale, sea turtle, or sturgeon.

Elliot et al. (2019) presented a representative high operational noise scenario at an observed wind speed of 15 m/s (approximately 54 km/h, two to three times the expected average annual wind speed in the Ocean Wind lease area (COP Volume II, section 2.1.2.1.1), which is summarized in Table 7.1.3 below (Table 18 from BOEM's BA). As shown, the BIWF WTGs produced frequency weighted instantaneous noise levels of 103 and 79 dB SEL for the LFC and MFC marine mammal hearing groups in the 10-Hz to 8-kHz frequency band, respectively. Frequency weighted noise levels for the LFC and MFC hearing groups were higher for the 10-Hz to 20-kHz frequency band at 122.5- and 123.3-dB SEL, respectively.

Table 7.1.2. Frequency weighted underwater noise levels, based on NMFS 2018, at 50 m from an operational 6-MW WTG at the Block Island Wind Farm

Species Hearing Group	Instantaneous dB SEL*		Cumulative dB SEL†	
	10 Hz to 8 kHz	10 Hz to 20 kHz	10 Hz to 8 kHz	10 Hz to 20 kHz
Unweighted	121.2	127.1	170.6	176.5
LFC (North Atlantic right whale, fin whale, sei whale)	103.0	122.5	152.4	171.9
MFC (sperm whale)	79.0	123.3	128.4	172.7

Source: Elliot et al. (2019) in BOEM's January 2021 BA.
* 1-second SEL re 1 μPaS2 at 15 m/s (33 mph) wind speed. 1sec SEL = RMS
† Cumulative SEL re 1 μPaS2 assuming continuous 24 exposure at 50 m from WTG foundation operating at 15 m/s.

Elliot et al. (2019) also summarizes sound levels sampled over the full survey duration. These averages used data sampled between 10 PM and 10 AM each day to reduce the risk of sound contamination from passing vessels. The loudest noise recorded was 126 dB re 1uPa at 50 m from the turbine when wind speeds exceeded 56 km/h; at wind speeds of 43.2 km/h and less, measured noise did not exceed 120 dB re 1uPa at 50 m from the turbine. Average annual wind speeds in the Ocean Wind lease area are not expected to exceed 25.2 km/h (COP Volume II). As indicated by data from the nearby Ambrose Buoy maintained by NOAA's National Data Buoy Center (November 2008 – February 2023), instances of wind speeds exceeding 56 km/h in the lease area are expected to be rare, with wind speeds exceeding 40 km/h less than 3% of the time across a year[30].

Table 7.1.3. Summary of unweighted SPL RMS average sound levels (10 Hz to 8 kHz) measured at 50 m (164 ft.) from WTG 5

Wind speed (Km/h)	Overall average sound level, dB re 1 µPa
7.2	112.2
14.4	113.1
21.6	114

[30] https://www.windfinder.com/windstatistics/ambrose_buoy. and https://www.ndbc.noaa.gov/station_page.php?station=44065; last accessed March 30, 2023

28.8	115.1
36	116.7
43.2	119.5
46.8	120.6
Average over survey duration	119
Background sound levels in calm conditions	107.4 [30 km from turbine]
	110.2 [50 m from turbine]

Reproduced from Elliot et al. (2019); wind speeds reported as m/s converted to km/h for ease of reference

High-Resolution Geophysical Surveys

Ocean Wind plans to conduct HRG surveys in the lease area and along the export cable routes to landfall locations in New Jersey intermittently through the construction and operation periods. Equipment planned for use includes side-scan sonar, multibeam echosounder, magenetomers and gradiometers, parametric sub-bottom profiler (SBP), compressed high-intensity radiated pulses (CHIRP) SBP, boomers, or sparkers. No air guns are proposed for use. In years 1, 4, and 5 of the effective period of the MMPA ITA, 88 days of HRG surveys are planned annually; 180 days of HRG surveys are planned in years 2 and 3. After this period, surveys will be more intermittent and carried out to survey foundations, scour and scour protection, and cable burial; as described in the BA, a total of 38 surveys are anticipated over the life of the project. A number of measures to minimize effects to ESA listed species during HRG operations are proposed to be required by BOEM as conditions of COP approval and by NMFS OPR as conditions of the proposed MMPA ITA (see section 3.3).

All noise producing 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 survey transects; thus, the area ensonified is constantly moving, making survey noise transient and intermittent. The maximum anticipated distances from the HRG sound sources to noise thresholds of concern are presented in the tables below.

Consistent with conclusions made by BOEM, and by NMFS OPR in the Notice of Proposed ITA, operation of some survey equipment types is not reasonably expected to result in any effects to ESA listed species in the area. Parametric sub-bottom profilers (SBP), also called sediment echosounders, generate short, very narrow-beam (1° to 3.5°) signals at high frequencies (generally around 85-100 kHz). The narrow beamwidth significantly reduces the potential that an individual animal could be exposed to the signal, while the high frequency of operation means that the signal is rapidly attenuated in seawater. Ultra-Short Baseline (USBL) positioning systems produce extremely small acoustic propagation distances in their typical operating configuration. The single beam and Multibeam Echosounders (MBES), side-scan sonar, and the magnetometer/gradiometer that may be used in these surveys all have operating frequencies >180 kHz and are therefore outside the general hearing range of ESA listed species that may occur in the survey area.

BOEM completed a desktop analysis of nineteen HRG sources in Crocker and Fratantonio (2016) to evaluate the distance to thresholds of concern for listed species. Equipment types or frequency settings that would not be used for the survey purposes by the offshore wind industry were not included in this analysis. To provide the maximum impact scenario for these calculations, the highest power levels and most sensitive frequency setting for each hearing group were used when the equipment had the option for multiple user settings. All sources were analyzed at a tow speed of 2.315 m/s (4.5 knots), which is the expected speed vessels will travel while towing equipment. BOEM has conservatively used the highest power levels for each sound source reported in Crocker and Fratantonio (2016). The modeling approach used does not consider the tow depth and directionality of the sources; therefore, these are likely overestimates of actual disturbance distances but still within reason. Distances to potential onset of injury and behavioral disturbance thresholds were determined for sea turtles and Atlantic sturgeon, as presented in Table 7.1.4 and Table 7.1.5 below.

Table 7.1.4. Largest PTS Exposure Distances from mobile HRG Sources at Speeds of 4.5 knots – Fish and Sea Turtles

HRG SOURCE	**PTS DISTANCE (m)**				
	Highest Source Level (dB re 1 µPa)	**Sea Turtles**		**Fish[b]**	
Mobile, Impulsive, Intermittent Sources					
		Peak	*SEL*	*Peak*	*SEL*
Boomers, Bubble Guns	176 dB SEL 207 dB RMS 216 PEAK	0	0	3.2	0
Sparkers	188 dB SEL 214 dB RMS 225 PEAK	0	0	9	0
Chirp Sub-Bottom Profilers	193 dB SEL 209 dB RMS 214 PEAK	NA	NA	NA	NA
Mobile, Non-impulsive, Intermittent Sources					
Multi-beam echosounder (100 kHz)	185 dB SEL 224 dB RMS 228 PEAK	NA	NA	NA	NA
Multi-beam echosounder (>200 kHz) (mobile, non-impulsive, intermittent)	182 dB SEL 218 dB RMS 223 PEAK	NA	NA	NA	NA
	184 dB SEL	NA	NA	NA	NA

Side-scan sonar (>200 kHz) (mobile, non-impulsive, intermittent)	220 dB RMS 226 PEAK					

[a] Sea turtle PTS distances were calculated for 203 cSEL and 230 dB peak criteria from Navy (2017).
[b] Fisheries Hydroacoustic Working Group (2008).
[c] PTS injury distances for listed marine mammals were calculated with NOAA's sound exposure spreadsheet tool using sound source characteristics for HRG sources in Crocker and Fratantonio (2016)
NA = not applicable due to the sound source being out of the hearing range for the group.

Table 7.1.5. Largest disturbance distances by equipment type – Sea Turtles and Fish

HRG SOURCE	Highest Source Level (dB re 1uPa)	DISTURBANCE DISTANCE (m)	
		Sea Turtles (175 dB re 1uPa rms)	Fish (150 dB re 1uPa rms)
Boomers, Bubble Guns	176 dB $L_{E,24h}$ 207 dB Lrms 216 Lpk	40	708
Sparkers	188 dB $L_{E,24h}$ 214 dB L_{rms} 225 Lpk	90	1,996[a]
Chirp Sub-Bottom Profilers	193 dB $L_{E,24h}$ 209 dB RMS 214 L_{pk}	2	32
Multi-beam Echosounder (100 kHz)	185 dB $L_{E,24h}$ 224 dB L_{rms} 228 Lpk	NA	NA
Multi-beam Echosounder (>200 kHz)	182 dB $L_{E,24h}$ 218 dB L_{rms} 223 Lpk	NA	NA
Side-scan Sonar (>200 kHz)	184 dB $L_{E,24h}$ 220 dB L_{rms} 226 L_{pk}	NA	NA

a – the calculated distance to the 150 dB rms threshold for the Applied Acoustics Dura-Spark is 1,996m; however, the distances for other equipment in this category is significantly smaller
NA = not applicable due to the sound source being out of the hearing range for the group.

As described in the Notice of Proposed ITA, modeling was carried out, using the source levels described in Crocker and Fratantonio (2016) to estimate distances to the Level A and Level B harassment thresholds for marine mammals (see Table 30 in the Notice of Proposed ITA, reproduced in part as table 7.1.6 below). BOEM presents these same distances in the BA.

Table 7.1.6. Distance to Weighted Level A Harassment and Level B Harassment Thresholds for Each HRG Sound Source or Comparable Sound Source Category for Each Marine Mammal Hearing Group.

Equipment Type	HRG Sources	Distance to Level A harassment threshold (m)		Distance to Level B harassment threshold (m)
		Low-frequency cetaceans (SEL_{CUM})	Mid-frequency cetaceans (SEL_{CUM})	All (SPL_{rms})
Non-impulsive, non-parametric, shallow SBP (CHIRPs)				
Sub-bottom Profilers (CHIRPs)	EdgeTech 216	<1	<1	9
	EdgeTech 424	0	0	4
	EdgeTech 512i	0	0	6
	GeoPulse 5430	< 1	< 1	21
	Teledyn Benthos Chirp III - TTV 170	1.5	< 1	48
Impulsive, medium SBP (Boomers and Sparkers)				
Boomer	AA Triple plate S-Boom (700/1,000 J)	< 1	0	34
Sparker	AA Dura-spark UHD (500 J/400 tip)	< 1	0	141

	AA Dura-spark UHD 400+400	< 1	0	141
	GeoMarine Geo-Source dual 400 tip sparker	< 1	0	141

7.1.3 Effects of Project Noise on ESA-Listed Whales

Background Information – Acoustics and Whales

The *Federal Register* notice prepared for the Proposed ITA (87 FR 64868; October 26, 2022) presents extensive information on the potential effects of underwater sound on marine mammals. Rather than repeat that information, that information is incorporated by reference here. As explained in detail in the *Federal Register* notice, anthropogenic sounds cover a broad range of frequencies and sound levels and can have a range of highly variable impacts on marine life, from none or minor to potentially severe behavioral responses, depending on received levels, duration of exposure, behavioral context, and various other factors. Underwater sound from active acoustic sources can have one or more of the following effects: temporary or permanent hearing impairment, non-auditory physical or physiological effects (including injury), behavioral disturbance, stress, and masking (Richardson et al., 1995; Gordon et al., 2004; Nowacek et al., 2007; Southall et al., 2007; Götz et al., 2009). The degree of effect is intrinsically related to the signal characteristics, received level, distance from the source, and duration of the sound exposure. In general, sudden, high level sounds can cause hearing loss, as can longer exposures to lower level sounds. Temporary or permanent loss of hearing (i.e. temporary (TTS) or permanent threshold shift (PTS) respectively) will occur almost exclusively for noise within an animal's hearing range.

Richardson et al. (1995) described zones of increasing intensity of effect that might be expected to occur, in relation to distance from a source and assuming that the signal is within an animal's hearing range. First is the area within which the acoustic signal would be audible (potentially perceived) to the animal but not strong enough to elicit any overt behavioral or physiological response. The next zone corresponds with the area where the signal is audible to the animal and of sufficient intensity to elicit behavioral or physiological responsiveness. Third is a zone within which, for signals of high intensity, the received level is sufficient to potentially cause discomfort or tissue damage to auditory or other systems. Overlaying these zones to a certain extent is the area within which masking may occur. Masking occurs when the receipt of a sound is interfered with by another coincident sound at similar frequencies and at similar or higher intensity, and may occur whether the sound is natural (e.g., snapping shrimp, wind, waves, precipitation) or anthropogenic (e.g., shipping, sonar, seismic exploration) in origin. Masking is when a sound interferes with or masks the ability of an animal to detect a signal of interest that is above the absolute hearing threshold. The masking zone may be highly variable in size. Masking can lead to behavioral changes in an attempt to compensate for noise levels or because sounds that would typically have triggered a behavior were not detected.

In general, the expected responses to pile driving noise may include threshold shift, behavioral effects, stress response, and auditory masking. Threshold shift is the loss of hearing sensitivity at certain frequency ranges (Finneran 2015). It can be permanent (PTS), in which case the loss of hearing sensitivity is not fully recoverable, or temporary (TTS), in which case the animal's hearing threshold would recover over time (Southall et al., 2007). PTS is an auditory injury, which may vary in degree from minor to significant. Behavioral disturbance may include a variety of effects, including subtle changes in behavior (e.g., minor or brief avoidance of an area or changes in vocalizations), more conspicuous changes in similar behavioral activities, and more sustained and/or potentially severe reactions, such as displacement from or abandonment of high-quality habitat. Not all behavioral disturbance would have meaningful consequences to an individual. The duration of the disturbance and the activity that is impacted are considered when evaluating the potential for a behavioral disturbance to significantly disrupt normal behavioral patterns. An animal's perception of a threat may be sufficient to trigger stress responses consisting of some combination of behavioral responses, autonomic nervous system responses, neuroendocrine responses, or immune responses (e.g., Seyle, 1950; Moberg, 2000). In many cases, an animal's first and sometimes most economical response in terms of energetic costs is behavioral avoidance of the potential stressor. Autonomic nervous system responses to stress typically involve changes in heart rate, blood pressure, and gastrointestinal activity. These responses have a relatively short duration and may or may not have a significant long-term effect on an animal's fitness.

Criteria Used for Assessing Effects of Noise Exposure to Blue, Fin, Right, Sei, and Sperm Whales

NMFS *Technical Guidance for Assessing the Effects of Anthropogenic Noise on Marine Mammal Hearing* compiles, interprets, and synthesizes scientific literature to produce updated acoustic thresholds to assess how anthropogenic, or human-caused, sound affects the hearing of all marine mammals under NMFS jurisdiction (NMFS 2018[31]). Specifically, it identifies the received levels, or thresholds, at which individual marine mammals are predicted to experience temporary or permanent changes in their hearing sensitivity for acute, incidental exposure to underwater anthropogenic sound sources. As explained in the document, these thresholds represent the best available scientific information. These acoustic thresholds cover the onset of both temporary (TTS) and permanent hearing threshold shifts (PTS).

[31] See www.nmfs.noaa.gov/pr/acoustics/guidelines.htm for more information.

Table 7.1.9. Impulsive acoustic thresholds identifying the onset of permanent threshold shift and temporary threshold shift for the marine mammal species groups considered in this opinion (NMFS 2018)

Hearing Group	Generalized Hearing Range[32]	Permanent Threshold Shift Onset[33]	Temporary Threshold Shift Onset
Low-Frequency Cetaceans (LF: baleen whales)	7 Hz to 35 kHz	*L*pk,flat: 219 dB *L*E,LF,24h: 183 dB	*L*pk,flat: 213 dB *L*E,LF,24h: 168 dB
Mid-Frequency Cetaceans (MF: sperm whales)	150 Hz to 160 kHz	*L*pk,flat: 230 dB *L*E,MF,24h: 185 dB	*L*pk,flat: 224 dB *L*E,MF,24h: 170 dB

Note: Peak sound pressure level (Lp,0-pk) has a reference value of 1 µPa, and weighted cumulative sound exposure level (LE,p) has a reference value of 1µPa2 s. In this Table, thresholds are abbreviated to be more reflective of International Organization for Standardization standards (ISO 2017). The subscript "flat" is being included to indicate peak sound pressure are flat weighted or unweighted within the generalized hearing range of marine mammals (i.e., 7 Hz to 160 kHz). The subscript associated with cumulative sound exposure level thresholds indicates the designated marine mammal auditory weighting function (LF, MF, and HF cetaceans) and that the recommended accumulation period is 24 hours. The weighted cumulative sound exposure level thresholds could be exceeded in a multitude of ways (i.e., varying exposure levels and durations, duty cycle).

These thresholds are a dual metric for impulsive sounds, with one threshold based on peak sound pressure level (0-pk SPL) that does not incorporate the duration of exposure, and another based on cumulative sound exposure level (SEL_{cum}) that does incorporate exposure duration. Cumulative SEL represents the total energy accumulated by a receiver over a defined time window or during an event. Peak sound pressure (also referred to as zero-to-peak sound pressure or 0-pk) is the maximum instantaneous sound pressure measurable in the water at a specified distance from the source, The cumulative sound exposure criteria incorporate auditory weighting functions, which estimate a species group's hearing sensitivity, and thus susceptibility to TTS and PTS, over the exposed frequency range, whereas peak sound exposure level criteria do not incorporate any frequency dependent auditory weighting functions.

In using these thresholds to estimate the number of individuals that may experience auditory effects in the context of the MMPA, NMFS classifies any exposure equal to or above the threshold for the onset of PTS as auditory injury (and thus MMPA Level A harassment). As defined under the MMPA, Level A harassment means any act of pursuit, torment, or annoyance that has the potential to injure a marine mammal or marine mammal stock in the wild. NMFS

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

[33] $L_{pk,flat}$: unweighted ($_{flat}$) peak sound pressure level (L_{pk}) with a reference value of 1 µPa; $L_{E,XF,24h}$: weighted (by species group; $_{LF}$: Low Frequency, or $_{MF}$: Mid-Frequency) cumulative sound exposure level (L_E) with a reference value of 1 µPa^2-s and a recommended accumulation period of 24 hours ($_{24h}$)

considers exposure to impulsive noise greater than 160 dB re 1uPa rms to result in MMPA Level B harassment. As defined under the MMPA, Level B harassment refers to acts that have the potential to disturb (but not injure) a marine mammal or marine mammal stock in the wild by disrupting behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering. As defined in the MMPA, Level B harassment does not include an act that has the potential to injure a marine mammal or marine mammal stock in the wild. Among Level B exposures, NMFS OPR does not distinguish between those individuals that are expected to experience TTS and those that would only exhibit a behavioral response. The 160 dB re 1uPa rms threshold is based on observations of behavioral responses of mysticetes (Malme et al. 1983; Malme et al. 1984; Richardson et al. 1986; Richardson et al. 1990), but is used for all marine mammal species.

Given the differences in the definitions of "harassment" under the MMPA and ESA, it is possible the some activities could result in harassment, as defined under the MMPA, but meet the ESA definition of "not likely to adversely affect." Under the ESA, take is defined as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct." Harm is defined by regulation (50 C.F.R. §222.102) as "an act which actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation which actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including, breeding, spawning, rearing, migrating, feeding, or sheltering." NMFS does not have a regulatory definition of "harass." However, on December 21, 2016, NMFS issued interim guidance[34] on the term "harass," under the ESA, 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." The NMFS interim ESA definition of "harass" is not equivalent to MMPA Level B harassment. Due to the differences in the definition of "harass" under the MMPA and ESA, there may be activities that result in effects to a marine mammal that would meet the threshold for harassment under both the MMPA and the ESA, while other activities may result in effects that would meet the threshold for harassment under the MMPA but not under the ESA. This issue is addressed further in the sections that follow.

For this consultation, we considered NMFS' interim guidance on the term "harass" under the ESA when evaluating whether the proposed activities are likely to harass ESA-listed species, and we considered the available scientific evidence to determine the likely nature of the behavioral responses and their potential fitness consequences.

Effects of Project Noise on ESA-Listed Whales
Blue, fin, sei, sperm, and right whales may be exposed to increased underwater noise from a variety of sources during construction, operation, and/or decommissioning of the Ocean Wind 1 project. As explained in section 3, Orsted/Ocean Wind 1 applied for an Incidental Take Authorization (ITA) to authorize Level A harassment of fin and sei whales and Level B harassment of blue, fin, sei, sperm, and right whales expected to result from exposure to noise resulting from the installation of WTGs and OSSs, installation and removal of cofferdams at

[34] NMFS Policy Directive 02-110-19; available at *https://media.fisheries.noaa.gov/dam-migration/02-110-19.pdf*; last accessed March 10, 2023.

locations of export cable route to landfall transitions, potential detonations of up to 10 UXO, and performance of HRG site characterization surveys operating at less than 180 kHz. NMFS OPR is proposing to authorize this take. Ocean Wind did not apply for an ITA for any other noise sources, and OPR is not proposing to authorize MMPA take of any ESA listed whale species for any noise sources other than pile driving, UXO detonation, and HRG surveys. No serious injury or mortality is expected to result from exposure to any project noise sources and none is proposed to be authorized through the MMPA ITA.

Here, we consider the effects of exposure and response to underwater noise during construction, operations, and decommissioning in the context of the ESA. Information on the relevant acoustic thresholds and a summary of the best available information on likely responses of whales to underwater noise is presented above. More information on Ocean Wind's ITA application and details of the acoustic modeling are available in the *Federal Register* notice of the proposed rule (87 FR 64868; October 26, 2022), the ITA application (available at: https://www.fisheries.noaa.gov/action/incidental-take-authorization-ocean-wind-lcc-construction-ocean-wind-1-wind-energy-facility), and the Ocean Wind's Underwater Acoustic and Exposure Modeling report (Appendix R2 to the COP, Küsel et al. 2022). The information presented in BOEM's BA is consistent with the analysis in NMFS OPR's Notice of Proposed ITA.

Pile Driving

In their ITA application and in a Revised Density and Take Estimate Memo[35], Ocean Wind estimated exposure of marine mammals (including ESA listed right, blue, fin, sei, and sperm whales) known to occur in the lease area and along the cable corridor to a number of noise sources above the Level A and Level B harassment thresholds. As part of the response to the MMPA ITA application, OPR conducted their own review of the model reports and determined they were based on the best available information. OPR relied on the model results to develop the proposed ITA.

For the purposes of this ESA section 7 consultation, we evaluated the applicants' and OPR's exposure estimates of the number of ESA-listed cetaceans that would be "taken" relative to the definition of MMPA Level A and Level B harassment and considered this expected MMPA take in light of the ESA definition of take including the NMFS definition of harm (64 FR 60727; November 8, 1999) and NMFS interim guidance on the definition of harass (see NMFS policy directive 02-110-19[36]). We have adopted OPR's analysis of the number of blue, fin, sei, sperm, and right whales expected to be exposed to pile driving noise because, after our independent review, we determined it utilized the best available information and methods to evaluate exposure of these whale species to such noise. BOEM's BA carries forward the analysis and exposure estimates presented in the Notice of Proposed ITA. Below we describe Ocean Wind and NMFS OPR's exposure analyses for these species.

[35] https://media.fisheries.noaa.gov/2022-09/Ocean%20Wind%201%20OWF%20Construction_2022SuppApp_OPR1.pdf; last accessed 3/10/23

[36] Available at: https://www.fisheries.noaa.gov/national/laws-and-policies/protected-resources-policy-directives. Last accessed January 8, 2022.

Acoustic Modeling

The Notice of Proposed ITA and BOEM's BA provide extensive information on the acoustic modeling prepared for the project (Küsel et al. 2022; COP Appendix R2). That information is summarized here. As noted above, two scenarios are being considered for construction: installation of monopiles to support 98 WTGs and 3 OSSs and installation of monopiles to support 98 WTGs and pin piles to support 3 OSSs. As addressed above, BOEM and NMFS OPR will require use of a noise abatement system to achieve 10 dB noise attenuation; thus, modeling and exposure estimates incorporated 10 dB noise attenuation. As described in Küsel et al. 2022, installation of the Ocean Wind monopile foundations was modeled at a representative location selected because it represents the range of water depths in the Lease Area and would produce representative sound fields for the full construction area. Summer (May – November) and Winter (December – April) sound profiles were considered; the summer speed profile is based on oceanographic conditions that stratify layers and refract propagating sound while the winter speed profile reflects conditions that thoroughly mix layers and result in more even propagation.

As noted above, the updated acoustic thresholds for impulsive sounds (such as impact pile driving) contained in the Technical Guidance (NMFS, 2018) are dual metric acoustic thresholds using both SEL_{cum} and peak sound pressure level metrics (Table 7.1.9). As dual metrics, NMFS considers onset of PTS (MMPA Level A harassment) to have occurred when either one of the two metrics is exceeded. The SEL_{cum} metric considers both level and duration of exposure, as well as auditory weighting functions by marine mammal hearing group. For example, the distance from the source to the peak Level A threshold marks the outer bound of the area within which an animal needs to be located to be exposed to enough noise to experience Level A harassment from a single pile strike. The distance from the source to the cumulative Level A threshold marks the outer bound of the area within which an animal needs to stay for the entire duration of the activity considered (e.g., the entire four hours of pile driving to install a monopile).

As described in the Notice of Proposed ITA, modeled acoustic ranges to threshold levels may overestimate the actual distances at which animals receive exposures meeting the Level A (SEL_{cum}) harassment threshold criterion. Applying animal movement and behavior within the propagated noise fields provides the exposure range, which results in a more realistic indication of the distances at which acoustic thresholds are met. For modeled animals that have received enough acoustic energy to exceed a given threshold, the exposure range for each animal is defined as the closest point of approach (CPA) to the source made by that animal while it moved throughout the modeled sound field, accumulating received acoustic energy. The resulting exposure range for each species is the 95th percentile of the CPA distances for all animals that exceeded threshold levels for that species (termed the 95 percent exposure range $ER_{95percent}$). Notably, the $ER_{95percent}$ are species-specific rather than categorized only by hearing group, which affords more biologically-relevant data (*e.g.*, dive durations, swim speeds, etc.) to be considered when assessing impact ranges.

Tables 7.1.7 and 7.1.8 below represent the ER_{95}% exposure ranges (for SEL_{cum} and SPL_{rms}) for monopile foundations, with Table 7.1.7 demonstrating the ranges using the summer sound speed profile and Table 7.1.8 using the winter sound speed profile. For both tables, a single monopile and two monopiles per day are presented; the two per day ranges are shown in the parenthesis. Tables 7.1.9 and Table 7.1.10 represent the ER_{95}% exposure ranges (for SEL_{cum} and SPL_{rms}) for pin pile foundations (to support the OSSs), with Table 7.1.9 demonstrating the ranges using the summer sound speed profile and Table 7.1.10 using the winter sound speed profile. For both tables, three pin piles per day are provided. Exposure modeling for the blue whale was not conducted because impacts to those species approach zero due to their low predicted densities in the Project area (Roberts et al. 2016a, 2016b, 2017, 2018, 2020, 2021a, 2021b as cited in Appendix A of Küsel et al. 2022). Instead, Ocean Wind requested take of blue whales based on group size. NMFS OPR is proposing to authorize take of blue whales based on group size (4 individuals). Blue whales are expected to be rare in the lease area as they typically occur in deeper, offshore areas; however, the best available data indicates that they could occur in the area where increased underwater noise may be experienced, most likely at the furthest offshore extent of this area (Muirhead et al. 2018, Zoidis et al. 2021). Therefore, it is reasonable to expect that over the duration of the pile driving one group of blue whales could be exposed to pile driving noise.

Ocean Wind also modeled the distance to the Level A peak harassment threshold (Table 1-11 and 1-12 in their MMPA application); for all ESA listed species, the ER95% was 0 for a one or two monopile per day scenario in summer and winter with 10 dB attenuation. The same result was obtained for the pin piles. As such, no noise above the Level A peak thresholds is anticipated.

Table 7.1.7. Level A Harassment (SELcum) and Level B Harassment (SPLrms) Exposure Ranges (ER95%) in Kilometers for Monopile Foundations in the Summer (May – November); for one and (two) monopiles per day

Species	**Ranges to Threshold in KM (Assuming 10 dB attenuation)**	
	Level A Harassment	**Level B Harassment**
North Atlantic right whale	1.28 (1.37)	2.95 (2.98)
Fin whale	1.58 (1.65)	3.04 (3.13)
Sei whale	1.36 (1.27)	3.13 (3.09)
Sperm whale	0	0

Table 7.1.8. Level A Harassment (SELcum) and Level B Harassment (SPLrms) Exposure Ranges (ER95%) in Kilometers for Monopile Foundations in the Winter (December); for one and (two) monopiles per day

Species	**Ranges to Threshold in KM (Assuming 10 dB attenuation)**	
	Level A Harassment	**Level B Harassment**
North Atlantic right whale	1.85 (2.03)	3.28 (3.35)
Fin whale	2.33 (2.49)	3.48 (3.44)
Sei whale	1.86 (2.19)	3.42 (3.45)
Sperm whale	0 (0)	0 (0)

Table 7.1.9. Level A Harassment (SELcum) and Level B Harassment (SPLrms) Exposure Ranges (ER95%) in Kilometers for Impact Pile Driving of Three Pin Piles per day in the Summer (adapted from Table 15 in the Notice of MMPA ITA)

Species	**Ranges to Threshold in KM (Assuming 10 dB attenuation)**	
	Level A Harassment	**Level B Harassment**
North Atlantic right whale	0.58	1.72
Fin whale	0.59	1.79
Sei whale	0.36	1.84
Sperm whale	0 (0)	0 (0)

Table 7.1.10. Level A Harassment (SELcum) and Level B Harassment (SPLrms) Exposure Ranges (ER95%) in Kilometers for Impact Pile Driving of Three Pin Piles per day in the Winter (adapted from Table 16 in the Notice of MMPA ITA)

Species	**Ranges to Threshold in KM (Assuming 10 dB attenuation)**	
	Level A Harassment	**Level B Harassment**
North Atlantic right whale	0.70	2.11
Fin whale	0.74	2.04
Sei whale	053	2.03
Sperm whale	0 (0)	0 (0)

JASCO's Animal Simulation Model Including Noise Exposure (JASMINE) animal movement model was used to predict the number of marine mammals exposed to impact pile driving sound above NMFS' injury and behavioral harassment thresholds. Sound exposure models like JASMINE use simulated animals (also known as "animats") to forecast behaviors of animals in new situations and locations based on previously documented behaviors of those animals. The predicted 3D sound fields (*i.e.*, the output of the acoustic modeling process described earlier) are sampled by animats using movement rules derived from animal observations; however, no aversion/avoidance behavior is incorporated into the model runs that were used as the basis for the take estimate for any species. A full description of the model is provided in the Notice of Proposed ITA and in Ocean Wind's MMPA Application. Note that animal aversion was not incorporated into the JASMINE model runs that were the basis for the take estimate for any species; that is, the models do not incorporate any animal movements or avoidance behavior that would be expected to result from exposure to underwater noise.

As described in the Notice of Proposed ITA, to estimate the number of animals of each species likely to be exposed above the Level A and Level B thresholds, the construction schedule used for the model considered installation of 60 WTG monopiles (at a rate of two per day for 30 days) during the highest density month of each species (i.e., the month with the highest density of individuals for a particular species across the May – December pile driving window, Table 7.12) and installation of 38 WTG monopiles (at a rate of two per day for 19 days) during the month with the second highest species density. Two scenarios were considered for the three OSS foundations: either three monopiles (at a rate of two per day for one day and then one on a second day in the highest density month) or 48 pin piles (at a rate of three per day for a total of

16 days in the highest density month). The densities used to estimate take from foundation installation were calculated based on average monthly densities for all grid cells within the lease area as well as grid cells extending an additional 5 km (3.11 mi) beyond the lease area.

Table 7.11. Construction Schedule Assumptions for Both WTG and OSS Foundations

Foundation Type	Configuration	Days of Impact Pile Driving	
		1st Highest Density Month	2nd Highest Density Month
WTG	Monopile foundation, 2 piles per day	30	19
OSS, Scenario 1	Monopile foundation, 2 piles per day	1	0
	Monopile foundation, 1 pile per day	0	1
OSS, Scenario 2	Jacket foundation, 3 pin piles per day	16	0

Table 7.12. Monthly Marine Mammal Densities (Animals per Km^2) Used for the Modeling of Ocean Wind's WTGs and OSSs (Note: because of the January – April time of year restriction, only densities from May – December are considered)

Marine Mammal Species	First Highest Density	Second Highest Density
North Atlantic right whale	0.00045 (December)	0.00012 (November)
Fin whale	0.00141 (December)	0.00080 (May)
Sei whale	0.00042 (December)	0.00021 (November)
Sperm whale	0.00008 (May)	0.00004 (December)

In summary, exposures were estimated in the following way:

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

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

(3) Animal movement modeling integrated the estimated sound fields with species-typical behavioral parameters in the JASMINE model to estimate received sound levels for the animals that may occur in the operational area; and
(4) The number of potential exposures above Level A and Level B harassment thresholds were calculated.

The results of marine mammal exposure modeling for the full monopile scenario (WTG and OSS) and joint foundation approach (WTGs use monopiles; OSSs use jackets with pin piles) assuming 10dB attenuation are shown in Tables 7.13 and 7.14.

Table 7.1.13. Modeled Potential Level A and Level B Harassment Exposures (assuming 10 dB Sound Attenuation) Due To Impact Pile Driving of Monopile Foundations (Assuming 98 Total Monopiles for WTGs)

Species	Level A Harassment (SEL_{cum})	Level B Harassment (160 db rms)
North Atlantic right whale	0.9	3.11
Fin whale	3.69	7.05
Sei whale	0.89	2.00
Sperm whale	0	0

Table 7.1.14. Modeled Potential Level A and Level B Harassment Exposures (assuming 10 dB of Sound Attenuation) Due To Impact Pile Driving of OSS Foundations (Assuming 3 Monopiles or 3 Jackets with 16 Pin Piles Each).

Marine Mammal Species	8/11-m Monopile Foundation Scenario		2.44-m Pin Pile for Jacket Foundation Scenario	
	Level A (SEL_{cum})	Level B (160 dB rms)	Level A (SEL_{cum})	Level B (160 dB rms)
North Atlantic right whale	0.04	0.14	0.10	0.75
Fin whale	0.15	0.27	0.48	1.20
Sei whale	0.04	0.08	0.14	0.45

Sperm whale	0	0	0	0

Based on the exposure estimates for impact pile driving activities related to WTGs and OSS installation (monopile foundations and/or jacket foundations with pin piles), the take estimates, as proposed by NMFS OPR, are found below in Tables 7.1.15 and 7.1.16. For fin, sei, and sperm whales, to determine the proposed take numbers, the calculated exposures were rounded to the next whole number. As explained above, NMFS OPR is proposing to authorize the Level B harassment of four blue whales due to exposure to impact pile driving noise; this number is based on group size and potential occurrence in the area where increased underwater noise may be experienced. As elaborated on below, JASCO's modeling estimated 0.90 Level A exposures for North Atlantic right whales; NMFS OPR determined that with the implementation of the mitigation measures required by the proposed MMPA ITA, no Level A takes are expected or requested. As described in section 3, these measures are considered part of the proposed action we are consulting on.

Table 7.1.15. Estimated Number of Individuals Exposed to Noise above the Level A and B Harassment Thresholds Resulting from Impact Pile Driving of 98 WTG Foundations

Species	Level A Harassment	Level B Harassment
North Atlantic right whale	0	4
Blue whale	0	4
Fin whale	4	8
Sei whale	1	2
Sperm whale	0	3

Table 7.1.16. Level A and B Harassment Take Proposed for Authorization through the MMPA ITA Resulting from Impact Pile Driving Associated with OSS Using 8/11-m Monopile Foundations (Assuming 3 total) Or 2.44-m Jacket Foundation Using Pin Piles (48 Total Pin Piles)

Species	**Three 8/11-m Monopile Foundation Scenario**		**48 2.44-m Pin Pile (Jacket Foundation) Scenario**	
	Level A Harassment	**Level B Harassment**	**Level A Harassment**	**Level B Harassment**
North Atlantic right whale	0	0	0	1

Blue whale	0	0	0	0
Fin whale	0	0	0	2
Sei whale	0	0	0	0
Sperm whale	0	0	0	3

Vibratory Pile Driving for Cofferdam Installation and Removal
As described in the BA and notice of proposed ITA, installation and extraction of up to seven temporary cofferdams is proposed. All cofferdams will be located in nearshore locations; the closest cofferdam to the lease area (BL England) is approximately 24 km away. Installation of each cofferdam would require a maximum of 12 hours of vibratory driving while removal using a vibratory extractor would require 18 hours. Vibratory installation and removal will occur over 28 non-consecutive days, with vibratory driving and extractor used for no more than 12 hours per day. There is no time of year restriction proposed for these activities, but the construction schedule indicates that installation would occur during year 1 of construction activities between October 1 and March 31; removal could occur in April and May of year 2 if delays prevent this work from being completed in year 1. All installation and removal will occur during daylight hours only.

Noise generated from vibratory pile driving is mostly concentrated at lower frequencies. Rise time is slower, and sound energy is distributed over a great amount of time, reducing the probability and severity of potential injury (Nedwell and Edwards, 2002; Carlson *et al*. 2005). Vibratory hammers produce peak SPLs that may be 180 dB or greater, but are generally 10 to 20 dB lower than SPLs generated during impact pile driving of the same-sized pile (Oestman *et al*., 2009). The source level of the vibratory hammer planned for use is 165 dB re 1uPa (BOEM 2022).

As conditions of COP approval and as required by the MMPA ITA, Ocean Wind would establish clearance and shutdown zones for vibratory pile driving activities associated with cofferdam installation. Clearance zones for ESA listed whales will extend 150 m from the cofferdam, and shutdown zones will extend 100 m from the cofferdam. Prior to the start of vibratory pile driving activities, at least two PSOs will monitor the clearance zone for 30 minutes; they will continue monitoring during pile driving and for 30 minutes post pile driving. If a marine mammal is observed entering or within the respective zones, piling will not commence or will be delayed until the animal has exited the zone or until 30 minutes has elapsed since the last sighting. If a marine mammal is observed entering or within the respective shutdown zone after vibratory pile driving has begun, the PSO will call for a temporary cessation of vibratory pile driving. Ocean Wind must immediately cease pile driving upon orders of the PSO unless shutdown is not feasible due to imminent risk of injury or loss of life to an individual from pile refusal or pile instability (see description in section 3.3 for more information on this issue). In situations where a shutdown is called for but is not feasible due to risk of injury or loss of life, reduced hammer energy must be implemented. Pile driving must not restart until either the marine mammal(s) has voluntarily left the specific clearance zones and have been visually or acoustically confirmed beyond that clearance zone, or, when 30 minutes have elapsed with no further sightings or acoustic detections. Because a vibratory hammer can grip a pile without operating, pile instability should not be a concern, and no caveat for re-starting pile driving due to pile instability is proposed. As explained in section 3, scenarios that would prevent shutdown of pile driving are expected to be very rare due to the engineering of the piles which is designed to avoid and minimize the potential for piling refusal and the consideration of weather windows to only allow pile driving to proceed when there is a weather window of at least 6 hours which minimizes the likelihood that a piling vessel would have to “let go” of a pile being installed for safety reasons.

An extensive discussion of the modeling used to predict noise levels associated with the installation and removal of the cofferdams is presented in the Notice of Proposed ITA (87 FR 64868 at 64871, 64875-64876) and is summarized here. Vibratory driving sound source characteristics were generated using the GRLWEAP 2010 wave equation model (Pile Dynamics, Inc., 2010). Installation and removal of the cofferdams were modeled from a single location that was deemed representative of the two potential cable routes. The radiated sound waves were modeled as discrete point sources over the full length of the pile in the water. Ocean Wind is not proposing to employ noise mitigation during vibratory piling and neither BOEM or NMFS OPR are proposing to require any noise mitigation; therefore, no abatement is applied. To estimate the sound field to harassment isopleths generated during installation and removal during pile driving, a practical spreading loss model and a source level of 165.0 dB *re 1*m *Pa* was used (JASCO, 2021). Ocean Wind did not separately analyze the removal of the cofferdams using a vibratory extractor but has assumed that the removal would be acoustically comparable to the installation. Based on available pile driving data (Caltrans, 2020), this is a conservative assumption as pile removal is expected to be quieter than pile installation.

Given the short duration of the activity and shallow, near coast location, animat exposure modeling was not conducted for cofferdam installation and removal to determine potential exposures from vibratory pile driving. Rather, the modeled acoustic range distances to isopleths corresponding to the Level A harassment and Level B harassment threshold values were used to calculate the area around the cofferdam predicted to be ensonified daily to levels that exceed the thresholds (i.e., the Ensonified Area). The Ensonified Area is calculated as the following: *Ensonified Area* = p r^2,where r is the linear acoustic range distance from the source to the isopleth to Level A harassment or Level B harassment thresholds. The Level A and Level B harassment threshold distances were mapped in GIS to remove any areas that overlapped landmasses or areas where water was blocked by land as these areas would not be ensonified during the cofferdam installation and removal. These results are shown in Table 7.1.17.

Table 7.1.17 Areas Calculated for the Maximum Level A and Level B Threshold Distances for Vibratory Installation of Sheet Piles

Cofferdam Location	Area of Level A Zone (km^2)		Area of Level B Zone (km^2)
	Low-frequency cetaceans	Mid-frequency cetaceans	

Ocean City HDD	0.024	less than 0.000	163.75
BL England HDD			158.59
Farm Property HDD			77.01
ISBP Barnegat Bay HDD			76.70

The average monthly density value from October through May for each marine mammal species (Table 7.1.18) were then multiplied by the estimated Level A harassment and Level B harassment areas and the expected durations for each component of the cofferdams (*i.e.,* installation and removal). Finally, the resulting value was multiplied by the number of proposed activity days, which for cofferdam installation and removal, is conservatively and reasonably estimated as 4 days (2 days for installation, 2 days for removal). For Level A harassment, exposures were less than 0.01; thus, Ocean Wind did not request, and NMFS OPR is not proposing to authorize, any Level A harassment as a result of vibratory pile driving for cofferdam installation and removal. The amount of Level B harassment proposed for authorization through the MMPA ITA is presented in Table 7.1.19.

Table 7.1.18. Densities (Animals per Km^2) Used for Analysis of Ocean Wind's Cofferdam Installation and Removal for October through May

Marine Mammal Species	Period of Density Used	Estimated Density
North Atlantic right whale	October - May average	0.00028
Blue whale	Annual Density	0.00075
Fin whale	October - May average	0.00039
Sei whale	October - May average	0.00014
Sperm whale	October - May average	0.00002

Table 7.1.19. Level A and B Harassment Take Proposed for Authorization through the MMPA ITA Resulting From Vibratory Pile Driving Associated With The Installation and Removal of Temporary Cofferdams

Marine Mammal Species	Level A Harassment	Level B Harassment
North Atlantic right whale	0	1

Blue whale	0	0
Fin whale	0	2
Sei whale	0	1
Sperm whale	0	0

Total Take Estimates for All Pile Driving
Table 7.1.20 summarizes the amount of Level A and Level B harassment that NMFS OPR is proposing to authorize. This is consistent with the number of individuals BOEM estimated in the BA would be exposed to noise above the Level A and Level B harassment thresholds as a result of impact and vibratory pile driving for the totality of WTG and OSS foundation and cofferdam installation and removal. Below we present information to support the determination that no right whales are expected to be exposed to noise above the Level A harassment threshold.

Table 7.1.20. Total Level A harassment and Level B harassment Proposed for Authorization through the MMPA ITA resulting from impact pile driving using 10 dB broadband noise attenuation and vibratory installation/removal of cofferdams

Species	Proposed Take Authorization	
	Level A	Level B
Blue whale	0	4
Fin whale	4	12
North Atlantic right whale	0	6
Sei whale	1	3
Sperm whale	0	6

7.1.3.1 Consideration of Proposed Measures to Minimize Exposure of ESA Listed Whales to Pile Driving Noise
Here, we consider the measures that are part of the overall proposed action, either because they are proposed by Ocean Wind in the COP, by BOEM as described in the BA regarding potential COP approval conditions, or by NMFS OPR as requirements of the ITA. We also consider how those measures may serve to minimize exposure of ESA listed whales to pile driving noise. Details of these proposed measures are included in section 3 above.

Seasonal Restriction on Impact Pile Driving of Foundations
No impact pile driving activities would occur between January 1 and April 30 to avoid the time of year with the highest densities of right whales in the WDA. This seasonal restriction is factored into the acoustic modeling that supported the development of the amount of take

proposed in the ITA. That is, the modeling does not consider any impact pile driving in the January 1 – April 30 period. Thus, the take estimates do not need to be adjusted to account for this seasonal restriction.

Sound Attenuation Devices
For all impact pile driving, Ocean Wind would implement sound attenuation technology that would target at least a 10 dB reduction in pile driving noise; BOEM is requiring that the noise mitigation device(s) perform such that measured ranges to the Level A and Level B harassment thresholds are consistent with (i.e., no larger than) those modeled assuming 10 dB attenuation, determined via sound source verification. This requirement is also proposed in the MMPA ITA. The 10 dB attenuation was incorporated into the take estimate calculations presented above. Thus, the take estimates do not need to be adjusted to account for the use of sound attenuation. If a reduction greater than 10 dB is achieved, the actual amount or extent of take would be expected to be lower as a result of resulting smaller distances to thresholds of concern. In section 7.1.2, we provided an explanation for why it is reasonable to expect that 10 dB of sound attenuation for impact pile driving can be achieved.

Clearance and Shutdown Zones
Ocean Wind proposed as part of the COP and in their application for an MMPA ITA to implement clearance and shutdown zones for impact and vibratory pile driving. Clearance and shutdown requirements are proposed by BOEM as conditions of the COP, and by NMFS OPR as conditions of the proposed ITA. Ocean Wind will use PSOs to establish clearance zones around the pile driving equipment to ensure these zones are clear of marine mammals prior to the start of pile driving. The primary goal is to avoid exposure to the areas with the loudest noise, which is the area closest to the pile being driven. This reduces the potential for injury and may reduce the extent of disturbance. Shutdown zones will be implemented whereby if an animal enters the shutdown zone, the PSO will call for shutdown of pile driving activity as described below. Through conditions of the proposed ITA, NMFS OPR is also implementing minimum visibility requirements; these are distances from the pile being driven that must be fully visible to the visual PSOs prior to the start of monitoring the clearance zones. These distances are 1,650 m from May – November and 2,500 m in December.

Table 7.1.19. Proposed Clearance and Shutdown Zones

Impact pile driving of Foundations		
Minimum Visibility required for all impact pile driving: 1,650 May – November; 2,500 m December		
Species	**Clearance Zone (m)**	**Shutdown Zone (m)**
North Atlantic right whale – PAM	3,500 May-November; 3,800 December [a]	1,650 May – November; 2,500 December [a]
North Atlantic right whale – visual detection	Visual detection of a right whale at any distance by a PSO stationed at the pile	

	driving platform or PSO vessel triggers the required clearance or shutdown procedures	
Blue, Fin, sei, and sperm whale	2,000 May – November; 2,500 December [b]	1,800 May – November; 2,500 December [b]
Vibratory Pile driving for Cofferdam Installation/Removal		
Species	**Clearance Zone (m)**	**Shutdown Zone (m)**
Right, fin, sei, and sperm whale	150	100
HRG Surveys		
Species	**Clearance Zone (m)**	**Shutdown Zone (m)**
North Atlantic right whale	500	500
Blue, Fin, sei, and sperm whale	100	100

a – The clearance and shutdown zone for right whales will be monitored through a combination of visual observers and PAM; PAM detections within these the clearance and shutdown distances will trigger the required clearance and/or shutdown procedures
b – The 2,200 m clearance zone for fin, sei, and sperm whales will be monitored by visual observers and is equivalent to the minimum visibility zone as described in the ITA.

For impact pile driving, clearance zones will be monitored by at least two PSOs at the pile driving platform and at least two PSOs on a dedicated PSO vessel transiting in a radius within the clearance zone. All distances to the edge of clearance zones are the radius from the center of the pile. The proposed clearance zones are larger than the modeled distances to the isopleths corresponding to Level A harassment (considering peak and cumulative thresholds) for all ESA listed whales. The dedicated PSO vessel would be located at the outer edge of the 2 km (in the summer; 2.5 km in the winter) large whale clearance zone. These PSOs would be required to maintain watch at all times when impact pile driving of monopiles and/or pin piles is underway. Concurrently, at least one PAM operator would be actively monitoring for marine mammals before, during, and after pile driving (more information on PAM is provided below). PSOs would visually monitor for marine mammals for a minimum of 60 minutes while PAM operators would review data from at least 24 hours prior to pile driving and actively monitor hydrophones for 60 minutes prior to pile driving. Prior to initiating soft-start procedures, all clearance zones must be visually confirmed to be free of marine mammals for 30 minutes immediately prior to starting a soft-start of pile driving. If a marine mammal is observed entering or within the relevant clearance zone prior to the initiation of impact pile driving activities, pile driving must be delayed and will not begin until either the marine mammal(s) has voluntarily left the clearance zone and has been visually or acoustically confirmed beyond that clearance zone, or, when 30 minutes have elapsed with no further sightings or acoustic detections. Pile driving must only commence when the clearance zone is fully visible (i.e., not obscured by darkness, rain, fog, etc.) for at least 30 minutes. Additionally, impact pile driving activity must be delayed upon visual observation of a North Atlantic right whale by a PSO at any distance from the pile. As required by the proposed MMPA ITA, any large whale sighted by a PSO or acoustically detected by a PAM operator that cannot be identified as a species other than a North Atlantic right whale must be treated as if it were a North Atlantic right whale.

Prior to the start of vibratory pile driving activities, at least two PSOs will monitor the clearance zone for 30 minutes, and will continue monitoring during pile driving and for 30 minutes post pile driving. If a marine mammal is observed entering or is observed within the respective zones, pile driving will not commence or will be delayed until the animal has exited the zone or 30 minutes has elapsed since the last sighting. If a marine mammal is observed entering or within the respective shutdown zone after vibratory pile driving has begun, the PSO will call for a temporary cessation of vibratory pile driving. Ocean Wind must immediately cease pile driving upon orders of the PSO unless shutdown is not practicable due to imminent risk of injury or loss of life to an individual as a result of pile refusal or pile instability. Pile driving must not restart until either the marine mammal(s) has voluntarily left the specific clearance zones and have been visually or acoustically confirmed beyond that clearance zone, or, when 30 minutes have elapsed with no further sightings or acoustic detections have occurred. Because a vibratory hammer can grip a pile without operating, pile instability should not be a concern and no caveat for re-starting pile driving due to pile instability is proposed.

As described above, unless an alternative monitoring plan is approved by BOEM, NMFS OPR, and NMFS GARFO and that plan demonstrates that PSOs working at night can observe the clearance and shutdown zones as well at night as during the day, pile driving would not be initiated at night, or, when conditions prevent the full extent of all relevant clearance zones to be confirmed to be clear of marine mammals, as determined by the lead PSO on duty. The requirement for the minimum visibility zone of 1,650 m (May-November, 2,000 m in December) and requirement that PSOs be working from two platforms (two near the pile driving platform, two on a vessel circling about 2,000 m from the pile), the full extent of the clearance zones are expected to be able to be observed. The clearance zones may only be declared clear, and pile driving started, when the full extent of all clearance zones are visible (*i.e.*, when not obscured by dark, rain, fog, etc.) for a full 30 minutes prior to pile driving. To ensure adequate visibility for PSOs, impact pile driving may commence only during daylight hours and no earlier than one hour after civil sunrise. Impact pile driving may not be initiated any later than 1.5 hours before civil sunset and may continue after dark only when the installation of that pile began during daylight hours, and must proceed for human safety or installation feasibility reasons (i.e., stopping would result in pile refusal or pile instability that would risk human life). Pile driving may continue after dark only when the driving of the same pile began during the day when clearance zones were fully visible and it was anticipated that pile installation could be completed before sundown. Given that the time to install the pile is expected to be predictable, we expect these instances of pile driving taking longer than anticipated to be very rare.

For impact pile driving, monitoring of the clearance zones by PSOs at the stationary platform and PSO vessel will be supplemented by real-time passive acoustic monitoring (PAM). PAM systems are designed to detect the vocalizations of marine mammals, allowing for detection of the presence of whales underwater or outside of the range where a visual observer may be able to detect the animals. Monitoring with PAM not only allows for potential documentation of any whales exposed to noise above thresholds of concern that were not detected by the visual PSOs but also allows for greater awareness of the presence of whales in the project area. As with the monitoring data collected by the visual PSOs, this information can be used to plan the pile driving schedule to minimize pile driving at times when whales are nearby and may be at risk of exposure to pile driving noise. The PAM system will be designed and established such that calls can be localized within 5 km from the pile driving location and to ensure that the PAM operator is able to review acoustic detections within 15 minutes of the original detection. If the PAM operator has confidence that a vocalization originated from a right whale located within the 5 km radius clearance zone, the appropriate associated clearance or shutdown procedures must be implemented (i.e., delay or stop pile driving). More details on PAM operator training and PAM protocols are included in the Notice of Proposed ITA (87 FR 64963-64969).

If a marine mammal is observed entering or within the respective clearance zones (Table 7.1.19) after pile driving has begun, a shutdown must be implemented. The purpose of a shutdown is to prevent a specific acute impact, such as auditory injury or severe behavioral disturbance of sensitive species, by halting the activity. Additionally, pile driving must be halted upon visual observation of a North Atlantic right whale by PSOs at any distance from the pile, or upon a confirmed PAM detection of a North Atlantic right whale within the shutdown zone. If a marine mammal is observed entering or within the respective shutdown zone after impact pile driving has begun, the PSO will request a temporary cessation of impact pile driving. In situations when shutdown is called for but Ocean Wind determines shutdown is not feasible due to imminent risk of injury or loss of life to an individual, or risk of damage to a vessel that creates risk of injury or loss of life for individuals, reduced hammer energy must be implemented. As described in section 3.3, in rare instances, shutdown may not be feasible as shutdown would result in a risk to human life. Specifically, pile refusal or pile instability could result in not being able to shut down pile driving immediately. Pile refusal occurs when the pile driving sensors indicate the pile is approaching refusal (i.e., the limits of installation), and a shutdown would lead to a stuck pile which then poses an imminent risk of injury or loss of life to an individual, or risk of damage to a vessel that creates risk for individuals. Pile instability occurs when the pile is unstable and unable to stay standing if the piling vessel were to "let go." During these periods of instability, the lead engineer may determine a shut-down is not feasible because the shut-down combined with impending weather conditions may require the piling vessel to "let go," which then poses an imminent risk of injury or loss of life to an individual, or risk of damage to a vessel that creates risk for individuals as it means the pile would be released while unstable and could fall over. As explained in section 3 and above, the likelihood of shutdown being called for and not implemented is considered to be very low.

After shutdown, impact pile driving may be restarted once all clearance zones are clear of marine mammals for the minimum species-specific periods, or, if required to maintain pile stability, at which time the lowest hammer energy must be used to maintain stability. If pile driving has been shut down due to the presence of a North Atlantic right whale, pile driving may not restart until the North Atlantic right whale is no longer observed or 30 minutes has elapsed since the last detection. Upon re-starting pile driving, soft start protocols must be followed.

Consideration of the Effectiveness of Clearance and Shutdown Zones

Sperm Whales

Impact Pile Driving

Modeling indicates that no sperm whales will be exposed to noise during pile driving above the Level A harassment threshold. There will be at least two PSOs stationed at an elevated position at or near the pile being driven, as well as at least two PSOs stationed on a dedicated PSO vessel moving in a radius around the pile between the pile driving vessel and the edge of the large whale clearance zone (2,000 m from the pile). Given that PSOs are reasonably expected to be able to detect large whales at distances of at least 1.5 km from their station (Roberts et al. 2016[37]) and that there will be PSOs monitoring from the two locations–at or near the pile and at or near the clearance zone's edge–we expect that the PSOs will be able to effectively monitor the clearance zone (2,000 m in the summer and 2,500 m in the winter). As explained above, noise above the Level A peak harassment threshold is not anticipated to occur.

For sperm whales, the distance to the cumulative Level A harassment threshold extends less than 18 m from the pile being driven. Given the ability of a PSO to detect sperm whales at this distance, it is not reasonable to expect that pile driving would be started with a sperm whale at this distance. Further, the cumulative threshold considers that an individual whale is exposed to the total duration of pile driving during a 24-hour period. It is not reasonable to expect that even if a sperm whale swam into the exclusion zone while pile driving was occurring and pile driving could not be halted, that the whale would stay within 18 m of a monopile foundation for the duration of all pile driving during a 24-hour period, which would be approximately 4 hours. Based on this, maintenance of the exclusion zone is expected to result in exposure of sperm whales to noise above the Level A harassment threshold being extremely unlikely to occur. As such, we conclude that it is extremely unlikely that any sperm whales will experience permanent threshold shift or any other injury. This is consistent with the conclusions made by BOEM in the BA and by NMFS OPR, both determining that no Level A take of sperm whales was expected. We also note that Ocean Wind did not request an authorization for Level A take of sperm whales. However, given that the size of the area with noise above the Level B harassment threshold is larger than the clearance and shutdown zone, the exclusion and shutdown procedures may limit the duration of exposure of sperm whales to noise above the Level B harassment thresholds but do not eliminate the potential for exposure. Therefore, given exposure modeled and presented in the Proposed ITA and BA, which is the best available scientific information, we conclude that 6 sperm whales may be exposed to noise above the Level B harassment threshold during the installation of monopiles and/or pin piles.

[37] Roberts et al. 2016 reports an effective strip width (a measure of how far animals are seen from the vessel) for North Atlantic right whales (1,309 m) and beaked whales (1,587 m). Detectability from the pile driving platform may be greater given the stability, elevation of the observers, the number of observers used, and the requirement to only install piles during good visibility conditions.

Vibratory Pile Driving
Modeling indicates that the Level A harassment thresholds will not be exceeded for mid-frequency cetaceans (including sperm whales) during vibratory installation or removal of piles. The clearance and shutdown zone of 150 m will be able to be effectively monitored for any large whales.

Blue, Fin, and Sei Whales
As explained above, noise above the Level A peak harassment threshold is not anticipated to occur. During monopile installation, to be exposed to noise above the Level A cumulative threshold, a blue, fin, or sei whale would need to remain within 1.65 km or 2.49 km of the pile being driven depending on the time of year for the entire duration of the pile installation (i.e., 4 hours). These distances align with the minimum visibility requirements for the visual PSOs. For pin piles the distances to the Level A cumulative threshold are smaller (less than 1 km). Given the very low predicted density of blue whales in the WDA, no blue whales are expected to be exposed to pile driving noise above the Level A cumulative threshold.

The modeling presented in the BA and proposed ITA predicts the exposure of up to 4 fin whales and 1 sei whale to noise above the cumulative Level A harassment threshold. As explained above, we expect that the PSO will be able to reliably detect large whales at distances up to 1.5 km from their monitoring station (Roberts et al. 2016). PSOs will be on an elevated platform near the pile driving vessel and on a boat transiting within the clearance zone at a distance of about 2,000 m from the pile. The distance to the cumulative Level A harassment threshold is smaller than the distance through the clearance zone. For large whales other than North Atlantic right whales, the shutdown distance is 1,800 m May – November and 2,500m in December, which is just larger than the distance to the level A cumulative harassment threshold. Given the visibility requirements and the ability of the PSOs to monitor the entirety of the clearance zone, it is unlikely that any pile driving would begin with a fin, or sei whale within the clearance zone. However, we do not expect the clearance and shutdown procedures to be wholly effective at eliminating exposure of all sei and fin whales to noise above the Level A cumulative threshold. This is because the PSOs may not be able to detect a blue, sei, or fin whale as soon as it enters the clearance zone, particularly if the whale is submerged, pile driving is started late in the day and continues after dark, or if there is a sudden change in weather conditions that affects visibility. Even if a fin or sei whale is detected immediately upon entering the shutdown zone, it will take some time to initiate a shutdown, and in rare events a shutdown may not be possible. As such, we expect that even with adherence to the clearance and shutdown requirements, up to 4 fin whales and 1 sei whale may be exposed to pile driving noise above the cumulative Level A harassment threshold.

Given that the size of the area with noise above the Level B harassment threshold is larger than the clearance and shutdown zone, the exclusion and shutdown procedures may limit the duration of exposure to noise above the Level B harassment thresholds but are not expected to eliminate the potential for exposure to noise above the Level B harassment threshold. Therefore, we cannot reduce or refine the take estimates based on the Level B harassment thresholds in consideration of the effectiveness of the clearance zone. We anticipate that, as modeled and presented in the Proposed ITA and BA, 4 blue, 10 fin, and 2 sei whales may be exposed to noise above the Level B threshold during the installation of monopiles and/or pin piles.

Vibratory Pile Driving
Modeling indicates that the Level A harassment thresholds will not be exceed for low-frequency cetaceans (including blue, fin, and sei whales) during vibratory installation or removal of piles. The clearance and shutdown zone of 150 m will be able to be effectively monitored for any large whales. However, given that the size of the area with noise above the Level B harassment threshold is very large and much larger than the clearance and shutdown zone, the clearance and shutdown procedures are not expected to reduce or eliminate the potential for exposure above the Level B harassment threshold. Therefore, given the size of the area, we cannot reduce or refine the take estimates based on consideration of the effectiveness of the exclusion zone. We anticipate that, in light of the best available scientific information on exposure, which is modeled and presented in the Proposed ITA and BA, 2 fin, 1 sei and 3 sperm whales may be exposed to noise above the Level B threshold.

Right Whales
As noise will not exceed the Level A peak noise threshold during installation of monopiles or jackets, no right whales will be exposed to noise above the Level A threshold. The model results indicate that 0.9 right whales are expected to be exposed above the Level A cumulative threshold during the installation of 98 monopiles and 0.04 or 0.1 right whales during the installation of the OSS foundations, depending on whether it is 3 monopiles or 3 jackets. This exposure estimate incorporates the time of year restriction (i.e., no pile driving January 1 – April 30) and 10 dB sound attenuation.

The best available data provides NMFS confidence that North Atlantic right whales are expected in the WDA predominantly from January – April (Roberts et al. 2022), with the highest density months outside of that period being May and December. Right whales predominantly use the WDA as they migrate north in March and April and south in November and December. While opportunistic foraging may occur in the WDA if prey is available in suitable densities to trigger foraging behavior, the WDA is not an area where right whales are known to aggregate for foraging, and it is not known to support regular or sustained foraging. Additionally, neither mating nor calving are known or expected to occur in the WDA.

Due to this seasonal pattern in North Atlantic right whale occurrence in the project area, we expect the most significant measure to minimize impacts to North Atlantic right whales is the prohibition on impact pile driving from January through April, when North Atlantic right whale abundance in the project area is greatest. During impact pile driving, PSOs and PAM will be used to monitor clearance and shutdown zones for right whales. A clearance zone larger than the distance to the Level A cumulative harassment threshold will be maintained for North Atlantic right whales through the use of PAM and PSOs. The PAM clearance zone is 3,500 from May – November and 3,800 m in December. Pile driving cannot begin if a right whale is detected via PAM within those distances or is detected by the visual PSOs at any distance from the pile to be driven. The minimum visibility requirement is 1,650 m May – November and 2,500 m in December. Visual PSOs are expected to be able to monitor the area extending at least 3,500 m from the pile being driven (considering placement at the pile driving platform and on a vessel 2,000 m from the pile being driven with a visual range of another 1,500 m), which is larger than the area where noise will be above the Level A cumulative noise threshold (for monopiles: 1.37

km May – November, 2.03 km in December; for pin piles: 0.58 km May – November, 0.70 km December). Visual monitoring will be supplemented by PAM, which has the potential to detect vocalizing right whales that are too far away to be seen by the visual observer or that are submerged. As noted above, pile driving will not begin if the PSOs detect a right whale within any distance from the pile (i.e., even if it is further away than the Level A cumulative harassment threshold distance) or if a right whale is detected via PAM within 3,500 m of the pile from May – November or 3,800 m in December. We expect that these measures in combination with the requirements for monitoring North Atlantic right whale sightings reports, which increases awareness of potential North Atlantic right whales in the WDA, and the low density of right whales in the WDA when pile driving could occur make it extremely unlikely that pile driving would begin with a right whale in the clearance zone. Shutdown is required if a PSO observes a right whale at any distance from the pile being driven or if a whale at a distance of 1,000 m of the pile cannot be detected to species. Additionally, shutdown is required if a right whale is detected via PAM within 1,650 m of the pile from May – November or 2,500 m in December. As explained above and detailed in section 3, instances where a shutdown is called for and is not able to be implemented are expected to be very rare.

Together, we expect the use of PAM and visual PSOs at two locations to be able to effectively monitor the clearance zone before pile driving and the shutdown zone during pile driving. If a right whale is detected within the shutdown zone, it is expected that pile driving will be stopped and not re-started until the right whale has left the clearance zone. This would prevent the right whale from being close enough to the pile driving for long enough to exceed the Level A (cumulative) harassment threshold. In the event that shutdown cannot occur (i.e., to prevent imminent risk of injury or loss of life to an individual, or risk of damage to a vessel that creates risk for individuals), the energy that the pile driver operates at will be reduced. The lower energy results in less noise and shorter distances to thresholds. As such, even if shutdown cannot occur, we do not expect that a right whale would remain close enough to the pile being driven for a long enough period to be exposed to noise above the Level A cumulative harassment threshold. As a result of these mitigation measures, and in light of our independent review, we agree with BOEM's and NMFS OPR's determinations that the already small potential for North Atlantic right whales to be exposed to project-related sound above the Level A cumulative harassment threshold is extremely unlikely to occur. As such, we conclude that it is extremely unlikely that any right whales will experience permanent threshold shift or any other injury.

The use of PSOs and PAM to monitor the clearance zone may also reduce the potential for exposure of North Atlantic right whale to noise above the Level B harassment threshold. However, as the distance to the Level B harassment threshold is larger than the clearance and shutdown zones, and it will still represent an area that right whales would avoid during pile driving, these effects will not be eliminated. Therefore, we anticipate that, based on the best available scientific information modeled and presented in the Proposed ITA and BA, 5 right whales may be exposed to noise above the Level B threshold during impact pile driving for WTG and OSS foundations.

Vibratory Pile Driving

Modeling indicates that the Level A harassment thresholds will not be exceeded for low-frequency cetaceans (including right whales) during vibratory installation or removal of piles.

The clearance and shutdown zone of 150 m will be able to be effectively monitored for any large whales. However, given that the size of the area with noise above the Level B harassment threshold is very large and much larger than the clearance and shutdown zone, the clearance and shutdown procedures are not expected to reduce or eliminate the potential for exposure above the Level B harassment threshold. Therefore, given the size of the area, we cannot reduce or refine the take estimates for the cumulative noise threshold based on consideration of the effectiveness of the exclusion zone. We anticipate that, based on our independent review of exposure estimates modeled and presented in the Proposed ITA and BA, 1 right whale may be exposed to noise above the Level B threshold during vibratory pile driving for installation and removal of cofferdams.

Soft Start

As described in the Notice of Proposed ITA (87 FR 64968), the use of a soft start procedure is believed to provide additional protection to marine mammals by warning marine mammals or providing them with a chance to leave the area prior to the hammer operating at full capacity, and typically involves a requirement to initiate sound from the hammer at reduced energy followed by a waiting period. Ocean Wind will utilize soft start techniques for impact pile driving including by performing 4-6 strikes per minute at 10 to 20 percent of the maximum hammer energy (i.e., 400 to 800 KJ), for a minimum of 20 minutes. Soft start would be required at the beginning of each day's impact pile driving work and at any time following a cessation of impact pile driving of thirty minutes or longer. Without soft start procedures, pile driving would begin with full hammer energy, which would present a greater risk of more severe impacts to more animals. In this context, soft start is a mitigation measure designed to reduce the amount and severity of effects incidental to pile driving.

Use of a soft start can reduce the cumulative sound exposure if animals respond to a stationary sound source by swimming away from the source quickly (Ainslie et al. 2017). The result of the soft start will be an increase in underwater noise in an area radiating from the pile that is expected to exceed the Level B harassment threshold and, therefore, is expected to cause any whales exposed to the noise to swim away from the source. The use of the soft start gives whales near enough to the piles to be exposed to the soft start noise a "head start" on escape or avoidance behavior by causing them to swim away from the source. It is possible that some whales may swim out of the noisy area before full force pile driving begins; in this case, the number of whales exposed to noise that exceeds the cumulative Level A harassment threshold would be reduced. It is likely that by eliciting avoidance behavior prior to full power pile driving, the soft start will reduce the duration of exposure to noise that could result in Level A or Level B harassment. However, we are not able to predict the extent to which the soft start will reduce the number of whales exposed to pile driving noise or the extent to which it will reduce the duration of exposure. Therefore, while the soft start is expected to reduce effects of pile driving, we are not able to modify the estimated take numbers to account for any benefit provided by the soft start.

Sound Field Verification

Through conditions of the proposed ITA and conditions of the proposed COP approval, Ocean Wind will conduct sound field verification for the first three monopiles and a full jacket foundation (16 pin piles). As explained above, the differences in conditions (i.e., water depth, temperature, substrate type) across the lease area that could result in variations in noise propagation are minimal; thus, it is expected that any particular pile installation will be representative of other pile locations throughout the lease area. However, Ocean Wind is required to conduct sound field verification of any additional monopiles and pin piles in locations that are not represented by the previous locations where sound field verification was carried out. Details of the required sound field verification are included in the proposed MMPA ITA.

The required sound field verification will provide information necessary to confirm that the sound source characteristics predicted by the modeling are reflective of actual sound source characteristics in the field. As described in the proposed MMPA ITA, if sound field verification measurements on any of the first three piles indicate that the ranges to Level A harassment and Level B harassment isopleths are larger than those modeled, assuming 10-dB attenuation, Ocean Wind must modify and/or apply additional noise attenuation measures (e.g., improve efficiency of bubble curtain(s), modify the piling schedule to reduce the source sound, install an additional noise attenuation device) before the second pile is installed. Until sound field verification confirms the ranges to Level A harassment and Level B harassment isopleths are less than or equal to those modeled, assuming 10-dB attenuation, the shutdown and clearance zones must be expanded to match the ranges to the Level A harassment and Level B harassment isopleths based on the sound field verification measurements. If the application/use of additional noise attenuation measures still does not achieve ranges less than or equal to those modeled, assuming 10-dB attenuation, and no other actions can further reduce sound levels, Ocean Wind must expand the clearance and shutdown zones according to those identified through sound field verification, in coordination with NMFS OPR. In the event that sound field verification indicates that characteristics in the field are such that the model is invalid or is determined to underestimate exposure of listed species, reinitiation of this consultation may be necessary.

7.1.3.2 Effects to ESA-Listed Whales from Exposure to Pile Driving Noise

Effects of Exposure to Noise Above the Level A Harassment Threshold

As explained above, four fin whale and one sei whale are expected to be exposed to impact pile driving noise that is loud enough to result in Level A harassment in the form of permanent threshold shift. Consistent with OPR's determination in the notice of proposed ITA, in consideration of the duration and intensity of noise exposure we expect that the consequences of exposures above the Level A harassment threshold would be in the form of slight permanent threshold shift (PTS), i.e. minor degradation of hearing capabilities within regions of hearing that align most completely with the energy produced by pile driving (i.e. the low-frequency region below 2 kHz), not severe hearing impairment. If hearing impairment occurs, it is most likely that the affected animal would lose a few decibels in its hearing sensitivity, which, given the limited impact to hearing sensitivity, is not likely to meaningfully affect its ability to forage and communicate with conspecifics. No severe hearing impairment or serious injury is expected because of the received levels of noise anticipated and the short duration of exposure. The PTS anticipated is considered a minor but permanent auditory injury. The measures designed to minimize exposure or effects of exposure that are proposed to be required by NMFS OPR through the terms of the ITA, and by BOEM through the conditions of COP approval, and implemented by Ocean Wind–all of which are considered elements of the proposed action–make it extremely unlikely that any whale will be exposed to pile driving noise that would result in severe hearing impairment or serious injury. Through use of soft start, marine mammals are expected to move away from a sound source that is annoying, thereby avoiding exposure resulting in a serious injury and avoiding sound sources at levels that would cause hearing loss (Southall et al. 2007, Southall et al. 2016). The potential for serious injury is also minimized through the use of a sound attenuation system, and the implementation of clearance zones. The latter would facilitate a delay of pile driving if marine mammals were observed approaching or within areas that could be ensonified above sound levels that could result in auditory injury. The proposed requirement that pile driving can only commence when the clearance zone is fully visible to PSOs will ensure a high marine mammal detection capability, which will enable a high rate of success in implementation of clearance zones to avoid serious injury.

Effects of Exposure to Noise Above the Level B Harassment Threshold
Considering impact and vibratory pile driving, we anticipate that up to 4 blue, 12 fin, 6 right, 3 sei, and 6 sperm whales will be exposed to noise above the Level B harassment threshold. Potential impacts associated with this exposure would include only low-level, temporary behavioral modifications, most likely in the form of avoidance behavior or potential alteration of vocalizations, as well as potential Temporary Threshold Shift (TTS).

An extensive discussion of TTS is presented in the proposed MMPA ITA (87 FR 64986-64987) and is summarized here, with additional information presented in Southall et al. (2019) and NMFS 2018. TTS represents primarily tissue fatigue and is reversible (Henderson et al. 2008). In addition, investigators have suggested that TTS is within the normal bounds of physiological variability and tolerance and does not represent physical injury (*e.g.,* Ward, 1997; Southall *et al.,* 2019). Therefore, NMFS does not consider TTS to constitute auditory injury.

While experiencing TTS, the hearing threshold rises, and a sound must be at a higher level in order to be heard; that is, the animal experiences a temporary loss of hearing sensitivity. TTS, a temporary hearing impairment, can last from a few minutes to days, be of varying degree, and occur across different frequency bandwidths. All of these factors determine the severity of the impacts on the affected individual, which can range from minor to more severe. In many cases, hearing sensitivity recovers rapidly after exposure to the sound ends. Observations of captive odontocetes suggest that wild animals may have a mechanism to self-mitigate the impacts of noise exposure by dampening their hearing during prolonged exposures to loud sound, or if conditioned to anticipate intense sounds (Finneran, 2018, Nachtigall *et al.,* 2018).

Impact and vibratory pile driving generate sounds in the lower frequency ranges (with most of the energy below 1-2 kHz but with a small amount energy ranging up to 20 kHz); therefore, in general and all else being equal, we would anticipate the potential for TTS as more likely to occur in frequency bands in which the animals communicate. However, we would not expect the TTS to span the entire communication or hearing range of any species, given the frequencies produced by pile driving do not span entire hearing ranges for any particular species. Additionally, though the frequency range of TTS that marine mammals might sustain would overlap with some of the frequency ranges of their vocalization types, the frequency range of TTS from Ocean Wind's pile driving activities would not usually span the entire frequency range of one vocalization type, much less span all types of vocalizations or other critical auditory cues for any given species.

Generally, both the degree of TTS and the duration of TTS would be greater if the marine mammal is exposed to a higher level of energy (which would occur when the peak dB level is higher or the duration is longer). Source level alone is not a predictor of TTS. An animal would have to approach closer to the source or remain in the vicinity of the sound source appreciably longer to increase the received SEL, which would be difficult considering the proposed mitigation and the anticipated movement of the animal relative to the stationary sources such as impact pile driving. The recovery time of TTS is also of importance when considering the potential impacts from TTS. In TTS laboratory studies--some using exposures of almost an hour in duration or up to 217 SEL--almost all individuals recovered within 1 day or less, often in minutes. We note that while the impact pile driving activities last for four hours at a time, it is unlikely that ESA listed whales would stay in the close proximity to the source long enough to incur more severe TTS. Overall, given that we do not expect an individual to experience TTS from pile driving more than once, the low degree of TTS and the short anticipated duration (less than a day), and that it is extremely unlikely that any TTS overlapped the entirety of a critical hearing range, we expect that the effects of any behavioral response to this TTS will be so small that it cannot be meaningfully measured, evaluated, or detected. Thus, this minor, temporary hearing loss is unlikely to have any consequences to the health or fitness of any individual. Effects of TTS resulting from exposure to Ocean Wind project noise are addressed more fully below.

In order to evaluate whether or not individual behavioral responses, in combination with other stressors, impact animal populations, scientists have developed theoretical frameworks that can then be applied to particular case studies when the supporting data are available. One such framework is the population consequences of disturbance model (PCoD), which attempts to assess the combined effects of individual animal exposures to stressors at the population level (NAS 2017). Nearly all PCoD studies and experts agree that infrequent exposures of a single day or less are unlikely to impact individual fitness, let alone lead to population level effects (Booth et al. 2016; Booth et al. 2017; Christiansen and Lusseau 2015; Farmer et al. 2018; Harris et al. 2017; Harwood and Booth 2016; King et al. 2015; McHuron et al. 2018; NAS 2017; New et al. 2014; Pirotta et al. 2018; Southall et al. 2007; Villegas-Amtmann et al. 2015).

Since we expect that any exposures would be brief (limited only to the time it takes to swim out of the area with noise above the Level B threshold but never more than 4 hours), and repeat exposures to the same individuals are unlikely (based on abundance, distribution and sightings data including that whales in the WDA are transient and not remaining in the area for extended periods), any behavioral responses that would occur due to animals being exposed to pile driving are expected to be temporary, with behavior returning to a baseline state shortly after the acoustic stimuli ceases (i.e., pile driving stops or the animal swims far enough away from the source to no longer be exposed to disturbing levels of noise). Given this, and our evaluation of the available PCoD studies, any such behavioral responses are not expected to impact individual animals' health or have effects on individual animals' survival or reproduction. Specific effects to the different species are considered below.

North Atlantic Right Whales

We expect that 6 North Atlantic right whales may experience TTS or behavioral disturbance from exposure to pile driving noise. We expect that this exposure will be of six different individuals each experiencing a single exposure to pile driving noise above the Level B harassment threshold. We expect that up to 5 individuals will be exposed to impact pile driving noise, which will last for no more than four hours at a time, and 1 individual will be exposed to vibratory pile driving noise, which will last for no more than 12 hours. We do not expect repeat exposures (i.e., the same individual exposed to multiple pile driving events) due to the transient nature of individual right whales in the WDA. That is, because right whales are not expected to stay in the WDA for any extended period of time (regardless of pile driving activity) we do not expect an individual to be present in the WDA for multiple days such that it could be exposed to multiple pile driving events. When in the action area surrounding and including the WDA, where noise exposure would occur, the primary activity North Atlantic right whales are expected to be engaged in is migration. However, we also expect the animals to perform other behaviors, including opportunistic foraging and resting. If North Atlantic right whales exhibited a behavioral response to the pile driving noise, the activity that the animal was carrying out would be disrupted, and it may pose some energetic cost; these effects are addressed below. Because use of this area is limited to transient individuals, we do not expect that animals displaced from a particular portion of the area due to exposure to pile driving noise would return to the area, rather, they would continue their normal behaviors from the location they moved to.

Right whales are considerably slower than the other whale species in the action area, with maximum speeds of about 9 kilometers per hour (kph). Hatin et al. (2013) report median swim speeds of singles, non mother-calf pairs, and mother-calf pairs in the southeastern United States recorded at 1.3 kph, with examples that suggest swim speeds differ between within-habitat movement and migration-mode travel (Hatin et al. 2013). Studies of marine mammal avoidance of sonar, which like pile driving is an impulsive sound source, demonstrate clear, strong, and pronounced behavioral changes, including sustained avoidance with associated energetic swimming and cessation of feeding behavior (Southall et al. 2016) suggesting that it is reasonable to assume that a whale exposed to noise above the Level B harassment threshold would take a direct path to get outside of the noisy area. During impact pile driving of monopiles, the area with noise above the Level B harassment threshold extends no more than 2.98 km in May-November and 3.35 km in December from the pile being driven, with much smaller areas during impact pile driving of pin piles (1.72 and 2.11 km). As such, considering a right whale that was at the pile driving location when pile driving starts (i.e., at the center of the area with a 1.72-3.35 km radius that will experience noise above the 160 dB re 1uPa threshold), we would expect that right whale swimming at maximum speed (9 kph) would escape from the area with noise above 160 dB re 1uPa the noise in about 11-22 minutes, but at the median speed observed in Hatin et al. (1.3 kph, 2013), it would take the animal approximately 1.3-2.5 hours to move out of the noisy area. However, given the requirements for ensuring an area extending 5 km from the pile is clear of right whales before pile driving begins, such a scenario is unlikely to occur. Rather, it is far more likely that any exposure and associated disturbance would be for a significantly shorter period of time as a right whale would be much further from the pile being driven when pile driving started. In any event, it would not exceed the period of pile driving (about four hours a day for a monopile installed with an impact hammer).

During vibratory pile driving, which is considered a continuous noise source, the area predicted to have noise above the 120 dB re 1uPa threshold is approximately 77-164 km^2 with the maximum distance to the Level B threshold of approximately 10 km (Küsel et al. 2022). As such, a right whale located at the edge of the 150 m clearance zone would need to swim 10 km from the cofferdam being installed to clear the area with noise above the 120 dB re 1uPa threshold. At a speed of 9 km/h, it would need to travel for less than an hour, at 1.3 km/h it would take the whale nearly 8 hours.

Based on best available information that indicates whales resume normal behavior quickly in their new location after the cessation of sound exposure (e.g., Goldbogen et al. 2013a; Melcon et al. 2012), we anticipate that the six individuals exposed to noise above the Level B harassment threshold will resume normal behavioral patterns (i.e., resting, migrating, foraging) after the exposure ends. If an animal exhibits an avoidance response, it would experience a cost in terms of the energy associated with traveling away from the acoustic source. That said, migration is not considered a particularly costly activity in terms of energetics (Villegas-Amtmann et al. 2015). An animal that was migrating through the area and was exposed to pile driving noise would make minor alterations to their route, taking them 1.72 to 10 km out of their way. This is far less than the distance normally travelled over the course of a day (they have been tracked moving more than 80 km in a day in the Gulf of St. Lawrence) and we expect that even for stressed individuals or mother-calf pairs, this alteration in course would result in only a small energetic impact that would not have consequences for the animals health or fitness.

The WDA and surrounding areas where pile driving noise will be experienced are not known to regularly support right whale prey in sufficient densities to support foraging. Observations of potentially foraging right whales in the WDA and surrounding waters is limited to two juveniles exhibiting lunge feeding behavior; however, foraging was not confirmed as no sampling was carried out and no observable prey patches were detected. Due to a lack of prey in sufficient densities, opportunities for foraging are expected to be limited in the WDA and surrounding waters where increased noise will be experienced during pile driving. The area is not known to support dense aggregations of copepods that right whales seek out as forage. Rather, any consumption of prey is likely opportunistic, infrequent, and limited to copepod species and/or aggregations with lower energy values and thus less desirability. Given that, it is very unlikely that foraging would be disrupted or that energetic loss from displaced foraging would be significant. Goldbogen et al. (2013a) hypothesized that if the temporary behavioral responses due to acoustic exposure interrupted feeding behavior, this could have impacts on individual fitness and eventually, population health. However, for this to be true, we would have to assume that an individual whale could not compensate for this lost feeding opportunity by either immediately feeding at another location once it escapes the noisy area, by feeding shortly after cessation of acoustic exposure, or by feeding at a later time. Based on the information presented above, there is no indication this assumption is reasonable to expect. We also note that unconsumed prey would still be available in the environment following the cessation of acoustic exposure (i.e., the pile driving is not expected to disrupt copepod prey). The disruption or loss of a single foraging opportunity for a period of minutes to at most a few hours is not likely to impact the health or fitness of any individual; this is because it is not likely to represent any loss in available energy and the lack of repeated exposure means the animal can make up for the lost opportunity.

We have also considered the possibility that a resting animal could be exposed to pile driving noise and its rest disturbed. Resting would be disrupted until the animal moved outside of the area with increased pile driving noise. As explained above, we expect this disruption would last between 11 minutes to 2.5 hours if it was one of the five right whales expected to be exposed to disturbing levels of noise during impact pile driving and 1 to 8 hours for the one right whale expected to be exposed to disturbing levels of noise during vibratory pile installation/removal of cofferdams. Given that disruptions to resting will be a one-time event that likely lasts only a few minutes and at most a few hours, we expect that any exposed individuals would be able to make up that lost rest without consequences to their health or fitness.

Stress responses are also anticipated in the six right whales experiencing temporary behavioral disruption. However, the available literature suggests these acoustically induced stress responses will be of short duration (similar to the duration of exposure), and not result in a chronic increase in stress that could result in physiological consequences to the animal; this is true for all potentially exposed animals, including mother-calf pairs. The stress response is expected to fully resolve when the animal has moved away from the disturbing levels of noise; as such, the stress response is limited to between 11 minutes to 2.5 hours if it was one of the five right whales expected to be exposed to disturbing levels of noise during impact pile driving and 1 to 8 hours for the one right whale expected to be exposed to disturbing levels of noise during vibratory pile installation/removal of cofferdams. These short-term stress responses are not equivalent to stress responses and associated elevated stress hormone levels that have been observed in North Atlantic right whales that are chronically entangled in fishing gear (Rolland et al. 2017). This is also in contrast to stress level changes observed in North Atlantic right whales due to fluctuations in chronic ocean noise. Rolland et al. (2012) documented that stress hormones in North Atlantic right whales significantly decreased following the events of September 11, 2001 when shipping was significantly restricted. This was thought to be due to the resulting decline in ocean background noise level because of the decrease in shipping traffic. As noted in Southall et al. (2007a), substantive behavioral reactions to noise exposure (such as disruption of critical life functions, displacement, or avoidance of important habitat) are considered more likely to be significant if they last more than 24 hours, or recur on subsequent days; this is not the case here as the behavioral response and associated effects will in all cases last less than 12 hours and will not recur on subsequent days. Because we expect these 6 individuals to only be exposed to a single pile driving event, we do not expect chronic exposure to pile driving noise. In summary, we do not anticipate long duration exposures to occur, and we do not anticipate that behavioral disturbance and associated stress response as a result of exposure to pile driving noise will affect the health of any individual and therefore, there would be no consequences on body condition or other factor that would affect health, survival, reproductive or calving success**.**

TTS represents primarily tissue fatigue and is reversible (Southall et al., 2007). Temporary hearing loss is not considered physical injury but will cause auditory impairment to animals over the short period in which the TTS lasts. The TTS experienced by up to 6 right whales is expected to be a minor degradation of hearing capabilities within regions of hearing that align most completely with the energy produced by pile driving (i.e. the low-frequency region below 2 kHz), not severe hearing impairment. If hearing impairment occurs, it is most likely that the affected animal would lose a few decibels in its hearing sensitivity, which, given the limited impact to hearing sensitivity, is not likely to meaningfully affect its ability to forage and communicate with conspecifics, including communication between mothers and calves. We anticipate that any instances of TTS will be of minimum severity and short duration. This conclusion is based on literature indicating that even following relatively prolonged periods of sound exposure resulting in TTS, recovery occurs quickly (Finneran 2015). TTS will resolve within a week of exposure (that is, hearing sensitivity will return to normal) and is not expected to affect the health of any whale or its ability to migrate, forage, breed, or calve (Southall et al. 2007).

Masking occurs when the receipt of a sound is interfered with by another coincident sound at similar frequencies and at similar or higher intensity. Pile driving noise may mask right whale calls and could have effects on mother-calf communication and behavior. If such effects were severe enough to prevent mothers and calves from reuniting or initiating nursing, they may result in missed feeding opportunities for calves, which could lead to reduced growth, starvation, and even death. Any mother-calf pairs in the action area would have left the southern calving grounds and be making northward migrations to northern foraging areas. The available data suggests that North Atlantic right whale mother-calf pairs rarely use vocal communication on the calving grounds and so the two maintain visual contact until calves are approximately three to four months of age (Parks and Clark 2007; Parks and Van Parijs 2015; Root-Gutteridge et al. 2018; Trygonis et al. 2013). Such findings are consistent with data on southern right and humpback whales, which appear to rely more on mechanical stimulation to initiate nursing rather than vocal communication (Thomas and Taber 1984; Videsen et al. 2017). When mother-calf pairs leave the calving grounds and begin to migrate to the northern feeding grounds, if they begin to rely on acoustic communication more, then any masking could interfere with mother-calf reunions. For example, even though humpback whales do not appear to use vocal communication for nursing, they do produce low-level vocalizations when moving that have been suggested to function as cohesive calls (Videsen et al. 2017). However, when calves leave the foraging grounds at around four months of age, they are expected to be more robust and less susceptible to a missed or delayed nursing opportunity. Any masking would only last for the duration of the exposure to pile driving noise, which in all cases would be no more than four hours. As such, even if masking were to interfere with mother-calf communication in the action area, we do not anticipate that such effects would result in fitness or health consequences given their short-term nature. We also note that given the time of year restriction on impact pile driving and that mother-calf pairs are most likely to swim through the WDA in March and April (LaBreque et al. 2015) and are less likely to be present when impact pile driving occurs between May and December.

Quantifying the fitness consequences of sub-lethal impacts from acoustic stressors is exceedingly difficult for marine mammals, and we do not currently have data to conduct a quantitative analysis on the likely consequences of such sub-lethal impacts. While we are unable to conduct a quantitative analysis on how sub-lethal behavioral effects and temporary hearing impacts (i.e., masking and TTS) may impact animal vital rates (and therefore fitness), based on the best available information, we expect an increased likelihood of consequential effects when exposures and associated effects are long-term and repeated, occur in locations where the animals are conducting critical activities, and when the animal affected is in a compromised state. While we acknowledge that some of the 6 right whales exposed to pile driving noise may be in a compromised state, individual exposures will be short term (in most cases less than an hour but for one individual up to 8-12 hours) and none will be repeated. Animals in this area are transient. The effects of this temporary exposure and associated behavioral response will not affect the health or fitness of any individual right whale.

Harris et al. (2017a) summarized the research efforts conducted to date that have attempted to understand the ways in which behavioral responses may result in long-term consequences to individuals and populations. Efforts have been made to try to quantify the potential consequences of such responses, and frameworks have been developed for this assessment (e.g., Population Consequences of Disturbance). However, models that have been developed to date to address this question require many input parameters and, for most species, there are insufficient data for parameterization (Harris et al. 2017a). Nearly all studies and experts agree that infrequent exposures of a single day or less are unlikely to impact an individual's overall energy budget (Farmer et al. 2018; Harris et al. 2017b; King et al. 2015b; NAS 2017; New et al. 2014; Southall et al. 2007d; Villegas-Amtmann et al. 2015). Based on best available information, we expect this to be the case for North Atlantic right whales exposed to pile driving noise even for animals that may already be in a stressed or compromised state due to factors unrelated to the Ocean Wind project. We do not anticipate that instances of behavioral response and any associated energy expenditure or stress will impact an individual's overall energy budget or result in any health or fitness consequences to any individual North Atlantic right whales.

The ESA's definition of take includes harassment of a listed species. NMFS Interim Guidance on the ESA Term "Harass" (PD 02-110-19; December 21, 2016[38] provides for a four-step process to determine if a response meets the definition of harassment. The Interim Guidance defines harassment as to "[c]reate the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering." The guidance states that NMFS will consider the following steps in an assessment of whether proposed activities are likely to harass: 1) Whether an animal is likely to be exposed to a stressor or disturbance (i.e., an annoyance); and 2) The nature of that exposure in terms of magnitude, frequency, duration, etc. Included in this may be type and scale as well as considerations of the geographic area of exposure (e.g., is the annoyance within a biologically important location for the species, such as a foraging area, spawning/breeding area, or nursery area?); 3) The expected response of the exposed animal to a stressor or disturbance (e.g., startle, flight, alteration [including abandonment] of important behaviors); and 4) Whether the nature and duration or intensity of that response is a significant disruption of those behavior patterns which include, but are not limited to, breeding, feeding, or sheltering, resting or migrating.

Here, we carry out that four-step assessment to determine if the effects to the six individuals expected to be exposed to noise above the Level B harassment threshold meet the definition of harassment. As explained above, the six individual right whales exposed to disturbing levels of noise, are expected to abandon their activity for up to four hours during impact pile driving to install a monopile, or up to 12 hours during vibratory installation or removal of the cofferdam, while they swim to an alternate area to resume this behavior. Or, they will avoid the ensonified

[38] Available at: https://www.fisheries.noaa.gov/national/laws-and-policies/protected-resources-policy-directives

area extending 1.72-3.35km from the pile being driven for the four-hour duration of the impact pile driving or the area extending 10 km from the cofferdam for a 12-hour period. This means they will need to alter their migration route or disrupt any resting or foraging. As explained above, the energetic costs of these alterations to movements are expected to be insignificant because of the short duration and small distance that needs to be travelled. The consequences of disrupting resting are not documented, however, it is reasonable to expect that a single disturbance of resting would be fully recoverable, even for animals in a compromised state. As noted above, foraging in the area affected by pile driving noise is expected to be rare; as such, disruptions of foraging are not expected. However, even if they did occur it would be the disruption of a single opportunistic foraging event. A single lost foraging event in this area is not expected to have consequences to the health or fitness of any individual, even stressed individuals, or mother-calf pairs. These whales will also experience masking and TTS, which would affect their ability to detect certain environmental cues and may impact their ability to communicate and their behavior; while masking will only last for as long as the animal is exposed to the pile driving noise, TTS may take up to a week to resolve. We have determined that, taken together, the nature and duration of the response to exposure to pile driving noise above the Level B harassment threshold is a significant disruption of behavior patterns. Therefore, based on this four-step analysis, we find that the 6 right whales exposed to pile driving noise louder than 160 dB re 1uPa rms are likely to be adversely affected and that effect amounts to harassment. As such, we expect the harassment of 6 right whales as a result of pile driving.

NMFS defines “harm” in the ESA’s definition of “take” as “an act which actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding or sheltering” (50 CFR §222.102). No right whales will be injured or killed due to exposure to pile driving noise. Further, while exposure to pile driving noise will significantly disrupt behaviors of individual right whales, it will not significantly impair any essential behavioral patterns. This is due to the short term, localized nature of the effects and because we expect these behaviors to resume in a new location once the right whale is no longer exposed to the noise. The energetic consequences of the evasive behavior and delay in resting or unlikely disruption and delay of foraging are not expected to 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 successfully in nursing, breeding, or calving. TTS will resolve within a week of exposure and is not expected to affect the health of any whale or its ability to migrate, forage, breed, calve, or raise its young. Thus, the response of right whales to pile driving noise does not meet the definition of “harm.”

We have also considered whether TTS, masking, or avoidance behaviors would be likely to increase the risk of vessel strike or entanglement in fishing gear. As explained above, we would not expect the TTS to span the entire communication or hearing range of right whales given the frequencies produced by pile driving do not span entire hearing ranges for right whales. Additionally, though the frequency range of TTS that right whales might sustain would overlap with some of the frequency ranges of their vocalization types, the frequency range of TTS from Ocean Wind's pile driving activities would not span the entire frequency range of one vocalization type, much less span all types of vocalizations or other critical auditory cues for any given species. As such, we do not expect TTS to affect the ability of a right whale to communicate with other right whales or to detect audio cues to the extent they rely on audio cues to avoid vessels or other threats. Similarly, we do not expect masking to affect the ability of a right whale to avoid a vessel. These risks are lowered even further by the short duration of TTS (less than a week) and masking (limited only to the time that the whale is exposed to the pile driving noise, so less than four hours). We also do not expect that avoidance of pile driving noise would result in right whales moving to areas with higher risk of vessel strike or entanglement in fishing gear. A right whale that was exposed to pile driving noise from the cofferdams would be in the portion of the WDA with the heaviest amount of vessel traffic (i.e., the relatively nearshore coastal transit routes used by vessels moving north and south along the coast and by vessels moving to and from ports along the coast). If avoiding the pile driving noise moved the right whale further offshore, its exposure to vessel traffic would be lower. Considering pile driving for WTG and OSS foundations, the areas with more dense vessel traffic (e.g., the Traffic Separation Schemes and the nearshore coastal waters) are at least 10 nm (18.5 km) away from the edge of the WFA. As we expect right whales disturbed by foundation pile driving noise to only need to move 1.72-3.35km to avoid pile driving noise that is above the behavioral disturbance threshold, we do not expect right whales to be displaced into areas with higher vessel traffic. Similarly, based on available mapping of fishing activity around the WFA (Figures 2-8 to 2-19 in the NRSA, COP Appendix M), it is extremely unlikely that any movement within the WFA or up to 3.35 km outside the WFA would result in a right whale moving into an area with higher risk of entanglement or capture in fishing gear. As such, increased risk of vessel strike or entanglement in fishing gear as a result of exposure to pile driving noise is extremely unlikely to occur.

Blue, Fin, Sei and Sperm Whales
Behavioral responses may impact health through a variety of different mechanisms, but most Population Consequences of Disturbance models focus on how such responses affect an animal's energy budget (Costa et al. 2016c; Farmer et al. 2018; King et al. 2015b; NAS 2017; New et al. 2014; Villegas-Amtmann et al. 2017). Responses that relate to foraging behavior, such as those that may indicate reduced foraging efficiency (Miller et al. 2009) or involve the complete cessation of foraging, may result in an energetic loss to animals. Other behavioral responses, such as avoidance, may have energetic costs associated with traveling (NAS 2017). When considering whether energetic losses due to reduced foraging or increased traveling will affect an individual's fitness, it is important to consider the duration of exposure and associated response. Nearly all studies and experts agree that infrequent exposures of a single day or less are unlikely to impact an individual's overall energy budget and that long duration and repetitive disruptions would be necessary to result in consequential impacts on an animal (Farmer et al. 2018; Harris et al. 2017b; King et al. 2015b; NAS 2017; New et al. 2014; Southall et al. 2007d; Villegas-Amtmann et al. 2015). As explained below, individuals exposed to pile driving noise will experience only a singular, temporary behavioral disruption that will not last for more than a few hours and will not be repeated. As such, the factors necessary for behavioral disruption to have consequential impacts on an animal are not present in this case. We also recognize that aside from affecting health via an energetic cost, a behavioral response could result in more indirect impacts to health and/or fitness. For example, if a whale hears the pile driving noise and avoids

the area, this may cause it to travel to an area with other threats such as vessel traffic or fishing gear. However, as explained below, this is extremely unlikely to occur.

Quantifying the fitness consequences of sub-lethal impacts from acoustic stressors is exceedingly difficult for marine mammals and we do not currently have data to conduct a quantitative analysis on the likely consequences of such sub-lethal impacts. While we are unable to conduct a quantitative analysis on how sub-lethal behavioral effects and temporary hearing impacts (i.e., masking) may impact animal vital rates (and therefore fitness), based on the best available information, we expect an increased likelihood of consequential effects when exposures and associated effects are long-term and repeated, occur in locations where the animals are conducting critical activities, and when the animal affected is in a compromised state.

We do not have information to suggest that affected blue, sperm, sei, or fin whales are likely to be in a compromised state at the time of exposure. During exposure, affected animals may be engaged in migration, foraging, or resting. If blue, fin, sei, or sperm whales exhibited a behavioral response to pile driving noise, these activities would be disrupted, and the disruption may pose some energetic cost. However, as noted previously, responses to pile driving noise are anticipated to be singular and short term (four hours for exposure to impact pile driving and less than 12 hours for vibratory pile driving); that is, the identified number of individuals are each expected to be exposed to a single pile driving event that will result in the individual altering their behavior to avoid the disturbing level of noise. Based on the estimated abundance of blue, fin, sei, and sperm whales in the action area, anticipated residency time in the lease area, and the number of instances of behavioral disruption expected, multiple exposures of the same animal are not anticipated. Sperm whales normal cruise speed is 5-15 kph, with burst speed of up to 35-45 kph for up to an hour. Fin whales cruise at approximately 10 kph while feeding and have a maximum swim speed of up to 35 kph. Sei whales swim at speeds of up to 55 kph. Blue whales transit around 5 kph, with burst speeds of at least 20 kph. During impact pile driving, the area with noise above the Level B harassment threshold extends up to approximately 3.5 km from the pile being driven. Assuming that a whale exposed to noise above the Level B harassment threshold takes a direct path to get outside of the noisy area, a blue, sperm, fin, or sei whale that was at the pile driving location when pile driving starts (i.e., at the center of the area with a 3.5 km radius that will experience noise above the 160 dB re 1uPa threshold), would escape from the area with noise above 160 dB re 1uPa the noise in less than an hour, even at a slow speed of 5 kph. However, given the requirements for ensuring an area extending 2-2.5 km from the pile is clear of fin, sei, and sperm whales before pile driving begins, such a scenario is unlikely to occur. Rather, it is far more likely that any exposure and associated disturbance would be for a significantly shorter period. In any event, it would not exceed the period of a pile driving event.

During vibratory pile driving, which is considered a continuous noise source, the area predicted to have noise above the 120 dB re 1uPa threshold extends approximately 10 km from the pile. Given known swim speeds, a whale located even several km from the pile at the start of pile driving may need to swim for a few hours to move out of the area with noise above 120 dB re1uPa. Based on best available information that indicates whales resume normal behavior quickly in a new location after the cessation of sound exposure (e.g., Goldbogen et al. 2013a; Melcon et al. 2012), we anticipate that exposed animals will return to normal behavioral patterns after they swim away from the disturbing levels of noise.

Goldbogen et al. (2013a) suggested that if the documented temporary behavioral responses interrupted feeding behavior, this could have impacts on individual fitness and eventually, population health. However, for this to be true, we would have to assume that an individual whale could not compensate for this lost feeding opportunity by either immediately feeding at another location, by feeding shortly after cessation of acoustic exposure, or by feeding at a later time. There is no indication this will occur, particularly since unconsumed prey would still be available in the environment following the cessation of acoustic exposure (i.e., the pile driving is not expected to result in a reduction in prey). There would likely be an energetic cost associated with any temporary habitat displacement to find alternative locations for foraging, but unless disruptions occur over long durations or over subsequent days, we do not anticipate this movement to be consequential to the animal over the long-term (Southall et al 2007). Based on the estimated abundance of fin, sei, and sperm whales in the action area, anticipated residency time in the lease area, and the number of instances of behavioral disruption expected, multiple exposures of the same animal are not anticipated. Therefore, we do not anticipate repeat exposures, and based on the available literature that indicates infrequent exposures are unlikely to impact an individual's overall energy budget (Farmer et al. 2018; Harris et al. 2017b; King et al. 2015b; NAS 2017; New et al. 2014; Southall et al. 2007d; Villegas-Amtmann et al. 2015), we do not expect this level of exposure to impact the fitness of exposed animals.

There is no indication that sperm whale calves occur in the action area. For blue, fin, and sei whales, little information exists on where they give birth as well as on mother-calf vocalizations. As such, it is difficult to assess whether masking could significantly interfere with mother-calf communication in a way that could result in fitness consequences. To be conservative, we assume here that some of the blue, sei or fin whales exposed to pile driving noise are mother-calf pairs. Absent data on mother-calf communication for these species within the action area, we rely on our analysis of the effects of masking to North Atlantic right whales, which given their current status, are considered more vulnerable than any of these whale species. Based on this analysis, we do not expect that TTS and or masking will affect blue, fin, or sei whale mother-calf fitness.

Here, we carry out that four-step assessment to determine if the expected responses to exposure to noise above the behavioral disturbance threshold will result in harassment explained and summarized above. For individual whales exposed to disturbing levels of noise, there will be a significant disruption of their behavior because they may abandon that activity for one to six hours while they swim to an alternate area to resume this behavior or they will avoid the area extending up to approximately 3.5 km from the pile being driven for the two to four hour duration of the impact pile driving as well as an area extending approximately 10 km from the cofferdam for the 18 hour period during both installation and removal. This means they will need to find an alternate migration route or alternate place for foraging or resting. These whales will also experience masking and TTS, which would affect their ability to detect certain environmental cues for the duration of pile driving and may impact their ability to communicate. Based on this four-step analysis, we find that the 4 blue, 12 fin, 3 sei, and 6 sperm whales exposed to pile driving noise louder than 160 dB re 1uPa rms are likely to be adversely affected and that effect amounts to harassment. As such, we expect the harassment of 4 blue, 12 fin, 3 sei, and 6 sperm whales as a result of pile driving.

As noted, NMFS defines "harm" for ESA take purposes as "an act which actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding or sheltering." Injury is limited to minor auditory injury, no serious injury or mortality will result from exposure to pile driving noise. Further, while exposure to pile driving noise will significantly disrupt behaviors of individual whales, it will not significantly impair any essential behavioral patterns. This is due to the short term, localized nature of the effects and because we expect these behaviors to resume once the whale is no longer exposed to the noise. The energetic consequences of the evasive behavior and delay in resting or foraging are expected to be minor and will not 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. Thus, the response of whales to pile driving noise does not meet the definition of "harm."

We have also considered whether TTS, masking, or avoidance behaviors would be likely to increase the risk of vessel strike or entanglement in fishing gear. As explained above, we would not expect the TTS to span the entire communication or hearing range of blue, fin, sei, or sperm whales given the frequencies produced by pile driving do not span entire hearing ranges for any whales. Additionally, though the frequency range of TTS that blue, fin, sei, or sperm whales might sustain would overlap with some of the frequency ranges of their vocalization types, the frequency range of TTS from Ocean Wind's pile driving activities would not span the entire frequency range of one vocalization type, much less span all types of vocalizations or other critical auditory cues for any given species. As such, we do not expect TTS to affect the ability of any of these whales to communicate with other whales or to detect audio cues to the extent they rely on audio cues to avoid vessels or other threats. Similarly, we do not expect masking to affect the ability of a whale to avoid a vessel. These risks are lowered even further by the short duration of TTS (less than a week) and masking (limited only to the time that the whale is exposed to the pile driving noise, so less than four hours). We also do not expect that avoidance of pile driving noise would result in whales moving to areas with higher risk of vessel strike or entanglement in fishing gear. A whale that was exposed to pile driving noise from the cofferdams would be in the portion of the WDA with the heaviest amount of vessel traffic (i.e., the relatively nearshore coastal transit routes used by vessels moving north and south along the coast and by vessels moving to and from ports along the coast); if avoiding the pile driving noise moved the right whale further offshore, its exposure to vessel traffic would be less. Considering pile driving for WTG and OSS foundations, the areas with more dense vessel traffic (e.g., the Traffic Separation Schemes and the nearshore coastal waters) are at least 10 nm (18.5 km) away from the edge of the WFA. As we expect whales disturbed by foundation pile driving noise to only need to move 1.72-3.35km to avoid pile driving noise that is above the behavioral disturbance threshold, we do not expect right whales to be displaced into areas with higher vessel traffic. Similarly, based on available mapping of fishing activity around the WFA (Figures 2-8 to 2-19 in the NRSA, COP Appendix M), it is extremely unlikely that any movement within the WFA or up to 3.35 km outside the WFA would result in a whale moving into an area with higher risk of entanglement or capture in fishing gear. As such, increased risk of vessel strike or entanglement in fishing gear as a result of exposure to pile driving noise is extremely unlikely to occur.

7.1.3.3 Effects of Exposure to UXO Detonations

The proposed action as described by BOEM in the BA includes the detonation of up to 10 UXOs. NMFS OPR has also considered the detonation of up to 10 UXOs in the notice of proposed ITA. As described above, modeling was carried out to support the assessment of effects of UXO detonation. JASCO's analysis assumed that all 10 of the potential UXOs would be 454 kg in weight. Though Ocean Wind does not expect that all UXOs would consist of this charge weight, it was determined to be a conservative, but reasonable, approach for estimating the exposures and take estimates. Because Ocean Wind will be required (through conditions of COP approval and conditions of the proposed ITA) to implement noise attenuation of at least 10 dB for all UXO detonations, effects to marine mammals from attenuated detonations are considered here.

All marine mammal exposures were modeled using frequency-weighted sound exposure levels (SEL). The maximum distances to the thresholds for mortality, lung injury, and gastro-intestinal injury are shown in Table 7.1.21. The SEL-based ($R_{95\%}$) isopleths for Level A harassment (PTS) and Level B harassment (TTS) were calculated from the area where the noise is expected to be above the PTS and TTS thresholds as shown in Tables 7.1.22 and 7.1.23.

Table 7.1.21 Maximum Distances to Non-Auditory Injury and Mortality Thresholds for Marine Mammals (10 dB mitigation) source: Table 3-14 in BOEM's BA

Threshold Type	**Marine Mammal Species**	**Maximum Distance (m) to Thresholds**	
		Adult	**Calf**
Mortality	Baleen whale/sperm whale	29	108
Lung Injury	Baleen whale/sperm whale	78	237
Onset Gastrointestinal Injury (all species)[a]		125	125

Source: Hannay and Zykov 2022.
Notes: Maximum ranges are based on worst-case scenario modeling results for charge size E12 (454 kilograms) and deepest water depth (45 meters).
[a] Based on 1% of animals exposed (mortality/Lung injury).
m = meters; UXO = unexploded ordnance

Table 7.1.22. SEL-based $R_{95\%}$ PTS-onset Areas (km^2) for the E12 Charge Weight (454 kg) at Various Depths (12, 20, 30, and 45 m) with 10 dB Reduction

Marine Mammal Hearing Group	Threshold (dB *re 1 µPa²s*)	Level A harassment (PTS SEL) Area km² 10 dB sound reduction			
		12 m	20 m	30 m	45 m
Low-frequency cetaceans	183	32.57	44.89	40.94	40.94
Mid-frequency cetaceans	185	0.6	0.47	0.53	0.53

Table 7.1.23. SEL-based $R_{95\%}$ TTS-onset Areas (km^2) for the E12 Charge Weight (454 kg) at Various Depths Assuming 10dB Reduction

Marine Mammal Hearing Group	Threshold (dB *re 1 µPa²s*)	Level B harassment (TTS SEL) Area (km²) 10 dB sound reduction			
		12 m	20 m	30 m	45 m
Low-frequency cetaceans	168	380.13	444.88	415.48	437.44
Mid-frequency cetaceans	170	204.43	18.55	19.32	19.32

The ranges to PTS thresholds were larger than ranges to mortality and non-auditory injury criteria for each charge size modeled. Because of this, the PTS thresholds were carried forward into the modeling to estimate the potential for exposure to noise that could result in injury. For UXO detonations, given that UXOs have the potential to occur anywhere within the WDA, a 15-km (9.32-mi) perimeter was applied to both the lease area and the export cable route for purposes of obtaining density information to inform the model. Highest monthly densities (from May – October) for the area of interest were used as described in the Notice of Proposed ITA. The densities used are presented in Table 7.1.24.

Table 7.1.24. Highest Monthly Marine Mammal Densities (Animals per Km^2) Used for the Modeling of Ocean Wind's UXO/MEC detonations (considering the May – October window)

Marine Mammal Species	Highest Density Month	Estimated Density
North Atlantic right whale	May	0.00008

Blue whale	Annual Density	0.0001
Fin whale	May	0.00068
Sei whale	May	0.00021
Sperm whale	May	0.00008

The estimated maximum PTS and TTS exposures are presented in Table 7.1.25. As explained in the notice of proposed ITA, as there is no more than one detonation per day, the TTS threshold is expected to represent the level above which any behavioral disturbance might occur. As such, the number of individuals estimated to be exposed to noise above the Level B harassment threshold accounts for those that would experience TTS or behavioral disturbance.

Table 7.1.25. Estimated Potential Maximum Level A And B Harassment Exposures Of Marine Mammals Resulting From The Possible Detonations Of Up To 10 UXOs Assuming 10 dB Of Sound Attenuation.

Species	Including 10 dB of Sound Attenuation	
	Level A Harassment (PTS SEL)	Level B Harassment (TTS SEL)
North Atlantic right whale	0.03	0.35
Blue whale	less than 0.01	0.04
Fin whale	0.28	2.87
Sei whale	0.08	0.87
Sperm whale	less than 0.01	0.01

Ocean Wind proposed to implement a clearance zone encompassing a radius of 3.78 km around the detonation site using both visual and acoustic monitoring methods. This distance represents the modeled Level A (PTS) harassment threshold for low-frequency cetaceans (i.e., right, fin, blue, sei whales) rounded up to the nearest km assuming a 454 kg charge weight and use of a bubble curtain. However, through conditions of the ITA, NMFS OPR proposes to require Ocean Wind to clear a zone extending 10 km for large whales. These zones are based on (but not equal to) the greatest TTS threshold distances from 454 kg charge at any site modeled. If a marine mammal is observed entering or within the clearance zone prior to denotation, the activity would be delayed. Through conditions of the proposed ITA, clearing the zone would require use of at least six visual PSOs and one PAM operator on at least two dedicated PSO vessels and an aerial survey must also be performed prior to detonation and immediately after detonation to monitor for marine mammals. Only when marine mammals have been confirmed to have voluntarily left the clearance zones and been visually confirmed to be beyond the clearance zone, or when 60 minutes have elapsed without any redetections for whales may detonation commence. It is reasonable to expect that visual observers will be able to monitor the full extent of the 10 km exclusion zone given the multiple observer platforms, which include two vessels and an airplane. It is also important to note that given the extremely short duration of the noise associated with the detonation (one second) there is no risk of sustained or cumulative noise exposure.

With these mitigation measures in place, NMFS OPR determined that there was no potential for exposure of any ESA listed whales to noise above the Level A harassment threshold. As such, NMFS OPR is not proposing to authorize any Level A harassment of any ESA listed whale species resulting from exposure to noise above the Level A harassment threshold. This is consistent with the determination made in the BA by BOEM. We agree that given the distances to the Level A harassment threshold (less than 4 km), the clearance zone (10 km) and the extensive mitigation measures that will ensure that detonation does not occur if any whales are close enough to the detonation site to be exposed to noise above the Level A harassment threshold, exposure of any whales to noise that could result in PTS is extremely unlikely to occur. Similarly, given the distances to the thresholds for non-auditory injury and mortality are even smaller (less than 250 m), it is also extremely unlikely that any ESA listed whales will experience non-auditory injury or mortality as a result of any UXO detonation.

Table 7.1.26 presents the amount of Level A (none) and Level B harassment proposed for authorization through the MMPA ITA. Fractions of individuals were rounded up to whole animals. Modeled exposure of blue whales was so close to zero that no exposure is actually anticipated to occur. The estimated exposure of sperm whales was rounded up to typically group size (3 individuals).

Table 7.1.26. Anticipated Number of Individuals exposed to noise above the Level A Harassment and B Harassment thresholds Resulting From The Detonation Of Up To 10 UXOs, Assuming 10 dB of Sound Attenuation

Species	Level A Harassment	Level B Harassment (TTS)
North Atlantic right whale	0	1
Blue whale	0	0
Fin whale	0	3
Sei whale	0	1
Sperm whale	0	3

As noted above, the individuals anticipated to be exposed to noise above the Level B harassment threshold includes those that may be exposed to noise that would result in TTS as well as those that would not experience TTS but may experience behavioral disturbance. Given the extremely short duration (one second) of the noise exposure, we expect any behavioral reaction to also be extremely short in duration and limited to momentary startle or alteration in swimming behavior that nearly immediately resolves or returns to normal. Effects to individuals from this extremely short behavioral disturbance will be so small that they cannot be meaningfully measured, evaluated, or detected and are therefore insignificant. Whales exposed to noise above the Level B harassment threshold may experience minor TTS (limited due to the very limited exposure period). As explained in the consideration of exposure to pile driving noise, TTS affects an individual through temporary hearing impairment which can affect the behavior of the individual by making it more difficult to hear certain sounds; however, while this minor TTS may affect the way an individual senses its environment we do not expect this minor TTS to affect communication between individuals or affect the ability of an individual to migrate, forage or rest. TTS is considered to meet the ESA definition of harassment; however, it does not meet the definition of harm. That is because TTS is not expected to result in significant impairment of essential behavioral patterns that actually kill or injure any individuals. Therefore, we expect the 1 right, 3 fin, 1 sei, and 3 sperm whales that experience TTS as a result of exposure to UXO detonation noise to meet the definition of ESA harassment but not harm applying the definitions and processes for evaluation described above. Therefore, we expect the 10 detonations to result in the harassment of no more than 1 right, 3 fin, 1 sei, and 3 sperm whales (in total, not per detonation). The effects to individuals experiencing TTS are the same as those effects described above in the consideration of effects of pile driving noise. We expect recovery from the noise exposure to occur within hours to days of exposure and that there would be no permanent effects to any individuals.

Vessel Noise and Cable Installation

The frequency range for vessel noise (10 to 1000 Hz; MMS 2007) overlaps with the generalized hearing range for blue, sei, fin, and right whales (7 Hz to 35 kHz) and sperm whales (150 Hz to 160 kHz) and would therefore be audible. As described in the BA, vessels without ducted propeller thrusters would produce levels of noise of 150 to 170 dB re 1 μPa-1 meter at frequencies below 1,000 Hz, while the expected sound-source level for vessels with ducted propeller thrusters level is 177 dB (RMS) at 1 meter. For ROVs, source levels may be as high as 160 dB. Given that the noise associated with the operation of project vessels is below the thresholds that could result in injury, no injury is expected. Noise produced during cable installation is dominated by the vessel noise; therefore, we consider these together.

Marine mammals may experience masking due to vessel noises. For example, right whales were observed to shift the frequency content of their calls upward while reducing the rate of calling in areas of increased anthropogenic noise (Parks et al. 2007a) as well as increasing the amplitude (intensity) of their calls (Parks et al. 2011a; Parks et al. 2009). Right whales also had their communication space reduced by up to 84 percent in the presence of vessels (Clark et al. 2009a). Although humpback whales did not change the frequency or duration of their vocalizations in the presence of ship noise, their source levels were lower than expected, potentially indicating some signal masking (Dunlop 2016).

Vessel noise can potentially mask vocalizations and other biologically important sounds (e.g., sounds of prey or predators) that marine mammals may rely on. Potential masking can vary depending on the ambient noise level within the environment, the received level and frequency of the vessel noise, and the received level and frequency of the sound of biological interest. In the open ocean, ambient noise levels are between about 60 and 80 dB re 1 μPa in the band between 10 Hz and 10 kHz due to a combination of natural (e.g., wind) and anthropogenic sources (Urick 1983a), while inshore noise levels, especially around busy ports, can exceed 120 dB re 1 μPa. When the noise level is above the sound of interest, and in a similar frequency band, masking could occur. This analysis assumes that any sound that is above ambient noise levels and within an animal's hearing range may potentially cause masking. However, the degree of masking increases with increasing noise levels; a noise that is just detectable over ambient levels is unlikely to cause any substantial masking.

Vessel noise has the potential to disturb marine mammals and elicit an alerting, avoidance, or other behavioral reaction. These reactions are anticipated to be short-term, likely lasting the amount of time the vessel and the whale are in close proximity (e.g., Magalhaes et al. 2002; Richardson et al. 1995d; Watkins 1981a), and not consequential to the animals. We also note that we do not anticipate any project vessels to occur within close proximity of any ESA listed whales; regulations prohibit vessels from approaching right whales closer than 500m and the vessel strike avoidance measures identified in Table 3.3.1 are expected to ensure no project vessels operate in close proximity to any whales in the action area. Additionally, short-term masking could occur. Masking by passing ships or other sound sources transiting the action area would be short term and intermittent, and therefore unlikely to result in any substantial costs or consequences to individual animals or populations. Areas with increased levels of ambient noise from anthropogenic noise sources such as areas around busy shipping lanes and near harbors and ports may cause sustained levels of masking for marine mammals, which could reduce an animal's ability to find prey, find mates, socialize, avoid predators, or navigate.

Based on the best available information, ESA-listed marine mammals are either not likely to respond to vessel noise or are not likely to measurably respond in ways that would significantly disrupt normal behavior patterns that include, but are not limited to, breeding, feeding or sheltering. Therefore, the effects of vessel noise on ESA-listed marine mammals are insignificant (i.e., so minor that the effect cannot be meaningfully evaluated or detected).

Operation of WTGs

As described above, many of the published measurements of underwater noise levels produced by operating WTGs range from older geared WTGs and are not expected to be representative of newer direct-drive WTGs, like those that will be installed for the Ocean Wind 1 project. Elliot et al. (2019) reports underwater noise monitoring at the BIWF, which has direct-drive GE Haliade 150-6 MW turbines; as explained in section 7.1.2, this is the best available data for estimating operational noise of the Ocean Wind turbines.

In considering the potential effects of operational noise on ESA listed whales we consider the expected noise levels from the operational turbines and the ambient noise (i.e., background noise that exists without the operating turbines) in the lease area. Ambient noise is a relevant factor because if the operational noise is not louder than ambient noise we would not expect an animal to react to it.

Ambient noise includes the combination of biological, environmental, and anthropogenic sounds occurring within a particular region. In temperate marine environments including the WDA, major contributors to the overall acoustic ambient noise environment include the combination of surface wave action (generated by wind), weather events such as rain, lightning, marine organisms, and anthropogenic sound sources such as ships. The coastal waters off New Jersey have relatively high levels of ambient noise, attributed to nearby shipping noise (Rice et al. 2014). Salisbury et al. 2018 monitored ambient noise off the coast of Virginia in consideration of the hearing frequencies of a number of marine mammal species. In the right whale frequency band (71-224 Hz), ambient noise exceeded 110 dB 50% of the time and 115 dB 14% of the time. Noise levels in the fin whale frequency band (18-28 Hz) were lower than the other whale species, with noise levels exceeding 100 dB 50% of the time. Kraus et al. (2016) surveyed the ambient underwater noise environment in the RI/MA WEA. Depending on location, ambient underwater sound levels within the RI/MA WEA varied from 96 to 103 dB in the 70.8- to 224-Hz frequency band at least 50% of the recording time, with peak ambient noise levels reaching as high as 125 dB in proximity to the Narraganset Bay and Buzzards Bay shipping lanes (Kraus et al. 2016). Similar to the conclusions of Rice et al. (2014) for New Jersey, low-frequency sound from large marine vessel traffic in these and other major shipping lanes to the east (Boston Harbor) and south (New York) were the dominant sources of underwater noise in the RI/MA WEA.

Elliott et al. (2019) notes that the direct-drive turbines measured at BIWF generated operational noise above background sound levels at the measurement location of 50 m (164 ft.) from the foundation. The authors also conclude that even in quiet conditions (i.e., minimal wind or weather noise, no transiting vessels nearby), operational noise at any frequency would be below background levels within 1 km (0.6 mi) of the foundation. This information suggests that in quiet conditions, a whale located within 1 km of the foundation may be able to detect operational noise above ambient noise conditions. However, given the typical ambient noise in the WDA, we expect these instances of quiet to be rare. Regardless, detection of the noise does not mean that there would be any effect to the individual.

Elliot et al. (2019) conclude that based on monitoring of underwater noise at the Block Island site, under worst-case assumptions, no risk of temporary or permanent hearing damage (PTS or TTS) could be projected even if an animal remained in the water at 50 m (164 ft.) from the turbine for a full 24-hour period. As such, we do not expect any PTS, TTS, or other potential injury to result from even extended exposure to the operating WTGs. The loudest noise recorded by Elliot et al. (2019) was 126 dB re 1uPa at 50 m from the turbine when wind speeds exceeded 56 kmh; at wind speeds of 43.2 km/h and less, measured noise did not exceed 120 dB re 1uPa at 50 m from the turbine (Eliot et al. 2019). As noted above, based on wind speed records from the Ambrose Buoy (November 2008 – February 2023), instances of wind speeds exceeding 56 km/h in the lease area are expected to be rare, with wind speeds exceeding 40 kmh less than 3% of the time across a year and wind speeds exceeding 56 km/h occurring even less frequently.

Given the conditions necessary to result in noise above 120 dB re 1uPa only occur 0-3% of the time on an annual basis, and that in such windy conditions ambient noise is also increased, we do not anticipate the underwater noise associated with the operations noise of the direct-drive WTGs to result in avoidance of an area any larger than 50m from the WTG foundation. As such, even if ESA-listed marine mammals avoided the area with noise above ambient, any effects would be so small that they could not be meaningfully measured, detected, or evaluated, and are therefore insignificant.

We recognize that the data from Elliot et al. (2019) represents WTGs that are of a smaller capacity than those proposed for use at Ocean Wind 1. We also recognize the literature that has predicted larger sound fields for larger turbines. However, we also note that Tougaard et al. (2020) and Stober and Thomsen (2021) both indicate that operational noise is less than shipping noise; this suggests that in areas with consistent vessel traffic, such as the Ocean Wind 1 lease area, operational noise is not expected to be detectable above ambient noise at a distance more than 50 m from the foundation. Additionally, while there are no studies documenting distribution of large whales in an area before and after construction of a wind farm, data from other marine mammals (harbor porpoise) indicates that any reduction in abundance in the wind farm area that occurred during the construction period resolves and that harbor porpoise are as abundant in the wind farm area during project operations as they were before. This supports our determination that effects of operational noise are likely to be insignificant.

HRG Survey Equipment
HRG surveys are planned within the lease area and cable routes. A number of minimization measures for HRG surveys are included as part of the proposed action. This includes maintenance of a 500 m clearance and shutdown zone for North Atlantic right whales and 100 m clearance and shutdown zone for other ESA listed marine mammals during the operations of equipment that operates within the hearing frequency of these species (i.e., less than 180 kHz).

In their ITA application, Ocean Wind requested Level B harassment take associated with HRG surveys during the 5-year effective period of the ITA. During this period, 88 days of HRG surveys per year are planned in Years 1, 4, and 5 and 180 days of surveys per year are planned in Years 2 and 3. Ocean Wind has requested the take of 12 fin, 2 sei, 7 North Atlantic right whales, and 15 sperm whales due to exposure to noise associated with HRG survey equipment during the five-year effective period of the ITA. NMFS OPR is proposing to authorize this take. As described below, we do not expect that exposure of any ESA listed whales to noise resulting from HRG surveys will result in any take as defined by the ESA. That is, as explained further below, while we expect that some ESA listed whales may be exposed to noise above the Level B harassment threshold during HRG surveys, due to the very brief duration of exposure and the minor behavioral reactions, we expect all effects of exposure to HRG survey noise to be insignificant or extremely unlikely to occur. Extensive information on HRG survey noise and potential effects of exposure to ESA listed whales is provided in NMFS June 29, 2021 programmatic ESA consultation on certain geophysical and geotechnical survey activities (NMFS GAR 2021). We summarize the relevant conclusions here.

Considering all sources, the distance to the Level A thresholds (peak and cumulative) is less than 1.5 m (Table 7.1.6). Animals in the survey area during the HRG survey are unlikely to incur any hearing impairment due to the characteristics of the sound sources, considering the source levels (176 to 205 dB re 1 μPa-m) and generally very short pulses and duration of the sound. Individuals would have to make a very close approach and also remain very close to vessels operating these sources (<1 m) in order to receive multiple exposures at relatively high levels, as would be necessary to have the potential to result in any hearing impairment. Kremser et al. (2005) noted that the probability of a whale swimming through the area of exposure when a sub-bottom profiler emits a pulse is small—because if the animal was in the area, it would have to pass the transducer at close range in order to be subjected to sound levels that could cause PTS and would likely exhibit avoidance behavior to the area near the transducer rather than swim through at such a close range. Further, the restricted beam shape of many of HRG survey devices planned for use makes it unlikely that an animal would be exposed more than briefly during the passage of the vessel. The potential for exposure to noise that could result in PTS is even further reduced by the use of PSOs to monitor a clearance zone (500 m for right whales and 100 m for sei, fin, sperm, and blue whales) and to call for a shutdown of equipment operating within the hearing range of ESA-listed whales should a right whale or unidentified large whale be detected within 500 m or 100 m for an identified blue, sei, fin, or sperm whale (see Table 3.3.1). Based on these considerations, it is extremely unlikely that any ESA-listed whale will be exposed to noise that could result in PTS. Therefore, no injury, serious injury, or mortality of any ESA listed whales is expected to occur as a result of exposure to pile driving noise.

Masking is the obscuring of sounds of interest to an animal by other sounds, typically at similar frequencies. Marine mammals are highly dependent on sound, and their ability to recognize sound signals amid other sounds is important in communication and detection of both predators and prey (Tyack 2000). Although masking is a phenomenon which may occur naturally, the introduction of loud anthropogenic sounds into the marine environment at frequencies important to marine mammals increases the severity and frequency of occurrence of masking. The components of background noise that are similar in frequency to the signal in question primarily determine the degree of masking of that signal. In general, little is known about the degree to which marine mammals rely upon detection of sounds from conspecifics, predators, prey, or other natural sources. In the absence of specific information about the importance of detecting these natural sounds, it is not possible to predict the impact of masking on marine mammals (Richardson et al., 1995). In general, masking effects are expected to be less severe when sounds are transient than when they are continuous. Masking is typically of greater concern for those marine mammals that utilize low-frequency communications, such as baleen whales, because of how far low-frequency sounds propagate. In the Notice of Proposed ITA, NMFS OPR concluded that marine mammal communications would not likely be masked by the sub-bottom HRG survey equipment types planned for use for the types of surveys considered here and the brief period when an individual mammal is likely to be within its beam. Because effects of masking, if any, will be so small that they cannot be meaningfully measured, evaluated, or detected, any effects of masking on ESA-listed whales will be insignificant.

The area ensonified by noise greater than 160 dB re: 1uPa rms will extend no further than 141m from the source (Table 7.1.6). Given that the distance to the 160 dB re: 1 uPa rms threshold extends beyond the required Shutdown Zone for all ESA listed whale species except for right whales, (100 m for blue, sei, fin, and sperm whales; 500 m for right whales), it is possible that non-right whales will be exposed to potentially disturbing levels of noise during the surveys considered here. We have determined that, in this case, the exposure to noise above the MMPA Level B harassment threshold (160 dB re: 1uPa rms) will result in effects that are insignificant. We expect that the result of this exposure would be, at worst, temporary avoidance of the area with underwater noise louder than this threshold, which is a reaction that is considered to be of low severity and with no lasting biological consequences (e.g., Ellison et al. 2007). The noise source itself will be moving. This means that any co-occurrence between a whale, even if stationary, will be brief and temporary. Given that exposure will be short (no more than a few seconds, given that the noise signals themselves are short and intermittent and because the vessel towing the noise source is moving) and that the reaction to exposure is expected to be limited to changing course and swimming away from the noise source only far/long enough to get out of the ensonified area (141 m or less, depending on the noise source), the effect of this exposure and resulting response will be so small that it will not be able to be meaningfully detected, measured or evaluated and, therefore, is insignificant. Further, the potential for disruption to activities such as feeding (including nursing), resting, and migrating is extremely unlikely given the very brief exposure to any noise (given that the source is traveling and the area ensonified at any given moment is so small). Any brief interruptions of these behaviors are not anticipated to have any lasting effects. Additionally, given the extremely short duration of any behavioral disruption and the very small distance any animal would have to swim to avoid the noise it is extremely unlikely that the behavioral response would increase the risk of exposure to other threats including vessel strike or entanglement in fisheries gear. Because the effects of these temporary behavioral changes are so minor as to be insignificant, it is not reasonable to expect that, under the NMFS' interim ESA definition of harassment, they are equivalent to an act that would "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."

7.1.4 Effects of Project Noise on Sea Turtles

Background Information – Sea Turtles and Noise
Sea turtles are low frequency hearing specialists, typically hearing frequencies from 30 Hz to 2 kHz, with a range of maximum sensitivity between 100 to 800 Hz (Bartol and Ketten 2006, Bartol et al. 1999, Lenhardt 1994, Lenhardt 2002, Ridgway et al. 1969). Below, we summarize the available information on expected responses of sea turtles to noise.

Stress caused by acoustic exposure has not been studied for sea turtles. As described for marine mammals, a stress response is a suite of physiological changes that are meant to help an organism mitigate the impact of a stressor. If the magnitude and duration of the stress response is too great or too long, it can have negative consequences to the animal such as low reproductive rates, decreased immune function, diminished foraging capacity, etc. Physiological stress is typically analyzed by measuring stress hormones (such as cortisol), other biochemical markers, and vital signs. To our knowledge, there is no direct evidence indicating that sea turtles will experience a stress response if exposed to acoustic stressors such as sounds from pile driving. However, physiological stress has been measured for sea turtles during nesting, capture and handling (Flower et al. 2015; Gregory and Schmid 2001; Jessop et al. 2003; Lance et al. 2004), and when caught in entangling nets and trawls (Hoopes et al. 2000; Snoddy et al. 2009). Therefore, based on their response to these other anthropogenic stressors, and including what is known about cetacean stress responses, we assume that some sea turtles will exhibit a stress response if exposed to a detectable sound stressor.

Marine animals often respond to anthropogenic stressors in a manner that resembles a predator response (Beale and Monaghan 2004b; Frid 2003; Frid and Dill 2002; Gill et al. 2001;

Harrington and Veitch 1992; Lima 1998; Romero 2004). As predators generally induce a stress response in their prey (Dwyer 2004; Lopez and Martin 2001; Mateo 2007), we assume that sea turtles may experience a stress response if exposed to acoustic stressors, especially loud sounds. We expect breeding adult females may experience a lower stress response, as studies on loggerhead, hawksbill, and green turtles have demonstrated that females appear to have a physiological mechanism to reduce or eliminate hormonal response to stress (predator attack, high temperature, and capture) in order to maintain reproductive capacity at least during their breeding season; a mechanism apparently not shared with males (Jessop 2001; Jessop et al. 2000; Jessop et al. 2004). We note that the only portion of the action area where breeding females may occur is the portion of vessel transit routes between Charleston, SC and the WDA that travel south of Virginia, and that presence is limited seasonally.

Due to the limited information about acoustically induced stress responses in sea turtles, we assume physiological stress responses would occur concurrently with any other response such as hearing impairment or behavioral disruptions. However, we expect such responses to be brief, with animals returning to a baseline state once exposure to the acoustic source ceases. As with cetaceans, such a short, low-level stress response may in fact be adaptive and beneficial as it may result in sea turtles exhibiting avoidance behavior, thereby minimizing their exposure duration and risk from more deleterious, high sound levels.

Effects to Hearing
Interference, or masking, occurs when a sound is a similar frequency and similar to or louder than the sound an animal is trying to hear (Clark et al. 2009b; Erbe et al. 2016). Masking can interfere with an individual's ability to gather acoustic information about its environment, such as predators, prey, conspecifics, and other environmental cues (Richardson 1995). This can result in loss of environmental cues of predatory risk, mating opportunity, or foraging options. Compared to other marine animals, such as marine mammals, which are highly adapted to use sound in the marine environment, sea turtle hearing is limited to lower frequencies and is less sensitive. Because sea turtles likely use their hearing to detect broadband low-frequency sounds in their environment, the potential for masking would be limited to certain sound exposures. Only continuous anthropogenic sounds that have a significant low-frequency component, are not of brief duration, and are of sufficient received level could create a meaningful masking situation (e.g., long-duration vibratory pile extraction or long term exposure to vessel noise affecting natural background and ambient sounds); this type of noise exposure is not anticipated based on the characteristics of the sound sources considered here.

There is evidence that sea turtles may rely primarily on senses other than hearing for interacting with their environment, such as vision (Narazaki et al. 2013), magnetic orientation (Avens and Lohmann 2003; Putman et al. 2015), and scent (Shine et al. 2004). Thus, any effect of masking on sea turtles could be mediated by their normal reliance on other environmental cues.

Behavioral Responses
To date, very little research has been done regarding sea turtle behavioral responses relative to underwater noise. Popper et al. (2014) describes relative risk (high, moderate, low) for sea turtles exposed to pile driving noise and concludes that risk of a behavioral response decreases with distance from the pile being driven. O'Hara and Wilcox (1990) and McCauley et al.

(2000b), who experimentally examined behavioral responses of sea turtles in response to seismic airguns. O'Hara and Wilcox (1990) found that loggerhead turtles exhibited avoidance behavior at estimated sound levels of 175 to 176 dB re: 1 µPa (rms) (or slightly less) in a shallow canal. Mccauley et al. (2000a) experimentally examined behavioral responses of sea turtles in response to seismic air guns. The authors found that loggerhead turtles exhibited avoidance behavior at estimated sound levels of 175 to 176 dB rms (re: 1 µPa), or slightly less, in a shallow canal. Mccauley et al. (2000a) reported a noticeable increase in swimming behavior for both green and loggerhead turtles at received levels of 166 dB rms (re: 1 µPa). At 175 dB rms (re: one µPa), both green and loggerhead turtles displayed increased swimming speed and increasingly erratic behavior (Mccauley et al. 2000a). Based on these data, NMFS GARFO finds that sea turtles would exhibit a behavioral response in a manner that constitutes harassment as defined for ESA take purposes above in this opinion, when exposed to received levels of 175 dB rms (re: 1 µPa) for a period long enough such that the behavioral response significantly disrupts normal behavioral patterns. This is the level at which sea turtles are expected to begin to exhibit avoidance behavior based on experimental observations of sea turtles exposed to multiple firings of nearby or approaching air guns.

7.1.4.1 Thresholds Used to Evaluate Effects of Project Noise on Sea Turtles

In order to evaluate the effects of exposure to noise by sea turtles that could result in physical effects, NMFS relies on the available literature related to the noise levels that would be expected to result in sound-induced hearing loss (i.e., TTS or PTS); we relied on acoustic thresholds for PTS and TTS for impulsive sounds developed by the U.S. Navy for Phase III of their programmatic approach to evaluating the environmental effects of their military readiness activities (U.S. Navy 2017a). At the time of this consultation, we consider these the best available data since they rely on all available information on sea turtle hearing and employ the same methodology to derive thresholds as in NMFS recently issued technical guidance for auditory injury of marine mammals (NMFS 2018). Below we briefly detail these thresholds and their derivation. More information can be found in the U.S. Navy's Technical report on the subject (U.S. Navy 2017a).

To estimate received levels from airguns and other impulsive sources expected to produce TTS in sea turtles, the U.S. Navy compiled all sea turtle audiograms available in the literature in an effort to create a composite audiogram for sea turtles as a hearing group. Since these data were insufficient to successfully model a composite audiogram via a fitted curve as was done for marine mammals, median audiogram values were used in forming the hearing group's composite audiogram. Based on this composite audiogram and data on the onset of TTS in fishes, an auditory weighting function was created to estimate the susceptibility of sea turtles to TTS. Data from fishes were used since there are currently no data on TTS for sea turtles and fishes are considered to have hearing range more similar to sea turtles than do marine mammals (Popper et al. 2014). Assuming a similar relationship between TTS onset and PTS onset as has been described for humans and the available data on marine mammals, an extrapolation to PTS susceptibility of sea turtles was made based on the methods proposed by Navy 2017. From these data and analyses, dual metric thresholds were established similar to those for marine mammals: one threshold based on peak sound pressure level (0-pk SPL) that does not incorporate the auditory weighting function nor the duration of exposure, and another based on cumulative sound exposure level (SELcum) that incorporates both the auditory weighting function and the exposure duration (Table 7.1.27). The cumulative metric accumulates all sound exposure within a 24-hour period and is therefore different from a peak, or single exposure, metric.

Table 7.1.27. Acoustic thresholds identifying the onset of permanent threshold shift and Temporary threshold shift for sea turtles exposed to impulsive sounds (U.S. Navy 2017a)

Hearing Group	Generalized Hearing Range	Permanent Threshold Shift Onset	Temporary Threshold Shift Onset
Sea Turtles	30 Hz to 2 kHz	204 dB re: 1 $Pa^2 \cdot s$ SEL_{cum} 232 dB re: 1 μPa SPL (0-pk)	189 dB re: 1 $\mu Pa^2 \cdot s$ SEL_{cum} 226 dB re: 1 μPa SPL (0-pk)

Non-auditory Injury Criteria for Explosives (Unexploded Ordnance)
NMFS has adopted criteria used by the U.S. Navy to assess the potential for non-auditory injury (i.e., lung and GI tract) and mortality from underwater explosive sources as presented in U.S. Navy (2017). Unlike auditory thresholds, these depend upon an animal's mass and depth. Table 7.1.28 provides mass estimates used in the assessment. For sea turtles, a harbor seal (*Phoca vitulina*) pup and adult masses are used as conservative surrogate values as outlined in U.S. Navy (2017).

Single blast events within a 24-hour period are not presently considered by NMFS to produce behavioral effects if they are below the onset of TTS thresholds for frequency-weighted SEL (LE,24h) and peak pressure levels. As only one charge detonation per day is planned for the Project, the effective disturbance threshold for single events in each 24-hour period is the TTS onset.

Table 7.1.28 Representative Pup and Adult Mass Estimates Used for Assessing Impulse-based Onset of Lung Injury and Mortality Threshold Exceedance Distances

Impulse Animal Group	**Representative Species**	**Pup Mass (kg)**	**Adult Mass (kg)**
Sea Turtles	Harbor Seal (*Phoca vitulina*)	8	60

Note: These values are based on the smallest expected animals for the species that might be present within Project areas. Masses listed here are used for assessing impulse-based onset of lung injury and mortality threshold exceedance distances. kg = kilograms

Hearing Group	Mortality (Severe lung injury)*	Slight Lung Injury*	G.I. Tract Injury
Sea Turtles	*Cell 1* Modified Goertner model; Equation 1	*Cell 2* Modified Goertner model; Equation 2	*Cell 3* $L_{pk,flat}$: 237 dB

* Lung injury (severe and slight) thresholds are dependent on animal mass (Recommendation: Table C.9 from DoN 2017 based on adult and/or calf/pup mass by species).

Modified Goertner Equations for severe and slight lung injury (pascal-second)

Equation 1: $103M^{1/3}(1 + D/10.1)^{1/6}$ Pa-s

Equation 2: $47.5M^{1/3}(1 + D/10.1)^{1/6}$ Pa-s

M animal (adult and/or juvenile) mass (kg) (Table C.9 in DoN 2017)
D animal depth (meters)

Criteria for Considering Behavioral Effects
For assessing behavioral effects, in the BA BOEM used the 175 dB re 1uPa RMS criteria based on McCauley et al. (2000b), consistent with NMFS recommendations. This level is based upon work by Mccauley et al. (2000a), who experimentally examined behavioral responses of sea turtles in response to seismic air guns. The authors found that loggerhead turtles exhibited avoidance behavior at estimated sound levels of 175 to 176 dB rms (re: 1 μPa), or slightly less, in a shallow canal. Mccauley et al. (2000a) reported a noticeable increase in swimming behavior for both green and loggerhead turtles at received levels of 166 dB rms (re: 1 μPa). At 175 dB rms (re: 1 μPa), both green and loggerhead turtles displayed increased swimming speed and increasingly erratic behavior (Mccauley et al. 2000a). Based on these data, NMFS assumes that sea turtles would exhibit a significant behavioral response when exposed to received levels of 175 dB rms (re: 1 μPa). This is the level at which sea turtles are expected to begin to exhibit avoidance behavior based on experimental observations of sea turtles exposed to multiple firings of nearby or approaching air guns. Because data on sea turtle behavioral responses to pile driving is limited, the air gun data set is used to inform potential risk.

7.1.4.2 Effects of Project Noise on Sea Turtles
Here, we consider the effects of the noise producing activities of the Ocean Wind 1 project in the context of the noise thresholds presented above.

UXO Detonation
As explained above, no more than 10 detonations of UXO are anticipated. No more than one detonation will occur in any 24-hour period. Mitigation for UXO detonations that is described in the BA as being part of the proposed action include pre-clearance zones, restricting detonations to daylight hours and the use of a dual noise mitigation system for all detonations to achieve a 10 dB attenuation. Additionally, enough vessels would be deployed to provide 100% temporal and spatial coverage of the pre-clearance zones and, if necessary, aerial surveys would be used to

provide coverage. The size of the pre-clearance zone is dependent on the estimated charge weight of the UXO (see below).

Ocean Wind conducted modeling of acoustic fields for UXO detonations which is described in detail in Section 3.2.6.2 of the BA (also, Küsel et al. 2022). Ranges to auditory injury (PTS), non-auditory injury and mortality, and the behavioral threshold were calculated based on the representative body mass of harbor seal pups as surrogates for sea turtles and used to determine the number of individuals potentially exposed. Table 7.1.29 summarizes the maximum ranges to PTS and behavioral thresholds per charge weight bin for sea turtles. Ranges to PTS thresholds were larger than ranges to mortality, slight lung injury, and gastrointestinal injury criteria. Therefore, the pre-clearance zones for sea turtles were based on the ranges to PTS threshold. Table 7.1.30 presents the maximum-modeled range to the non-auditory injury thresholds from a detonation of a 454 kg charge (the largest anticipated to occur) and incorporation of 10dB attenuation. Table 7.1.30 presents the maximum distances to the PTS thresholds for the maximum anticipated detonation with 10 dB attenuation, which are also the clearance zones incorporated into the proposed action.

Table 7.1.29 Maximum Ranges (meters) to Non-Auditory Injury Thresholds for Sea Turtles – Mitigated (10 dB Attenuation)

Injury Type	Adult	Pup
Mortality - Impulse (severe lung injury)	224	332
Injury - Impulse (slight lung injury)	429	607
Gastrointestinal Injury [a]	125	125

Notes: Maximum ranges are based on worst-case scenario modeling results: charge size E12 (454 kilograms), deepest water depth (45 meters).

[a] Based on 1% of animals exposed (mortality/lung injury) (Hannay and Zykov 2022). dB = decibels; UXO = unexploded ordnance

Table 7.1.30 Maximum PTS Zones and Applicable Pre-clearance Zones (m) to be Applied during UXO Detonations for Sea Turtles - Mitigated

Charge Size									
E4 (2.3 kg)		E6 (9.1 kg)		E8 (45.5 kg)		E10 (227 kg)		E12 (454 kg)	
PTS/ Pre-clearance Zone	Behavioral Zone	PTS/Pre-clearance Zone	Behavioral Zone	PTS/Pre-clearance Zone	Behavioral Zone	PTS/ Pre-clearance Zone	Behavioral Zone	PTS/ Pre-clearance Zone	Behavioral Zone
<50	203	54	448	159	870	348	1,780	472	2,250

Notes: UXO charge weights are groups of similar munitions defined by the U.S. Navy and binned into five categories (E4-E12) by weight (equivalent weight in TNT). Four Project sites (S1-S4) were chosen and modeled for the detonation of each charge weight bin.
PTS zone represent maximum/largest $R_{95\%}$ values in meters calculated per charge size bin (e.g., E/kg). Pre-start clearance zones were calculated by selecting the largest distance to the PTS threshold. The chosen values were the most conservative per charge weight bin across each of the Four modeled sites.
kg = kilograms; E = equivalent; TNT = trinitrotoluene; m = meters; PTS = permanent threshold shift; $R_{95\%}$ = 95th percentile exposure range; UXO = unexploded ordnance

Table 7.1.31 (Table 3-37 in BOEM's BA) outlines the number of ESA-listed turtles potentially exposed to sound sources above PTS, behavioral thresholds and non-auditory thresholds associated with UXO detonations. As described in the BA, calculations were conducted separate from the modeling exercise presented in Hannay and Zykov (2022). The calculations used the largest ranges to thresholds for the maximum charge weight (E12; 1,000 pound [454 kg]) scenario presented in Hannay and Zykov 2022 and the highest density months for each species outlined in Appendix A of the BA (summer for all species except leatherback turtle where fall densities were highest). As Ocean Wind is committing to a 10 dB attenuation for all detonations, the number of exposed sea turtles outlined in Table 3-37 are based on the mitigated ranges presented in Table 3-35 and Table 3-36.

Table 7.1.31 Total Number of ESA-Listed Sea Turtle Exposed to Sound Levels above PTS, Non- Auditory Mortality/Injury and Behavioral Thresholds for the Detonation of 10 UXOs – Mitigated (10 dB)

Sea Turtle Species	PTS	Mortality - Impulse (severe lung injury)	Injury - Impulse (slight lung injury)	Gastrointestinal Injury	Behavior
Kemp's ridley turtle	0	0	0	0	<1 (0.47)

Leatherback turtle	0	0	0	0	<1 (0.39)
Loggerhead turtle	<1 (0.59)	<1 (0.29)	1 (0.97)	0	13 (13.38)
Green turtle	0	0	0	0	0

Source: Distances to thresholds taken from Hannay and Zykov (2022); densities compile from various sources outlined in Appendix A of the Acoustics Report.

Note: Calculation used the largest ranges which were for sea turtle masses (using harbor seals pup as a surrogate as outlined in U.S. Navy [2017]) for the maximum charge weight (E12 [454 kg]) presented in Hannay and Zykov (2022) and the highest density months for each species outlined in Appendix A.

dB = decibels; ESA = Endangered Species Act; kg = kilograms; PTS = permanent threshold shift; UXO = unexploded ordnance

As reflected in the table, the model predicts that no Kemp's ridley, leatherback, or green sea turtles would be exposed to noise that could result in PTS, mortality, or injury. The model predicts that one (rounding up from the fraction) loggerhead could be exposed to noise that could result in PTS, mortality, or injury. However, the modeling does not take the pre-clearance zone into account. The clearance zone for sea turtles will extend 472 m from the site of the planned detonation. Given that a sea turtle would need to be within 472 meters of the detonation to be exposed to noise/pressure that could result in injury and mortality and that detonation will only occur during daylight areas and the area will be monitored by multiple vessels and use aerial coverage as necessary to ensure complete visibility of the pre-clearance area, it is extremely unlikely that a sea turtle would be close enough to the blast to experience injury or mortality.

When rounding up fractions of animals to whole numbers, the model estimates that one Kemp's ridley, one leatherback, and 14 loggerheads would be exposed to noise above the 175 dB re 1uPa RMS threshold such that a behavioral response would be expected. However, given that the duration of the noise exposure will last only as long as the explosion (one second), we expect that any behavioral response would also be limited to that extremely short duration and as such, be a startle response. Any effects to these turtles would be so small that they cannot be meaningfully measured, evaluated, or detected. As such, effects are insignificant.

Impact Pile Driving for WTG and OSS Foundation Installation

Similar to the results presented for marine mammals, the exposure ranges (ER95%) for sea turtles were modeled (Küsel et al. 2022); these are summarized below for monopile and jacket foundations, assuming 10 dB broadband attenuation and a summer acoustic propagation environment. Exposure ranges vary between species due to differences in their behavioral definitions (e.g., swim speeds, dive depths). These differences can impact both dwell time and how the animats (i.e., simulated animals) sample the sound field. For acoustic modeling, January was used for the winter profile, and June, July, and August were averaged for summer. Summer is presented here because it represents a worst case/maximum sound propagation scenario and because the potential for pile driving in the winter months is limited by the January – April time of year restriction. As described in Küsel et al. 2022, "From June to September, the average temperature of the upper (10–15 m) water column is higher, which can lead to a surface layer of increased sound speeds. This creates a downward refracting environment in which propagating sound interacts with the seafloor more than in a well-mixed environment. Increased wind mixing combined with a decrease in solar energy during winter, from December through

March, results in a sound speed profile that is more uniform with depth."

Table 7.1.32. Monopile foundation (8/11 m diameter, summer): Exposure ranges (ER95%) in km to sea turtle threshold criteria with 10 dB attenuation.

Species	One pile per day			Two piles per day		
	PTS		Behavior	PTS		Behavior
	LE, 24h	*Lpk*	*Lpk*	***LE, 24h***	*Lpk*	*Lpk*
Kemp's ridley turtle	0.13	0	1.08	0.15	0	1.06
Leatherback turtle	0.03	0	0.76	0.03	0	0.98
Loggerhead turtle	<0.01	0	1.04	<0.01	0	0.90
Green turtle	0.31	0	1.18	0.30	0	1.02

Table 7.1.33. Jacket foundation (2.44 m diameter, summer): Exposure ranges (ER95%) in km to sea turtle threshold criteria with 10 dB attenuation.

Species	Two pin piles per day			Three pin piles per day		
	PTS		Behavior	PTS		Behavior
	LE, 24h	*Lpk*	*Lpk*	***LE, 24h***	*Lpk*	*Lpk*
Kemp's ridley turtle	0	0	0.29	0	0	0.29
Leatherback turtle	0	0	0.22	0	0	0.25
Loggerhead turtle	0	0	0.19	0	0	0.24
Green turtle	0	0	0.26	0	0	0.23

Modeling was carried out to determine the numbers of individual sea turtles predicted to receive sound levels above threshold criteria using animal movement modeling (Küsel et al. 2022). Küsel et al. (2022) used the JASCO Animal Simulation Model Including Noise Exposure (JASMINE) to predict the exposure of animats (virtual sea turtles) to sound arising from sound sources. An individual animat's modeled sound exposure levels are summed over the total simulation duration, such as 24 hours or the entire simulation, to determine its total received energy, and then compared to the assumed threshold criteria. The tables below include results assuming broadband attenuation of 10 dB for impact pile driving with maximum seasonal densities for each species (as described below). No aversion behaviors (e.g., avoidance) or mitigation measures (e.g., shutdown zones) other than the 10 dB attenuation for impact pile driving were incorporated into the modeling to generate the number of sea turtles of each species that are expected to be exposed to the noise.

As described in Küsel et al. (2022), there are limited density estimates for sea turtles in the Ocean Wind lease area. In the New York Bight, a multi-year series of seasonal aerial surveys were conducted by Normandeau Associates for the New York State Energy Research and Development Authority (NYSERDA; Normandeau Associates and APEM 2018b, 2019c, 2019a, 2019, 2020). The purpose of the aerial surveys was to gather high resolution data on marine resources within the offshore planning area (OPA) off Long Island, New York. High-resolution digital aerial photographs were collected along specific line transects each season for three consecutive years. Küsel et al. (2022) used the density estimates from the NYSERDA study as a reasonable proxy for the Ocean Wind lease area. We agree that given the geographic and habitat similarity of the Ocean Wind lease area to the NYSERDA study area it is reasonable to expect that the density of sea turtles in the Ocean Wind area would be substantially the same.

Table 7.1.34. Sea turtle density estimates for the Ocean Wind WDA. Küsel et al. (table 47)

Common name	**Density (animals/100km^2)** [a]			
	Spring	***Summer***	***Fall***	***Winter***
Kemp's ridley sea turtle	0.050	0.991	0.190	0
Leatherback sea turtle	0	0.331	0.789	0
Loggerhead sea turtle	0.254	26.799	0.190	0.025
Green sea turtle	0	0.038	0	0

[a] Densities calculated from NYSERDA aerial survey reports (Normandeau Associates and APEM 2018b, 2019c, 2019a, 2019, 2020)

As explained in the Status of the Species and Environmental Baseline sections of this Opinion, due to seasonal water temperature patterns, sea turtles are most likely to occur in the lease area from June through October, with few sea turtles present in May, November, and early December and turtles absent in the winter months (January – April).

We considered whether sufficient information was available on detection rates from aerial surveys from which we could further adjust the exposure estimates. We reviewed the NYSERDA reports that informed the density estimates and note that they do not appear to make any adjustments to sea turtle sightings based on detectability from the survey platform. Describing an aerial survey in the MA/RI Wind Energy Area, Kraus et al. (2016) notes that the number of sea turtle sightings was substantially increased by detections in the vertical camera (mounted under the plane) compared to the number observed by observers using binoculars during the aerial survey but does not provide any information on overall sea turtle detectability nor does it adjust observations to account for availability bias. We note that the NYSERDA studies used high-resolution digital aerial photographs, which would improve detectability.

Some studies have concurrently conducted tagging studies to account for availability bias. We reviewed the literature for similar studies conducted in the lease area, however no studies were found. The closest geographic study, NEFSC 2011, estimated regional abundance of loggerhead turtles in Northwestern Atlantic Ocean continental shelf waters using aerial surveys and accounted for availability bias using satellite tags. However, as determining availability bias depends on the species and is influenced by habitat, season, sea surface temperature, time of day, and other factors, we determined that while we may be able to identify studies that identified availability bias (such as NEFSC 2011) it would not be reasonable to apply those post-hoc to the density estimates given differences in the study designs, location, habitat, sea surface temperature, etc.

We also considered whether it would be reasonable to adjust the density estimates to account for the percent of time that sea turtles are likely to be at the surface while in the WDA and therefore would be available to be detected for such a survey. However, after consulting with subject matter experts we determined it was not reasonable to adjust the density estimates with general observations about the amount of time sea turtles may be spending at the surface. Therefore, we have determined that there is no information available for us to use that could result in a different estimate of the amount of exposure that is reasonably certain to occur and have not made any further adjustments to the exposure estimates.

Table 7.1.35. WTG monopile foundations: Number of sea turtles predicted to receive sound levels above exposure criteria with 10 dB attenuation for a total of 98 monopiles. Installation of two monopiles per 24-hour period, 50-m penetration depth, 4,000 kJ hammer. (source: Table 19 in Küsel et al. 2022)

Sea Turtle Species	Injury (PTS)		Behavior
	Peak	Cum. (24 hour)	
Kemp’s ridley	0	0.83	15
Leatherback	0	0.25	6.61
Loggerhead	0	7.5	168.84
Green	0	0.06	0.47

Table 7.1.36. OSS monopile foundations: Number of sea turtles predicted to receive sound levels above exposure criteria with 10 dB attenuation for a total of 3 monopiles. (source: Table 20 in Küsel et al. 2022)

Sea Turtle Species	Injury (PTS)		Behavior
	Peak	Cum. (24 hour)	
Kemp’s ridley	0	0.02	0.43

Leatherback	0	<0.01	0.18
Loggerhead	0	0.23	5.97
Green	0	<0.01	0.01

Table 7.1.37. OSS monopile foundations: Number of sea turtles predicted to receive sound levels above exposure criteria with 10 dB attenuation for a total of 48 pin piles. (source: Table 20 in Küsel et al. 2022)

Sea Turtle Species	Injury (PTS)		Behavior
	Peak	Cum. (24 hour)	
Kemp's ridley	0	0	0.31
Leatherback	0	0	0.44
Loggerhead	0	0	14.70
Green	0	0	0.02

The table below represents the maximum anticipated exposure for each species considering all impact pile driving. Note that for each of the two construction scenarios we have added up all modeled exposures and rounded up fractions to whole animals with the exception that fractions 0.1 or less have been rounded down to zero as we consider modeled exposures at that level extremely unlikely to occur. These estimates do not account for any aversion behavior and they do not incorporate the clearance or shutdown zones.

Table 7.1.38. Maximum anticipated exposure for each species across months and pile driving scenarios

Scenario 1 (98 monopiles for WTG foundations and 3 monopiles for OSS foundation

	PTS peak	PTS cum	Behavioral (175 dB rms)
Kemp's ridley	0	1	16
Leatherback	0	1	7
Loggerhead	0	8	175
Green	0	0	1

Scenario 2 (98 monopiles for WTG foundations and 3 pin-pile foundations for OSSs

	PTS peak	PTS cum	Behavioral (175 dB rms)
Kemp's ridley	0	1	16
Leatherback	0	1	7
Loggerhead	0	8	184
Green	0	0	1

Proposed Measures to Minimize Exposure of Sea Turtles to Pile Driving Noise
Here, we consider the measures that are part of the proposed action, because either they are proposed by Ocean Wind or BOEM and reflected in the proposed action as described to us by BOEM in the BA, or they are proposed to be required through the ITA (recognizing that those measures are required for marine mammals but may provide benefit to sea turtles). Specifically, we consider how those measures will serve to minimize exposure of ESA listed sea turtles to pile driving noise. Details of these proposed measures are included in the Description of the Action section above. We do not consider the use of PAM here; because sea turtles do not vocalize, PAM cannot be used to monitor sea turtle presence.

Seasonal Restriction on Pile Driving
No impact pile driving activities for monopiles would occur between January 1 and April 30 to avoid the time of year with the highest densities of right whales in the project area. The January 1 – April 30 period overlaps with the period when we do not expect sea turtles to occur in the action area due to cold water temperatures. This seasonal restriction is factored into the acoustic modeling that supported the development of the amount of exposure estimates above. That is, the modeling does not consider any pile driving in the January 1 – April 30 period. Thus, the exposure estimates do not need to be adjusted to account for this seasonal restriction.

Sound Attenuation Devices
Ocean Wind will implement sound attenuation technology that would achieve at least a 10 dB reduction in pile driving noise, as described above. The attainment of a 10 dB reduction in pile driving noise was incorporated into the exposure estimate calculations presented above. Thus, the exposure estimates do not need to be adjusted to account for the use of sound attenuation. If a reduction greater than 10 dB is achieved, the number of sea turtles exposed to pile driving noise could be lower as a result of resulting smaller distances to thresholds of concern.

Clearance Zone
As described in the BA, Ocean Wind would use PSOs to establish clearance zones of 500 m around the pile driving equipment to ensure the area is clear of sea turtles prior to the start of pile driving. Prior to the start of pile driving activity, the clearance zone will be monitored for 60 minutes for protected species including sea turtles. If a sea turtle is observed approaching or entering the clearance zone prior to the start of pile driving operations, pile driving activity will be delayed until either the sea turtle has voluntarily left the respective clearance zone and been

visually confirmed beyond that clearance zone, or, 30 minutes have elapsed without re-detection of the animal. Sea turtles observed within a clearance zone will be allowed to remain in the clearance zone (*i.e.*, must leave of their own volition), and their behavior will be monitored and documented. The clearance zones may only be declared clear, and pile driving started, when the entire clearance zones are visible (*i.e.*, when not obscured by dark, rain, fog, etc.) for a full 30 minutes prior to pile driving. As required by conditions of the ITA, a zone of at least 1,650 m (May – November; 2,000 m in December) must be fully visible before pile driving can begin. If a sea turtle is observed entering or within the clearance zone after pile driving has begun, the PSO will request a temporary cessation of pile driving as explained for marine mammals above.

There will be at least two PSOs stationed at an elevated position at or near the pile being driven and at least two PSOs on a vessel transiting the area about 2,000 m from the pile; given that PSOs are expected to reasonably be able to detect sea turtles at a distance of 500 m from their station, we expect that the PSOs will be able to effectively monitor the clearance zone. While visibility of sea turtles in the clearance zone is limited to only sea turtles at or very near the surface, we expect that the use of the clearance zone will reduce the number of times that pile driving begins with a sea turtle closer than 500 m to the pile being driven. The single strike PTS (peak) threshold will not be exceeded during any impact pile driving of monopiles or pin piles; thus, injury is not expected to occur even if a sea turtle was within the clearance zone for long enough to be exposed to a single pile strike. Given that the clearance zone is larger than the area within which a sea turtle would need to remain for 24 hours to experience injury from exposure to pile driving noise (less than 500 m), the requirement to implement a clearance and shutdown zone further reduces the already low likelihood of a sea turtle being exposed to noise above the injury threshold. The clearance and shutdown requirements may also reduce the number of sea turtles potentially exposed to noise above the behavioral disturbance thresholds but we are not able to estimate the extent of any reduction.

Soft Start

As described above, before full energy pile driving begins, the hammer will operate at 10-20% energy for 20 minutes (400 – 800 kJ for monopiles, less than 500 kJ for pin piles). Based on information in Küsel et al. 2022, at these hammer energies, underwater noise does not exceed the peak threshold for considering PTS or TTS for sea turtles; noise above the 175 dB re 1uPa threshold would extend approximately 1 km from the pile during the soft start period. The use of the soft start gives sea turtles near enough to the piles to be exposed to the soft start noise a “head start” on escape or avoidance behavior by causing them to swim away from the source. This means that sea turtles within 1 km of the pile would be expected to begin to swim away from the noise before full force pile driving begins; in this case, the number of sea turtles exposed to noise that may result in injury would be reduced. It is likely that by eliciting avoidance behavior prior to full power pile driving, the soft start will reduce the duration of exposure to noise that could result in behavioral disturbance. Without soft start procedures, pile driving would begin with full hammer energy, which would present a greater risk of more severe impacts to more animals. In this context, soft start is a mitigation measure designed to reduce the amount and severity of effects incidental to pile driving. However, we are not able to predict the extent to which the soft start will reduce the number of sea turtles exposed to pile driving noise or the extent to which it will reduce the duration of exposure. Therefore, while the soft start is expected to reduce effects of pile driving, we are not able to modify the estimated exposures to account for any benefit provided by the soft start.

Sound Source Verification
As described above, Ocean Wind will also conduct hydroacoustic monitoring for a subset of impact-driven piles. The required sound source verification will provide information necessary to confirm that the sound source characteristics predicted by the modeling are reflective of actual sound source characteristics in the field and that the sound attenuation system is reducing noise to levels modeled with 10dB attenuation. In the event that sound source verification indicates that characteristics in the field are such that the model is invalid or is determined to underestimate exposure of listed species, reinitiation of this consultation may be necessary.

7.1.4.1 Effects to Sea Turtles Exposed to Impact Pile Driving Noise for Foundation Installation
As noted above, the peak PTS threshold is not exceeded in any pile driving scenario and the cumulative PTS threshold is only exceeded for monopiles (one or two piles per day). The exposure analysis conducted by Küsel et al. (2022) predicts exposure of no more than 1 Kemp's ridley, 1 leatherback, and 8 loggerheads to noise above the cumulative PTS threshold (and no green sea turtles). In order for noise exposure above the cumulative PTS threshold to occur, a sea turtle would need to remain within 0.31 km of a single monopile being installed for the entire 3-4 hour duration of the pile driving event. Based on the clearance and shutdown requirements which are triggered if a sea turtle is within 500 m of the pile being installed and the anticipated behavioral response to noise above the 175 dB re 1uPa RMS threshold (which extends approximately 1km from monopiles), it is extremely unlikely that this will occur. Based on this, despite the modeled predictions of sea turtles exposed to noise above the cumulative PTS threshold we do not expect this to occur and no sea turtles are expected to experience permanent hearing loss or any other injury. No mortalities are anticipated due to exposure to pile driving noise. Therefore, take by auditory injury, non-auditory injury or mortality as the result of impact pile driving is not reasonably certain to occur.

The exposure analysis also predicts exposure of sea turtles to noise expected to result in a behavioral response. It predicts the exposure of up to 16 Kemp's ridleys, 17 leatherbacks, 175 loggerheads (184 if pin piles are used for the 3 OSS foundations), and 1 green sea turtle to be exposed to noise above the behavioral impacts threshold. Neither Ocean Wind nor BOEM modeled the number of sea turtles expected to be exposed to noise above the TTS threshold thus, we are assuming that some of the sea turtles exposed to noise above the 175 dB threshold would also be exposed to noise above the TTS threshold.

Any sea turtles affected by TTS would experience a temporary, recoverable, hearing loss manifested as a threshold shift around the frequency of the pile driving noise. Because sea turtles do not use noise to communicate, any TTS would not impact communications. We expect that this temporary hearing impairment would affect frequencies utilized by sea turtles for acoustic cues such as the sound of waves, coastline noise, or the presence of a vessel or predator. Sea turtles are not known to depend heavily on acoustic cues for vital biological functions (Nelms et al. 2016; Popper et al. 2014), and instead, may rely primarily on senses other than hearing for interacting with their environment, such as vision (Narazaki et al. 2013) and magnetic orientation (Avens and Lohmann 2003; Putman et al. 2015). As such, it is unlikely that the loss of hearing in a sea turtle would affect its fitness (i.e., survival or reproduction). That said, it is possible that sea turtles use acoustic cues such as waves crashing, wind, vessel and/or predator noise to perceive the environment around them. If such cues increase survivorship (e.g., aid in avoiding predators, navigation), hearing loss may have effects on individual sea turtle fitness. TTS of sea turtles is expected to only last for several days following the initial exposure (Moein et al. 1994). Given this short period of time, and that sea turtles are not known to rely heavily on acoustic cues, we do not anticipate single TTSs would have any impacts on the fitness of individual sea turtles; TTS is considered in the context of harassment below. .

Masking
Sea turtle hearing abilities and known use of sound to detect environmental cues is discussed above. Sea turtles are thought capable of detecting nearby broadband sounds, such as would be produced by pile driving. Thus, environmental sounds, such as the sounds of waves crashing along coastal beaches or other important cues for sea turtles, could possibly be masked for a short duration during pile driving. However, any masking would not persist beyond the period it takes to complete pile driving each day (two to four hours). As addressed in Hazel et al. (2004), sea turtle reaction to vessels is thought to be based on visual cues and not sound; thus, we do not expect that any masking would increase the risk of vessel strike as sea turtles are not expected to rely on the noise of vessels to avoid vessels.

Behavioral Response and Stress
Based on prior observations of sea turtle reactions to sound, if a behavioral reaction were to occur, the responses could include increases in swim speed, change of position in the water column, or avoidance of the sound. The area where pile driving will occur is not known to be a breeding area and is over 200 km north of the nearest beach where sea turtle nesting has been documented (Virginia Beach, VA). Therefore, breeding adults and hatchlings are not expected in the area. The expected behavioral reactions would disrupt migration, feeding, or resting. However, that disruption will last for no longer than it takes the sea turtle to swim away from the noisy area (less than 1 km) or, at the longest, the duration of pile driving (two to four hours). There is no evidence to suggest that any behavioral response would persist beyond the duration of the sound exposure, which in this case is the time it takes the turtle to swim less than 1 km or the time to drive a pile, two to four hours. For migrating sea turtles, it is unlikely that this temporary disturbance, which would result in a change in swimming direction, would have any consequence to the animal. Resting sea turtles are expected to resume resting once they escape the noise. Foraging sea turtles would resume foraging once suitable forage is located outside the noisy area.

While in some instances, temporary displacement from an area may have significant consequences to individuals or populations this is not the case here. For example, if individual turtles were prevented from accessing nesting beaches and missed a nesting cue or were precluded from a foraging area for an extensive period, there could be impacts to reproduction and the health of individuals, respectively. However, the area where noise may be at disturbing levels at any one time is an extremely small portion of the coastal area used for north-south and south-north migrations and is only a fraction of the project area used by foraging sea turtles. We have no information to indicate that any particular portion of the project area is more valuable to sea turtles than another and no information to indicate that resting, foraging and migrating cannot take place in any portion of the project area or that any area is better suited for these activities than any other area. A disruption in migration, feeding, or resting for no more than four hours, and likely even less given the short distance a sea turtle would need to swim to avoid the noise, is not expected to result in any reduction in the health or fitness of any sea turtle. Additionally, significant behavioral responses that result in disruption of important life functions are more likely to occur from multiple exposures within a longer period of time, which are not expected to occur during the pile driving operations for the Ocean Wind project as the impact pile driving noise will be intermittent and temporary.

Concurrent with the above responses, sea turtles are also expected to experience physiological stress responses. Stress is an adaptive response and does not normally place an animal at risk. Distress involves a chronic stress response resulting in a negative biological consequence to the individual. While all ESA-listed sea turtles that experience TTS and behavioral responses are also expected to experience a stress response, such responses are expected to be short-term in nature given the duration of pile driving (no more than four hours at a time) and because we do not expect any sea turtles to be exposed to pile driving noise on more than one day. As such, we do not anticipate stress responses would be chronic, involve distress, or have negative long-term impacts on any individual sea turtle's fitness.

All behavioral responses to a disturbance, such as those described above, will have an energetic or metabolic consequence to the individual reacting to the disturbance (e.g., adjustments in migratory movements or disruption/delays in foraging or resting). Short-term interruptions of normal behavior are likely to have little effect on the overall health, reproduction, and energy balance of an individual or population (Richardson *et al.* 1995). As the disturbance will occur for a portion of each day for a period of 65 to 114 days, with pile driving occurring for no more than 4 to 12 hours per day, this exposure and displacement will be temporary and not chronic. Therefore, any interruptions in behavior and associated metabolic or energetic consequences will similarly be temporary. Thus, we do not anticipate any impairment of the health, survivability, or reproduction of any individual sea turtle.

As explained above, the NMFS Interim Guidance on the ESA Term "Harass" (NMFS PD-02-111-XX) provides for a four-step process to determine if a response meets the definition of harassment. Here, we carry out those steps.

Sea turtles occur in the action area during the time of year when pile driving will occur. As explained above, we expect up to 16 Kemp's ridley, 1 green, 17 leatherback and 184 loggerhead sea turtles would be expected to be exposed to noise that would result in behavioral disturbance and/or TTS. These turtles could experience TTS, masking, stress, and/or behavioral disturbance. With the exception of TTS, which could take several days to recover from, the duration of the other responses are limited to the period of time the animal is exposed to pile driving noise (no more than four hours). This exposure is expected to result in disruption of migrating, resting, and/or foraging behaviors, movement away from the noise source, and avoidance of the area with disturbing levels of noise.

For individual sea turtles exposed to disturbing levels of noise, there will be a significant disruption of their behavior because they will need to abandon that activity for up to four hours while they swim to an alternate area before resuming this behavior, or they will avoid the area extending approximately 1 km from the pile being driven for the up to four hour duration of the pile driving. This means they will need to find an alternate migration route or alternate place for foraging or resting. These sea turtles will also experience masking or TTS which would affect their ability to detect certain environmental cues for the duration of pile driving (masking) or for up to several days after (TTS). Based on this four-step analysis, we find that the sea turtles exposed to noise above the TTS and behavioral harassment thresholds are likely to be adversely affected and that effect is harassment as the effect is reasonably certain to significantly disrupt normal behavioral patterns creating the likelihood of injury. As such, we expect the harassment of up to 15 Kemp's ridley, 1 green, 7 leatherback, and 184 loggerhead sea turtles as a result of pile driving.

NMFS defines "harm" in the definition of "take" as "an act which actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding or sheltering" (50 CFR §222.102). No sea turtles will be injured or killed due to exposure to pile driving noise. Further, while exposure to pile driving noise will significantly disrupt behaviors of individual sea turtles, it will not significantly impair any essential behavioral patterns. This is due to the short term, localized nature of the effects and because we expect these behaviors to resume once the sea turtle is no longer exposed to the noise. The energetic consequences of the evasive behavior and delay in resting or foraging are not expected to 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 nesting or impact the success of breeding or nesting. TTS will resolve within a week of exposure and is not expected to affect the health of any sea turtle or its ability to migrate, forage, breed, or nest. Thus, the response of sea turtles to pile driving noise does not meet the definition of "harm."

As explained above, we do not expect masking to increase the risk of vessel strike as sea turtles are expected to rely on visual, rather than acoustic, cues when attempting to avoid vessels. We have considered if the avoidance of pile driving noise is likely to result in an increased risk of vessel strike or entanglement in fishing gear. This could theoretically occur if displacement from an area ensonified by pile driving noise resulted in individuals moving into areas where vessel traffic was higher or where fishing gear was more abundant. Information available in the Navigational Safety Risk Assessment describes vessel traffic and fishing activity within and outside the WFA where pile driving will occur. Both vessel traffic and fishing activity, including fishing gear that may result in the entanglement or capture of sea turtles, are more frequent outside the WFA than in the WFA (DNV GL 2021 (Ocean Wind NSRA, COP Appendix M)). However, the areas with more dense vessel traffic (e.g., the Traffic Separation Schemes and the nearshore coastal waters) are at least 10 nm (18.5 km) away from the edge of the WFA. As we expect sea turtles disturbed by pile driving noise to only need to move 1 km to avoid pile driving noise that is above the behavioral disturbance threshold, we do not expect sea turtles to be displaced into areas with higher vessel traffic. Similarly, based on available mapping of fishing activity around the WFA (Figures 2-8 to 2-19 in the NRSA, COP Appendix M), it is extremely unlikely that any movement within the WFA or up to 1 km outside the WFA would result in a sea turtle have an increased risk of entanglement or capture in fishing gear. Therefore, we do not anticipate take due to avoidance of pile driving noise resulting in an increased risk of vessel strike or entanglement in fishing gear.

Offshore Cable Transition Point - Temporary Cofferdam Installation and Removal
A cofferdam will be constructed to facilitate at the offshore transition point where the offshore and onshore cables are spliced together. The cofferdam will be constructed by installing sheet piles with vibratory hammer; installation will include up to 18 hours of vibratory hammering over 2 days, with no more than 12 hours in any particular day. Similar effort is anticipated for cofferdam removal. Ocean Wind estimates sound source levels of 165.0 dB re 1 µPa RMS (JASCO 2021). In the BA, BOEM presents distances to the 175 dB re: 1 µPa RMS behavioral threshold based on the "GARFO Acoustics Tool" and concludes that the threshold will not be exceeded at any distance during cofferdam installation or removal. To inform our analysis, we used a newer NMFS Multi-Species Pile Driving Tool to estimate the distance to the threshold and obtained a similar result; the model predicts that noise will be above the PTS (cum) threshold within a distance of less than 3 m and above the behavioral threshold at a distance of less than 3 m.

Prior to the start of vibratory pile driving, a clearance zone with a 500 m radius around the piles to be driven will be monitored by a PSO for at least 30 minutes. Any visual detection of sea turtles within the 500-m clearance zones will trigger a delay in pile installation. Upon a visual detection of a sea turtle entering or within the relevant clearance zone during pile-driving, pile driving will not start until: 1) The lead PSO verifies that the animal(s) voluntarily left and headed away from the clearance area; or 2) 30 minutes have elapsed without re-detection of the sea turtle(s) by the lead PSO. Similarly, if a sea turtle is detected in the clearance zone once pile driving is started, pile driving will stop until the above conditions are met. At a distance of 500 m or less, sea turtles at the surface are expected to be able to be sighted by the PSO; however, submerged sea turtles may not be detected.

Given the extremely small distances to the PTS (cum) threshold (less than 3 m) and that a sea turtle would need to remain within that distance for a full 12 hours to experience PTS, it is extremely unlikely that this would occur. A sea turtle needs to surface to breathe at least every 30 minutes, so even if it remained in the area, the observer would have multiple opportunities to detect it. As such, we do not expect any sea turtles to experience PTS. Similarly, as a sea turtle would need to be within 3 m of the pile being driven, we do not expect any sea turtles to be exposed to noise above the behavioral threshold.

Vessel Noise and Cable Installation
The vessels used for the proposed project will produce low-frequency, broadband underwater sound below 1 kHz (for larger vessels), and higher-frequency sound between 1 kHz to 50 kHz (for smaller vessels), although the exact level of sound produced varies by vessel type. Noise produced during cable installation is dominated by the vessel noise; therefore, we consider these together.

ESA-listed turtles could be exposed to a range of vessel noises within their hearing abilities. Depending on the context of exposure, potential responses of green, Kemp's ridley, leatherback, and loggerhead sea turtles to vessel noise disturbance, would include startle responses, avoidance, or other behavioral reactions, and physiological stress responses. Very little research exists on sea turtle responses to vessel noise disturbance. Currently, there is nothing in the available literature specifically aimed at studying and quantifying sea turtle response to vessel noise. However, a study examining vessel strike risk to green sea turtles suggested that sea turtles may habituate to vessel sound and may be more likely to respond to the sight of a vessel rather than the sound of a vessel, although both may play a role in prompting reactions (Hazel et al. 2007). Regardless of the specific stressor associated with vessels to which turtles are responding, they only appear to show responses (avoidance behavior) at approximately 10 m or closer (Hazel et al. 2007).

Therefore, the noise from vessels is not likely to affect sea turtles from further distances, and disturbance may only occur if a sea turtle hears a vessel nearby or sees it as it approaches. These responses appear limited to non-injurious, minor changes in behavior based on the limited information available on sea turtle response to vessel noise.

For these reasons, vessel noise is expected to cause minimal disturbance to sea turtles. If a sea turtle detects a vessel and avoids it or has a stress response from the noise disturbance, these responses are expected to be temporary and only endure while the vessel transits through the area where the sea turtle encountered it. Therefore, sea turtle responses to vessel noise disturbance are considered insignificant (i.e., so minor that the effect cannot be meaningfully evaluated), and a sea turtle would be expected to return to normal behaviors and stress levels shortly after the vessel passes by.

Operation of WTGs
As described above, many of the published measurements of underwater noise levels produced by operating WTGs are from older geared WTGs and may not be representative of newer direct-drive WTGs, like those that will be installed for the Ocean Wind 1 project. Elliot et al. (2019) reports underwater noise monitoring at the Block Island Wind Farm, which has direct-drive GE Haliade turbines; as explained in section 7.1.2, this is the best available data for estimating operational noise of the Ocean Wind turbines. The loudest noise recorded was 126 dB re 1uPa at a distance of 50 m from the turbine when wind speeds exceeded 56 kmh. As noted above, based on wind speed records from the Ambrose Buoy (November 2008 – February 2023), instances of wind speeds exceeding 56 kmh in the lease area are expected to be rare, with wind speeds exceeding 40 kmh less than 3% of the time across a year.

Elliot et al. (2019) conclude that based on monitoring of underwater noise at the Block Island site, under worst-case assumptions, no risk of temporary or permanent hearing damage (PTS or TTS) for sea turtles could be projected even if an animal remained in the water at 50 m (164 ft.) from the turbine for a full 24-hour period. As underwater noise associated with the operation of the WTGs is below the thresholds for considering behavioral disturbance, and considering that there is no potential for exposure to noise above the peak or cumulative PTS or TTS thresholds, effects to sea turtles exposed to noise associated with the operating turbines are extremely unlikely to occur.

HRG Surveys

Some of the equipment that is described by BOEM for use for HRG surveys produces underwater noise that can be perceived by sea turtles. This may include boomers, sparkers, and bubble guns. The maximum distance to the 175 dB re 1uPa behavioral disturbance threshold is 90 meters; the TTS and PTS thresholds are not exceeded at any distance (see table 7.1.6 and 7.1.7). Extensive information on HRG survey noise and potential effects of exposure to sea turtles is provided in NMFS June 29, 2021 programmatic ESA consultation on certain geophysical and geotechnical survey activities (NMFS GAR 2021). We summarize the relevant conclusions here.

None of the equipment being operated for these surveys that overlaps with the hearing range (30 Hz to 2 kHz) for sea turtles has source levels loud enough to result in PTS or TTS based on the peak or cumulative exposure criteria (Table 7.1.5). Therefore, physical effects are extremely unlikely to occur.

As explained above, we find that sea turtles would exhibit a behavioral response when exposed to received levels of 175 dB re: 1 µPa (rms) and are within their hearing range (below 2 kHz). For boomers and bubble guns, the distance to this threshold is 40 m, and is 90 m for sparkers and 2 m for chirps (Table 7.17). Thus, a sea turtle would need to be within 90 m of the source to be exposed to potentially disturbing levels of noise. We expect that sea turtles would react to this exposure by swimming away from the sound source; this would limit exposure to a short time period, just the few seconds it would take an individual to swim away to avoid the noise. As the noise source is moving, this further limits the potential for exposure that would result in sustained behavioral disturbance and we expect exposure to be limited to only seconds to minutes. BOEM calculated that for a survey with equipment being towed at 3 knots, exposure of a turtle that was within 90 m of the source would last for less than two minutes.

The risk of exposure to potentially disturbing levels of noise is reduced by the use of PSOs to monitor for sea turtles. A Clearance Zone (500 m in all directions) for ESA-listed species must be monitored around all vessels operating equipment at a frequency of less than 180 kHz. At the start of a survey, equipment cannot be turned on until the Clearance Zone is clear for at least 30 minutes. This condition is expected to reduce the potential for sea turtles to be exposed to noise that may be disturbing. However, even in the event that a sea turtle is submerged and not seen by the PSO, in the worst case, we expect that sea turtles would avoid the area ensonified by the survey equipment that they can perceive. Because the area where increased underwater noise will be experienced is transient and increased underwater noise will only be experienced in a particular area for less than two minutes, we expect any effects to behavior to be minor and limited to a temporary disruption of normal behaviors, temporary avoidance of the ensonified area and minor additional energy expenditure spent while swimming away from the noisy area. If foraging or migrations are disrupted, we expect that they will quickly resume once the survey vessel has left the area. No sea turtles will be displaced from a particular area for more than a few minutes. While the movements of individual sea turtles will be affected by the sound associated with the survey, these effects will be temporary (no more than two minutes) and localized (avoiding an area no larger than 90 m) and there will be only a minor and temporary impact on foraging, migrating, or resting sea turtles. For example, BOEM calculated that for a survey with equipment being towed at 3 knots, exposure of a sea turtle that was within 90 m of the source would last for less than two minutes.

Given the intermittent and short duration of exposure to any potentially disturbing noise from HRG equipment, effects to individual sea turtles from brief exposure to potentially disturbing levels of noise are expected to be minor and limited to a brief startle, short increase in swimming speed and/or short displacement from an area not exceeding 90 m in diameter, and will be so small that they cannot be meaningfully measured, detected, or evaluated; therefore, effects are insignificant, and take is not anticipated to occur.

7.1.5. Effects of Project Noise on Atlantic sturgeon

Background Information – Atlantic sturgeon and Noise
Impulsive sounds such as those produced by impact pile driving can affect fishes in a variety of ways, and in certain circumstances, have been shown to cause mortality, auditory injury, barotrauma, and behavioral changes. Impulsive sound sources produce brief, broadband signals that are atonal transients (e.g., high amplitude, short-duration sound at the beginning of a waveform; not a continuous waveform). They are generally characterized by a rapid rise from ambient sound pressures to a maximal pressure followed by a rapid decay period that may include a period of diminishing, oscillating maximal and minimal pressures. For these reasons, they generally have an increased capacity to induce physical injuries in fishes, especially those with swim bladders (Casper et al. 2013a; Halvorsen et al. 2012b; Popper et al. 2014). These types of sound pressures cause the swim bladder in a fish to rapidly and repeatedly expand and contract, and pound against the internal organs. This pneumatic pounding may result in hemorrhage and rupture of blood vessels and internal organs, including the swim bladder, spleen, liver, and kidneys. External damage has also been documented, evident with loss of scales, hematomas in the eyes, base of fins, etc. (e.g., Casper et al. 2012c; Gisiner 1998; Halvorsen et al. 2012b; Wiley et al. 1981; Yelverton et al. 1975a). Fishes can survive and recover from some injuries, but in other cases, death can be instantaneous, occur within minutes after exposure, or occur several days later.

Hearing impairment
Research is limited on the effects of impulsive noise on the hearing of fishes, however some research on seismic air gun exposure has demonstrated mortality and potential damage to the lateral line cells in fish larvae, fry, and embryos after exposure to single shots from a seismic air gun near the source (0.01 to 6 m; Booman et al. 1996; Cox et al. 2012). Popper et al. (2005a) examined the effects of a seismic air gun array on a fish with hearing specializations, the lake chub (*Couesius plumbeus*), and two species that lack notable hearing specializations, the northern pike (*Esox lucius*) and the broad whitefish (*Coregonus nasus*), a salmonid species. In this study, the average received exposure levels were a mean peak pressure level of 207 dB re 1 μPa; sound pressure level of 197 dB re 1 μPa; and single-shot sound exposure level of 177 dB re 1 μPa^2-s. The results showed temporary hearing loss for both lake chub and northern pike to both 5 and 20 air gun shots, but not for the broad whitefish. Hearing loss was approximately 20 to 25 dB at some frequencies for both the northern pike and lake chub, and full recovery of hearing took place within 18-24 hours after sound exposure. Examination of the sensory surfaces showed no damage to sensory hair cells in any of the fish from these exposures (Song et al. 2008). Popper et al. (2006) also indicated exposure of adult fish to a single shot from an air gun array (consisting of four air guns) within close range (six meters) did not result in any signs

of mortality, seven days post-exposure. Although non-lethal injuries were observed, the researchers could not attribute them to air gun exposure as similar injuries were observed in controlled fishes. Other studies conducted on fishes with swim bladders did not show any mortality or evidence of other injury (Hastings et al. 2008; McCauley and Kent 2012; Popper et al. 2014; Popper et al. 2007; Popper et al. 2005a).

McCauley et al. (2003) showed loss of a small percent of sensory hair cells in the inner ear of the pink snapper (*Pagrus auratus*) exposed to a moving air gun array for 1.5 hours. Maximum received levels exceeded 180 dB re 1 μPa^2-s for a few shots. The loss of sensory hair cells continued to increase for up to at least 58 days post-exposure to 2.7 percent of the total cells. It is not known if this hair cell loss would result in hearing loss since TTS was not examined. Therefore, it remains unclear why McCauley et al. (2003) found damage to sensory hair cells while Popper et al. (2005a) did not. However, there are many differences between the studies, including species, precise sound source, and spectrum of the sound that make it difficult speculate what the caused hair cell damage in one study and no the other.

Hastings et al. (2008) exposed the pinecone soldierfish (*Myripristis murdjan*), a fish with anatomical specializations to enhance their hearing and three species without notable specializations: the blue green damselfish (*Chromis viridis*), the saber squirrelfish (*Sargocentron spiniferum*), and the bluestripe seaperch (*Lutjanus kasmira*) to an air gun array. Fish in cages in 16 ft. (4.9 m) of water were exposed to multiple air gun shots with a cumulative sound exposure level of 190 dB re 1 μPa^2-s. The authors found no hearing loss in any fish following exposures. Based on the tests to date that indicated TTS in fishes from exposure to impulsive sound sources (air guns and pile driving) the recommended threshold for the onset of TTS in fishes is 186 dB SEL_{cum} re 1 μPa^2-s, as described in the 2014 *ANSI Guidelines*.

Physiological Stress

Physiological effects to fishes from exposure to anthropogenic sound are increases in stress hormones or changes to other biochemical stress indicators (e.g., D'amelio et al. 1999; Sverdrup et al. 1994; Wysocki et al. 2006). Fishes may have physiological stress reactions to sounds that they can detect. For example, a sudden increase in sound pressure level or an increase in overall background noise levels can increase hormone levels and alter other metabolic rates indicative of a stress response. Studies have demonstrated elevated hormones such as cortisol, or increased ventilation and oxygen consumption (Hastings and C. 2009; Pickering 1981; Simpson et al. 2015; Simpson et al. 2016; Smith et al. 2004a; Smith et al. 2004b). Although results from these studies have varied, it has been shown that chronic or long-term (days or weeks) exposures of continuous anthropogenic sounds can lead to a reduction in embryo viability (Sierra-Flores et al. 2015) and decreased growth rates (Nedelec et al. 2015).

Generally, stress responses are more likely to occur in the presence of potentially threatening sound sources such as predator vocalizations or the sudden onset of loud and impulsive sound signals. Stress responses are typically considered brief (a few seconds to minutes) if the exposure is short or if fishes habituate or have previous experience with the sound. However, exposure to chronic noise sources may lead to more severe effects leading to fitness consequences such as reduced growth rates, decreased survival rates, reduced foraging success, etc. Although physiological stress responses may not be detectable on fishes during sound exposures, NMFS assumes a stress response occurs when other physiological impacts such as injury or hearing loss occur.

Some studies have been conducted that measure changes in cortisol levels in response to sound sources. Cortisol levels have been measured in fishes exposed to vessel noises, predator vocalizations, or other tones during playback experiments**.** Nichols et al. (2015a) exposed giant kelpfish (*Heterostichus rostratus*) to vessel playback sounds, and fish increased levels of cortisol were found with increased sound levels and intermittency of the playbacks. Sierra-Flores et al. (2015) demonstrated increased cortisol levels in fishes exposed to a short duration upsweep (a tone that sweeps upward across multiple frequencies) across 100 to 1,000 Hz. The levels returned to normal within one hour post-exposure, which supports the general assumption that spikes in stress hormones generally return to normal once the sound of concern ceases**.** Gulf toadfish (*Opsanus beta*) were found to have elevated cortisol levels when exposed to low-frequency dolphin vocalization playbacks (Remage-Healey et al. 2006). Interestingly, the researchers observed none of these effects in toadfish exposed to low frequency snapping shrimp "pops," indicating what sound the fish may detect and perceive as threats. Not all research has indicated stress responses resulting in increased hormone levels. Goldfish exposed to continuous (0.1 to 10 kHz) sound at a pressure level of 170 dB re 1 μPa for one month showed no increase in stress hormones (Smith et al. 2004b). Similarly, Wysocki et al. (2007b) exposed rainbow trout to continuous band-limited noise with a sound pressure level of about 150 dB re 1 μPa for nine months with no observed stress effects. Additionally, the researchers found no significant changes to growth rates or immune systems compared to control animals held at a sound pressure level of 110 dB re 1 μPa.

Masking

As described previously in this biological opinion, masking generally results from a sound impeding an animal's ability to hear other sounds of interest. The frequency of the received level and duration of the sound exposure determine the potential degree of auditory masking. Similar to hearing loss, the greater the degree of masking, the smaller the area becomes within which an animal can detect biologically relevant sounds such as those required to attract mates, avoid predators or find prey (Slabbekoorn et al. 2010). Because the ability to detect and process sound may be important for fish survival, anything that may significantly prevent or affect the ability of fish to detect, process or otherwise recognize a biologically or ecologically relevant sound could decrease chances of survival. For example, some studies on anthropogenic sound effects on fishes have shown that the temporal pattern of fish vocalizations (e.g., sciaenids and gobies) may be altered when fish are exposed to sound-masking (Parsons et al. 2009). This may indicate fish are able to react to noisy environments by exploiting "quiet windows" (e.g., Lugli and Fine 2003) or moving from affected areas and congregating in areas less disturbed by nuisance sound sources. In some cases, vocal compensations occur, such as increases in the number of individuals vocalizing in the area, or increases in the pulse/sound rates produced (Picciulin et al. 2012). Fish vocal compensations could have an energetic cost to the individual, which may lead to a fitness consequence such as affecting their reproductive success or increase detection by predators (Amorin et al. 2002; Bonacito et al. 2001).

Behavioral Responses

In general, NMFS assumes that most fish species would respond in similar manner to both air guns and impact pile driving. As with explosives, these reactions could include startle or alarm responses, quick bursts in swimming speeds, diving, or changes in swimming orientation. In other responses, fish may move from the area or stay and try to hide if they perceive the sound as a potential threat. Other potential changes include reduced predator awareness and reduced feeding effort. The potential for adverse behavioral effects will depend on a number of factors, including the sensitivity to sound, the type and duration of the sound, as well as life stages of fish that are present in the areas affected.

Fish that detect an impulsive sound may respond in "alarm" detected by Fewtrell (2003), or other startle responses may also be exhibited. The startle response in fishes is a quick burst of swimming that may be involved in avoidance of predators. A fish that exhibits a startle response may not necessarily be injured, but it is exhibiting behavior that suggests it perceives a stimulus indicating potential danger in its immediate environment. However, fish do not exhibit a startle response every time they experience a strong hydroacoustic stimulus. A study in Puget Sound, Washington suggests that pile driving operations disrupt juvenile salmon behavior (Feist et al. 1992). Though no underwater sound measurements are available from that study, comparisons between juvenile salmon schooling behavior in areas subjected to pile driving/construction and other areas where there was no pile driving/construction indicate that there were fewer schools of fish in the pile-driving areas than in the non-pile driving areas. The results are not conclusive but there is a suggestion that pile-driving operations may result in a disruption in the normal migratory behavior of the salmon in that study, though the mechanisms salmon may use for avoiding the area are not understood at this time.

Because of the inherent difficulties with conducting fish behavioral studies in the wild, data on behavioral responses for fishes is largely limited to caged or confined fish studies, mostly limited to studies using caged fishes and the use of seismic air guns (Lokkeberg et al. 2012). In an effort to assess potential fish responses to anthropogenic sound, NMFS has historically applied an interim criteria for onset injury of fish from impact pile driving which was agreed to in 2008 by a coalition of federal and non-federal agencies along the West Coast (FHWG 2008). These criteria were also discussed in Stadler and Woodbury (2009), wherein the onset of physical injury for fishes would be expected if either the peak sound pressure level exceeds 206 dB (re 1 μPa), or the SEL_{cum}, (re 1 μPa^2-s) accumulated over all pile strikes occurring within a single day, exceeds 187 dB SEL_{cum} (re 1 μPa^2-s) for fish two grams or larger, or 183 dB re 1 μPa^2-s for fishes less than two grams. The more recent recommendations from the studies conducted by Halvorsen et al. (2011a), Halvorsen et al. (2012b), and Casper et al. (2012c), and summarized in the 2014 *ANSI Guidelines* are similar to these levels, but also establishes levels based upon fish hearing abilities, the presence of a swim bladder as well as severity of effects ranging from mortality, recoverable injury to TTS. The interim criteria developed in 2008 were developed primarily from air gun and explosive effects on fishes (and some pile driving) because limited information regarding impact pile driving effects on fishes was available at the time.

7.1.5.1. Criteria Used for Assessing Effects of Noise Exposure to Atlantic Sturgeon

There is no available information on the hearing capabilities of Atlantic sturgeon specifically, although the hearing of two other species of sturgeon have been studied. While sturgeon have swimbladders, they are not known to be used for hearing, and thus sturgeon appear to only rely directly on their ears for hearing. Popper (2005) reported that studies measuring responses of the ear of European sturgeon (*Acipenser sturio*) using physiological methods suggest sturgeon are likely capable of detecting sounds from below 100 Hz to about 1 kHz, indicating that sturgeon should be able to localize or determine the direction of origin of sound. Meyer and Popper (2002) recorded auditory evoked potentials of varying frequencies and intensities for lake sturgeon (*Acipenser fulvescens*) and found that lake sturgeon can detect pure tones from 100 Hz to 2 kHz, with best hearing sensitivity from 100 to 400 Hz. They also compared these sturgeon data with comparable data for oscar (*Astronotus ocellatus*) and goldfish (*Carassius auratus*) and reported that the auditory brainstem responses for the lake sturgeon were more similar to goldfish (that can hear up to 5 kHz) than to the oscar (that can only detect sound up to 400 Hz); these authors, however, felt additional data were necessary before lake sturgeon could be considered specialized for hearing (Meyer and Popper 2002). Lovell et al. (2005) also studied sound reception and the hearing abilities of paddlefish (*Polyodon spathula*) and lake sturgeon. Using a combination of morphological and physiological techniques, they determined that paddlefish and lake sturgeon were responsive to sounds ranging in frequency from 100 to 500 Hz, with the lowest hearing thresholds from frequencies in a bandwidth of between 200 and 300 Hz and higher thresholds at 100 and 500 Hz; lake sturgeon were not sensitive to sound pressure. We assume that the hearing sensitivities reported for these other species of sturgeon are representative of the hearing sensitivities of all Atlantic sturgeon DPSs.

The Fisheries Hydroacoustic Working Group (FHWG) was formed in 2004 and consists of biologists from NMFS, USFWS, FHWA, USACE, and the California, Washington and Oregon DOTs, supported by national experts on underwater sound producing activities that affect fish and wildlife species of concern. In June 2008, the agencies signed an MOA documenting criteria 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. It should be noted that these criteria are for the onset of physiological effects (Stadler and Woodbury, 2009), not levels at which fish are necessarily mortally damaged. These criteria were developed to apply to all fish species, including listed green sturgeon, which are biologically similar to shortnose and Atlantic sturgeon and for these purposes can be considered a surrogate. The interim criteria are:

- Peak SPL: 206 dB re 1 μPa
- SELcum: 187 dB re 1μPa^2-s for fishes 2 grams or larger (0.07 ounces).
- SELcum: 183 dB re 1μPa^2-s for fishes less than 2 grams (0.07 ounces).

At this time, these criteria represent the best available information on the thresholds at which physiological effects to sturgeon are likely to occur. It is important to note that physiological effects may range from minor injuries from which individuals are anticipated to completely recover with no impact to fitness to significant injuries that will lead to death. The severity of injury is related to the distance from the pile being installed and the duration of exposure. The closer to the source and the greater the duration of the exposure, the higher likelihood of significant injury.

Popper et al. (2014) presents a series of proposed thresholds for onset of mortality and potential injury, recoverable injury, and temporary threshold shift for fish species exposed to pile driving noise. This assessment incorporates information from lake sturgeon and includes a category for fish that have a swim bladder that is not involved in hearing (such as Atlantic sturgeon). The criteria included in Popper et al. (2014) are:

- Mortality and potential mortal injury: 210 dB SELcum or >207 dB peak
- Recoverable injury: 203 dB SELcum or >207 dB peak
- TTS: >186 dB SELcum.

While these criteria are not exactly the same as the FHWG criteria, they are very similar. Based on the available information, for the purposes of this Opinion, we consider the potential for physiological effects upon exposure to 206 dB re 1 µPa peak and 187 dB re 1 μPa^2-s cSEL. Use of the 183 dB re 1 μPa^2-s cSEL threshold is not appropriate for this consultation because all sturgeon in the action area will be larger than 2 grams. Physiological effects could range from minor injuries that a fish is expected to completely recover from with no impairment to survival to major injuries that increase the potential for mortality, or result in death.

NMFS has adopted thresholds described in FHWG 2008 and Popper et al. 2014 for the anticipated onset of mortality and physical injury resulting from exposure to underwater explosives. These thresholds are:

- onset of mortality (received level): $L_{p,0\text{-pk,flat}}$: 229 dB
- onset of physical injury (received level): $L_{p,0\text{-pk,flat}}$: 206 dB; $L_{E,p,,12h}$: 187 dB (fish 2 grams or greater); $L_{E,p,,12h}$: 183 dB (fish less than 2 g)

We use 150 dB re: 1 µPa RMS as a threshold for examining the potential for behavioral responses by individual listed fish to noise with frequency less than 1 kHz. This is supported by information provided in a number of studies described above (Andersson et al. 2007, Purser and Radford 2011, Wysocki et al. 2007). Responses to temporary exposure of noise of this level is expected to be a range of responses indicating that a fish detects the sound, these can be brief startle responses or, in the worst case, we expect that listed fish would completely avoid the area ensonified above 150 dB re: 1 uPa rms. Popper et al. (2014) does not identify a behavioral threshold but notes that the potential for behavioral disturbance decreases with the distance from the source.

7.1.5.2 Effects of Project Noise on Atlantic sturgeon

Using the same methodology described above for marine mammals and sea turtles, acoustic propagation modeling of impact pile driving (monopiles and pin piles) and UXO detonations was undertaken by JASCO Applied Sciences to determine distances to injury and behavioral disturbance thresholds for fish (Hannay and Zykov 2022; Küsel et al. 2022). The distances from the pile where noise will be elevated above the identified thresholds are presented in table 7.1.39 and 7.1.40 below.

Table 7.1.39. Acoustic ranges to acoustic thresholds used to evaluate responses of sturgeon to impact pile driving noise for monopile installation. Information for installation of two 8/11 m diameter monopiles in 24 hours with 10 dB attenuation, 4,000 kJ hammer, 50m penetration depth (source: table 3-43 in BOEM 2022 BA)

Threshold		$R_{95\%}$ (km)
Physiological Effects	206 peak	0.07
	187 SELcum	8.66
Behavior	150 dB rms	7.54

Table 7.1.40. Acoustic ranges to acoustic thresholds used to evaluate responses of sturgeon to impact pile driving noise resulting from modeling of pin piles with 10 dB attenuation. Information for installation of three 2.44-m diameter pin piles in 24 hours with 10 dB attenuation, 2,500 kJ hammer energy, 60 m penetration depth. (source: Table 3-44 in BOEM 2022 BA)

Threshold		$R_{95\%}$ (km)
Physiological Effects	206 peak	0.06
	187 SELcum	4.05
Behavior	150 dB rms	5.32

Table 7.1.41 Maximum range to thresholds used to evaluate onset of mortality for Atlantic sturgeon exposed to underwater explosives. (source: Table 3-45 in BOEM's BA)

Onset of Mortality	Maximum (m)				
	E4 (2.3 kg)	E6 (9.1 kg)	E8 (45.5 kg)	E10 (227 kg)	E12 (454 kg)
$L_{p,\ 0\text{-pk},\ flat}$: 229 dB	49	80	135	230	290

Note: Water Depth 50 m.
dB = decibels; dB re 1 μPa = decibels relative to 1 micropascal; kg = kilograms; L_{pk} = peak sound pressure level; m = meters

As described above, cofferdams may be installed and removed with a vibratory hammer. Ocean Wind estimates sound source levels of 165.0 dB re 1 µPa RMS (JASCO 2021). In the BA, BOEM presents distances to the 150 dB re: 1 µPa RMS behavioral threshold based on the "GARFO Acoustics Tool" and estimates a distance of less than 100 m from the cofferdam will have noise above the threshold. To inform our analysis, we used a newer NMFS Multi-Species Pile Driving Tool to estimate the distance to the threshold and obtained a similar result; the model predicts that noise will be above the threshold within a distance of approximately 100 meters from the cofferdam during installation and removal.

No density estimates for Atlantic sturgeon are available for the action area or for any area that could be used to estimate density in the action area. Therefore, it was not possible to conduct an exposure analysis to predict the number of Atlantic sturgeon likely to be exposed to any of the thresholds identified here.

Consideration of Mitigation Measures

Here, we consider the measures that are part of the proposed action, either because they are proposed by Ocean Wind or by BOEM and reflected in the proposed action as described to us by BOEM in the BA, or are proposed to be required through the ITA. Specifically, we consider how those measures may minimize exposure of Atlantic sturgeon to pile driving noise. Details of these proposed measures are included in the Description of the Action section above.

Atlantic sturgeon are not visible to PSOs because they occur near the bottom, and depths in the areas where pile driving is planned would preclude visual observation of fish near the bottom. Therefore, monitoring of clearance zones or areas beyond the clearance zones will not minimize exposure of Atlantic sturgeon to pile driving noise. Because Atlantic sturgeon do not vocalize, PAM cannot be used to monitor Atlantic sturgeon presence; therefore, the use of PAM will not reduce exposure of Atlantic sturgeon to pile driving noise.

No impact pile driving activities for monopiles would occur between January 1 and April 30 to avoid the time of year with the highest densities of right whales in the project area. No UXO detonations will occur between January 1 and April 30, with an additional restriction on UXO detonations in federal waters (greater than 3nm from shore) from November through April. Information from Ingram et al. (2019) indicates that abundance of Atlantic sturgeon in the New York Wind Energy Area peaked from November through January. Absent a similar study in the Ocean Wind lease area, it is not possible to determine if similar seasonal patterns are present in this area. We do not have enough information on the density or seasonal distribution of Atlantic sturgeon in the action area encompassing the WDA to determine how these seasonal restrictions may or may not reduce the exposure of Atlantic sturgeon to pile driving noise.

For all impact pile driving of monopiles and for UXO detonation, Ocean Wind would implement sound attenuation technology that would target at least a 10 dB reduction in noise, and that must achieve in-field measurements no greater than those modeled and presented in the BA. The attainment of a 10 dB reduction in impact pile driving and explosive noise was incorporated into the estimates of the area where injury or behavioral disruption may occur as presented above. If a reduction greater than 10 dB is achieved, the size of the area of impact would be smaller which would likely result in a smaller number of Atlantic sturgeon exposed to pile driving noise.

Soft start procedures can provide a warning to animals or provide them with a chance to leave the area prior to the hammer operating at full capacity. As described above, for impact pile driving before full energy pile driving begins, pile driving will occur at 4-6 strikes per minute at 10 to 20 percent of the maximum hammer energy (i.e., 450 to 900 kJ for monopiles, 200 to 500 kJ for pin piles), for a minimum of 20 minutes. For monopiles, at 500-1,000 kJ hammer intensity, a sturgeon would need to be within 10 to 30m of the pile to be exposed to be exposed to noise above the 206 dB re 1uPa threshold (see Tables 26 and 27 in Küsel et al. 2022).

Similarly, for pin piles, at 500-1,000 kJ hammer intensity, a sturgeon would need to be within 10 to 30m of the pile to be exposed to be exposed to noise above the 206 dB re 1uPa threshold (see Tables 28 and 29 in Küsel et al. 2022). Given the dispersed nature of Atlantic sturgeon in the lease area, this co-occurrence is extremely unlikely to occur. We expect that any Atlantic sturgeon close enough to the pile to be exposed to noise above 150 dB re 1uPa rms would experience behavioral disturbance as a result of the soft start and that these sturgeon would exhibit evasive behaviors and swim away from the noise source. During the soft start period, noise will be above 150 dB at a distance of approximately 3 km from the monopile being driven and approximately 2km from a pin pile being driven (see tables 26-29 in Küsel et al. 2022). The use of the soft start is expected to give Atlantic sturgeon near enough to the piles to be exposed to the soft start noise a "head start" on escape or avoidance behavior by causing them to swim away from the source. It is possible that some Atlantic sturgeon would swim out of the noisy area before full force pile driving begins; in this case, the number of Atlantic sturgeon exposed to noise that may result in injury would be reduced. It is likely that by eliciting avoidance behavior prior to full power pile driving, the soft start will reduce the duration of exposure to noise that could result in behavioral disturbance. However, we are not able to predict the extent to which the soft start will reduce the extent of exposure above the 150 dB re 1uPa threshold for considering behavioral impacts.

As described above, Ocean Wind will also conduct hydroacoustic monitoring for a subset of impact-driven piles. The required sound source verification will provide information necessary to confirm that the sound source characteristics predicted by the modeling are reflective of actual sound source characteristics in the field. In the event that sound source verification indicates that characteristics in the field are such that the model is invalid or is determined to underestimate exposure of listed species, reinitiation of this consultation may be necessary.

7.1.5.3 Exposure of Atlantic sturgeon to Noise that May Result in Injury or Behavioral Disturbance

As described in the Environmental Baseline section of this Opinion, the WDA has not been systematically surveyed for Atlantic sturgeon; however, based on the best available information on the distribution of Atlantic sturgeon in the marine environment, we expect Atlantic sturgeon to occur at least occasionally in the portion of the action area encompassing the WDA where they could be exposed to pile driving noise. Given the area in which pile driving noise will occur is offshore and outside of any known aggregation areas, we expect its use by Atlantic sturgeon will be intermittent and limited to transient individuals moving through it that may be foraging 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. This intermittent, transient presence of individuals is consistent with tagging and tracking studies of Atlantic sturgeon in other marine areas (Ingram et al. 2019, Rothermel et al. 2020) where residence was detected for short durations (less than 2 hours to less than 2 days in the same area).

Impact Pile Driving for Foundations

Installation of a monopile or pin pile is estimated to require approximately 3 to 4 hours of impact pile driving for a total of 438 to 584 hours. Over the course of the potential pile-installation window of May 1 – December 31, pile driving will occur approximately 10% of the time (584 hours of pile driving/5,856 total hours). Considering the narrowest window within which pile driving could occur (65 days, with 2 monopiles or 3 pin piles per day), pile driving will occur for approximately 38% of the time (584 hours of pile driving/1,560 total hours).

In order to be exposed to pile driving noise that could result in injury, an Atlantic sturgeon would need to be within 70 m of a monopile for a single strike (based on the 206 dB peak threshold). Similarly, in order to be exposed to noise above the 206 dB peak threshold during the installation of pin piles for the OSS foundation, an Atlantic sturgeon would need to be within 60 m of the pile. Given the dispersed distribution of Atlantic sturgeon in and near the lease area, the potential for co-occurrence in time and space is extremely unlikely given the small area where exposure to peak noise could occur (extending 60 or 70 m from the pile). This risk is further reduced by the small amount of time that pile driving will occur (up to four hours at a time for no more than two monopiles per day and no more than four hours at a time for no more than three pin piles a day). The soft-start, which we expect would result in a behavioral reaction and movement outside the area with the potential for exposure to the peak injury threshold, reduces this risk even further. As described above, during the soft start, an Atlantic sturgeon would need to be within 30 meters of the pile being driven to be exposed to peak noise that could result in physiological effects. Given these considerations, we do not expect any Atlantic sturgeon to be exposed to noise above the peak injury threshold during monopile or pin pile installation.

Considering the 187 dB SELcum threshold, an Atlantic sturgeon would need to remain within 8,660 m of both monopiles being installed in a 24-hour period or within 4,050 m of all three pin piles being installed in a 24-hour period. Considering the anticipated behavioral reaction of sturgeon to avoid pile driving noise above 150 dB re 1 uPa RMS and the swimming abilities of Atlantic sturgeon, this is extremely unlikely to occur. Downie and Kieffer (2017) reviewed available information on maximum sustained swimming ability (Ucrit) for a number of sturgeon species. No information was presented on Atlantic sturgeon. Kieffer and May (2020) report that swimming speed of sturgeons is consistent at approximately 2 body lengths/second. Considering that the smallest Atlantic sturgeon in the ocean environment where piles will be driven will be migratory subadults (at least 75 cm length), we can assume a minimum swim speed of 150 cm/second (equivalent to 5.4 km/hour) for Atlantic sturgeon in the lease area. Assuming a straight line escape and the slowest anticipated swim speed (5.4 km/h), even a sturgeon that was close by the pile at the start of pile driving would be able to swim away from the noisy area well before being exposed to the noise for a long enough period to meet the 187 dB SELcum threshold. The distance we would expect a sturgeon to cover in the up to 4 hours it would take to install a monopile or pin pile is 21.6 km. We expect that the soft-start will mean that the closest a sturgeon is to the pile being driven at the start of full power driving is several hundred meters away which further reduces the duration of exposure to noise that could accumulate to exceed the 187 dB SELcum threshold. Given these considerations, we expect any Atlantic sturgeon that are exposed to pile driving noise will be able to avoid exposure to noise above the levels that could result in exposure to the cumulative injury threshold. Based on this analysis, it is extremely unlikely that any Atlantic sturgeon will be exposed to noise that will result in injury. Therefore, no injury of any Atlantic sturgeon is expected to occur.

Vibratory Pile Driving
As indicated above, the installation and removal of the cofferdam with a vibratory hammer does not have the potential to exceed the injury thresholds. As such, there is no potential for injury to

result from exposure to vibratory pile installation or removal.

UXO Detonation

Injury to fish from exposures to blast pressure waves is attributed to compressive damage to tissue surrounding the swim bladder and gastrointestinal tract, which may contain small gas bubbles. In order to be exposed to blast pressure that could result in injury or mortality, a sturgeon would need to be within 49-290 m of the UXO being detonated, depending on charge size. Given the dispersed and transient nature of Atlantic sturgeon in the area, the placement of bubble curtains or other NAS at a distance from the UXO, and that no more than 10 detonations are anticipated, it is extremely unlikely that a sturgeon would be close enough to any detonation to experience injury or mortality.

7.1.5.4 Effects of Noise Exposure above 150 dB re 1uPa rms but below the injury threshold

We expect Atlantic sturgeon to exhibit a behavioral response upon exposure to noise louder than 150 dB re 1uPa RMS but below the injury threshold. This response could range from a startle with immediate resumption of normal behaviors to complete avoidance of the area. The area where pile driving and UXO detonation will occur is used for migration of Atlantic sturgeon, with opportunistic foraging expected to occur where suitable benthic resources are present. The area is not an aggregation area, and sustained foraging is not known to occur in this area.

UXO Detonation

Given the extremely short duration of UXO detonations (seconds), any behavioral response of sturgeon is expected to be limited to a brief startle and change in swimming direction, with resumption of normal behavior as soon as the explosion is complete. Given the brief exposure, effects to Atlantic sturgeon are so small that they could not be meaningfully measured, detected, or evaluated and are insignificant. Take is not anticipated to occur.

Vibratory Pile Driving and Removal for Cofferdams

As noted above the distance to the 150 dB re 1uPa RMS threshold was calculated using a source level of 165 dB RMS with the NMFS Multi-Species Pile Driving tool. During the 12-18 hour periods where the cofferdam is installed and removed, the area that will have underwater noise above the 150 dB re 1uPa RMS threshold will extend approximately 100 m from the cofferdam. Given the very small area of potential overlap and avoidance behavior, effects to Atlantic sturgeon are extremely unlikely to occur; therefore, take is not anticipated.

Impact Pile Driving for Monopile and OSS Installation

During the 4 hour periods where impact pile driving occurs for monopile and pin pile installation, the area that will have underwater noise above the 150 dB re 1uPa RMS threshold will extend approximately 7.54 km and 5.32 km, respectively, from the pile being installed. Atlantic sturgeon would avoid the entire area where noise is louder than 150 dB re 1uPa RMS. The consequences for an individual sturgeon would be alteration of movements to avoid the noise and temporary cessation of opportunistic foraging.

While in some instances temporary displacement from an area may have significant consequences to individuals or populations, this is not the case here. For example, if individual Atlantic sturgeon were prevented or delayed from accessing spawning or overwintering grounds or were precluded from a foraging area for an extensive period, there could be impacts to reproduction and the health of individuals, respectively. However, as explained above, the area where noise may be at disturbing levels is used only for movement between other more highly used portions of the coastal Atlantic Ocean and is used only for opportunistic, occasional foraging.

All behavioral responses to a disturbance, such as those described above, will have an energetic or metabolic consequence to the individual reacting to the disturbance (e.g., adjustments in migratory movements or disruption in opportunistic foraging). Short-term interruptions of normal behavior are likely to have little effect on the overall health, reproduction, and energy balance of an individual or population (Richardson *et al.* 1995). As the disturbance will occur for a portion of each day for a period of up to 65 non-consecutive days (assuming multiple piles are installed per day as planned), with pile driving occurring for no more than 8-12 non-continuous hours per day during that period, this exposure and displacement will be temporary and intermittent and not chronic. Therefore, any interruptions in behavior and associated metabolic or energetic consequences will similarly be temporary. Thus, we do not anticipate any impairment of the health, survivability, or reproduction of any individual Atlantic sturgeon.

Based on this analysis, we have determined that it is extremely unlikely that any Atlantic sturgeon will experience a significant disruption of migration or foraging, the two behaviors that occur in the action area. We have also considered if the avoidance of the area where pile driving noise will be experienced would increase the risk of vessel strike or entanglement in fishing gear. As explained above, a sturgeon would need to travel no more than 7.5 km to swim outside the area where noise is above the threshold where behavioral disturbance is expected; this distance would result from a sturgeon being very near the source when pile driving started, it is more likely that the distance traveled would be smaller. As we do not expect vessel strike to occur in the open ocean, regardless of traffic levels, we do not expect any increase in risk of vessel strike even if a sturgeon was displaced into an area with higher vessel traffic. Based on the available information on the distribution of fishing activities that may interact with sturgeon (i.e., gillnets, trawl), it is extremely unlikely that a sturgeon avoiding pile driving noise would be more at risk of entanglement or capture than had it not been exposed to the noise source. This is because the distance that a sturgeon would need to move to avoid potentially disturbing level of noise would not put the individual in areas with higher levels of trawl or gillnet fishing than in the WDA (see Figure 2-17 to 2-19 in DNV GL 2021 (Ocean Wind NSRA). Based on this analysis, all effects to Atlantic sturgeon from exposure to impact pile driving noise are expected to be extremely unlikely, or so small that they cannot be meaningfully measured, detected, or evaluated and are, therefore, insignificant. Take is not anticipated.

Vessel Noise and Cable Installation
The vessels used for the proposed project will produce low-frequency, broadband underwater sound below 1 kHz (for larger vessels), and higher-frequency sound between 1 kHz to 50 kHz (for smaller vessels), although the exact level of sound produced varies by vessel type. Noise produced during cable installation is dominated by the vessel noise; therefore, we consider these together. Vessels operating with dynamic positioning thrusters produce peak noise of 171 dB SEL peak at a distance of 1 m, with noise attenuating to below 150 dB rms at a distance of 135 m (BOEM 2021, see table 23).

In general, information regarding the effects of vessel noise on fish hearing and behaviors is limited. Some TTS has been observed in fishes exposed to elevated background noise and other white noise, a continuous sound source similar to noise produced from vessels. Caged studies on sound pressure sensitive fishes show some TTS after several days or weeks of exposure to increased background sounds, although the hearing loss appeared to recover (e.g., Scholik and Yan 2002; Smith et al. 2006; Smith et al. 2004b). Smith et al. (2004b) and Smith et al. (2006) exposed goldfish (a fish with hearing specializations, unlike any of the ESA-listed species considered in this opinion) to noise with a sound pressure level of 170 dB re 1 μPa and found a clear relationship between the amount of TTS and duration of exposure, until maximum hearing loss occurred at about 24 hours of exposure. A short duration (e.g., 10-minute) exposure resulted in 5 dB of TTS, whereas a three-week exposure resulted in a 28 dB TTS that took over two weeks to return to pre-exposure baseline levels (Smith et al. 2004b). Recovery times were not measured by researchers for shorter exposure durations, so recovery time for lower levels of TTS was not documented.

Vessel noise may also affect fish behavior by causing them to startle, swim away from an occupied area, change swimming direction and speed, or alter schooling behavior (Engas et al. 1998; Engas et al. 1995; Mitson and Knudsen 2003). Physiological responses have also been documented for fish exposed to increased boat noise. Nichols et al. (2015b) demonstrated physiological effects of increased noise (playback of boat noise) on coastal giant kelpfish. The fish exhibited acute stress responses when exposed to intermittent noise, but not to continuous noise. These results indicate variability in the acoustic environment may be more important than the period of noise exposure for inducing stress in fishes. However, other studies have also shown exposure to continuous or chronic vessel noise may elicit stress responses indicated by increased cortisol levels (Scholik and Yan 2001; Wysocki et al. 2006). These experiments demonstrate physiological and behavioral responses to various boat noises that have the potential to affect species' fitness and survival, but may also be influenced by the context and duration of exposure. It is important to note that most of these exposures were continuous, not intermittent, and the fish were unable to avoid the sound source for the duration of the experiment because this was a controlled study. In contrast, wild fish are not hindered from movement away from an irritating sound source, if detected, so are less likely to be subjected to accumulation periods that lead to the onset of hearing damage as indicated in these studies. In other cases, fish may eventually become habituated to the changes in their soundscape and adjust to the ambient and background noises.

All fish species can detect vessel noise due to its low-frequency content and their hearing capabilities. Because of the characteristics of vessel noise, sound produced from vessels is unlikely to result in direct injury, hearing impairment, or other trauma to Atlantic sturgeon. In addition, in the near field, fish are able to detect water motion as well as visually locate an oncoming vessel. In these cases, most fishes located in close proximity that detect the vessel either visually, via sound and motion in the water would be capable of avoiding the vessel or move away from the area affected by vessel sound. Thus, fish are more likely to react to vessel noise at close range than to vessel noise emanating from a greater distance away. These reactions may include physiological stress responses, or avoidance behaviors. Auditory masking due to vessel noise can potentially mask biologically important sounds that fish may rely on.

However, impacts from vessel noise would be intermittent, temporary, and localized, and such responses would not be expected to compromise the general health or condition of individual fish from continuous exposures. Instead, the only impacts expected from exposure to project vessel noise for Atlantic sturgeon may include temporary auditory masking, physiological stress, or minor changes in behavior.

Therefore, similar to marine mammals and sea turtles, exposure to vessel noise for fishes could result in short-term behavioral or physiological responses (e.g., avoidance, stress). Vessel noise would only result in brief periods of exposure for fishes and would not be expected to accumulate to the levels that would lead to any injury, hearing impairment or long-term masking of biologically relevant cues. For these reasons, exposure to vessel noise is not expected to significantly disrupt normal behavior patterns (i.e., cause harassment) of Atlantic sturgeon in the action area or harm the species. The effects are so minor that they cannot be meaningfully measured, detected, or evaluated. Therefore, the effects of vessel noise on Atlantic sturgeon are considered insignificant.).

Operation of WTGs
As described above, many of the published measurements of underwater noise levels produced by operating WTGs are from older geared WTGs and are not expected to be representative of newer direct-drive WTGs, like those that will be installed for the Ocean Wind 1 project. Elliot et al. (2019) reports underwater noise monitoring at the Block Island Wind Farm, which has direct-drive GE Haliade turbines; as explained in section 7.1.2, this is the best available data for estimating operational noise of the Ocean Wind turbines. The loudest noise recorded was 126 dB re 1uPa at a distance of 50 m when wind speeds exceeded 56 kmh. As noted above, based on wind speed records from the Ambrose Buoy (November 2008 – February 2023), instances of wind speeds exceeding 56 kmh are expected to be rare, with wind speeds exceeding 40 kmh less than 3% of the time across a year. Elliot et al. note that based on monitoring of underwater noise at the Block Island site, the noise levels identified in the vicinity of the turbine are far below any numerical criteria for adverse effects on fish. As underwater noise associated with the operation of the WTGs is expected to be below the thresholds for injury or behavioral disturbance for Atlantic sturgeon, we do not expect any impacts to any Atlantic sturgeon due to noise associated with the operating turbines. Additionally, we note that many studies of fish resources within operating wind farms, including the Block Island Wind Farm, and wind farms in Europe with the older, louder geared turbines report localized increases in fish abundance during operations (due to the reef effect; e.g., Stenburg et al. 2015, Methartta and Dardick 2019, Wilber et al. 2022). This data supports the conclusion that operational noise is not likely to result in the displacement or disturbance of Atlantic sturgeon.

HRG Surveys
Some of the equipment that is described by BOEM for use for surveys produces underwater noise that can be perceived by Atlantic sturgeon. This may include boomers, sparkers, and bubble guns. The maximum distance to the injury threshold is 9 m and the maximum distance to the 150 dB re 1uPa behavioral disturbance threshold is 1.9 km for the loudest equipment (sparker). Extensive information on HRG survey noise and potential effects of exposure to Atlantic sturgeon is provided in NMFS June 29, 2021 programmatic ESA consultation on certain

geophysical and geotechnical survey activities (NMFS GAR 2021). We summarize the relevant conclusions here.

As explained above, the available information suggests that for noise exposure to result in physiological impacts to the fish species considered here, received levels need to be at least 206 dB re: 1uPa peak sound pressure level (SPLpeak) or at least 187 dB re: u1Pa cumulative. The peak thresholds are exceeded only very close to the noise source (<3.2 m for the boomers/bubble guns and <9 m for the sparkers; the cumulative threshold is not exceeded at any distance. As such, in order to be exposed to peak sound pressure levels of 206 dB re: 1uPa from any of these sources, an individual fish would need to be within 9 m of the source. This is extremely unlikely to occur given the dispersed nature of the distribution of ESA-listed Atlantic sturgeon in the action area, the use of a ramp up procedure, the moving and intermittent/pulsed characteristic of the noise source, and the expectation that ESA-listed fish will swim away, rather than towards the noise source. Based on this, no physical effects to any Atlantic sturgeon, including injury or mortality, are expected to result from exposure to noise from the geophysical surveys.

The calculated distances to the 150 dB re: 1 uPa rms threshold for the boomers/bubble guns, sparkers, and sub-bottom profilers is 708 m, 1,996 m, and 32 m, respectively (Table 7.1.7). It is important to note that these distances are calculated using the highest power levels for each sound source reported in Crocker and Fratantonio (2016); thus, they likely overestimate actual sound fields, but are still within a reasonable range to consider.

Because the area where increased underwater noise will be experienced is transient (because the survey vessel towing the equipment is moving), increased underwater noise will only be experienced in a particular area for a short period of time. Given the transient and temporary nature of the increased noise, we expect any effects to behavior to be minor and limited to a temporary disruption of normal behaviors, potential temporary avoidance of the ensonified area and minor additional energy expenditure spent while swimming away from the noisy area. If foraging, resting, or migrations are disrupted, we expect that these behaviors will quickly resume once the survey vessel has left the area (i.e., in seconds to minutes, given its traveling speed of 3 – 4.5 knots). Therefore, no fish will be displaced from a particular area for more than a few minutes. While the movements of individual fish will be affected by the sound associated with the survey, these effects will be temporary and localized. These fish are not expected to be excluded from any particular area, and there will be only a minimal impact on foraging, migrating, or resting behaviors. Sustained shifts in habitat use, distribution, or foraging success are not expected. Effects to individual fish from brief exposure to potentially disturbing levels of noise are expected to be limited to a brief startle or short displacement and will be so small that they cannot be meaningfully measured, detected, or evaluated; therefore, effects of exposure to survey noise are insignificant. Take is not anticipated to occur.

7.1.6 Effects of Noise on Prey

Generally speaking, the ESA listed species in the action area encompassing the WDA forage in varying frequencies and intensities on a wide variety of prey. With the exception of fish, little information is available on the effects of underwater noise on many prey species, such as most benthic invertebrates and zooplankton, including copepods and krill. Effects to schooling fish that are preyed upon by some whale species are likely to be similar to the effects described for

Atlantic sturgeon. However, given that these smaller fish species are more abundant and have a greater biomass throughout the area where increased underwater noise will be experienced, it is possible that there may be some mortality or injury of some fish. However, we only expect this to occur as a result of the UXO detonations. Given that fish would need to be within 500 m of the detonation to be seriously injured or killed, and that no more than 10 detonations will occur, any effects to the abundance or distribution of potential fish prey are likely to be so small that they cannot be meaningfully measured, evaluated, or detected. Fish may also react behaviorally to the noise sources discussed here and move away from loud noise sources, such as pile driving and UXO detonations. However, like Atlantic sturgeon, we expect these disturbances and changes in distribution to be temporary and not represent any reduction in biomass or reduction in the availability of prey. Most benthic invertebrates have limited mobility or move relatively slowly compared to the other species considered in this analysis. As such, there may be some small reductions in prey for sea turtles and Atlantic sturgeon as a result of exposure of benthic prey species to pile driving noise. However, these reductions are expected to be small and limited to the areas immediately surrounding the piles being installed. We expect that the effects to Atlantic sturgeon and loggerhead and Kemp's ridley sea turtles from any small and temporary reduction in benthic invertebrates due to exposure to pile driving noise or UXO detonations to be so small that they cannot be meaningfully measured, detected, or evaluated and are therefore insignificant. No take is anticipated.

We are not aware of any information on the effects of pile driving or UXO noise exposure to krill, copepods, or other zooplankton. McCauley et al. (2017) documented mortality of juvenile krill exposed to seismic airguns. No airguns are proposed as part of the Ocean Wind project. We expect that zooplankton that are within close proximity to the UXO detonations may be killed. We are not aware of any evidence that pile driving noise, HRG surveys, or the other noise sources considered here are likely to result in the mortality of zooplankton. Based on the available data, we expect the mortality of zooplankton to be limited to exposure to the 10 UXO detonations and that losses will be limited due to the small number of detonations (10) and the extremely short duration of the explosion (one second). Effects to marine mammals due to disturbance of prey are expected to be so small that they cannot be meaningfully measured, detected, or evaluated and are therefore insignificant. No take is anticipated to occur.

Similarly, we expect that any effects of operational noise on the prey of ESA listed species to be extremely unlikely or so small that they cannot be meaningfully measured, detected, or evaluated. As described above, many of the published measurements of underwater noise levels produced by operating WTGs are from older geared WTGs and are not expected to be representative of newer direct-drive WTGs, like those that will be installed for the Ocean Wind 1 project. Elliot et al. (2019) reports underwater noise monitoring at the Block Island Wind Farm, which has direct-drive GE Haliade turbines; as explained in section 7.1.2, this is the best available data for estimating operational noise of the Ocean Wind turbines. The loudest noise recorded was 126 dB re 1uPa at a distance of 50 m when wind speeds exceeded 56 kmh. As noted above, based on wind speed records from the Ambrose Buoy (November 2008 – February 2023), instances of wind speeds exceeding 56 kmh are expected to be rare, with wind speeds exceeding 40 kmh less than 3% of the time across a year. Elliot et al. note that based on monitoring of underwater noise at the Block Island site, the noise levels identified in the vicinity of the turbine are far below any numerical criteria for adverse effects on fish. As underwater noise associated with the operation of the WTGs is expected to be below the thresholds for injury or behavioral disturbance for fish species, we do not expect any impacts to any fish species due to noise associated with the operating turbines. There is no information to indicate that operational noise will affect krill, copepods, or other zooplankton. Additionally, we note that many studies of fish and benthic resources within operating wind farms, including the Block Island Wind Farm, and wind farms in Europe with the older, louder geared turbines report localized increases in fish and benthic invertebrate abundance during operations (due to the reef effect; e.g., Stenburg et al. 2015, Methartta and Dardick 2019, Wilber et al. 2022). This data supports the conclusion that operational noise is not likely to result in the displacement or disturbance of prey species.

7.2 Effects of Project Vessels

In this section we consider the effects of the operation of project vessels on listed species in the action area by describing the existing vessel traffic in the action area (i.e. previously summarized in the environmental baseline, Section 6 of this Opinion), estimating the anticipated increase in vessel traffic associated with construction, operations, and decommissioning of the project, and then analyzing risk and determining likely effects to sea turtles, listed whales, and Atlantic sturgeon. We also consider impacts to air quality from vessel emissions and whether those impacts may cause effects to listed species. Section 3 of the Opinion describes proposed vessel use over all phases of the project, and is not repeated here but some information is summarized. Effects of vessel noise were considered in section 7.1, above, and are not repeated here. Project vessels will operate in three areas over the life of the project: 1) in and around the lease area and cable corridor and to/from relatively nearby ports in Atlantic City, NJ, and the Delaware River (Paulsboro and New Jersey Wind Port) and Delaware Bay (Port Elizabeth, NJ); 2) between the lease area and more distant ports in Norfolk, VA, and Charleston, SC; and, 3) between the lease area and foreign ports in Europe. Transits during the operation period will only be between the lease area and cable corridor and the O&M facility in Atlantic City, with the exception of a limited number of vessel transits of fisheries and benthic survey vessels from ports along the Atlantic coast of New Jersey.

7.2.1 Project Vessel Descriptions and Increase in Vessel Traffic from Proposed Project

Descriptions of project vessel use and traffic are described in Section 3 of this Opinion and summarized here for reference.

Vessel traffic will occur in the lease area, along the offshore export cable routes, and along routes between the lease area and export cable routes and the ports used to support Project construction. Construction vessels will travel between the WDA and the following ports that are expected to be used during construction: Atlantic City, New Jersey, as a construction management base; Paulsboro, New Jersey, or from Europe directly for foundation fabrication and load out; Norfolk, Virginia, or Hope Creek, New Jersey, for WTG pre-assembly and load out; and Port Elizabeth, New Jersey, or Charleston, South Carolina, or directly from Europe for cable staging (Figure 7.2.2). During construction, 86% of the vessels and 79% of the vessel trips would travel between the WDA and Atlantic City, New Jersey (Table 7.2.1). Five vessels and 149 trips would travel between the WDA and Paulsboro, New Jersey, or Europe for foundation scope. Two vessels and 99 trips would travel between the WDA and Norfolk, Virginia, or Hope

Creek, New Jersey ("New Jersey Wind Port"), for WTG scope. Fifteen vessels and 346 vessel trips would travel between the WDA and Port Elizabeth, New Jersey, Charleston, South Carolina, and/or Europe for cable staging. The amount of time vessels will transit back and forth to the WDA and how long they will remain on station is greatly dependent on final design factors, weather, sea conditions, and other natural factors.

Figure 7.2.1. NJPARS Navigation and Vessel Traffic Geographic Analysis Area

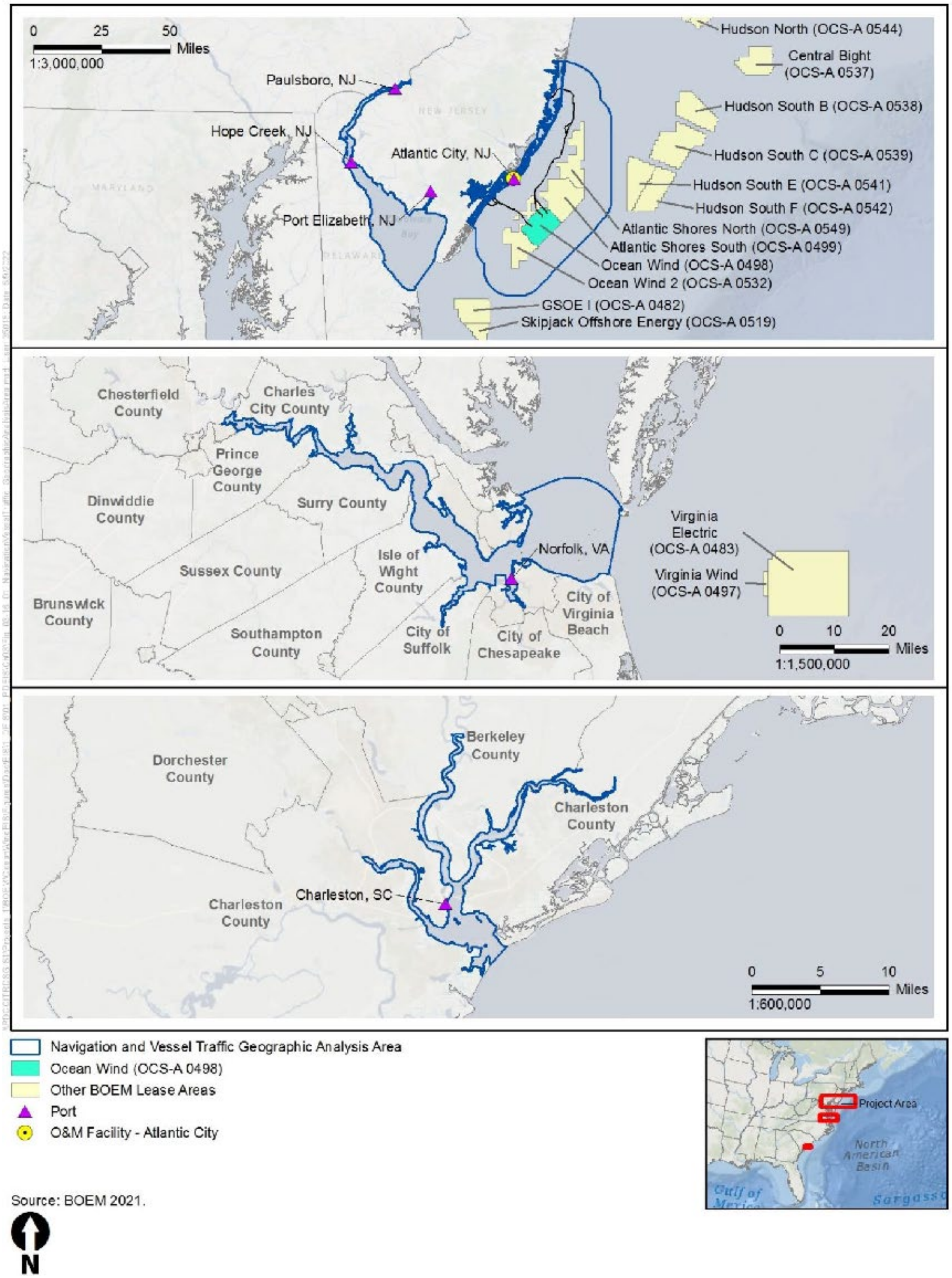

Table 7.2.1. Potential Primary Ports and Estimated Total Number of Vessels and Trips Needed for Construction Activities.

Primary Port	Purpose	Total Number of Vessels	Total Number of Trips
Atlantic City, New Jersey	Construction Management –All CTVs	134	2,259
Paulsboro, New Jersey	Foundation Scope	5	149
OR Europe		5	149
Norfolk, Virginia	WTG Scope	2	99
OR Hope Creek, New Jersey		2	99
Port Elizabeth, New Jersey	Cable Staging	15	346
OR Charleston, South Carolina		15	346
OR Europe		15	346

Source: Ocean Wind 2022.
Note: All CTV captures all support and transport vessel numbers and trips.
CTV = crew transfer vessel; WTG = wind turbine generator

Construction of the offshore export cables will require various vessel types including a cable-laying vessel, tugs, barges, and work and transport vessels (see table 3.X). Cable installation will begin at the offshore site of the sea-to-shore transition points and proceed to the Ocean Wind 1 OSSs. Project components may be transported by vessels from foreign ports in Europe and the following U.S. ports: Port Elizabeth, New Jersey, or Charleston, South Carolina (Figure 7.2.2).

The construction phase will feature project-specific construction vessels, which are generally slower moving (<10 knots) installation and transport vessels that range from 325 to 350 feet in length, from 60 to 100 feet in beam, and draft from 16 to 20 feet, as well as smaller (from 80 to 100 feet in length) and faster moving support vessels (maximum speeds up to 23 knots). The larger installation vessels, like the floating/jack-up crane and cable-laying vessel, will generally travel to and out of the construction area at the beginning and end of the wind farm construction and will not make transits on a regular basis. Many of these larger, Project-specific vessels do not currently exist in the U.S. and will travel from ports in Europe. Tugs and barges transporting construction equipment and materials will make more frequent trips (e.g., weekly) from ports to the project site while smaller support vessels carrying supplies and crew may travel to the WDA daily. However, we note that construction crews responsible for assembling the WTGs will hotel onboard installation vessels at sea thus limiting the number of crew vessel transits expected during wind farm installation. As described in the BA (see Table 1-5), the anticipated normal operating speeds of all vessels, except crew transport vessels (<23 knots) and some project support vessels, is 10 knots or less. Within the lease area, many vessels will be stationary or very slow moving (4 knots or less).

As described in the BA, dredging may be required in shallow areas in Barnegat Bay to facilitate vessel access for export cable installation west of Island Beach State Park and near the landfall at Lacey or Ocean Township. Ocean Wind also proposes to dredge Barnegat Inlet and the Oyster Creek Channel, if necessary to facilitate passage of construction vessels into Barnegat Bay. Deepening and dredging activities require the use of dredge and support vessels. Clamshell dredging takes place from a barge with a mounted excavator. Barges typically require one or two tugboats to position them. Clamshell dredging also involves a scow vessel where contractors deposit the dredged material for disposal.
During O&M, vessel traffic will be limited to routine maintenance visits and non-routine maintenance, as needed; all O&M transits will occur from Atlantic City, New Jersey, to the Project area. The majority of operations and maintenance vessel trips would be conducted by the CTVs (908 crew vessel trips annually), with larger vessels making less frequent trips (102 jack-up vessel trips and 104 supply vessel trips annually) to repair scour protection, or replace damaged WTGs on an as needed basis. As described in the BA, project decommissioning is expected to require a total of 120 round trips between the O&M facility and the WDA. Vessels types used during the decommissioning phase of the project are anticipated to be similar to those used during the installation phase.

Additionally, there will be limited vessel traffic that will be associated with the marine resource survey and monitoring activities (fisheries surveys, benthic monitoring) that will occur pre, during, and post-construction, for a period up to nine years total. The associated vessel trips to execute monitoring for the Project (passive acoustic monitoring, HRG surveys, benthic, and fisheries) would include:

- As described in table 1-4 the BA, vessels used during surveys may include lengths of 98 feet with beams of 49 feet. During survey activities, vessels are expected to be moving slowly at speeds of 5 knots or less.

- 624 days of HRG surveys totaling approximately 16,942 nm (31,376 kilometers) in distance traveled, not including round-trip vessel transit to the survey site.

- The benthic monitoring plan is composed of five separate surveys with varying levels of effort pre-, during, and post-construction. Vessel traffic for these surveys was analyzed based on the number of stations visited during each survey event. Surveys would deploy visual equipment at 162 stations for pre-construction, 500 stations for immediately after construction, 662 stations 1 year post-construction, 112 stations 2 years post-construction, 662 stations 3 years post-construction, and 112 stations 5 years post-construction. A minimum 2,210 stations would require visitation over the 5-year post-construction period (sand ridge and cable-associated benthic surveys have the potential to be extended if benthic organism densities and assemblages continue to differ from the baseline after 3 years). Hard-bottom and structure-associated soft-bottom surveys would overlap at the same sites and were considered together.

- 960 separate trawl surveys with 20-minute tows (320 hours total) over a 6-year period with an approximately 428-nm (793-kilometer) round-trip vessel transit to the site for each seasonal survey

- 24 separate survey events for structure-associated fishes survey that span 3 days each at 12 to 15 locations over a 6-year period with a 90-minute soak time on six baited traps and an approximately 90-nm (167-kilometer) area for each survey event

- Six separate clam dredge survey events with 40 minutes total of dredge time across three sites over a 6-year period with an approximately 44-nm (81-kilometer) round-trip vessel transit for each survey event

- 24 separate acoustic telemetry tows of an omni-directional hydrophone for an unspecified amount of time per survey event over a 6-year period with an approximately 42- to 46-nm (78- to 85-kilometer) round-trip vessel transit per survey event (transits for the telemetry tow vessel are unclear, as it can be driven on a trailer to a nearby boat ramp; BOEM assumes that a nearby boat ramp from Ocean City or Atlantic City would be chosen).

As described by BOEM, total vessel trips during the construction period are 2,870 plus 254 survey transits over a 2.5-year construction period (anticipated over 3 calendar years); these trips will be between the WDA and the ports identified above. During the operation period, 3,699 vessel trips will occur annually, with the exception of the survey trips noted above, all trips would occur to/from Atlantic City. During the decommissioning period, 120 round trips are anticipated. As explained above, the best available data indicate there are 74,352 vessel transits annually in the area that the Ocean Wind vessel transits will overlap. The table below describes the calculated increase in traffic attributable to Ocean Wind 1 project vessels.

Table 7.2.2. Percent Increase Above Baseline Vessel Traffic in the Project Area Due to Ocean Wind 1 Project Vessels

Phase	Annual Project-Related Vessel Transits	Phase Duration	% Increase in Annual Vessel Transits in the Project Area[d]
Construction	3,124 [a]	2.5 years	+ 1.4%
Operation	3,688 [b]	35 years	+ 4.5-5.0%
Decommissioning	120 [c]	2 years	+ 0.16 %

[a] Source: BOEM November BA Addendum, plus fisheries survey vessel transits
[b] Source: BOEM November 2022 BA Addendum, plus fisheries surveys vessel transits for a portion of these years
[c] Source: BOEM pers. comm (3/2023 email from L. Landers to NMFS)
[d] Source: Baseline vessel traffic in the Project Area is 74,352 transits (USCG 2020)

7.2.2 Minimization and Monitoring Measures for Vessel Operations

There are a number of measures that Ocean Wind is proposing to take and/or BOEM is proposing to require as conditions of COP approval that are designed to avoid, minimize, or monitor effects of the action on ESA-listed species during construction, operation, and decommissioning of the project. NMFS OPR's proposed ITA also contains requirements for vessel strike avoidance measures for marine mammals; these measures will be implemented only during the construction phase when the ITA is active (5 years from when first valid). The complete list of required measures is provided in section 3.0 (Table 3.3.1). These measures can be grouped into two main categories: vessel speed reductions and increased vigilance/animal avoidance.

Specific measures related to vessel speed reduction include that vessels of all sizes will operate at 10 knots or less between November 1 and April 30 when traveling between the WDA and ports in NJ, VA, and SC and that all vessels regardless of size will travel at 10 knots or less within any SMAs, DMAs, and Slow Zones. Additionally, at all times of the year regardless of vessel size, visual observers must monitor a vessel strike avoidance zone and if an animal is spotted, the vessel must slow down and take action to transit safely around the animal. Additional requirements for monitoring transit zones with PAM systems are in place for the construction, operations, and decommissioning period. Monitoring measures will also include the integration of sighting communication tools such as Mysticetus, Whale Alert, and WhaleMap to establish a situational awareness network for marine mammal and sea turtle detections. To minimize risk to sea turtles, if a sea turtle is sighted within 100 meters 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 meters at which time the vessel may resume normal operations. Additionally, 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. These measures are all considered part of the proposed action or are otherwise required by regulation.

7.2.3 Assessment of Risk of Vessel Strike – Construction, Operations and Maintenance, and Decommissioning

Here, we consider the risk of vessel strike to ESA-listed species. This assessment incorporates the strike avoidance measures identified in Section 3, because they are considered part of the proposed action or are otherwise required by regulation. This analysis is organized by species group (i.e., Atlantic sturgeon, shortnose sturgeon, whales, and sea turtles) because the risk factors and effectiveness of strike avoidance measures are different for the different species groups. Within the species groups, the effects analysis is organized around the different geographic areas where project related vessel traffic would be experienced.

As noted in section 2 of this Opinion and further addressed below, the effects of some vessel transits have been addressed in other Biological Opinions. Specifically, some Ocean Wind 1 project vessels will utilize the Paulsboro Marine Terminal in Paulsboro, NJ, the New Jersey Wind Port in Hope Creek, NJ, and the Nexans Cable Plant in Charleston, SC, which were constructed pursuant to USACE permits. The Biological Opinions prepared by NMFS for the Paulsboro Marine Terminal (July 19, 2022, "2022 Paulsboro Opinion") and New Jersey Wind Port (February 25, 2022, "2022 NJWP Opinion") considered effects of vessels transiting to/from these ports on shortnose sturgeon, Atlantic sturgeon and critical habitat designated for the New

York Bight DPS of Atlantic sturgeon. The May 4, 2020 Biological Opinion prepared by NMFS' Southeast Regional Office (SERO) considers the effects of the construction and subsequent use of the Nexans Plant (2020 Nexans Opinion) on shortnose sturgeon, Atlantic sturgeon, and critical habitat designated for the Carolina DPS of Atlantic sturgeon.

Each of these three Biological Opinions analyzed an overall amount of vessel transits, of which Ocean Wind would contribute a small part. The effects analyzed in the three completed port Opinions have been considered as part of the Environmental Baseline of this Opinion, given the definition of that term at 50 CFR §402.02. The effects specific to Ocean Wind's vessel use of those ports will be discussed here in this Effects of the Action section by referencing the analysis in three port Opinions and determining whether the effects of Ocean Wind's vessels transiting to and from those ports are consistent with those analyses or anticipated to cause additional effects. As previously explained, by using this methodology, this Opinion ensures that all of the effects of Ocean Wind's vessel transits to and from the ports analyzed in other Biological Opinions will be considered in the Integration and Synthesis section and reflected in this Opinion's final determination under ESA 7(a)(2). This methodology also ensures this Opinion does not "double-count" effects of Ocean Wind's vessel transits to and from the ports–once in the Environmental Baseline and once here in this Opinion's *Effects of the Action* section. This approach is being taken because BOEM was not a party to the three port Biological Opinions' consultation process, yet Ocean Wind's vessel transits would not occur but for BOEM's proposed COP approval with conditions.

7.2.3.1 Atlantic Sturgeon

The distribution of Atlantic sturgeon does not overlap with the entirety of the action area. The marine range of Atlantic sturgeon extends from Hamilton Inlet, Labrador, Canada, to Cape Canaveral, Florida with distribution largely from shore to the 50m depth contour (ASMFC 2006; Stein et al. 2004). Atlantic sturgeon may occur in nearshore waters (depths less than 50 m) and some rivers and bays that may be transited by Project vessels, including the WDA. Additionally, Atlantic sturgeon occur along the nearshore and estuarine/riverine portions of the vessel transit routes used by vessels transiting Delaware Bay and Delaware River (Paulsboro Marine Terminal, New Jersey Wind Port, and Pt. Elizabeth), the Chesapeake Bay (Norfolk International Terminal, Virginia), and Charleston Harbor/lower Cooper River (Nexans facility). Atlantic sturgeon would only occur along the portion of the vessel routes to/from Europe that are in U.S. Atlantic coastal waters less than 50 m depth.

Vessel Operations in the Lease Area, Cable Corridor, and to/from the O&M Facility

While Atlantic sturgeon are known to be struck and killed by vessels in rivers and in estuaries adjacent to spawning rivers (i.e., Delaware Bay), we have no reports of vessel strikes in the marine environment. We have considered whether Atlantic sturgeon are likely to be struck by project vessels or if the increase in vessel traffic is likely to otherwise increase the risk of strike for Atlantic sturgeon in the lease area, along the cable corridor and during transits to and from the O&M Facility in Atlantic City, NJ. As established elsewhere in this Opinion, Atlantic sturgeon use of the WDA (i.e., the lease area and cable corridors) is intermittent and disperse; there are no aggregation areas in the area in the WDA, the cable corridors or along the vessel transit route to Atlantic City. Additionally, these transit routes are not adjacent to, or within, any spawning rivers, which would increase the number and concentration of migrating Atlantic sturgeon. The dispersed nature of Atlantic sturgeon in this area means that the potential for co-occurrence between a project vessel and an Atlantic sturgeon in time and space is extremely low.

In order to be struck by a vessel, an Atlantic sturgeon needs to co-occur with the vessel hull or propeller in the water column. Given the depths in the vast majority of the this area (with the exception of near shore areas where vessels will dock) and that sturgeon typically occur at or near the bottom while in the marine environment, the potential for co-occurrence of a vessel and a sturgeon in the water column is extremely low even if a sturgeon and vessel co-occurred generally. The areas to be transited by the project vessels are free flowing with no obstructions; therefore, even in the event that a sturgeon was up in the water column such that it could be vulnerable to strike, there is ample room for a sturgeon swim deeper to avoid a vessel or to swim away from it which further reduces the potential for strike. The nearshore Atlantic City port area where vessels will enter shallower water and dock is not known to be used by Atlantic sturgeon; as such, co-occurrence between any Atlantic sturgeon and any project vessels in areas with shallow water or constricted waterways where the risk of vessel strike is theoretically higher, is extremely unlikely to occur. Considering this analysis, it is extremely unlikely that any project vessels operating in the Ocean Wind 1 lease area, along the cable corridor, or between these areas and the O&M facility in Atlantic City will strike an Atlantic sturgeon during any phase of the proposed project.

Trips to/from Europe
We expect that vessels transiting between ports in western Europe and the lease area will transit in offshore waters of the Atlantic Ocean and then enter the Nantucket to Ambrose TSS; from there they will travel south to the lease area. Given the deep water depths offshore of the lease area and that Atlantic sturgeon are extremely rare in waters deeper than 50 m, it is extremely unlikely that Atlantic sturgeon will occur in this portion of the action area. As such, any effects to Atlantic sturgeon from vessels operating in this portion of the action are extremely unlikely to occur.

Effects of Vessel Transits to Ports in Delaware River/Bay, Norfolk, and Charleston
Vessels traveling along the Atlantic coast between the lease area and ports in the Delaware River/Bay, Norfolk, and Charleston will transit past a number of Atlantic sturgeon aggregation areas or “hot spots”; however, these vessels will be transiting in deeper, more offshore waters and not actually pass through any of these areas. As such, the risk to Atlantic sturgeon from the oceanic portions of these trips is the same as identified for the marine environment above; that is, it is extremely unlikely that any Atlantic sturgeon will be struck by project vessels operating in the Atlantic Ocean on the way to/from any of these ports.

As explained in section 2.0 of this Opinion and above, NMFS completed ESA section 7 consultations on the construction and use of the Paulsboro Marine Terminal, New Jersey Wind Port, and the Nexans Facility in Charleston.

<u>New Jersey Wind Port (NJWP)</u>
In the February 25, 2022, Biological Opinion issued to USACE for the construction and operation of the NJWP, NMFS concluded that the construction and use of the New Jersey Wind Port was likely to adversely affect but not likely to jeopardize any DPS of Atlantic sturgeon.

NMFS determined that vessel traffic to and from the NJWP during 25 years of port operations will result in the mortality of 35 Atlantic sturgeon (23 New York Bight DPS, 5 Chesapeake Bay DPS, 5 South Atlantic DPS, 2 Gulf of Maine DPS) as a result of vessel strike. The Opinion calculated these mortalities based on 1,280 vessel trips during the 25-year operational life of the port. In the BA for the Ocean Wind 1 project, BOEM estimates up to 99 trips to the NJWP (Table 3-24 in the BA). This is approximately 7.7% of the total trips considered in the NJWP Biological Opinion. Based on the available information, we expect that Ocean Wind vessels are similar to the vessels considered in this Opinion; we have not identified any features of the vessels or their operations that would make them more or less likely to strike an Atlantic sturgeon. As such, assuming that all vessels using the port are equally likely to strike an Atlantic sturgeon, we would expect that 7.7% of the total vessel strikes of Atlantic sturgeon could result from Ocean Wind 1 vessels. Calculating 7.7% of 35 Atlantic sturgeon results in an estimate of 2.7 vessel struck sturgeon. As such, we anticipate that vessels using the NJWP as part of the Ocean Wind 1 project will result in the strike of no more than three Atlantic sturgeon. Considering the apportionment of take by DPS outlined in the February 2022 Opinion, we expect that two of these would be from the New York Bight DPS with one from the Chesapeake Bay, South Atlantic, or Gulf of Maine DPS.

Paulsboro Marine Terminal

In the July 19, 2022, Biological Opinion issued to USACE for the construction and operation of the Paulsboro Marine Terminal, NMFS concluded that the construction and use of the Paulsboro Marine Terminal was likely to adversely affect but not likely to jeopardize any DPS of Atlantic sturgeon. NMFS determined that vessel traffic transiting between the mouth of Delaware Bay to and from the Paulsboro Marine Terminal during 10 years of port operations will result in the mortality of seven Atlantic sturgeon as a result of vessel strike (4 from the New York Bight DPS, 1 from the Chesapeake Bay DPS, 1 from the South Atlantic DPS, and 1 from the Gulf of Maine DPS). The Opinion calculated this mortality based on a maximum of 880 vessel trips during the 10-year operational life of the port. In the BA for the Ocean Wind 1 project, BOEM estimates up to 149 trips to the Paulsboro Marine Terminal (Table 3-24 in the BA). This is approximately 17% of the total trips considered in the Paulsboro Biological Opinion. Based on the available information, we expect that Ocean Wind vessels are similar to the vessels considered in this Opinion; we have not identified any features of the vessels or their operations that would make them more or less likely to strike an Atlantic sturgeon. Assuming that all vessels using the port are equally likely to strike an Atlantic sturgeon, we would expect that 17% of the total vessel strikes of Atlantic sturgeon could result from Ocean Wind 1 vessels. Calculating 17% of 7 Atlantic sturgeon results in an estimate of 1.19 vessel struck sturgeon. As such, we anticipate that vessels using the Paulsboro Marine Terminal as part of the Ocean Wind 1 project will result in the strike of no more than two Atlantic sturgeon. Based on the proportional assignment of take in the July 2022 Paulsboro Opinion, we expect that these are likely to be Atlantic sturgeon belonging to the New York Bight DPS.

Nexans Facility, Charleston, SC

In the May 4, 2020, Biological Opinion issued to USACE for the construction and operations of the Nexans Cable Facility, NMFS concluded that the construction and use of the Nexans Facility was likely to adversely affect but not likely to jeopardize the Carolina DPS of Atlantic sturgeon. However, the only adverse effects to Atlantic sturgeon were dredging and riprap installation. In the Opinion, NMFS concluded that vessel strikes between vessels using the facility to transport cable were extremely unlikely to occur based on the frequency of vessel operations, type of vessel, and low transit speed and that vessels using the facility were not likely to adversely affect any DPS of Atlantic sturgeon. As the effects of this vessel traffic were already considered in the April 2020 Biological Opinion issued for the Nexans Facility, and no take of Atlantic sturgeon by vessel strike was anticipated, Ocean Wind's use of the Nexans Facility is also extremely unlikely to result in vessel strikes, and no take is anticipated.

Port of Norfolk

Vessels traveling to or from the port facilities in Norfolk Harbor would travel from the lower Chesapeake Bay to the Port of Norfolk along the Elizabeth River. Vessels are expected to travel within the Federal navigation channels. Large vessels, such as the Ocean Wind project vessels, that enter Norfolk Harbor are typically assisted by tug boats and travel at speeds of less than 1 knot with their propeller idling. The port received 1,908 vessel calls in 2021[39]. In the BA, BOEM estimates that up to 99 vessel trips to Norfolk could occur if turbine foundations are transported from this port. This represents approximately 5% of the annual vessel traffic to the port and as the vessels will be using existing port facilities, it is not expected to be an increase in vessel traffic at the Port. While Atlantic sturgeon vessel strikes are known to occur in the James River, particularly in the narrower freshwater reach, there have been no observed vessel strikes in the Port or in Norfolk Harbor. Given this information, vessel strikes of Atlantic sturgeon by Ocean Wind vessels transiting to and from the Port of Norfolk are extremely unlikely to occur.

Port Elizabeth, NJ

In the BA, BOEM indicates that some vessels supporting cable installation activities may transit from Port Elizabeth, New Jersey. Port Elizabeth is located on the Maurice River, NJ several miles upstream from its confluence with Delaware Bay. Vessels traveling to/from this port will travel within the lower 25 km of Delaware Bay. Vessels are expected to travel within the Federal navigation channels. Atlantic sturgeon are not known to occur in the Maurice River but subadult and adults are present in lower Delaware Bay as they migrate in and out of the Hudson River.

The annual number of trips for all vessels (self-propelled and non-self-propelled, all drafts) in the Delaware River Federal Navigation Channel from Trenton to the Sea ranged from 30,853 to 52,032 (median = 41,795) during the period from 2010 through 2019 (ACOE 2020). Non-self-propelled vessels likely pose minimal risk of a vessel strike that could injure or kill a sturgeon. Further, self-propelled vessels such as tugboats transport non-self-propelled vessels and, therefore, the self-propelled vessel and the barges they transport is considered one vessel trip and not two. The annual number of only self-propelled vessel trips ranged from 23,925 to 43,754 (median=33,799) with a total of 339,074 trips over the period from 2010 to 2019. In the BA, BOEM estimates that up to 346 vessel trips to Port Elizabeth could occur in support of cable installation activities; these trips would occur between 2023 and 2025. This represents approximately 0.3% of the annual vessel traffic through Delaware Bay, just considering the vessels reported in the waterborne commerce data, which is only a fraction of the total vessel traffic in the Bay. Given this extremely small increase in vessel traffic, it is extremely unlikely

[39] https://wp.portofvirginia.com/wp-content/uploads/2022/07/2021-Trade-Overview.pdf; last accessed February 14, 2023.

that an Ocean Wind vessel transiting within Delaware Bay to/from Port Elizabeth will increase the risk of a strike of an Atlantic sturgeon. This risk is further reduced by the geography of the Bay, which does not restrict Atlantic sturgeon distribution in the way that narrow or constricted river reaches may.

Considering all vessel traffic over the life of the project, we anticipate the mortality of 5 Atlantic sturgeon (4 New York Bight, 1 from the Carolina, South Atlantic, or Gulf of Maine DPS). These takes have been evaluated in the above referenced Biological Opinions issued by NMFS to the USACE for the NJWP and Paulsboro ports.

Critical Habitat Designated for the New York Bight DPS of Atlantic sturgeon

The action area overlaps with a portion of the Delaware River critical habitat unit designated for the New York Bight DPS. The only project activity that may affect this critical habitat is the transit of project vessels to or from the Paulsboro Marine Terminal in Paulsboro, NJ (approximately RKM 139) and the New Jersey Wind Port in Hope Creek, NJ (approximately RKM 84).

The Biological Opinions prepared by NMFS for the Paulsboro and New Jersey Wind Ports considered effects of construction of these port facilities and the effects of all vessels transiting between the mouth of Delaware Bay and these ports on critical habitat designated for the New York Bight DPS of Atlantic sturgeon. In the July 19, 2022, Biological Opinion NMFS concluded that the construction and use of the Paulsboro Marine Terminal was not likely to adversely affect critical habitat designated for the New York Bight DPS of Atlantic sturgeon. In the February 25, 2022, Biological Opinion NMFS concluded that the construction and use of the New Jersey Wind Port was likely to adversely affect but not likely to destroy or adversely modify critical habitat designated for the New York Bight DPS of Atlantic sturgeon. As explained in that Opinion, NMFS determined that there would be temporary and permanent effects as a result of construction and mitigation activities and that use of the NJWP channels by deep draft vessels and periodic maintenance dredging will continue to reduce the value of the habitat over the 25-year expected life-time of the NJWP operations. Based on the available information, we expect that Ocean Wind vessels are similar to the vessels considered in the NJWP Opinion; we have not identified any features of the vessels or their operations that would make them more or less likely to affect critical habitat at the NJWP. While we are not able to determine the proportional effects of Ocean Wind 1 vessel use of the NJWP on critical habitat we have determined that because the number of trips and vessel types are consistent with the activities described in the NJWP Opinion, effects to critical habitat are also within the scope of effects considered in that Opinion. The effects of these vessel trips on critical habitat designated for the New York Bight DPS of Atlantic sturgeon are included in the Environmental Baseline for the Ocean Wind project. We have not identified any effects of the Ocean Wind 1 project that are beyond what was considered in the Paulsboro and New Jersey Wind Port consultations.

7.2.4.2 Shortnose sturgeon

The only portion of the action area that overlaps with the distribution of shortnose sturgeon is a portion of the vessel transit routes within the Delaware River and Cooper River (SC).

Effects of Vessel Transits to Ports in Delaware River/Bay, Norfolk, and Charleston

Vessels traveling to or from the Port of Norfolk would travel from the lower Chesapeake Bay to the Port of Norfolk along the Elizabeth River. Shortnose sturgeon are not known to occur in the lower Chesapeake Bay where vessels would transit to Norfolk and are not known to occur in the Elizabeth River. As such, we do not anticipate any co-occurrence between shortnose sturgeon and project vessels in this portion of the action area; therefore, exposure to project vessels transiting to/from the Port of Norfolk are extremely unlikely to occur.

Cable-related vessels transiting to Port Elizabeth would travel through the lower 25 km of Delaware Bay. The available information, including trawl surveys, tracking studies, and environmental conditions (i.e., salinity of 25-30 ppt) indicates that shortnose sturgeon are very rare in lower Delaware Bay. As such, we do not anticipate any co-occurrence between shortnose sturgeon and project vessels in this portion of the action area; therefore, exposure to project vessels transiting to/from Port Elizabeth are extremely unlikely to occur.

Shortnose sturgeon occur in the portion of the Delaware River that would be transited by vessels moving to or from the Paulsboro Marine Terminal in Paulsboro, NJ (approximately river kilometer 139) and the New Jersey Wind Port in Hope Creek, NJ (approximately river kilometer 84). The Biological Opinions prepared by NMFS for the Paulsboro Marine Terminal (July 19, 2022, "2022 Paulsboro Opinion") and New Jersey Wind Port (February 25, 2022, "2022 NJWP Opinion") considered effects of vessels transiting between the mouth of Delaware Bay and these ports on shortnose sturgeon. Shortnose sturgeon may also occur in a portion of the Cooper River that would be transited by vessels traveling to and from the Nexans cable facility in Charleston, SC. The May 4, 2020, Biological Opinion prepared by NMFS for the Nexans Plant (2020 Nexans Opinion) included consideration of effects of vessel traffic to and from the port. Each of these three Biological Opinions analyzed an overall amount of vessel transits, of which Ocean Wind would contribute a small part.

New Jersey Wind Port

In the 2022 NJWP Biological Opinion[40] NMFS concluded that the construction and subsequent use of the New Jersey Wind Port by Ocean Wind and others was likely to adversely affect but not likely to jeopardize shortnose sturgeon. NMFS determined that vessel traffic to and from the NJWP during 25 years of port operations will result in the mortality of four shortnose sturgeon as a result of vessel strike. The Opinion calculated these mortalities based on 1,280 vessel trips during the 25-year operational life of the port. In the BA for the Ocean Wind 1 project, BOEM estimates a total of up to 99 trips to the NJWP (Table 3-24 in the BA). This is approximately 7.7% of the total trips considered in the NJWP Biological Opinion. If we assume that all vessels using the port are equally likely to strike a shortnose sturgeon, we would expect that 7.7% of the total vessel strikes of shortnose sturgeon could result from Ocean Wind 1 vessels. Calculating 7.7% of 4 shortnose sturgeon results in an estimate of 0.3 vessel struck sturgeon. As such, we anticipate that vessels using the NJWP as part of the Ocean Wind 1 project will result in the lethal strike of no more than one shortnose sturgeon.

[40] The USACE has requested reinitiation of the 2022 NJWP Opinion. However, NMFS has requested that the USACE provide additional information necessary for the analysis and reinitiation of the consultation may not commence until NMFS receives that information. Until a new biological opinion is produced, the 2022 NJWP Opinion remains the best analysis of effects on listed species and critical habitat due to NJWP construction and use.

Paulsboro
In the July 19, 2022, Biological Opinion NMFS concluded that the construction and subsequent use of the Paulsboro Marine Terminal by any vessels was likely to adversely affect but not likely to jeopardize shortnose sturgeon. NMFS determined that vessel traffic to and from the Paulsboro Marine Terminal during 10 years of port operations will result in the mortality of one shortnose sturgeon as a result of vessel strike. The Opinion calculated this mortality based on a maximum of 880 vessel trips during the 10-year operational life of the port. In the BA for the Ocean Wind 1 project, BOEM estimates a total of up to 149 trips to the Paulsboro Marine Terminal (Table 3-24 in the BA). This is approximately 17% of the total trips considered in the Paulsboro Biological Opinion. If we assume that all vessels using the port are equally likely to strike a shortnose sturgeon, we would expect that 17% of the total vessel strikes of shortnose sturgeon could result from Ocean Wind 1 vessels. Calculating 17% of 1 shortnose sturgeon results in an estimate of 0.17 vessel struck sturgeon. As such, we anticipate that vessels using the Paulsboro Marine Terminal as part of the Ocean Wind 1 project will result in the lethal strike of no more than 1 shortnose sturgeon.

Nexans Facility
In the May 4, 2020, Biological Opinion NMFS concluded that the construction and subsequent use of the Nexans Facility by any vessels was likely to adversely affect but not likely to jeopardize shortnose sturgeon. However, the only adverse effects to shortnose sturgeon were from dredging and riprap installation. In the Opinion, NMFS concluded that vessel strikes of shortnose sturgeon by vessels using the facility to transport cable were extremely unlikely to occur based on the frequency of vessel operations, type of vessel, and low transit speeds. In the Opinion, NMFS concluded that vessel use of the Nexans Facility was not likely to adversely affect shortnose sturgeon and, therefore, not likely to jeopardize the continued existence of shortnose sturgeon As the effects of this vessel traffic were already considered in the April 2020 Biological Opinion issued for the Nexans Facility, and no take of shortnose sturgeon by vessel strike was anticipated, Ocean Wind's use of the Nexans Facility is also extremely unlikely to result in vessel strikes, and no take is anticipated.

In summary, considering all vessel traffic over the life of the project, we anticipate vessel traffic related to the Ocean Wind project to cause the mortality of two shortnose sturgeon. This take has been evaluated in the above referenced Biological Opinions issued by NMFS to the USACE for the NJWP and Paulsboro Marine Terminal.

7.2.3.2 ESA-Listed Whales

Background Information on the Risk of Vessel Strike to ESA-Listed Whales
Vessel strikes of large whales from all sizes of commercial, recreational, and military vessels have resulted in serious injury and fatalities to the ESA listed whales that occur in the action area as described in more detail in section 6.1 (Environmental Baseline) (Lammers et al. 2003, Douglas et al. 2008, Laggner 2009, Berman-Kowalewski et al. 2010, Calambokidis 2012). Records of collisions date back to the early 17th century, and the worldwide number of collisions appears to have increased steadily during recent decades (Laist et al. 2001, Ritter 2012).

The most vulnerable marine mammals are those that spend extended periods at the surface feeding or in order to restore oxygen levels within their tissues after deep dives. Baleen whales, such as the North Atlantic right whale, seem generally unresponsive to vessel sound, making them more susceptible to vessel collisions (Nowacek et al. 2004). Many studies have been conducted analyzing the impact of vessel strikes on whales; these studies suggest that a greater rate of mortality and serious injury to large whales from vessel strikes correlates with greater vessel speed at the time of a ship strike (Laist et al. 2001, Vanderlaan and Taggart 2007 as cited in (Aerts and Richardson 2008)). Vessels transiting at speeds >10 knots present the greatest potential hazard of collisions (Jensen and Silber 2004, Silber et al. 2009). Vanderlann and Taggart (2007) demonstrated that between vessel speeds of 8.6 and 15 knots, the probability that a vessel strike is lethal increases from 21% to 79%. In assessing records with known vessel speeds, Laist et al. (2001) found a direct relationship between the occurrence of a whale strike and the speed of the vessel involved in the collision. The authors concluded that most deaths occurred when a vessel was traveling in excess of 24.1 km/h (14.9 mph; 13 knots (kn)). Large whales also do not have to be at the water's surface to be struck. In a study that used scale models of a container ship and a right whale in experimental flow tanks designed to characterize the hydrodynamic effects near a moving hull that may cause a whale to be drawn to or repelled from the hull, Silber et al. (2010) found when a whale is below the surface (about one to two times the vessel draft), there is likely to be a pronounced propeller suction effect. This modeling suggests that in certain circumstances, particularly with large, fast moving ships and whales submerged near the ship, this suction effect may draw the whale closer to the propeller, increasing the probability of propeller strikes. Additionally, Kelley et al (2020) found that collisions that create stresses in excess of 0.241 megapascals were likely to cause lethal injuries to large whales and through biophysical modeling that vessels of all sizes can yield stresses higher than this critical level. Growing evidence shows that vessel speed, rather than size, is the greater determining factor in the severity of vessel strikes on large whales.

In an effort to reduce the likelihood and severity of fatal collisions with right whales, NMFS established vessel speed restrictions in specific locations, primarily at key port entrances, and during certain times of the year, these areas are referred to as Seasonal Management Areas (SMA). A 10-knot speed restriction applies to vessels 65 feet and greater in length operating within any SMA (73 FR 60173, October 10, 2008). As noted above, NMFS has published proposed modifications to these regulations that would increase the scope of the speed restrictions (87 FR 46921; August 1, 2022).

In the 2008 regulations, NMFS also established a Dynamic Management Area (DMA) program whereby vessels are requested, but not required, to either travel at 10 knots or less or route around locations when certain aggregations of right whales are detected outside SMAs. These temporary protection zones are triggered when three or more whales are visually sighted within 2-3 miles of each other outside of active SMAs. The size of a DMA is larger if more whales are present. A DMA is a rectangular area centered over whale sighting locations and encompasses a 15-nautical mile buffer surrounding the sightings' core area to accommodate the whales' movements over the DMA's 15-day lifespan. The DMA lifespan is extended if three or more whales are sighted within 2-3 miles of each other within its bounds during the second week the DMA is active. Only verified sightings are used to trigger or extend DMAs; however, DMAs can be triggered by a variety of sources, including dedicated surveys, or reports from mariners.

Acoustically triggered Slow Zones were implemented in 2020 to complement the visually triggered DMAs. The protocol for the current acoustic platforms that are implemented in the Slow Zone program specify that 3 upcalls must be detected (and verified by an analyst) to consider right whales as "present" or "detected" during a specific time period. Acknowledging that visual data and acoustic data differ, experts from NMFS' right whale Northeast Implementation Team, including NEFSC and Woods Hole Oceanographic Institute staff, developed criteria for accepting detection information from acoustic platforms. To indicate right whale presence acoustically (and be used for triggering notifications), the system must meet the following criteria: (1) evaluation has been published in the peer-reviewed literature, (2) false detection rate is 10% or lower over daily time scales and (3) missed detection rate is 50% or lower over daily time scales. For consistency, acoustically triggered Slow Zones are active for 15 days when right whales are detected and can be extended with additional detections. However, acoustic areas are established by rectangular areas encompassing a circle with a radius of 20 nautical miles around the location of the passive acoustic monitoring system.
In an analytical assessment of when the vessel restrictions were and were not in effect, Conn and Silber (2013) estimated the speed restrictions required by the ship strike rule reduced total ship strike mortality by 80 to 90%. In 2020, NMFS published a report evaluating the conservation value and economic and navigational safety impacts of the 2008 North Atlantic right whale vessel speed regulations. The report found that the level of mariner compliance with the speed rule increased to its highest level (81%) during 2018-2019. In most SMAs more than 85% of vessels subject to the rule maintained speeds under 10 knots, but in some portions of SMAs mariner compliance is low, with rates below 25% for the largest commercial vessels outside four ports in the southeast. Evaluations of vessel traffic in active SMAs revealed a reduction in vessel speeds over time, even during periods when SMAs were inactive. An assessment of the voluntary DMA program found limited mariner cooperation that fell well short of levels reached in mandatory SMAs. The report examined AIS-equipped vessel traffic (<65 ft. in length, not subject to the rule) in SMAs, in the four New England SMAs, more than 83% of all <65 ft. vessel traffic transited at 10 knots or less, while in the New York, Delaware Bay, and Chesapeake SMAs, less than 50% of transit distance was below 10 knots. The southern SMAs were more mixed with 55-74% of <65 ft. vessel transit distance at speeds under 10 knots (NMFS 2020). The majority of AIS-equipped <65 ft. vessel traffic in active SMAs came from four vessel types: pleasure, sailing, pilot, and fishing vessels (NMFS 2020).

The Ocean Wind 1 WDA does not overlap with any SMAs, however, the vessel transit routes to a number of ports overlap with a number of Mid-Atlantic SMAs. Project vessels transiting to ports in Delaware River/Bay, Norfolk, and Charleston will travel through or adjacent to SMAs near the mouth of Delaware Bay, Chesapeake Bay, near Morehead City, NC and along the coast from Wilmington, NC to Charleston, SC. These Mid-Atlantic SMAs are in effect from November 1 - April 30 each year. Additionally, DMAs and acoustically triggered Slow Zones have been established in response to aggregations of right whales in the waters of Mid-Atlantic, and may overlap vessel transit routes and/or the lease area throughout the year. For example, in 2022, NMFS declared a total of 77[41] DMAs/Right Whale Slow Zones along the U.S. East Coast. Of these, 30 were triggered by right whale sightings and 47 were triggered by acoustic detections. DMAs/Slow Zones were declared in 11 locations in the Northeast/Mid-Atlantic U.S.

[41] https://www.fisheries.noaa.gov/s3/2023-01/2022_DMAs_and_Right_Whale_Slow_Zones_508.pdf; last accessed March 14, 2022.

(Martha's Vineyard, MA, Virginia Beach, VA, Portsmouth, NH, Nantucket, MA, Boston, MA, Chatham, MA, Portland, ME, Ocean City, MD, New York Bight, NY, Atlantic City, NJ and Cape Cod Bay, MA) and in one location in the Southeast U.S. (Ocracoke, NC). As elaborated on below, BOEM will require that Ocean Wind 1 vessels of any size travel at speeds of 10 knots or less in any SMA or DMA/Slow Zone in all project phases.

Exposure Analysis – ESA-Listed Whales

We consider vessel strike of ESA-listed whales in the context of specific project phases because the characteristics and volume of vessel traffic is distinctly different during the three phases of the project. Vessels trips between the WDA (i.e., the lease area and the cable corridors) and ports in NJ, VA, and SC as well as Europe will occur during the construction phase. The majority of traffic during all phases will be between the lease area and the O&M facility in Atlantic City, NJ (approximately 79% during construction and 100% during operations). Table 7.2.1 above details the vessel trips to U.S. ports and Europe during the construction phase of the project.

For our risk assessment, we carried out a four-step process. First, we used the best available information to establish an estimate of the number of right, fin, sei, sperm, and blue whales struck annually in the geographic area under consideration (i.e., the area where vessel traffic will occur); we used the best available information on cryptic mortality (i.e., the number of animals that are killed and never observed) to establish a correction factor to adjust the reported number of vessel struck animals to generate our best estimate of total vessel related mortality for each species in the geographic area. Second, we used the best available information on baseline traffic (i.e., the annual number of vessel transits within a particular geographic area absent the proposed action) and the information provided by BOEM and Ocean Wind 1 on the number of anticipated vessel transits in that area by Ocean Wind 1 project vessels to determine to what extent vessel traffic would increase in the area during each of the three phases of the Ocean Wind 1 project. For example, if baseline traffic in a particular area were 100 trips per year and the Ocean Wind 1 project would result in 10 new trips in that area, we would conclude that traffic was likely to increase by 10%. Third, based on the assumption that risk of vessel strike is related to the amount of vessel traffic (i.e., that more vessels operating in a geographic area would lead to a proportional increase in vessel strike risk), we calculated the increase in baseline vessel strikes by the increase in vessel traffic. For example, if in the baseline condition, we expect a whale to be struck and the project doubled traffic, we would produce an estimate of two strikes (double the baseline number). It is important to note that these steps were carried out without consideration of any measures designed to reduce vessel strike and the assumption that all vessels have the same likelihood of striking a whale. Finally, we considered the risk reduction measures that are part of the proposed action and whether, with those risk reduction measures in place, any vessel strike was reasonably certain to occur. The numbers of baseline vessel transits and Project vessel transits were used to evaluate the effects of vessel traffic on listed species as this provides the most accurate representation of vessel traffic in the region and from the proposed Project. As explained above, baseline vessel transits were estimated using vessel AIS density data (number of trips) which provides a quantifiable comparison and approximation to estimate risk to listed species from the increase in Project vessel traffic. We considered an approach using vessel-miles; however, we have an incomplete baseline of vessel traffic in the region in the terms of vessel miles, as there is significant variability in vessel-mileage between vessel type and activity and no reliable way to obtain vessel miles from the existing baseline data we have access to. While data on the miles that project vessels will travel is partially available, without a robust baseline to compare it to, we are not able to provide an accurate comparison to baseline traffic levels. Further, given that we are considering the area within which the vessels will operate (i.e., evaluating risk along particular vessel routes) we do not expect that the results of our analysis would be any different even if we did have the information necessary to evaluate the increase in vessel traffic in the context of miles traveled rather than number of trips.

Vessel Operations in the Lease Area, Along the Cable Routes and To/From Ports in NJ
ESA-listed whales use portions of the action area throughout the year, including the portion of the action area where vessels will transit in the lease area, along the Ocean Wind 1 export cable corridors, and between those locations and identified ports in NJ (see Section 5 and 6 for more information on distribution of whales in the action area). Baseline vessel traffic in the action area is described at the beginning of this section. Vessel traffic between the lease area/cable corridors and ports in NJ accounts for 79-100% of the anticipated vessel traffic during the construction phase (dependent on the actual ports used) and 100% of the anticipated traffic during the operations phase.

From the marine mammal stock assessment reports and serious injury and mortality reports produced by NMFS, for the period of 1999-2020 (the most recent period available), we identified a total of four records of ESA-listed whales with injuries consistent with vessel strike that were first detected in waters from Rehoboth, DE to Barnegat Inlet, NJ which is the best representation of the geographic area representing the lease area, the cable corridor, and the area where vessels will transit between these areas and the identified ports in NJ (Table 7.2.1 below). Considering the 1999-2020 stock assessment reports and serious injury and mortality reports as well as available information for 2021 through March 7, 2023, we did not identify any records of right, blue or sperm whales struck in this portion of the action area. We also did not identify any additional reports of vessel strikes for fin or sei whales in this area.

Considering the information presented in the available Serious Injury and Mortality Reports for 1999-2020 (as cited below) and information on the right whale UME from June 6, 2017 – March 7, 2023[42], there were no North Atlantic right whales reported with vessel strike injuries between Rehoboth Beach, DE and Barnegat Inlet, NJ. We note that right whales with evidence of vessel strike are reported in waters outside this area during this time-period. The closest reported vessel strike of a right whale to the area considered here is the reported vessel strike of a male calf near Elberon, NJ in June 2020 by a vessel traveling at approximately 28 knots (approximately 112 km north of Atlantic City, NJ) (Henry et al. 2022).

Table 7.2.3. Information on ESA-listed whales reported with injuries consistent with vessel strikes between Rehoboth, DE and Barnegat Inlet, NJ from 1999-2020.

ESA-listed Whales with Injuries Consistent with Vessel Strikes

[42] https://www.fisheries.noaa.gov/national/marine-life-distress/2017-2021-north-atlantic-right-whale-unusual-mortality-event; last accessed 3/7/23

Species	Total	Date and Location
Fin Whale	3	7/2/08 Barnegat Inlet, NJ; 9/23/10 Cape Henlopen State Park, DE; 1/23/12 Ocean City, NJ
Sei Whale	1	5/7/14 Delaware River (on ship's bow)

Source: Henry et al. 2022 (2016-2020 data); Henry et al. 2017 (2011-2015); Glass et al. 2012 (2006-2010); Nelson et al. 2007 (2001-2005 data); Cole et al. 2005 (1999-2000 data)

These mortalities were reported over a 22-year period (1999-2020). It is important to note that the locations recorded are, in nearly all cases, the area where the whale was first sighted and the actual location of the strike is unknown. For example, the sei whale recorded above was documented when the vessel came into port in the Delaware River; it is unknown where along the vessel's transit route the strike actually occurred. Considering these strikes over a 22-year period, this is an annual average reported strike rate of 0.14 fin whales, and 0.05 sei whales. Though this is a relatively small number of vessel strikes for the period, detection of carcasses is very difficult given the large open ocean, which means that this could be an underestimate. Conversely, the location of a recovered carcass is where it was first detected, not necessarily where the incident occurred, and some of the incidents detected in this area may be whales that were struck outside of the area, which would result in an overestimate of the strikes that occurred in the area. Additionally, depending on cetacean species, carcasses may be more likely to float or sink, they may be carried from where they were struck on the bow of a vessel and only noticed in port, or carried away from the ship strike location by wind, currents, and waves. All of these factors contribute to the difficulty in detecting carcasses, in particular from ship strike (Rockwood et al. 2017).

A number of studies have estimated carcass recovery rates for different cetacean species, including 17% for right whales, 6.5% for killer whales, <5% for grey whales, and 3.4% for sperm whales (Kraus et al. 2005). Pace et al. (2021) used an abundance estimation model to derive estimates of cryptic mortality for North Atlantic right whales and found that observed carcasses accounted for 36% of all estimated deaths during 1990–2017 (Pace et al. 2021). As increased search effort and stranding response in recent years would suggest a higher rate might apply now for right whales, the 36% rate is considered the best available estimate of carcass recovery for the time series considered here (2000-2021). These rates are largely related to how buoyant a species is, thus affecting how likely it will be detected. Right whales are the most buoyant species due to their thick blubber layer, and are most likely to be detected, thus providing a conservative estimate for extrapolation. Sperm whale buoyancy depends on lung inflation at mortality; near the surface, they have positive buoyancy, but overall negative tissue buoyancy (Rockwood et al. 2017). To determine an improved recovery rate estimate for other whale species relative to right whales, Rockwood et al. 2017 used an average of the sperm, grey, and killer whale rates.

Using the 5% rate (mean of sperm, grey, and killer whales) for fin and sei whales, we extrapolated ship strike mortality from the 1999-2020 serious injury/mortality data to produce an estimate of the total number of fin, and sei whales struck annually in the geographic area under consideration (i.e., Rehoboth Beach to Barnegat Inlet) as shown below. The calculation used is: ((total individuals detected in the geographic area of interest with injuries consistent with vessel strike)/(correction factor))/number of years of detection data. Using this formula, we calculate:

Fin whales: (3/0.05)/22 = 2.72/year
Sei whales: (1/0.05)/22 = 0.91/year

In spite of being one of the primary known sources of direct anthropogenic mortality to whales, ship strikes remain relatively rare, stochastic events. If we assume that an increase in vessel trips results in a proportional increase in risk of vessel strike, we can then use the calculated percent increase in vessel traffic attributable to the project, to calculate the increase in risk of vessel strike due to project activity (construction, operations, and decommissioning). As illustrated in Table 7.2.1, we expect a 1.4% increase in vessel trips over baseline conditions during the two and half-year construction period, a 4.5 - 5.0% increase in traffic during the 35-year operations period, and a 0.16% increase in traffic during the two-year decommissioning period. As such, assuming a linear relationship in vessel traffic and whales struck, we could predict a proportional increase in the number of fin and sei whales struck in the area that will be transited by Ocean Wind project vessels traveling between the lease area/cable corridors and the identified NJ ports with the following calculation: (baseline strikes per year)(% increase in annual traffic)(number of years in project phase) = theoretical increase in vessel strike during project phase.

Construction (1.4% increase annually over 2.5 years of construction):
Fin whales: (2.72)(0.014)(2.5)= 0.0952
Sei whales: (0.91)(0.014)(2.5)= 0.03185

Operations (4.5-5% annually over 35 year operational period)
Fin whales: (2.72)(0.05)(35)= 4.76
Sei whales: (.91)(0.05)(35) = 1.59

Decommissioning (0.16% increase in traffic for 2 years)

Fin whales: (2.72)(0.016)(2) = 0.08704
Sei whales: (0.91)(0.016)(2) = 0.02912

As described in these calculations, the theoretical increased risk of vessel strike anticipated to result from the increase in vessel traffic associated with the proposed action is equivalent to 0.09 fin whales and 0.03 sei whales during the two and half year construction period, 4.76 fin whales and 1.59 sei whales over the 35 year operational period, and 0.09 fin whales and 0.03 sei whales during the two-year decommissioning period. As noted above, these calculations do not take into account any risk avoidance measures that will be required as conditions of the project's approval, either through COP conditions or conditions of the MMPA ITA.

The vessel strike estimates above do not include right, blue or sperm whales because there are no records of vessel strike for either species in the portion of the action area considered here (based on available information from 1999-March 2023 as described above). Blue and sperm whales are typically found in deeper waters of the continental shelf, and are expected to be very rare in the lease area and even less likely to occur in the nearer shore portions of the action area where vessels will transit between coastal ports and the lease area. Thus, any theoretical increase in risk of strike of blue and sperm whales is even smaller than that calculated for fin and sei whales.

Considering right whales, absent any mitigation measures we could theoretically estimate an increase in risk based on the increase in vessel traffic. As such, this would increase risk during the construction period by 1.4%, during the operational period by 4.5-5%, and 0.16% during the decommissioning period. As noted above, there are no records of right whales with evidence of vessel strike between Rehoboth Beach, DE and Barnegat Inlet, NJ, which is where vessel transits between the lease site/cable corridors and the NJ ports will occur. This suggests that baseline risk of vessel strike in this area is low compared to other areas along the Atlantic coast.

There are a number of factors that result in us determining that any hypothetical increase in vessel strike will not occur. As described above in Section 3, a number of measures designed to reduce the likelihood of striking marine mammals including ESA-listed large whales, particularly North Atlantic right whales, are included as part of the proposed action. These measures include seasonal speed restrictions and enhanced monitoring via PSOs, PAM, and alternative monitoring technologies.

The vessel speed limit requirements proposed by Ocean Wind 1, BOEM, and NMFS OPR are in accordance with measures outlined in NMFS Ship Strike Reduction Strategy as the best available means of reducing ship strikes of right whales and are consistent with the changes proposed to vessel size in the recent proposed rule. As described in section 3.0 of this Opinion, between November 1 and April 30, all project vessels of all sizes transiting between all ports in NJ, VA, SC and the lease area/cable corridors, will be required to operate at 10 knots or less. Additionally, vessels of all sizes will be required to reduce speeds to 10 knots or less in any SMA or DMA, regardless of time of year. Most ship strikes have occurred at vessel speeds of 13-15 knots or greater (Jensen and Silber 2003; Laist et al. 2001). An analysis by Vanderlaan and Taggart (2006) showed that at speeds greater than 15 knots, the probability of a ship strike resulting in death increases asymptotically to 100%. At speeds below 11.8 knots, the probability decreases to less than 50%, and at ten knots or less, the probability is further reduced to approximately 30%. In rulemaking, NMFS has concluded, based on the best available scientific evidence, that a maximum speed of 10 knots, as measured as "speed over ground", in certain times and locations, is the most effective and practical approach to reducing the threat of ship strikes to right whales. Absent any information to the contrary, we assume that a 10-knot speed restriction similarly reduces the risk to other whale species. Substantial evidence (Laist et al., 2001; Jensen and Silber, 2003; Vanderlaan and Taggart, 2007; Kelley et al. 2020) indicates that vessel speed is an important factor affecting the likelihood and lethality of whale/vessel collisions. In a compilation of ship strikes of all large whale species that assessed ship speed as a factor in ship strikes, Laist et al. (2001) concluded that a direct relationship existed between the occurrence of a whale strike and the speed of the vessel. These authors indicated that most deaths occurred when a vessel was traveling at speeds of 14 knots or greater and that, as speeds declined below 14 knots, whales apparently had a greater opportunity to avoid oncoming vessels. Adding to the Laist et al. (2001) study, Jensen and Silber (2003) compiled 292 records of known or probable ship strikes of all large whale species from 1975 to 2002. Vessel speed at the time of the collision was reported for 58 of those cases; 85.5 percent of these strikes occurred at vessel speeds of 10 knots or greater. Effects of vessel speed on collision risks also have been studied using computer simulation models to assess hydrodynamic forces vessels have on a large whale (Knowlton et al., 1995; Knowlton et al., 1998). These studies found that, in certain instances, hydrodynamic forces around a vessel could act to pull a whale toward a ship. These forces increase with increasing speed and thus a whale's ability to avoid a ship in close quarters may be reduced with increasing vessel speed. Related studies by Clyne (1999) found that the number of simulated strikes with passing ships decreased with increasing vessel speeds, but that the number of strikes that occurred in the bow region increased with increasing vessel speeds. Additionally, vessel size has been shown to be less of a significant factor than speed, as biophysical modeling has demonstrated that vessels of all sizes can yield stresses likely to cause lethal injuries to large whales (Kelley et al. 2020). The speed reduction alone provides a significant reduction in risk of vessel strike as it both provides for greater opportunity for a whale to evade the vessel but also ensures that vessels are operating at such a speed that they can make evasive maneuvers in time to avoid a collision.

A number of measures will be in place to maximize the likelihood that during all times of the year and in all weather conditions that if whale is in the vicinity of a project vessel that the whale is detected, the captain can be notified and measures taken to avoid a strike (such as slowing down further and/or altering course). Although some of these measures have been developed to specifically reduce risk of vessel strike with right whales, all of these measures are expected to provide the same protection for other large whales as well. These measures apply regardless of the length of the transit and include dedicated PSOs or lookouts on all Project vessels during all phases to monitor the vessel strike avoidance zone and requirements to slow down less than 10 knots if a whale is spotted, alternative visual detection systems (e.g., thermal cameras) stationed on all transiting vessels that intend to operate at greater than 10 knots, and additional measures as outlined in Section 3. These measures are meant to increase earlier detection of whale presence and subsequently further increase time available to avoid a strike. Awareness of right whales in the area will also be enhanced through monitoring of reports on USCG Channel 16, communication between project vessel operators of any sightings, and monitoring of the NMFS Right Whale Sightings Advisory System.

Here, we explain how these measures support our determination that any hypothetical increase in vessel strike will not occur. . Many of these measures are centered on vessel speed restrictions and increased monitoring. To avoid a vessel strike, a vessel operator both needs to be able to detect a whale and be able to slow down or move out of the way in time to avoid collision. The speed limits and monitoring measures that are part of the proposed action maximize the opportunity for detection and avoidance.

Vessel speed restrictions:
As outlined in the BA, with the exception of crew transport vessels and some other support vessels, project vessels will normally transit at 10 knots or less. From November 1 – April 30, all project vessels, regardless of size, will be required to travel at speeds less than 10 knots:

when traveling between the WDA and ports in NJ, VA, and SC; and within any SMA or DMA/Slow Zone. The November – April period is the time of year when right whales are most likely to occur in the area transited by project vessels and covers the months when density is highest.

As described in section 3, BOEM and NMFS OPR are proposing to require that in order for vessels traveling between the lease area and the O&M facility in Atlantic City to go over 10 knots, a PAM system must be deployed in the transit corridor. Specifically, in the transit corridor (see figure below) and the lease area a semi-permanent acoustic network comprising near real-time bottom mounted and/or mobile acoustic monitoring platforms will be installed such that confirmed right whale detections are regularly transmitted to a central information portal and disseminated through the situational awareness network. The transit corridor and Offshore Wind Area will be divided into detection action zones; localized detections of right whales 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. This condition would apply to areas or times of year not already covered by the speed reduction requirements in place for SMAs and DMAs.

Vessels would also be required to slow to 10 knots or less any time a large whale (any species) is observed within 500 m of a vessel. All vessels, regardless of size, would immediately reduce speed to 10 kts or less when a North Atlantic right whale is sighted, at any distance, by an observer or anyone else on the vessel.

By reducing speeds below 10 knots, the probability of a lethal ship strike is greatly reduced; additionally, reduced speeds provide greater time to react if a PSO/lookout observes an animal in the path of a vessel and therefore reduces the likelihood of any strike occurring at all. With the exception of the CTVs and some support vessels, project vessels are expected to never, or rarely, operate at speeds over 10 knots (for a complete list of vessels and operating speeds see table 3.x). These measures presented below will be implemented for vessels that would otherwise travel at speeds above 10 knots.

Exceptions to 10 knot speed restriction:

Project vessels may travel at speeds greater than 10 knots at certain times of the year and in certain geographic areas. Project vessels may travel at speeds above 10 knots from May 1 – October 31 if the vessel is not transiting through a DMA/Slow Zone or a speed restriction has not been triggered by PAM detections. The period of time and areas when vessels can travel at speeds greater than 10 knots are at times when right whales are expected to occur in very low numbers and thus the risk of a vessel strike is significantly lower. Additionally, travel above 10 knots will only occur in areas with PAM monitoring (as described above). In all instances, PSOs/lookouts will be monitoring a vessel strike zone, see below.

PSOs/Lookouts and Increased right whale awareness:

A number of measures will be required by BOEM and/or NMFS OPR to increase awareness and detectability of whales. Vessel operators and crews will receive protected species identification training that covers species identification as well as making observations in good and bad weather. All vessel operators and crews must maintain a vigilant watch for all marine mammals and slow down, stop their vessel, or alter course (as appropriate) and regardless of vessel size, to avoid striking any marine mammal. During any vessel transits within or to/from the Ocean Wind project area, such as for crew transfers), an observer would be stationed at the best vantage point of the vessel(s) to ensure that the vessel(s) are maintaining the appropriate separation distance from marine mammals. A PSO or crew lookout must be posted during all times a vessel is underway (transiting or surveying) to monitor for listed species. During the vessel transit, these lookouts will have no other duty than to monitor for listed species and if one is sighted, communicate to the vessel captain to slow down and take measures to avoid the sighted animal. Visual observers will also be equipped with alternative monitoring technology for periods of low visibility (e.g., darkness, rain, fog, etc.). At all times the lookout will be monitoring for presence of whales and ensuring that the vessel stays at least 500 m away from any right whale or unidentified large whale. If any whale is detected within 500 m of the vessel, speed will be reduced to less than 10 knots; if any right whale is observed within any distance from the vessel, speed will be reduced to less than 10 knots.

Year-round, all vessel operators will monitor the project's Situational Awareness System, WhaleAlert, US Coast Guard VHF Channel 16, and the Right Whale Sighting Advisory System (RWSAS) for the presence of North Atlantic right whales once every 4-hour shift during project-related activities. The PSO and PAM operator monitoring teams for all activities will also monitor these systems no less than every 12 hours. If a vessel operator is alerted to a North Atlantic right whale detection within the project area, they will immediately convey this information to the PSO and PAM teams. All vessel operators must check for information regarding mandatory or voluntary ship strike avoidance (DMAs/Slow Zones and SMAs) and daily information regarding right whale sighting locations. Active monitoring of right whale sightings information provides situational awareness for monitoring of right whales in the area of vessel activities.

PAM:
As noted above, outside of DMAs, SMAs, and the November 1 through April 30 period, localized detections of North Atlantic right whales, using real-time PAM in the lease to Atlantic City transit corridor, would trigger a vessel slow-down to 10 knots or less in the area of detection (zone) for the following 12 hours. Each subsequent detection would trigger a 12-hr reset. A slow-down in that zone expires when there has been no further visual or acoustic detection in the past 12 hours within the triggered zone. This increases detectability beyond the area that an observer can see and enhances the effectiveness of required vessel avoidance measures.

In summary, we expect that despite the increase in vessel traffic that will result from the proposed action, the multi-faceted measures that will be required of all Project vessels will enable the detection of any ESA-listed whale that may be in the path of a Project vessel with enough time to allow for vessel operators to avoid any such whales. Combined with the already very low increased risk of vessel strike anticipated due to increased project vessel traffic, we expect that these measures will make it extremely unlikely that a Project vessel will strike a whale.

Effects of Foreign Vessel Transits (Project Site to Europe)
Due to project component and vessel availability, cable and/or WTG components and related vessels may transit from Europe to the lease area and/or cable corridor. These vessels will be specialized construction vessels and cargo vessels, during transit these vessels may travel up to 10 knots. Ports in Europe are unidentified at this time, but based on the location of major wind industry suppliers, we anticipate that any vessels would transit from ports in western Europe along the Atlantic coast.

Project vessels will represent an extremely small portion of the vessel traffic traveling to and from the U.S. Atlantic coast and foreign ports. Current vessel traffic between the U.S. and Europe is predominantly tankers, container ships, and passenger vessels, which are similar ships in size and speed to the ones that will be used during the construction phase of the project. In this portion of the action area, co-occurrence of project vessels and individual whales is expected to be extremely unlikely; this is due to the dispersed nature of whales in the open ocean and the only intermittent presence of project vessels. Given that these vessels will be in compliance with measures that NMFS has determined minimize the potential for ship strike (i.e., operating at 10 knots or less) and given the extremely small increase in vessel traffic in this portion of the action area that these vessels will represent, this makes it extremely unlikely that any ESA-listed whales will be struck by a project vessel.

Effects of Vessel Transits to Norfolk and Charleston
Ocean Wind 1 anticipates up to 99 vessel trips to Norfolk and/or up to 346 trips to Charleston over the 2.5-year construction phase of the project. As described in Section 6, ESA-listed whales occur in this area in varying distribution and abundance throughout the year. North Atlantic right whales occur in the area along coastal waters as they migrate through the Mid-Atlantic to the Southeast calving grounds, primarily in the fall and early spring. Fin whales most commonly occur throughout the year in offshore waters of the northern Mid-Atlantic. Sei whales typically are found offshore along the shelf break throughout the year, primarily in northern Mid-Atlantic waters. Sperm whales along the Mid-Atlantic and the Gulf of Mexico are found offshore along the shelf break year-round. Blue whales do not regularly occur within the U.S. EEZ and typically are found further offshore in areas with depths of 100 m or more. In general, ESA-listed whales are expected to be highly dispersed in deeper offshore waters and, given the large area over which Project vessels could potentially transit, the likelihood of co-occurrence is low in offshore waters.

As explained above, over 74,000 vessel transits a year occur in the area surrounding the WDA. Given the presence of large ports in the South Atlantic, we expect similar levels of baseline vessel traffic along the coast south of Delaware Bay to Charleston (i.e., over 74,000 transits within the area annually). Considering the potential trips to Norfolk and Charleston, this would be an increase in vessel traffic of no more than 0.24% in that 2.5-year period. Additionally, the multi-faceted measures, including 10-knot speed restrictions for vessels traveling to/from these ports in the November – April period, will enable the detection of any ESA-listed whale that may be in the path of a Project vessel with enough time to allow vessel operators to avoid any such whales. We expect that these measures will make it extremely unlikely that a Project vessel will strike a whale.

In summary, while there is an increase in risk of vessel strike during all phases of the proposed project due to the increase in vessel traffic, because of the measures that will be in place, particularly the vessel speed restrictions and use of enhanced monitoring measures, we do not expect that this increase in risk will result in a vessel strike caused by the action. Based on the best available information on the risk factors associated with vessel strikes of large whales (i.e., vessel size and vessel speed), and the measures required to reduce risk, it is extremely unlikely that any project vessel will strike a right, fin, sei, blue, or sperm whale during any phase of the proposed project.

7.2.3.3 Sea Turtles

Background Information on the Risk of Vessel Strike to Sea Turtles

While research is limited on the relationship between sea turtles, ship collisions, and ship speeds, sea turtles are at risk of vessel strike where they co-occur with vessels. Sea turtles are vulnerable to vessel collisions because they regularly surface to breathe, and often rest at or near the surface. 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). Although, Hazel et al. (2007) demonstrated sea turtles preferred to stay within the three meters of the water's surface, despite deeper water being available. Any of the sea turtle species found in the action area can occur at or near the surface in open-ocean and coastal areas, whether resting, feeding or periodically surfacing to breathe. Therefore, all ESA-listed sea turtles considered in the biological opinion are at risk of vessel strikes.

A sea turtle's detection of a vessel is likely based primarily on the animal's ability to see the oncoming vessel, which would provide less time to react to as vessel speed increases (Hazel et al. 2007), however, given the low vantage point of a sea turtle at the surface it is unlikely they are readily able to visually detect vessels at a distance. Hazel et al. (2007) examined vessel strike risk to green sea turtles and suggested that sea turtles may habituate to vessel sound and are more likely to respond to the sight of a vessel rather than the sound of a vessel, although both may play a role in eliciting responses (Hazel et al. 2007). Regardless of what specific stressor associated with vessels turtles are responding to, they only appear to show responses (avoidance behavior) at approximately 10 m or closer (Hazel et al. 2007). This is a concern because faster vessel speeds also have the potential to result in more serious injuries (Work et al. 2010). Although sea turtles can move quickly, Hazel et al. (2007) concluded that at vessel speeds above 4 km/hour (2.1 knots) vessel operators cannot rely on turtles to actively avoid being struck. Thus, sea turtles are not considered reliably capable of moving out of the way of vessels moving at speeds greater than 2.1 knots.

Stranding networks that keep track of sea turtles that wash up dead or injured have consistently recorded vessel propeller strikes, skeg strikes, and blunt force trauma as a cause or possible cause of death (Chaloupka et al. 2008). Vessel strikes can cause permanent injury or death from bleeding or other trauma, paralysis and subsequent drowning, infection, or inability to feed.

Apart from the severity of the physical strike, the likelihood and rate of a turtle's recovery from a strike may be influenced by its age, reproductive state, and general condition at the time of injury. Much of what has been documented about recovery from vessel strikes on sea turtles has been inferred from observation of individual animals for some duration of time after a strike occurs (Hazel et al. 2007; Lutcavage et al. 1997). In the U.S., the percentage of strandings that were attributed to vessel strikes increased from approximately 10 percent in the 1980s to a record high of 20.5 percent in 2004 (USFWS 2007). In 1990, the National Research Council estimated that 50-500 loggerhead and 5-50 Kemp's ridley sea turtles were struck and killed by boats annually in waters of the U.S. (NRC 1990). The report indicates that this estimate is highly uncertain and could be a large overestimate or underestimate.

Vessel strike has been identified as a threat in recovery plans prepared for all sea turtle species in the action area. As described in the Recovery Plan for loggerhead sea turtles (NMFS and USFWS 2008), propeller and collision injuries from boats and ships are common in sea turtles. From 1997 to 2005, 14.9% of all stranded loggerheads in the U.S. Atlantic and Gulf of Mexico were documented as having sustained some type of propeller or collision injuries although it is not known what proportion of these injuries were post or ante-mortem. The proportion of vessel-struck sea turtles that survive is unknown. In some cases, it is not possible to determine whether documented injuries on stranded animals resulted in death or were post-mortem injuries. However, the available data indicate that post-mortem vessel strike injuries are uncommon in stranded sea turtles. Based on data from off the coast of Florida, there is good evidence that when vessel strike injuries are observed as the principle finding for a stranded turtle, the injuries were both ante-mortem and the cause of death (Foley et al 2019). Foley et al. (2019) found that the cause of death was vessel strike or probable vessel strike in approximately 93% of stranded turtles with vessel strike injuries. Sea turtles found alive with concussive or propeller injuries are frequently brought to rehabilitation facilities; some are later released and others are deemed unfit to return to the wild and remain in captivity. Sea turtles in the wild have been documented with healed injuries so at least some sea turtles survive without human intervention. As noted in NRC 1990, the regions of greatest concern for vessel strike are outside the action area and include areas with high concentrations of recreational-boat traffic such as the eastern Florida coast, the Florida Keys, and the shallow coastal bays in the Gulf of Mexico. In general, the overall risk of strike for sea turtles in the Northwest Atlantic is considered greatest in areas with high densities of sea turtles and small, fast moving vessels such as recreational vessels (NRC 1990). This combination of factors in the action area is limited to nearshore areas in the southern extent of the action area, well outside the lease area and the transit routes to Atlantic City where the vast majority of vessel traffic will occur.

Exposure Analysis – Sea Turtles

We consider vessel strike of ESA-listed sea turtles in the context of specific project phases because the characteristics and volume of vessel traffic is distinctly different during the three phases of the project. As described above, vessels trips between the project site (i.e., the lease area and the cable corridors) and ports in NJ, Virginia, and/or South Carolina, as well as Europe will occur during the construction phase; at least 79% of vessel transits during the construction phase will be between the lease area and the O&M facility in Atlantic City, NJ. During the operations phase, all vessel traffic will be between the lease area/cable corridors and the Atlantic City O&M facility.

Transits in the Lease Area, Cable Corridor and to/from Ports in NJ
Here we consider the risk of vessel strike to sea turtles from project vessels transiting between the lease area/cable corridors and the identified ports in New Jersey. We queried the NMFS' Sea Turtle Stranding and Salvage Network (STSSN) database for records of sea turtles with injuries consistent with vessel strike (recorded as definitive vessel and blunt force trauma in the database) in New Jersey and Delaware from 2013 to 2022. We selected this geographic area as it represents the waters that will be transited by project vessels traveling to/from the lease area/cable corridors and the ports identified in NJ, inclusive of those in Delaware River/Bay and the O&M facility in Atlantic City. The results from this query are presented in Table 7.2.4.

While we recognize that some vessel strikes may be post-mortem, the available data indicate that post-mortem vessel strike injuries are uncommon in stranded sea turtles (Foley et al. 2019). Out of the 747 reported sea turtle stranding cases (excluding cold stuns) in the NJ and DE region during the 10-year time period (2013-2022) of data, there were 210 records of sea turtles recovered with definitive evidence from vessel strikes. In addition, there were 106 sea turtles with evidence from blunt force trauma, which indicates probable vessel collision. As anticipated based on abundance of turtle species in the area, the majority of these records are of loggerhead sea turtles.

Based on the findings of Foley et al. (2019) that found vessel strike was the cause of death in 93% of strandings with indications of vessel strike, to estimate the number of interactions where vessel strike was the cause of death we first added the number of "definitive vessel" and "blunt force trauma" cases and then calculated 93% of the total (e.g., for loggerheads in Delaware, we first added the "definitive vessel" (70) and "blunt force trauma" (41) then multiplied that value (111) by 0.93 (=103)).

Table 7.2.4. Preliminary STSSN cases from 2013 to 2022 with evidence of propeller strike or probable vessel collision in Delaware and New Jersey and estimated presumed vessel mortalities. Source STSSN **(March 2023)**

Delaware

Sea Turtles	**Total Records**	**Definitive Vessel**	**Blunt Force Trauma**	**Total Presumed Vessel Mortalities ***
Loggerhead	217	70	41	111
Green	9	2	3	5
Leatherback	15	9	3	11
Kemp's	28	10	9	18

*93% of the total vessel plus blunt force trauma

New Jersey

Sea Turtles	Total Records	Definitive Vessel	Blunt Force Trauma	Total Presumed Vessel Mortalities *
Loggerhead	344	85	41	117
Green	29	12	1	12
Leatherback	32	11	1	11
Kemp’s	35	7	6	12

*93% of the total vessel plus blunt force trauma

The data in Table 7.2.4 are only based on observed stranding records, which represent only a portion of the total at-sea mortalities of sea turtles. Sea turtle carcasses typically sink upon death, and float to the surface only when enough accumulation of decomposition gasses cause the body to bloat (Epperly et al., 1996). Though floating, the body is still partially submerged and acts as a drifting object. The drift of a sea turtle carcass depends on the direction and intensity of local currents and winds. As sea turtles are vulnerable to human interactions such as fisheries bycatch and vessel strike, a number of studies have estimated at-sea mortality of marine turtles and the influence of nearshore physical oceanographic and wind regimes on sea turtle strandings. Although sea turtle stranding rates are variable, they may represent as low as five percent of total mortalities in some areas but usually do not exceed 20 percent of total mortality, as predators, scavengers, wind, and currents prevent carcasses from reaching the shore (Koch et al. 2013). Strandings of dead sea turtles from fishery interaction have been reported to represent as low as seven percent of total mortalities caused at sea (Epperly et al. 1996). Remote or difficult to access areas may further limit the amount of strandings that are observed. Because of the low probability of stranding under different conditions, determining total vessel strikes directly from raw numbers of stranded sea turtle data would vary between regions, seasons, and other factors such as currents.

To estimate unobserved vessel strike mortalities, we relied on available estimates from the literature. Based on data reviewed in Murphy and Hopkins-Murphy (1989), only six of 22 loggerhead sea turtle carcasses tagged within the South Atlantic and Gulf of Mexico region were reported in stranding records, indicating that stranding data represent approximately 27 percent of at-sea mortalities. In comparing estimates of at-sea fisheries induced mortalities to estimates of stranded sea turtle mortalities due to fisheries, Epperly et al. (1996) estimated that strandings represented 7 to13 percent of all at-sea mortalities.

Based on these two studies, both of which include waters of the U.S. East Coast, stranding data likely represent 7 to 27 percent of all at-sea mortalities. While there are additional estimates of the percent of at-sea mortalities likely to be observed in stranding data for locations outside the action area (e.g., Peckham et al. 2008, Koch et al. 2013), we did not rely on these since stranding rates depend heavily on beach survey effort, current patterns, weather, and seasonal factors among others, and these factors vary greatly with geographic location (Hart et al. 2006). Thus, based on the mid-point between the lower estimate provided by Epperly et al. (1996) of seven percent, and the upper estimate provided by Murphy and Hopkins-Murphy (1989) of 27 percent, we assume that the STSSN stranding data represent approximately 17 percent of all at sea mortalities. This estimate closely aligns with an analysis of drift bottle data from the Atlantic Ocean by Hart et al. (2006), which estimated that the upper limit of the proportion of sea turtle carcasses that strand is approximately 20 percent.

To estimate the annual average vessel strike mortalities corrected for unobserved vessel strike mortalities, we adjusted our calculated total presumed vessel mortality with the detection value of 17%. The resulting, adjusted number of vessel strike mortalities of each species for New Jersey and Delaware are below. In using the 17 percent correction factor, we assume that all sea turtle species and at-sea mortalities are equally likely to be represented in the STSSN dataset. That is, sea turtles killed by vessel strikes are just as likely to strand or be observed at sea and be recorded in the STSSN database (i.e., 17 percent) as those killed by other activities, such as interactions with fisheries, and the likelihood of stranding once injured or killed does not vary by species.

Delaware

Sea Turtles	**Presumed Vessel Mortalities***	**Total (17% detection rate)**	**Annual Total presumed vessel mortalities**
Loggerhead	103	606	30
Green	5	29	1
Leatherback	11	65	3
Kemp's ridley	18	106	5

New Jersey

Sea Turtles	**Presumed Vessel Mortalities***	**Total (17% detection rate)**	**Annual Total presumed vessel mortalities**
Loggerhead	117	688	34
Green	12	71	4
Leatherback	11	65	3
Kemp's ridley	12	71	4

Finally, assuming a proportional relationship between vessel strikes and vessel traffic, we considered the phase-specific increase in vessel traffic and increased the number of baseline strikes to account for the increase in project vessel traffic. During the construction and decommissioning periods, we used a combination of the Delaware and New Jersey data as this best represents the area where vessels will be transiting between the lease area/cable corridors and the ports in NJ, including those in Delaware River/Bay and Atlantic City. Thus, the formula used to generate the estimate of project vessel strikes over the construction and decommissioning periods is: (annual DE and NJ baseline strikes)(% increase in traffic)(years of project phase). Operation = 4.5 - 5.0% increase in traffic for 35 years

Construction = 1.4% increase in traffic for 2.5 years

Loggerhead sea turtles: (64)(0.014)(2.5) = 2.24 loggerhead sea turtles

Green sea turtles: (5)(0.014)(2.5) = 0.175 green sea turtles

Leatherback sea turtles: (6)(0.014)(2.5) = 0.21 leatherback sea turtles

Kemp's Ridley sea turtles: (9)(0.014)(2.5) = 0.315

Decommissioning = 0.16% increase in traffic for 2 years

Loggerhead sea turtles: (64)(0.0016)(2) = 0.2048 loggerhead sea turtles

Green sea turtles: (5)(0.0016)(2) = 0.016 green sea turtles

Leatherback sea turtles: (6)(0.0016)(2) = 0.0192 leatherback sea turtles

Kemp's Ridley sea turtles: (9)(0.0016)(2) = 0.0288

During the operations period, all vessel transits will be between Atlantic City and the lease area/cable corridors. Thus, we only used the data from New Jersey as using Delaware and New Jersey would go beyond the geographic area where these trips will occur. Even using the New Jersey data likely overestimates the risk of vessel strike; the area between the lease and Atlantic City that could be transited by project vessels represents about 10% of the New Jersey coastline. Thus, we have considered that 10% of the total vessel strikes of sea turtles in New Jersey would occur in this area. The formula used to generate the estimate of project vessel strikes over the operational period is (10% annual NJ baseline strikes)(% increase in traffic)(years of project phase).

Operation = 4.5 - 5.0% increase in traffic for 35 years

Loggerhead sea turtles: (3.4)(0.05)(35) = 5.95 loggerhead sea turtles

Green sea turtles: (0.4)(0.05)(35) = 0.7 green sea turtles

Leatherback sea turtles: (0.3)(0.05)(35) = 0.525 leatherback sea turtles

Kemp's Ridley sea turtles: (0.4)(0.05)(35) = 0.7 Kemp's Ridley sea turtles

As explained above in section 7.2.3, Ocean Wind 1 is proposing to take and/or BOEM is proposing to require a number of measures designed to minimize the potential for strike of a protected species that will be implemented over the life of the project. These include reductions in speed in certain areas, including certain times of the year to minimize the risk of vessel strike of large whales, the use of look outs, slowing down if a sea turtle is sighted within 100 m of the operating vessel's forward path and if a sea turtle is sighted within 50 m of the forward path of the operating vessel, the vessel operator must shift to neutral when safe to do so and then proceed away from the individual at a speed of 4 knots or less, and seasonally avoiding transiting through areas of visible jellyfish aggregations or floating vegetation (e.g., sargassum lines or mats). While we expect that these measures will help to reduce the risk of vessel strike of sea turtles, individual sea turtles can be difficult to spot from a moving vessel at a sufficient distance to avoid strike due to their low-lying appearance. With this information in mind, we expect that the risk reduction measures that are part of the proposed action will reduce collision risk overall but will not eliminate that risk. We are not able to quantify any reduction in risk that may be realized and expect that any reduction in risk may be small.

To determine the likely total number of sea turtles that will be struck by project vessels, we have added up the numbers for each phase then rounded up to whole animals. As such, based on our analysis, the proposed action is expected to result in vessel strike of sea turtles identified in Table 7.2.5 below:

Table 7.2.5. Estimate of sea turtle vessel strikes as a result of the proposed action.

Species	**Vessel Strike**
NWA DPS Loggerhead sea turtle	9
NA DPS green sea turtle	1
Leatherback sea turtle	1
Kemp's ridley sea turtle	1

While not all strikes of sea turtles are lethal, we have no way of predicting what proportion of strikes will be lethal and what proportion will result in recoverable injury. As such, for the purposes of this analysis, we are assuming that all strikes will result in serious injury or mortality.

Effects of Foreign Vessel Transits (Project Site to Europe)

Due to project component and vessel availability, WTG and/or cable components and related vessels will transit from Europe to the lease area. These vessels will be specialized construction vessels and cargo vessels, during transit these vessels may travel up to 10 knots (Table 1-5 in BOEM's BA). BOEM has indicated that during the entire 2.5-year construction period there may be up to 495 vessel transits between the lease area/cable corridor and ports in Europe to transport project components. Ports in Europe are unidentified at this time, but based on the location of major wind industry suppliers, we anticipate that any vessels would transit from ports in Western Europe along the Atlantic coast.

Project vessels will represent an extremely small portion of the vessel traffic traveling to and from foreign ports. Current vessel traffic between the U.S. and Europe is predominantly tankers, container ships, and passenger vessels, which are similar ships in size and speed to the ones that will be used during the construction phase of the project. There are tens of thousands of vessel transits in the Atlantic between the U.S. and Europe annually. In this portion of the action area, co-occurrence of project vessels and individual sea turtles is expected to be extremely unlikely; this is due to overall low abundance of sea turtles in this portion of the action area, the dispersed nature of sea turtles in the open ocean, and the only intermittent presence of project vessels. Based on this, it is extremely unlikely that any sea turtles will occur along the vessel transit route at the same time that a project vessel is moving through the area. Together, this makes it extremely unlikely that any ESA-listed sea turtles will be struck by a project vessel.

Effects of Vessel Transits to Norfolk and Charleston
In the BA, BOEM indicates that there may be up to 99 total round vessel trips to the Port of Norfolk, VA during the construction phase and up to 346 total round vessel trips to Charleston, SC during the construction phase. These trips will occur over a 2.5-year period. Sea turtles are expected to be highly dispersed in deeper offshore waters and, given the large area over which Project vessels could potentially transit, the likelihood of co-occurrence is low in deeper offshore waters. Project vessels have the greatest chance to co-occur with sea turtles in the nearshore waters, near major ports, or in the shipping lanes. As explained above, over 74,000 vessel transits a year occur in the area within 40 nm of the lease. Given the presence of large ports in the South Atlantic, we expect similar levels of baseline vessel traffic along the coast south of Delaware Bay to Charleston (i.e., over 74,000 transits within the area annually). Considering the potential trips to Norfolk and Charleston, this would be an increase in vessel traffic of no more than 0.24% in that 2.5-year period. Based on this analysis, given the very small increase in vessel traffic and associated very small increase in subsequent risk, effects of this increase in traffic resulting in vessel strikes of sea turtles is extremely unlikely and the effect of adding the vessels to the baseline cannot be meaningfully measured, detected, or evaluated; therefore, effects are also insignificant.

7.2.3.4 Consideration of Potential Shifts in Vessel Traffic
Here, we consider how the proposed project may result in shifts or displacement of existing vessel traffic. As presented in the Navigational Risk Assessment ("NRA;" see COP Appendix M), the proposed WTG spacing is sufficient to allow the passage of vessels between the WTGs, and the directional trends of the vessel data are roughly in-line with the direction of the rows of WTGs as currently designed. However, transit through the lease area will be a matter of risk tolerance, and up to the individual vessel operators. While the presence of the WTGs and OSS will not result in any requirements to reroute vessel traffic, it is possible that it will result in changes to vessel routes due to operator preferences and risk tolerances.

Based on AIS and other data presented in the NRA, vessel traffic in the lease area is primarily recreational vessels and fishing vessels, which transit the area in non-uniform patterns. Most deep draft (cargo/carriers and tankers) in the vicinity of the least area take a route that passes to the east, but a fraction pass through the lease area while transiting between the Ambrose to Barnegat Traffic Lane and the Five Fathom Bank to Cape Henlopen Traffic Lane. Commercial fishing vessel traffic is also greater outside the lease than inside the lease area. Cruise ships and large ferries follow established routes to the east of the lease area en route to/from the Ambrose/Barnegat traffic lanes to the north of the lease area. Recreational boating activity is also greater in the nearshore waters to the west of the lease area than in the lease area itself. Most tug traffic near the lease area occurs between the lease area and the coast. In general, traffic is significantly higher in the summer and lowest in the winter.

In the NRA, Ocean Wind anticipates that fishing and pleasure boat traffic will continue through the lease area following construction while deep draft ships (e.g., cargo/carrier, tankers, cruise ships) may route around to the east of the project (a more oceanward route) while tug/service vessels may modify routes around the project towards the west (coastal rates). Given that the vast majority of traffic in the lease area is already recreational and fishing vessels and that any changes in vessel transit routes for these categories of vessels are likely to be very small, if there are any changes at all, we expect the effects of any shifts to be so small that they cannot be meaningfully measured, evaluated, or detected. Similarly, as primary traffic routes for other vessel types are also nearly all outside the lease area we expect any shifts in traffic to be very limited in scope. This small potential shift in traffic does not increase the risk of interaction with listed species as densities of listed species are not incrementally higher on the edges of the lease area where vessel traffic would theoretically shift to. As such, even if there is a shift in vessel traffic outside of the lease area or any other change in traffic patterns due to the construction and operation of the project, any effects to listed species would be so small that they would not be able to be meaningfully measured, evaluated, or detected and are therefore, insignificant.

7.2.4 Air Emissions Regulated by the OCS Air Permit

Ocean Wind has applied for an OCS Air Permit from the EPA. To date, EPA has not issued a proposed or draft OCS air permit. As described by EPA, the Outer Continental Shelf (OCS) Air Regulations, found at 40 CFR part 55, establish the applicable air pollution control requirements, including provisions related to permitting, monitoring, reporting, fees, compliance, and enforcement, for facilities subject to the Clean Air Act (CAA) section 328. Applicants within 25 nautical miles of a state seaward boundary are required to comply with the air quality requirements of the nearest or corresponding onshore area, including applicable permitting requirements. Applicants located beyond 25 nautical miles from the state seaward boundary are subject to federal air quality requirements and will likely need an OCS permit complying with the EPA's Prevention of Significant Deterioration (PSD) preconstruction permit program, and/or Part 71 Title V operating permit program requirements, and are subject to New Source Performance Standards and some standards for Hazardous Air Pollutants promulgated under section 112 of the CAA.

The "potential to emit" for Ocean Wind OCS source's includes emissions from vessels installing the WTGs and the Offshore Substation (OSS), engines on the WTGs and OSS, as well as vessels that are at and are traveling within 25 miles to-and-from the windfarm during construction, operations and maintenance of the windfarm. Criteria air pollutant emissions and their precursors generated from the construction and operation of the windfarm include nitrogen oxides, carbon monoxide, sulfur dioxide, particulate matter, and volatile organic compounds.

These air pollutants are associated with the combustion of diesel fuel in a vessel's propulsion and auxiliary engines and the engine(s) located on WTGs and OSS. The BA notes that Ocean Wind must demonstrate compliance with the national ambient air quality standards (NAAQS). The NAAQS are health-based standards that the EPA sets to protect public health with an adequate margin of safety. Prevention of significant deterioration (PSD) increments. The PSD increments are designed to ensure that air quality in an area that meets the NAAQS does not significantly deteriorate from baseline levels.

In the BA, BOEM determined that the impact from air pollutant emissions is anticipated to be minor and short-term in nature. They determine that because EPA will require compliance with the NAAQS and the NAAQS are designed to ensure that air quality does not significantly deteriorate from baseline levels, it is reasonable to conclude that any effects to listed species from these emissions will be so small that they cannot be meaningfully measured, detected, or evaluated and, therefore, are insignificant. At this time, there is no information on the effects of air quality on listed species that may occur in the action area. However, as the NAAQS and PSD increments are designed to ensure that air quality in the area regulated by the permit do not significantly deteriorate from baseline levels, it is reasonable to conclude that any effects to listed species from these emissions will be so small that they cannot be meaningfully measured, detected, or evaluated and, therefore, are insignificant. Reinitiation of consultation may be required if permit terms and/or effects are likely to be different than anticipated.

7.3 Effects to Species during Construction

Here, we consider the effects of the proposed action on listed species from exposure of species to stressors as well as alterations or disruptions to habitat and environmental conditions caused by project activities during the construction phase of the project. Specifically, we address dredging to facilitate construction, vessel access, inter-array and export cable installation including sand wave clearance, turbidity resulting from project activities including dredging, cable installation, pile driving, and installation of scour protection to support installation of the wind turbine generators and offshore substations, project lighting during construction, and seabed disturbance from potential UXO detonations. Noise associated with these activities is discussed in section 7.1; associated vessel activities are discussed in section 7.2.

7.3.1 Dredging for Vessel Access in Barnegat Bay, NJ

Prior to export cable installation, dredging may be required in Barnegat Bay to facilitate vessel access in an area identified west of Island Beach State Park and near the landfall sites in Lacey or Ocean Townships. Dredging would occur in the Oyster Creek Federal Channel within the authorized 200-foot width and 8-foot depth to allow for safe and reliable passage of construction vessels into Barnegat Bay; this dredging will only occur if the channel has not been dredged to its authorized depth and width by the USACE. The Oyster Creek Federal Channel in Barnegat Bay is part of the Barnegat Inlet Federal Navigation Project, operated and maintained by the USACE. Ocean Wind 1 has coordinated with the USACE Philadelphia District regarding current channel conditions and planned maintenance dredging. If necessary, dredging of approximately 18,000 cubic yards within a 3.7-acre area will be conducted using a hydraulic cutterhead or closed-clamshell dredge. The dredged material will be transferred to an upland disposal facility via a pipeline system, barge, or scow. Disposal of dredged material will be in accordance with EPA guidelines, USACE guidelines, N.J.A.C. 7:7 Appendix G for the

Management and Regulation of Dredging Activities and Dredged Material in New Jersey's Tidal Waters, and applicable State Surface Water Quality Standards at N.J.A.C. 7:9B and permit conditions. No effects to ESA listed species are anticipated from upland disposal of dredged material.

Hydraulic Cutterhead Dredging
Here, we consider effects to listed species of using a cutterhead dredge in the Oyster Creek Federal Channel. ESA listed whales are not known to occur in Barnegat Bay and thus would not be exposed to any effects of this dredging.

The State of New Jersey carried out studies to characterize fisheries in the Barnegat Bay watershed in 2012, 2013, and 2014 by sampling fish and blue crabs of varying age classes via trawling, nets, and traps at stations both inside creeks and out in Barnegat Bay across seasons. This effort included sampling stations within the Bay and within Forked River and Oyster Creek. Despite using sampling gear that Atlantic sturgeon would be susceptible to capture in (otter trawl and gill net), no Atlantic sturgeon were captured (Able et al., 2012, 2013, and 2014). We are not aware of any reports of Atlantic sturgeon in Barnegat Bay. Based on the best available information, we expect that the use of Barnegat Bay would be limited to rare, transient individuals.

Loggerhead, Kemp's ridley, green, and leatherback sea turtles are seasonally present in Barnegat Bay. If dredging occurred between the late spring and fall, sea turtles may be exposed to effects of the dredging.

A cutterhead dredge operates with the dredge head buried in the sediment; a flow field is produced by the suction of the operating dredge head. The amount of suction produced is dependent on linear flow rates inside the pipe and the pipe diameter (Clausner and Jones 2004). High flow rates and larger pipes create greater suction velocities and wider flow fields. The suction produced decreases exponentially with distance from the dredge head (Boysen and Hoover 2009). With a cutterhead dredge, material is pumped directly from the dredged area to a disposal site. The dredged material conducted during cutterhead dredging operations may be transferred to an upland disposal facility via a pipeline system, barge, or scow.

Sea Turtles
Sea turtles are not known to be vulnerable to capture in cutterhead dredges, presumably because they are able to avoid the dredge head, the dredge head is buried in the sediment, and the intake velocity surrounding the dredge head is low. Thus, if a sea turtle were to be present in the area where dredging was occurring, it would be extremely unlikely to be captured, injured, or killed as a result of dredging operations carried out by a cutterhead dredge. Based on this information, interactions between sea turtles and the cutterhead dredge are extremely unlikely to occur.

Atlantic Sturgeon
It is generally assumed that non-larval sturgeon (i.e., juveniles, sub-adults, and adults) are mobile enough to avoid the suction of an oncoming cutterhead dredge and that any sturgeon in the vicinity of such an operation would be able to avoid the intake and escape. An individual sturgeon would need to be in the immediate area where the dredge is operating to be entrained

(i.e., within one meter of the dredge head) for their even to be the potential for interaction with the draghead; as such, the overall risk of entrainment is low. Given the rarity of Atlantic sturgeon in Barnegat Bay, it is extremely unlikely that an Atlantic sturgeon would ever encounter the cutterhead dredge, as they would not occur within one meter of the dredge. Information from tracking studies in the James and Delaware River support this assessment of entrainment risk; during a number of studies of behavior of tagged Atlantic sturgeon in areas being actively dredged, none of the tagged sturgeon were attracted to or entrained in the operating of dredges and there was no evidence that the dredge impacted behavior (Balazik et al., 2020, Reine et al. 2014). Based on the information presented here, entrainment, injury, or mortality of any Atlantic sturgeon is extremely unlikely to occur.

Mechanical Dredging
Mechanical dredging entails lowering the open bucket or clamshell through the water column, closing the bucket after impact on the bottom, lifting the bucket up through the water column, and emptying the bucket into a barge or truck. The bucket operates without suction or hydraulic intake, moves relatively slowly through the water column, and impacts only a small area of the aquatic bottom at any time. In order to be captured in a dredge bucket, an animal must be on the bottom directly below the dredge bucket as it impacts the substrate and remain stationary as the bucket closes. Species captured in dredge buckets can be injured or killed if entrapped in the bucket or buried in sediment during dredging and/or when sediment is deposited into the dredge scow. Species captured and emptied out of the bucket can suffer stress or injury, which can lead to mortality.

Whales
As explained above, whales are not known to occur in Barnegat Bay. Due to their lack of presence in this area, there would be no effects on whales. Even if whales were present in the dredged area, they are far too large to be susceptible to entrapment by a mechanical dredge. As such, mechanical dredging will have no effect on whales, or at most interactions between the dredge and ESA-listed whales are extremely unlikely to occur.

Sea Turtles
Sea turtles may be present in the area to be mechanically dredged. However, they are not known to be vulnerable to capture in mechanical dredges, presumably because they are able to avoid the dredge bucket. Thus, if a sea turtle were to be present at the dredge sites, it would be extremely unlikely to be captured, injured, or killed as a result of dredging operations carried out by a mechanical dredge, because of the anticipated behavioral response. That response, however, would likely be short and the sea turtle would resume its normal behavior without fitness consequences once it perceived it was safe. Based on this information, interactions between sea turtles and the mechanical dredge causing adverse effects are extremely unlikely to occur. Any effects to individual sturgeon from avoiding the dredge bucket will be so small that they cannot be meaningfully measured, detected, or evaluated and are therefore insignificant.

Atlantic Sturgeon
The risk of interactions between sturgeon and mechanical dredges is considered very low but is thought to be highest in areas where large numbers of sturgeon are known to aggregate. The risk of capture may also be related to the behavior of the sturgeon in the area. While foraging,

sturgeon are at the bottom interacting with the sediment. This behavior may increase the susceptibility of capture with a dredge bucket. For entrapment to occur, an individual sturgeon would have to be present directly below the dredge bucket at the time of operation. Mechanical dredging is a common activity throughout the range of Atlantic sturgeon and very few interactions have ever been recorded. Given that dredging will not occur in areas where concentrations of sturgeon occur and the available information on use of the action area by sturgeon, the co-occurrence of an Atlantic sturgeon and the dredge bucket is extremely unlikely. As such, entrapment or any interactions with sturgeon causing adverse effects during the dredging operations is also extremely unlikely. Any effects to individual sturgeon from avoiding the dredge bucket will be so small that they cannot be meaningfully measured, detected, or evaluated and are therefore insignificant.

7.3.2 Cable Installation

A number of cables will be installed as part of the Ocean Wind 1 project. Activities associated with cable installation include seabed preparation and cable laying. Effects of these activities are described here.

The Ocean Wind 1 export cables include both offshore and onshore segments. Up to three 275-kV alternating current (AC) electric cables (installed within two export route corridors) will be located offshore and will connect the project to the mainland electric grid in Lacey Township, New Jersey, and Upper Township, New Jersey. In addition to the export cables, there will be two interconnector cables that connect the OSSs to each other. The offshore export cables and inter-array cables will be buried below the seabed surface within Federal waters and New Jersey State territorial waters. Two offshore export cable route corridors are identified in the COP: Oyster Creek and BL England. Approximately 384 miles (618 km) of in-water transmission cables will be installed. Ocean Wind 1 is proposing to simultaneously lay and bury cables at a speed of 1.9 miles (3 km) per day (410 feet/hour; 125 meters/hours; 0.125 km/hour) and post-lay burial speeds will be 0.6 miles (9.6 km) per day (1,312 feet/hour; 400 meters/hour), weather depending.

Up to two offshore export cables would be buried under the seabed within the Oyster Creek export cable route corridor and will make landfall and deliver electrical power to the Oyster Creek substation. The offshore export cable route corridor to Oyster Creek will begin within the Ocean Wind 1 Wind Farm Area and proceed northwest to the Atlantic Ocean side of Island Beach State Park with a maximum total length of 143 miles (230 km). The inshore export cable route corridor to Oyster Creek would extend north within parking lots, then northwest under Shore Road, and then west into the Bay side of Island Beach State Park before entering Barnegat Bay. Upon entering Barnegat Bay, the export cable route will run west within a previously dredged channel. Ocean Wind 1 is also proposing an alternative second cable route corridor that will extend directly across Island Beach State Park. Both routes will cross Barnegat Bay southwest to make landfall near Oyster Creek in either Lacey or Ocean Township. Additional detail on the export cable routes is provided in section 1.3.1 in the Ocean Wind 1 BA.

One offshore export cable will be buried under the seabed within the BL England export cable route corridor and will make landfall and deliver electrical power to the BL England substation. The BL England offshore export cable corridor will begin within the Ocean Wind 1 Wind Farm

Area and will proceed west to make landfall in Ocean City, New Jersey, with a maximum total cable length of 32 miles (51 km).

The inter-array cable will connect between WTGs and offshore substation interconnector cables within the Ocean Wind 1 Lease Area. The onshore export cable segments (overhead transmission lines) will connect to onshore substations and existing electric grids located in Berkeley, Lacey, Ocean, and Upper Townships, New Jersey, and Ocean City, New Jersey. Detailed specifications of offshore inter-array cables, export cables, and onshore cables are provided in Section 5.1.2 of the COP.

Ocean Wind 1 is proposing to lay the inter-array cable and offshore export cable using cable installation equipment that could include either a jetting tool (both jet ROV and/or jet sled), vertical injection, controlled-flow excavator, leveling, mechanical cutting, plowing (with or without jet-assistance), pre-trenching, and a backhoe dredger (OW1 COP, 2022; OW1 BA, 2022). The controlled-flow excavator is a tool that can be utilized in a variety of water depths and sediment types and functions by projecting a controlled flow of water to displace sediment in a localized area (OW1 BA, 2022). It is crane operated and hovers above the seabed to allow the controlled flow of water to target specific areas for sandwave clearance. Installation of the offshore cables may also include use of a displacement plow, which mechanically displaces materials from the trench so that the cable can be laid in the trench. In addition, inter-array and offshore export cables may be installed using a tool towed behind the installation vessel to simultaneously open the seabed and lay the cable, or by laying the cable and following with a tool to embed the cable (OW1 BA, 2022). The burial method will be dependent on suitable seabed conditions and sediments along the cable route. The installation methodologies for the inter-array cables and the offshore export cable are described in the COP in table 4.4-1 and section 5.1.2 respectively.

Prior to installation of the cables, HRG surveys and a pre-lay grapnel run (PLGR) would be performed to locate and clear obstructions such as abandoned fishing gear, boulders, UXOs and other marine debris. Following the PLGR, cable installation trials would occur to test that the installation equipment is working properly and is appropriate for the seabed conditions. In addition to clearing seabed obstructions, Ocean Wind 1 is proposing to level/clear sand waves along the cable routes. Effects of HRG surveys are addressed in section 7.1.

If seabed conditions do not permit burial of inter-array or export cables, Ocean Wind 1 is proposing to employ other methods of cable protection such as: (1) rock, (2) concrete mattresses, (3) frond mattresses, (4) rock bags, or (5) seabed spacers (OW1 BA, 2022). Cable inspection would be carried out to confirm the cable burial depth along the route and to identify the need for any further remedial burial activities and/or secondary cable protection. Details of the proposed cable protection measures are provided in Volume I, Section 6.1.2.6.3 of the COP. Ocean Wind 1 has conducted surveys to locate third-party infrastructure, such as existing cables that would be crossed by the Ocean Wind 1 export cable. Prior to cable installation over an existing live cable, Ocean Wind 1 is proposing to install a separation layer (typically three concrete mattresses) over each live cable crossing location. Ocean Wind 1 is developing a cable crossing agreement with third-party infrastructure owners.

The offshore export cables will connect with onshore export cables at transition joint bays (TJBs) with landfall sites located at BL England and Oyster Creek. Offshore export cables will be installed up to the transition joint bays by utilizing HDD or open cut trenching under the beach and intertidal water and will include temporary cofferdams. Sheet piles will be temporarily installed to support cofferdam installation during construction of HDD exit pits. The HDD installation involves excavation of an exit pit, drilling, and pumping drilling fluid to create a bore and then pulling conduit into the bore. The export cable is then pulled through the installed conduit. Installation methods being considered for each of the Oyster Creek export cable route landfall options in Barnegat Bay are listed below.

Table 7.3.1 Proposed Cable Installation Methods

Barnegat Bay Landfall Sites (Oyster Creek)	Installation Methods
IBSP Southern Route	HDD
IBSP Northern Route (Prior Channel)	Open cut trenching
Holtec/The Farm	HDD or open cut trenching
Bay Parkway One Shot	HDD or open cut trenching
Bay Parkway	HDD or open cut trenching
Nautilus Road	HDD or open cut trenching
Lighthouse Drive	HDD or open cut trenching
Marina	HDD or open cut trenching

7.3.2.1 Pre-lay Grapnel Run and Boulder Relocation

Prior to installation of the cables, a pre-lay grapnel run would be performed to locate and clear obstructions such as abandoned fishing gear, UXOs, and other marine debris. Additionally, large boulders that cannot be avoided would be relocated from the cable path. A combination of a displacement plow, subsea grab, or backhoe dredger may be used to clear boulders within cable route corridors. A displacement plow is being proposed to remove boulders that are located in dense patches along the cable routes. A displacement plow is a Y-shaped tool composed of a boulder board attached to a plow. The plow is pulled along the seabed and scrapes the seabed surface pushing boulders out of the cable corridor. Where appropriate, a boulder grab tool deployed from a DP vessel would also be used to relocate isolated or individual boulders.

The pre-lay grapnel run will involve towing a grapnel, via the main cable-laying vessel, along the benthos of the cable burial route. During the pre-lay grapnel run, the cable-lay vessel will tow the grapnel at slow speeds (i.e., approximately 1 knot or less) to ensure all debris is removed. Given the very slow speed of the operation, any listed species in the vicinity are expected to be able to avoid the devices and avoid an interaction. Additionally, the cable for the grapnel run and displacement plow will remain taught as it is pulled along the benthos; there is no risk for any listed species to become entangled in the cable. For these reasons, any interaction between the pre-lay grapnel run, a displacement plow, or a boulder grab tool and ESA-listed species is extremely unlikely to occur. As any material moved during the pre-lay grapnel run and associated boulder relocation would be placed adjacent to the cable corridor any effects to listed species from these changes in the structure of the habitat are extremely unlikely to occur.

7.3.2.2 Dredging to Facilitate Cable Installation

Following the prey-lay grapnel run, dredging within the WFA and along the inshore and offshore export cable corridor will occur where necessary to allow for effective cable laying through any identified sand waves. Tidal sand waves are mobile slopes of sediment on the seabed (Vol I, COP, 2022). Generally, sand wave features are dynamic and have wavelengths that consist of hundreds of meters with heights of several meters and typically migrate several meters per day (Terwindt, 1971, Campmans et al., 2021). The leveling or clearance of tidal sand waves is needed prior to cable installation. Sandwave clearance volumes were estimated based on sand wave height, anticipated cable burial depth, the most likely cable installation technique, and the required cable clearance area. Ocean Wind 1 anticipates that dredging would occur on sand waves with an average height of 17 ft. (5.2 m) within a corridor that is 98 ft. (29.9 m) wide. Specific details on sand wave clearing volumes are listed in Table 3.2.4 in Section 3 above. Sand wave clearance may occur where cable exposure is predicted over the lifetime of the Ocean Wind 1 project due to seabed mobility (OW1 COP, 2022). Alternatively, sand wave clearance may occur where sand slopes become greater than approximately 10° (17.6 percent) (OW1 COP, 2022). Planned dredging methods anticipated for sand wave clearance include: (1) mechanical clamshell dredge, (2) hydraulic trailing suction hopper; or (3) controlled-flow excavator (OW1 BA, 2022). There may be instances where there is a time lapse between sand wave clearance and cable installation activities. During this time lapse, tidal sediment may start to infill the areas that were cleared which would require pre-sweeping leveling to remove partial sediment infills.

Mechanical Dredging

Mechanical clamshell bucket dredging may occur, along the export cable corridors during sand wave clearance or to otherwise facilitate cable installation. Effects of mechanical dredging along the cable route are the same as for dredging in Barnegat Bay as addressed above.

Controlled-flow Excavation

A controlled flow excavator (CFE) may be used for sand wave clearance. The CFE uses jets of water to move sand and does not come into contact with the substrate. Given that there is no contact with the substrate and sand is not entrained or otherwise removed through the CFE there is not expected to be any risk of impingement, entrainment, capture, or other sources of injury associated with the CFE. As such, effects to listed species from the CFE are extremely unlikely to occur.

Trailing Suction Hopper Dredging

Hydraulic trailing suction hopper dredging involve the use of suction to either remove sediment from the seabed or relocate sediment from a particular location on the seafloor. A hopper dredge may be used for sandwave clearance.

Whales
Even if whales are present in the suction hopper dredged area, they are far too large to be susceptible to entrapment by a trailing suction hopper dredge. As such, interactions between the hopper dredge and ESA listed whales are extremely unlikely to occur.

Sea Turtles
Sea turtles have been known to become entrained in trailing suction hopper dredges, which can result in severe injury or mortality (Dickerson et al., 2004; USACE 2020). Animal interactions with a hopper dredge occur primarily from crushing when the draghead is placed on the bottom of the seabed or when an animal is unable to escape the suction of the dredge and becomes stuck on the draghead (impingement). Further, entrainment occurs when animals are sucked through the draghead into the hopper. Mortality most often occurs when animals are sucked into the dredge draghead, pumped through the intake pipe, and then killed as they cycle through the centrifugal pump and into the hopper.

Interactions with the draghead can also occur if the suction is turned on while the draghead is in the water column (i.e., not seated on the bottom). For any dredging that occurs to support cable installation, procedures will be required to minimize the operation of suction when the draghead is not properly seated on the bottom sediments, which reduces the risk of these types of interactions.

The risk of interaction between suction hopper dredging and individual sea turtles is expected to be lower in the open ocean areas compared to nearshore navigational channels where sea turtles may be more concentrated and constrained (Michel et al., 2013; USACE 20202). Documented turtle mortalities during dredging operations in the USACE South Atlantic Division (SAD; i.e., south of the Virginia/North Carolina border) are more common than in the USACE North Atlantic Division (NAD; Virginia-Maine) presumably due to the greater abundance of turtles in these waters and the greater frequency of hopper dredge operations. For example, in the USACE SAD, over 480 sea turtles have been entrained in hopper dredges since 1980 and in the Gulf Region over 200 sea turtles have been killed since 1995. Records of sea turtle entrainment in the USACE NAD began in 1994. Through 2018, 88 sea turtles deaths (see Table 7.31) related to hopper dredge activities have been recorded in waters north of the North Carolina/Virginia border (USACE Sea Turtle Database[43]); 79 of these turtles have been entrained in dredges operating in Chesapeake Bay.

Interactions are likely to be most numerous in areas where sea turtles are resting or foraging on the bottom. When sea turtles are at the surface, or within the water column, they are not likely to interact with the dredge because there is little, if any, suction force in the water column. Sea turtles have been found resting in deeper waters, which could increase the likelihood of

[43] The USACE Sea Turtle Data Warehouse is maintained by the USACE's Environmental Laboratory and contains information on USACE dredging projects conducted since 1980 with a focus on information on interactions with sea turtles.

interactions from dredging activities. In 1981, observers documented the take of 71 loggerheads by a hopper dredge at the Port Canaveral Ship Channel, Florida (Slay and Richardson 1988). This channel is a deep, low productivity environment in the Southeast Atlantic where sea turtles are known to rest on the bottom, making them extremely vulnerable to entrainment. The large number of turtle mortalities at the Port Canaveral Ship Channel in the early 1980s resulted in part from turtles being buried in the soft bottom mud, a behavior known as brumation. Since 1981, 77 loggerhead sea turtles have been taken by hopper dredge operations in the Port Canaveral Ship Channel, Florida. Chelonid turtles have been found to make use of deeper, less productive channels as resting areas that afford protection from predators because of the low energy, deep water conditions. Habitat in the action area is not consistent with areas where sea turtle brumation has been documented; therefore, we do not anticipate any sea turtle brumation in the action area.

As noted above, in the North Atlantic Division area, nearly all interactions with sea turtles have been recorded in nearshore bays and estuaries where sea turtles are known to concentrate for foraging (i.e., Chesapeake Bay and Delaware Bay). Very few interactions have been recorded at offshore dredge sites such as the ones considered in this Opinion. This may be because the area where the dredge is operating is more wide-open providing more opportunities for escape from the dredge as compared to a narrow river or harbor entrance. Sea turtles may also be less likely to be resting or foraging at the bottom while in open ocean areas, which would further reduce the potential for interactions.

Before 1994, endangered species observers were not required on board hopper dredges and dredge baskets were not inspected for sea turtles or sea turtle parts. The majority of sea turtle takes in the NAD have occurred in the Norfolk district. This is largely a function of the large number of loggerhead and Kemp's ridley sea turtles that occur in the Chesapeake Bay each summer and the intense dredging operations that are conducted to maintain the Chesapeake Bay entrance channels and for beach nourishment projects at Virginia Beach. Since 1992, the take of nine sea turtles (all loggerheads) has been recorded during hopper dredge operations in the Philadelphia, Baltimore, and New York Districts.

Table 7.3.2. Recorded Sea Turtle Takes in USACE NAD Dredging Operations

Project Location	**Year of Operation**	**Cubic Yardage Removed**	**Observed Takes**
Cape Henry Channel	2018	2,500,000	1 Loggerhead
Thimble Shoals Channel	2016	1,098,514	1 Loggerhead
York Spit Channel	2015	815,979	6 Loggerheads
Cape Henry Channel	2014	2,165,425	3 Loggerheads 1 Kemp's ridley
Sandbridge Shoal	2013	815,842	1 Loggerhead[44]
Cape Henry Channel	2012	1,190,004	1 Loggerhead

[44] Sea turtle observed in cage on beach (material pumped directly to beach from dredge).

York Spit	2012	145,332	1 Loggerhead
Thimble Shoal Channel	2009	473,900	3 Loggerheads
York Spit	2007	608,000	1 Kemp's Ridley
Cape Henry	2006	447,238	3 Loggerheads
Thimble Shoal Channel	2006	300,000	1 Loggerhead
Delaware Bay	2005	50,000	2 Loggerheads
Thimble Shoal Channel	2003	1,828,312	7 Loggerheads 1 Kemp's ridley 1 unknown
Cape Henry	2002	1,407,814	6 Loggerheads 1 Kemp's ridley 1 Green
VA Beach Hurricane Protection Project (Cape Henry)	2002	1,407,814	1 Loggerhead
York Spit Channel	2002	911,406	8 Loggerheads 1 Kemp's ridley
Cape Henry	2001	1,641,140	2 Loggerheads 1 Kemp's ridley
VA Beach Hurricane Protection Project (Thimble Shoals)	2001	4,000,000	5 Loggerheads 1 unknown
Thimble Shoal Channel	2000	831,761	2 Loggerheads 1 unknown
York River Entrance Channel	1998	672,536	6 Loggerheads
Atlantic Coast of NJ	1997	1,000,000	1 Loggerhead
Thimble Shoal Channel	1996	529,301	1 Loggerhead
Delaware Bay	1995	218,151	1 Loggerhead
Cape Henry	1994	552,671	4 Loggerheads 1 unknown
York Spit Channel	1994	61,299	4 Loggerheads
Delaware Bay	1994	NA	1 Loggerhead
Cape May NJ	1993	NA	1 Loggerhead
Off Ocean City MD	1992	1,592,262	3 Loggerheads
			TOTAL = 88 Turtles

Typically, endangered species observers are required to observe at least 50% of the dredge activity (i.e., 6 hours on watch, 6 hours off watch). To address concerns that some loads would be unobserved, procedures have been in place since at least 2002 to ensure that inflow cages were only inspected and cleaned by observers. This maximizes the potential that any entrained sea turtles were observed and reported.

It is possible that not all sea turtles killed by dredges are observed onboard the hopper dredge. Several sea turtles stranded on Virginia shores with crushing type injuries from May 25 to October 15, 2002. The Virginia Marine Science Museum (VMSM) found 10 loggerheads, 2 Kemp's ridleys, and 1 leatherback exhibiting injuries and structural damage consistent with what they have seen in animals that were known dredge takes. While it cannot be conclusively determined that these strandings were the result of dredge interactions, it is reasonable to conclude that the death of these sea turtles was attributable to dredging operations given the location of the strandings (e.g., in the southern Chesapeake Bay near ongoing dredging activity), the time of the documented strandings in relation to dredge operations, the lack of other ongoing activities which may have caused such damage, and the nature of the injuries (e.g., crushed or shattered carapaces and/or flipper bones, black mud in mouth). In 1992, three dead sea turtles were found on an Ocean City, Maryland beach while dredging operations were ongoing at a borrow area located 3 miles offshore. Necropsy results indicate that the deaths of all three turtles were dredge related. Because there were no observers on board the dredge, it is unknown if turtles observed on the beach with these types of injuries were crushed by the dredge and subsequently stranded on shore or whether they were entrained in the dredge, entered the hopper and then were discharged onto the beach with the dredge spoils. Further analyses need to be conducted to better understand the link between crushed strandings and dredging activities, and if those strandings need to be factored into an incidental take level. Regardless, it is possible that dredges are taking animals that are not observed on the dredge, which may result in strandings on nearby beaches. However, there is not enough information at this time to determine the number of injuries or mortalities that are not detected.

The number of interactions between dredge equipment and sea turtles seems to be best associated with the volume of material removed, which is closely correlated to the length of time dredging takes, with a greater number of interactions associated with a greater volume of material removed and a longer duration of dredging. The number of interactions is also heavily influenced by the time of year dredging occurs (with more interactions correlated to times of year when more sea turtles are present in the action area) and the type of dredge plant used (sea turtles are apparently capable of avoiding pipeline and mechanical dredges as no takes of sea turtles have been reported with these types of dredges). The number of interactions may also be influenced by the terrain in the area being dredged, with interactions more likely when the draghead is moving up and off the bottom frequently. Interactions are also more likely at times and in areas when sea turtle forage items are concentrated in the area being dredged, as sea turtles are more likely to be spending time on the bottom while foraging.

We are not aware of any hopper dredging that has occurred in the areas where sandwaves may be dredged as part of the Ocean Wind 1 project. The concentration of sea turtles in Chesapeake Bay is much higher than we anticipate for the areas to be dredged; therefore, using these projects to calculate an entrainment rate (i.e., sea turtles entrained per dredge volume) would result in a significant overestimate of the likelihood of interactions in the action area. We have calculated an entrainment rate by combining hopper dredge projects operating in Delaware Bay, in borrow areas on the Mid-Atlantic OCS, and mid-Atlantic navigation channels that have not used screening for unexploded ordnance (such screening decreases the ability of observers to detect entrained turtles) but have utilized endangered species observers for monitoring. These projects are combined in the table 7.32 below. Using these projects to calculate an entrainment rate is expected to result in a reasonable estimate of risk given the geographic similarity to the Ocean Wind 1 dredge areas. The entrainment rate calculated for the projects listed in Table 7.31 indicates that entrainment of a sea turtle is likely to occur for every 3.8 million cubic yards of material removed with a hopper dredge (calculated by dividing the total cubic yards removed by the number of sea turtles entrained: 15,280,061 CY / 4 sea turtles = 3,820,015) .

Table 7.3.3. Hopper dredging projects in the Mid-Atlantic without UXO screens and with endangered species observers.

Project Name	Year	CY Removed	Sea Turtle Interactions
Wallops Island, VA (OCS Borrow Area)	2013	1,000,000	0
Delaware Bay (Reach D)	2013	1,149,946	0
Wallops Island, VA (OCS Borrow Area)	2012	3,200,000	0
LBI Surf City	2006-2007	880,000	0
Delaware Bay - Channel Maintenance	2006	390,000	0
Delaware Bay - Channel Maintenance	2005	50,000	1
Delaware Bay - Channel Maintenance	2005	167,982	0
Delaware Bay	2005	162,682	0
Fenwick Island	2005	833,000	0
Cape May	2004	290,145	0
Delaware Bay - Channel Maintenance	2004	50,000	0
Cape May Meadows	2004	1,406,000	0

Cape May	2002	267,000	0
Delaware Bay - Channel Maintenance	2002	50,000	0 (bone)
Delaware Bay - Channel Maintenance	2001	50,000	0
Cape May City	1999	400,000	0
Delaware Bay - Channel Maintenance	1995	218,151	1
Bethany Beach and South Bethany Beach	1994	184,451	0
Delaware Bay - Channel Maintenance	1994	2,830,000	1
Dewey Beach	1994	624,869	0
Cape May	2005	300,000	0
Fenwick Island*	1998	141,100	0
Delaware Bay - Channel Maintenance (Brandywine)	1993	415,000	1
Bethany Beach*	1992	219,735	0
		15,280,061	**4**

Sand wave dredging associated with the installation of the Ocean Wind 1 project will remove no more than 1,198,740 cubic yards of dredged material with only a portion of the dredging occurring at a time of year when sea turtles are present in the action area. Considering the entrainment rate calculated above, we would predict entrainment of no more than 0.31 sea turtles during dredging for the proposed offshore cable installations. However, there are several factors that indicate this overestimates the risk of entrainment for the sandwave clearance activities, including that only a portion of the proposed dredging would occur when sea turtles are present in the action area and dredging in offshore areas outside of navigation channels in general appears to have a lower risk of interaction. Based on these considerations, interactions between the dredge and any sea turtles is extremely unlikely to occur and we do not expect any impingement or entrainment to occur.

Atlantic Sturgeon

Sturgeon are vulnerable to interactions with hopper dredges. The risk of interactions is related to both the amount of time sturgeon spend on the bottom and the behavior the fish are engaged in (i.e., whether the fish are overwintering, foraging, resting or migrating) as well as the intake velocity and swimming abilities of sturgeon in the area (Clarke 2011). Intake velocities at a typical large self-propelled hopper dredge are 11 feet per second. As noted above, exposure to the suction of the draghead intake is minimized by not turning on the suction until the draghead is properly seated on the bottom sediments and by maintaining contact between the draghead and the bottom.

A significant factor influencing potential entrainment is based upon the swimming stamina and size of the individual fish at risk (Boysen and Hoover, 2009). Swimming stamina is positively correlated with total fish length. Entrainment of larger sturgeon such as the ones in the action area is less likely due to the increased swimming performance and the relatively small size of the draghead opening. Juvenile entrainment is possible depending on the location of the dredging operations and the time of year in which the dredging occurs. Typically, major concerns of juvenile entrainment relate to fish below 200 mm (Hoover et al., 2005; Boysen and Hoover, 2009). Juvenile sturgeon are not powerful swimmers and they are prone to bottom-holding behaviors, which make them vulnerable to entrainment when in close proximity to dragheads (Hoover et al., 2011). Juvenile sturgeon do not occur in the action area. The estimated minimum size for sturgeon that out-migrate from their natal river is greater than 50cm; therefore, that is the minimum size of sturgeon anticipated in the action area.

In general, entrainment of large mobile animals, such as the Atlantic sturgeon in the action area, is relatively rare. Several factors are thought to contribute to the likelihood of entrainment. In areas where animals are present in high density, the risk of an interaction is greater because more animals are exposed to the potential for entrainment. The risk of entrainment is likely to be higher in areas where the movements of animals are restricted (e.g., in narrow rivers or confined bays) where there is limited opportunity for animals to move away from the dredge than in unconfined areas such as wide rivers or open bays. The hopper dredge draghead operates on the bottom and is typically at least partially buried in the sediment. Sturgeon are benthic feeders and are often found at or near the bottom while foraging or while moving within rivers. Sturgeon at or near the bottom could be vulnerable to entrainment if they were unable to swim away from the draghead. Atlantic sturgeon are not anticipated to be foraging in the sediment in the areas to be dredged given that they are areas of dynamic sand waves that would not support benthic invertebrates that sturgeon would forage on. As such, sturgeon are not anticipated to be so close to the sediment to be vulnerable to entrainment in the hopper dredge. If Atlantic sturgeon are up off the bottom while in offshore areas, such as the action area, the potential for interactions with the dredge are further reduced. Based on this information, the likelihood of an interaction of an Atlantic sturgeon with a hopper dredge operating in the action area is expected to be low.

Nearly all recorded entrainment of sturgeon during hopper dredging operations has been during maintenance or deepening of navigation channels within rivers with spawning populations of Atlantic sturgeon. We have records of three Atlantic sturgeon entrainments outside of such river channels. Two of these are from York Spit Channel, Virginia and based on the state of decomposition of one of these it was not killed interacting with the dredge. The other record is from the Sandy Hook Channel in New Jersey. To calculate an entrainment rate for Atlantic sturgeon that would be a reasonable estimate for the action area, we have considered projects where hopper dredges operated without UXO screens and with endangered species observers and where we expect the observers would have reported any observations of sturgeon. We have limited the projects considered to those that are outside of rivers or other inland areas as the size class of sturgeon present in those areas would be different from the action area and we expect behavior of sturgeon to be different in those areas. As such, the level of entrainment in these areas would not be comparable to the level of interactions that may occur in the action area.

Table 7.3.4: Hopper Dredging Operations in areas within the USACE NAD similar to the action area (only projects that operated without UXO screens, and carried observers and complete records available are included)

Project Location	Year of Operation	Cubic Yards Removed	Observed Entrainment
Wallops Island offshore VA borrow area	2013	1,000,000	0
Wallops Island offshore VA borrow area	2012	3,200,000	0
York Spit Channel, VA	2011	1,630,713	1
Cape Henry Channel, VA	2011	2,472,000	0
York Spit Channel, VA	2009	372,533	0
Sandy Hook Channel, NJ	2008	23,500	1
York Spit Channel, VA	2007	608,000	0
Atlantic Ocean Channel, VA	2006	1,118,749	0
Thimble Shoal Channel, VA	2006	300,000	0
Cape May	2004	290,145	0
Thimble Shoal Channel, VA	2004	139,200	0
VA Beach Hurricane Protection Project	2004	844,968	0
Thimble Shoal Channel	2003	1,828,312	0
Cape May	2002	267,000	0
Cape Henry Channel, VA	2002	1,407,814	0

York Spit Channel, VA	2002	911,406	0
East Rockaway Inlet, NY	2002	140,000	0
Cape Henry Channel, VA	2001	1,641,140	0
Thimble Shoal Channel, VA	2000	831,761	0
Cape Henry Channel, VA	2000	759,986	0
Cape May City	1999	400,000	0
York Spit Channel, VA	1998	296,140	0
Cape Henry Channel, VA	1998	740,674	0
Thimble Shoal Channel, VA	1996	529,301	0
East Rockaway Inlet, NY	1996	2,685,000	0
Cape Henry Channel, VA	1995	485,885	0
East Rockaway Inlet, NY	1995	412,000	0
York Spit Channel, VA	1994	61,299	0
Cape Henry Channel , VA	1994	552,671	0
	TOTAL	25,950,197	2

In the absence of any dredging in the areas to be dredged for the Ocean Wind 1 project to base an entrainment estimate, we consider other projects that have been conducted in a comparable environment to that of the action area (see Table 7.33). As noted above, based on what we know about Atlantic sturgeon behavior in environments comparable to the action area, we consider the risk of entrainment at this site is similar to that of the projects identified in Table 7.33. At this time, this is the best available information on the potential for interactions with Atlantic sturgeon.

Using this method, and using the dataset presented in Table 7.33, we have calculated an interaction rate indicating that for every 12.98 million cubic yards of material removed, one Atlantic sturgeon is likely to be injured or killed. This calculation is based on a number of assumptions including the following: that Atlantic sturgeon are evenly distributed throughout the action area, that all hopper dredges will have the same entrainment rate, and that Atlantic sturgeon are equally likely to be encountered throughout the time period when dredging will occur. While this estimate is based on several assumptions, it is reasonable because it uses the best available information on entrainment of Atlantic sturgeon from past dredging operations, including dredging operations in the vicinity of the action area, it includes multiple projects over several years, and all of the projects have had observers present which we expect would have documented any entrainment of Atlantic sturgeon.

Sand wave dredging associated with the installation of the Ocean Wind 1 project will remove no more than 1,198,740 cubic yards of dredged material. Considering the entrainment rate calculated above, we would predict entrainment of no more than 0.09 Atlantic sturgeon during dredging for the proposed offshore cable installation. Based on this, interactions between the dredge and Atlantic sturgeon that would cause adverse effects are extremely unlikely to occur.

7.3.2.3 Jet Plowing during Cable Laying

The jet plow uses jets of water to liquefy the sediment, creating a trench in which the cable is laid. Cable laying operations proceed at speeds of <1 knot. At these speeds, any sturgeon, sea turtle, or whale is expected to be able to avoid any interactions with the cable laying operation. Additionally, as the cable will be taut as it is unrolled and laid in the trench, there is no risk of entanglement. Based on this information adverse effects caused by this activity, including entanglement of any species during the cable laying operation, is extremely unlikely to occur.

7.3.3 Turbidity from Cable Installation and Dredging Activities

Installation of the Ocean Wind 1 export cable and inter-array cable would disrupt bottom habitat and suspend sediment in the water column. Vinhaterio et al. (2018) modeled anticipated total suspended solids (TSS) levels and the time required to dissipate those levels to ambient conditions. Potential types of equipment that may cause temporary increases in turbidity and sediment resuspension during cable installation include the use of a jet plow, mechanical plow, or a mechanical trench. As described in the BA, sediment dispersion modeling was conducted for three other offshore wind projects with conditions representative of the Ocean Wind 1 Wind Farm Area (see COP Volume II, Section 2.1.2.2.1 for detailed descriptions; Ocean Wind BA 2022). The modeling indicated that sediments suspended during trenching would settle quickly to the seabed within the trench and that potential plumes would be limited to right above the seabed. Potential suspended sediment plumes greater than 10 mg/L would be short in duration (up to 6 hours) and limited to within approximately 164 to 656 feet (50 to 200 meters) from the center of the trench. However, Vinhaterio et al. (2018) modeled offshore turbidity levels during the proposed installation of an inter-array cable at 100 mg/L and up to 131 feet (40 meters) from the source, with turbidity returning to ambient levels within 0.3 hours post cable installation. Jet plow activities in nearshore areas such as Barnegat Bay for the Ocean Wind 1 project would be similar to the modeling results for other shallow-water areas where the mostly fine sediment (silts and clays) were projected to persist for 2-days at very low levels of 10 mg/L above background levels (Normandeau, 2015). The Ocean Wind 1 BA indicates that impacts on water quality for finer sediments are anticipated to be localized, short lived in duration, and adjacent to cable laying trenches. The potential for sedimentation and deposition from the installation of the Ocean Wind 1 export cable is similar to that explained for the inter-array cable.

Whales

In a review of dredging impacts to marine mammals, Todd et al. (2015) found that direct effects from turbidity have not been documented in the available scientific literature. Because whales breathe air, some of the concerns about impacts of TSS on fish (i.e., gill clogging or abrasion) are not relevant. Cronin et al. (2017) suggest that vision may be used by North Atlantic right whales to find copepod aggregations, particularly if they locate prey concentrations by looking upwards. However, Fasick et al. (2017) indicate that North Atlantic right whales certainly must rely on other sensory systems (e.g. vibrissae on the snout) to detect dense patches of prey in very dim light (at depths >160 meters or at night). Because ESA listed whales often forage at depths deeper than light penetration (i.e., it is dark), which suggests that vision is not relied on exclusively for foraging, TSS that reduces visibility would not be expected to affect foraging ability. Data are not available regarding whales avoidance of localized turbidity plumes; however, Todd et al. (2015) conclude that since marine mammals often live in turbid waters and frequently occur at depths without light penetration, impacts from turbidity are not anticipated to occur. As such, any effects to ESA listed whales from exposure to increased turbidity during cable installation are extremely unlikely to occur. If turbidity-related effects did occur, they would likely be so small that they cannot be meaningfully measured, evaluated, or detected and would therefore be insignificant. Effects to whale prey are considered below.

Sea Turtles
Similar to whales, because sea turtles breathe air, some of the concerns about impacts of TSS on fish (i.e., gill clogging or abrasion) are not relevant. There is no scientific literature available on the effects of exposure of sea turtles to increased TSS. Michel et al. (2013) indicates that since sea turtles feed in water that varies in turbidity levels, changes in such conditions are extremely unlikely to inhibit sea turtle foraging even if they use vision to forage. Based on the available information, we expect that any effects to sea turtles from exposure to increased turbidity during dredging or cable installation are extremely unlikely to occur. If turbidity-related effects did occur, they would likely be so small that they could not be meaningfully measured, evaluated, or detected and would therefore be insignificant. Effects to sea turtle prey are addressed below in section 7.3.1.4.

Atlantic sturgeon
Atlantic sturgeon are adapted to natural fluctuations in water turbidity through repeated exposure (e.g., high water runoff in riverine habitat, storm events) and are adapted to living in turbid environments (Hastings 1983, ECOPR Consulting 2009). Atlantic sturgeon forage at the bottom by rooting in soft sediments meaning that they are routinely exposed to high levels of suspended sediments. Few data have been published reporting the effects of suspended sediment on sturgeon. Garakouei et al. (2009) calculated Maximum Allowable Concentrations (MAC) for total suspended solids in a laboratory study with *Acipenser stellatus* and *A. persicus* fingerlings (7-10 cm TL). The MAC value for suspended sediments was calculated as 853.9 mg/L for *A. stellatus* and 1,536.7 mg/L for *A. persicus*. All stellate sturgeon exposed to 1,000 and 2,320 mg/L TSS for 48 hours survived. All Persian sturgeon exposed to TSS of 5,000, 7,440, and 11,310 mg/L for 48 hours survived. Given that Atlantic sturgeon occupy similar habitats as these sturgeon species, we expect them to be a reasonable surrogate for Atlantic sturgeon. Wilkens et al. (2015) contained young of the year Atlantic sturgeon (100-175 mm TL) for a 3-day period in flow-through aquaria, with limited opportunity for movement, in sediment of varying concentrations (100, 250 and 500 mg L−1 TSS) mimicking prolonged exposure to suspended sediment plumes near an operating dredge. Four-percent of the test fish died; one was exposed to 250 TSS and three to 500 TSS for the full three-day period. The authors concluded

that the impacts of sediment plumes associated with dredging are minimal where fish have the ability to move or escape. As tolerance to environmental stressors, including suspended sediment, increases with size and age (ASMFC, 2012); we expect that the subadult and adults in the action area would be less sensitive to TSS than the test fish used in both of these studies.

Any Atlantic sturgeon within 40 m of the cable laying operations for the inter-array cable would be exposed to TSS greater than 100 mg/L. These elevated TSS levels are not expected to persist for more than 0.3 hours. Atlantic sturgeon within 200 m of the cable laying operations for the Ocean Wind 1 export cable in federal waters would be exposed to TSS at or below 10 mg/L. Elevated TSS levels associated with Ocean Wind 1 export cable-OCS installation are not expected to persist for more than 1.4 hours. Based on the information summarized above, any exposure to TSS would be below levels that would be expected to result in any effects to the subadult or adult Atlantic sturgeon occurring in the action area. As such, Atlantic sturgeon are extremely unlikely to experience any physiological or behavioral responses to exposure to increased TSS. Effects to Atlantic sturgeon prey are addressed below.

7.3.4 Impacts of Dredging and Cable Installation Activities on Prey

Cable installation could affect prey of whales, sea turtles, and Atlantic sturgeon due to impacts of sediment disturbance during dredging or cable laying and resulting exposure to increased TSS. Here, we provide a brief summary of the prey that the various listed species forage on and then consider the effects of dredging and cable installation on prey, with the analysis organized by prey type. We conduct this analysis to consider whether listed species could be exposed to adverse effects due to adverse consequences to species on which they forage.

Summary of Information of Feeding of ESA-listed Species

Right whales

Right whales feed almost exclusively on copepods, a type of zooplankton. Of the different kinds of copepods, North Atlantic right whales feed especially on late stage *Calanus finmarchicu*s, a large calanoid copepod (Baumgartner et al.. 2007), as well as *Pseudocalanus spp*. and *Centropages spp*. (Pace and Merrick 2008). Because a right whale's mass is ten or eleven orders of magnitude larger than that of its prey (late stage *C. finmarchicus* is approximately the size of a small grain of rice), right whales are 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).

Fin whales

Fin whales in the North Atlantic eat pelagic crustaceans (mainly euphausiids or krill, including *Meganyctiphanes norvegica* and *Thysanoessa inerrnis*) and schooling fish such as capelin (*Mallotus villosus*), herring (*Clupea harengus*), and sand lance (*Ammodytes spp*.) (NMFS 2010). Fin whales feed by lunging into schools of prey with their mouth open, using their 50 to 100 accordion-like throat pleats to gulp large amounts of food and water. A fin whale eats up to 2 tons of food every day during the summer months.

Sei whales

An average sei whale eats about 2,000 pounds 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.

Sperm whales

Sperm whales hunt for food during deep dives with feeding occurring at depths of 500–1000 m depths (NMFS 2010). Deepwater squid make up the majority of their diet (NMFS 2010). Given the shallow depths of the area where the cable will be installed (less than 50 m), it is extremely unlikely that any sperm whales would be foraging in the area affected by the cable installation and extremely unlikely that any potential sperm whale prey would be affected by cable installation or dredging activities.

Blue whales

Blue whales feed exclusively on krill. Given the rarity of blue whales in the area where project activities will occur, it is extremely unlikely that any blue whales would be foraging in the area where increased turbidity would occur and extremely unlikely that any potential blue whale prey would be affected by cable installation or dredging activities.

Sea turtles

Green sea turtles feed primarily on sea grasses and may feed on algae. Loggerhead turtles feed on benthic invertebrates such as gastropods, mollusks, and crustaceans. Diet studies focused on North Atlantic juvenile stage loggerheads indicate that benthic invertebrates, notably mollusks and benthic crabs, are the primary food items (Burke et al. 1993, Youngkin 2001, Seney 2003). Limited studies of adult loggerheads indicate that mollusks and benthic crabs make up their primary diet, similar to the more thoroughly studied neritic juvenile stage (Youngkin 2001). Kemp's ridleys primarily feed on crabs, with a preference for portunid crabs including blue crabs; crabs make up the bulk of the Kemp's ridley diet (NMFS et al. 2011).

Leatherback sea turtles feed exclusively on jellyfish. A study of the foraging ecology of leatherbacks off the coast of Massachusetts indicates that leatherbacks foraging off Massachusetts primarily consume the scyphozoan jellyfishes, *Cyanea capillata* and *Chrysaora quinquecirrha*, and ctenophores, while a smaller proportion of their diet comes from holoplanktonic salps and sea butterflies (*Cymbuliidae*) (Dodge et al. 2011); we expect leatherbacks in the Ocean Wind 1 area to be foraging on similar species.

Atlantic sturgeon

Atlantic sturgeon are opportunistic benthivores that feed primarily on mollusks, polychaete worms, amphipods, isopods, shrimps and small bottom-dwelling fishes (Smith 1985, Dadswell 2006). A stomach content analysis of Atlantic sturgeon captured off the coast of New Jersey indicates that polycheates were the primary prey group consumed; although the isopod *Politolana concharum* was the most important individual prey eaten (Johnson et al. 2008). The authors determined that mollusks and fish contributed little to the diet and that some prey taxa (i.e., polychaetes, isopods, amphipods) exhibited seasonal variation in importance in the diet of Atlantic sturgeon. Novak et al. (2017) examined stomach contents from Atlantic sturgeon captured at the mouth of the Saco River, Maine and determined that American Sand Lance *Ammodytes americanus* was the most common and most important prey.

7.3.4.1 Effects of Cable Installation and Dredging on the Prey Base of ESA-listed Species in the Action Area

Copepods

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). Baugmartner et al. (2011) concludes 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, we do not anticipate any burial or loss of copepods during installation of the cable. We were unable to identify any scientific literature that evaluated the effects to marine copepods of exposure to TSS. Based on what we know about effects of TSS on other aquatic life, it is possible that high concentrations of TSS could negatively affect copepods. However, given that: the expected TSS levels are below those that are expected to result in effects to even the most sensitive species evaluated; the sediment plume will be transient and temporary (i.e., persisting in any one area for no more than three hours); elevated TSS is limited to the bottom 3 meters of the water column; and will occupy only a small portion of the WFA at any given time, any effects to copepod availability, distribution, or abundance on foraging whales would be so small that they could not be meaningfully evaluated, measured, or detected. Therefore, effects are insignificant.

Fish

As explained above, elevated TSS will be experienced along the cable corridor during cable installation. Anticipated TSS levels are below the levels expected to result in the mortality of fish that are preyed upon by fin or sei whales or Atlantic sturgeon. In general, fish can tolerate at least short-term exposure to high levels of TSS. Wilber and Clarke (2001) reviews 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 was 650 mg/L for 5 d, which increased blood hematocrit (Sherk et al. 1974 in Wilber and Clarke 2001). Regarding lethal effects, Atlantic silversides and white perch were among the estuarine fish with the most sensitive lethal responses to suspended sediment exposures, exhibiting 10% 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 will 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, we do not anticipate the mortality of any forage fish; therefore, we do not anticipate any reduction in fish as prey for fin or sei whales or Atlantic sturgeon.

Benthic Invertebrates

In the BA, BOEM indicates that an area approximately 10-feet wide will be disturbed during cable installation; this is likely to result in the mortality of some benthic invertebrates in the path of the jet plow. Immediately following cable installation, this area will likely be devoid of any benthic invertebrates. However, given the narrow area, we expect recolonization to occur from adjacent areas that were not disturbed; therefore, this reduction in potential forage will be temporary.

As explained above, elevated TSS will be experienced along the cable corridor during cable installation. Because polychaete worms live in the sediment, we do not expect any effects due to exposure to elevated TSS in the water column. Wilbur and Clarke (2001) reviewed available information on effects of TSS exposure on crustacean and report that in experiments shorter than 2 weeks, nearly all mortality of crustaceans occurred with exposure to concentrations of suspended sediments exceeding 10,000 mg/L and that the majority of these mortality levels were less than 25%, even at very high concentrations. Wilbur and Clarke (2001) also noted that none of the crustaceans tested exhibited detrimental responses at dosages within the realm of TSS exposure anticipated in association with dredging. Based on this information, we do not anticipate any effects to crustaceans resulting from exposure to TSS associated with cable installation. Given the thin layer of deposition associated with the settling of TSS out of the water column following cable installation we do not anticipate any effects to benthic invertebrates. Based on this analysis, we expect any impact of the loss of benthic invertebrates to foraging Kemp's ridley and loggerhead sea turtles and Atlantic sturgeon due to cable installation to be so small that they cannot be meaningfully measured, evaluated, or detected and, therefore, are insignificant.

Jellyfish
A literature search revealed no information on the effects of exposure to elevated TSS on jellyfish. However, given the location of jellyfish in the water column and the information presented in the BA that indicates that any sediment plume associated with cable installation will be limited to the bottom 3 meters of the water column, we expect any exposure of jellyfish to TSS to be minimal. Based on this analysis, effects to leatherback sea turtles resulting from effects to their jellyfish prey are extremely unlikely to occur and thus discountable.

SAV/Eelgrass (Zostera marina)
In New Jersey, the dominant saltwater SAV species is eelgrass (Zostera marina), a species widely distributed along the Atlantic coast from Nova Scotia, Canada to North Carolina (Orth and Moore, 1982). Barnegat Bay and Little Egg Harbor estuarine systems contain approximately 75% of New Jersey's known seagrass habitat (Lathrop et al., 2001). The proposed Oyster Creek inshore export cable route corridor which is the area within Barnegat Bay from the Bay side of Island Beach State Park to the landfall site near Oyster Creek (which up to two offshore export cables will be installed) may transit through the vicinity of documented SAV beds and SAV habitat. Additional information is included in the June 2022 Ocean Wind 1 SAV monitoring plan.

SAV provides important nursery and foraging habitat for ESA-listed sea turtles. The installation of the Oyster Creek export cable corridor poses varying degrees of potential impacts to SAV. Specifically, the SAV could be disturbed by cable trenching, dredging (if required), anchoring, and cable protection. These actions may disturb a total of 2.92-acres of SAV within the 61,440-acre area of Barnegat Bay. The SAV growing season when seagrasses are at their most vulnerable is May through October in New Jersey (Colarusso and Verkade, 2016). Landfall cable installation is proposed to occur from September 2023 to May 2024, which avoids the SAV growing season. The offshore export cable installation is proposed to occur January 2024 through October 2024, throughout the entire 2024 SAV growing season, but SAV is not expected in offshore waters. Table 7.3.5 and 7.3.6 below detail anticipated impacts to SAV habitat within Barnegat Bay, NJ.

Table 7.3.5. Impacts to Mapped SAV Habitat by Construction Activity

Construction Activity	Impact Area to Mapped SAV Habitat (acres)
Cable Installation Activities	2.9
Anchoring/Mooring	0.02
Total	2.92

Table 7.3.6. Impacts to Mapped SAV Habitat by Location

Landfall	Impact Area to Mapped SAV Habitat (acres)
Western Barnegat Bay Landfall – Open Cut	1.1
Western Barnegat Bay Landfall - HDD	0
Prior Channel – Open Cut	1.8
Anchoring/Mooring within Barnegat Bay	0.02
Total	2.92

The project will develop and implement a site-specific SAV monitoring program to ensure that SAV is monitored before and after construction to determine the amount of restoration required. In addition, the project is proposing mitigation measures to avoid SAV where practicable. This includes: (1) use of HDD to avoid areas of SAV during construction on the eastern and western shores of Barnegat Bay and in Peck Bay, (2) in-water work window that will occur outside the SAV growing season in New Jersey, (3) silt curtains will be utilized when construction activities are within 500 feet from SAV beds, (4) when feasible a closed environmental clamshell bucket will be utilized; (5) the speed/jetting pressure during cable laying activities that occur within close proximity to SAV will be modified to minimize suspended sediment plumes. Based on this analysis, effects to ESA-listed sea turtles resulting from the disturbance of 2.92-acres of SAV is likely to occur. However, given the small area impacted and the restoration efforts to restore disturbed SAV, effects to sea turtle prey and foraging habitat will be negligible and effects to sea turtles will be insignificant as they will be too small to meaningfully measure, detect, or evaluate.

7.3.5 Onshore Cable Connections

The offshore export cables will connect with onshore export cables at transition joint bays (TJBs) with landfall sites located at BL England and Oyster Creek. Offshore export cables will be installed up to the transition joint bays by utilizing HDD or open cut trenching and may include installation of temporary cofferdams (see Table 7.3 above). Sheet piles will be temporarily installed to support cofferdam installation (if required) during construction of HDD exit pits.

The HDD installation involves excavation of an exit pit, drilling, and pumping drilling fluid to create a bore and then pulling conduit into the bore. The export cable is then pulled through the installed conduit. Noise associated with sheet pile installation is addressed in section 7.1,

For the construction of the HDD a drilling fluid of bentonite-water-based mud or another non-toxic drilling fluid would be used to cool the drill bit, maintain borehole stability, and control fluid loss during operations. Drilling mud would be injected into the drill pipe onshore using pumps that are located within the HDD workspace. The mud would be jetted through a rotating drill bit attached at the end of the drill pipe. Jetting of the mud would cool the drill bit and suspend drill cuttings within the mud solution. Mud and cuttings would flow back to the surface in the gap between the drill pipe and bore hole, which would stabilize the borehole. Once the mud flows back to the borehole entry, it would be collected and reused.

HDD allows the cable to transition from the onshore to marine environment under the sediments. Before HDD begins, a temporary cofferdam may be installed where the conduit exits from the seabed to facilitate cable pull-in. If conditions require a cofferdam, it will be installed as a sheet piled structure into the sea floor (see section 6.2 in the COP, Volume I). Noise associated with cofferdam installation is addressed in section 7.1 of this Opinion.

The only in-water work involved in the transition of the export cable from offshore to onshore would be at the transition site where a temporary cofferdam would be installed. Given the shallow, nearshore location of either transition site, we do not expect any whales, sea turtles, or Atlantic sturgeon to be exposed to any effects of the cofferdam installation or cable pull-in.

7.3.6 Turbidity during WTG and OSS Installation
Pile driving for WTG and OSS installation as well as the deposition of rock for scour protection at the base of these foundations may result in a minor and temporary increase in suspended sediment in the area immediately surrounding the foundation or scour protection being installed. The amount of sediment disturbed during these activities is minimal; thus, any associated increase in TSS will be small and significantly lower than the TSS associated with cable installation addressed above. Given the very small increase in TSS associated with foundation installation and placement of scour protection, any physiological or behavioral responses by ESA listed species from exposure to TSS are extremely unlikely to occur and thus discountable.

7.3.7 Lighting
In general, lights will be required on offshore platforms and structures, vessels, and construction equipment during construction. Construction activities would occur 24 hours a day to minimize the overall duration of activities and the associated period of potential impact on marine species. Although not anticipated, Ocean Wind 1 expects that pile driving that was started during daylight could continue after dark or in low visibility conditions. Construction and support vessels would be required to display lights when operating at night and deck lights would be required to illuminate work areas. However, lights would be down shielded to illuminate the deck, and would not intentionally illuminate surrounding waters. If sea turtles, Atlantic sturgeon, whales, or their prey is attracted to the lights, it could increase the potential for interaction with equipment or associated turbidity. However, due to the nature of project activities and associated seafloor disturbance, turbidity, and noise, listed species and their prey are not likely to be

attracted by lighting because they are disturbed by these other factors. As such, we have determined that any effects of project lighting on sea turtles, sturgeon, or whales are extremely unlikely to occur and thus discountable.

Lighting may also be required at on shore areas, such as where the cables will make landfall. Many of the onshore areas used for staging will be part of an industrial port where artificial lighting already exists. Sea turtle hatchlings are known to be attracted to lights and artificial beach lighting is known to disrupt proper orientation towards the sea. However, due to the distance from the nearest nesting beach to the project area (the straight-line distance through the Atlantic Ocean from Virginia Beach, VA, the northernmost area where successful nesting has occurred, and the WFA is approximately 300 km), there is no potential for project lighting to impact the orientation of any sea turtle hatchlings.

7.3.6 Unexploded Ordnance (UXO) Detonation - *Seabed Disturbance and Turbidity*

Ocean Wind 1 conservatively assumes that up to 10 UXOs may be detonated in place. Therefore, we are assessing the potential effects to the seabed from potential UXO blasting/detonation. If UXO detonation is necessary, no more than one detonation would occur within a 24-hour period. Both low-order (deflagration) and high-order (detonation) methods may be considered in situations where UXOs cannot be avoided or physically relocated through a "Lift and Shift" approach. In section 7.1, effects to whales, sea turtles, and Atlantic sturgeon from exposure to UXO/MEC detonations were addressed.

There is very limited information about seabed disturbances following the blasting/detonation of UXOs. Generally, it can be assumed that the detonation of a UXO may leave a creator or scar in the seabed following blasting. The total seabed area disturbed is expected to be related to the size of the UXO, the existing seabed conditions, and the UXO detonation method. Ocean Wind 1 proposes to first avoid interaction with any existing UXOs. If avoidance cannot be achieved, physical relocation through a "Lift and Shift" strategy where a UXO is moved to another suitable location would be next. In situations where UXOs cannot be avoided or physically relocated, a low-order (deflagration) method would be considered. Deflagration, a low-order detonation method, consists of a shape charge with insufficient shock to detonate, and with the explosive material inside the UXO reaching with a rapid burning rather than a chain reaction that would lead to a full explosion (ESTCP 2002, Robinson *et al*. 2020, Lepper, pers. comm. 2022). Deflagration would have little to no impact on the seabed as there is not a full explosion, thus we would not expect much disturbance of the surrounding substrate. A high-order detonation is conducted by exploding a donor charge placed adjacent to the UXO munition (Albright 2012, Aker et al. 2012, Sayle et al. 2009, Cooper and Cooke 2018, Robinson et al. 2020). In the event of a high-order UXO detonation, it is likely that the seabed around the location of the UXO will be disturbed. Given the sandy substrate in areas where UXO could be detonated and the dynamic benthic environment, we expect any craters or scars to fill in naturally over time. We do not expect any effects to listed species from these impacts. Additionally, while there could be increases in turbidity as sediment is disturbed during a detonation, any sediment would quickly settle out of the water column; effects to listed species from a localized, temporary increase in suspended sediment are expected to be so small that they cannot be meaningfully measured, evaluated, or detected, and are therefore insignificant.

7.4 Effects to Habitat and Environmental Conditions during Operation

Here, we consider the effects to listed species from alterations or disruptions to habitat and environmental conditions during the operations phase of the project. Specifically, we address electromagnetic fields and heat during cable operation, project lighting during operations, and the effects of project structures.

7.4.1 Electromagnetic Fields and Heat during Cable Operation

Electromagnetic fields (EMF) are generated by current flow passing through power cables during operation and can be divided into electric fields (called E-fields, measured in volts per meter, V/m) and magnetic fields (called B-fields, measured in µT) (Taormina et al. 2018). Buried cables reduce, but do not entirely eliminate, EMF (Taormina et al. 2018). When electric energy is transported, a certain amount is lost as heat by the Joule effect, leading to an increase in temperature at the cable surface and a subsequent warming of the sediments immediately surrounding the cable; for buried cables, thermal radiation can warm the surrounding sediment in direct contact with the cable, even at several tens of centimeters away from it (Taormina et al. 2018).

To minimize EMF generated by cables, all cabling would be contained in electrical shielding (i.e., bitumen impregnated hessian tape and polypropylene threads) to prevent detectable direct electric fields. Ocean Wind 1 would also bury cables to a target burial depth of approximately 4 – 6 feet (1.2 – 1.8 meters) below the surface. The electrical shielding and burial are expected to control the intensity of EMF. However, magnetic field emissions cannot be reduced by shielding, although multiple-stranded cables can be designed so that the individual strands cancel out a portion of the fields emitted by the other strands. Normandeau et al. (2011) compiled data from a number of existing sources, including 19 undersea cable systems in the U.S., to characterize EMF associated with cables consistent with those proposed for wind farms. The dataset considers cables consistent with those proposed by Ocean Wind 1 (i.e., up to 170kV kV). In the paper, the authors present information indicating that the maximum anticipated magnetic field would be experienced directly above the cable (i.e., 0 m above the cable and 0 m lateral distance), with the strength of the magnetic field dissipating with distance. Based on this data, the maximum anticipated magnetic field would be 7.85 µT at the source, dissipating to 0.08 µT at a distance of 10 m above the source and 10 m lateral distance. By comparison, the Earth's geomagnetic field strength ranges from approximately 20 to 75 µT (Bochert and Zettler 2006) and the estimated EMF level in the Project area is 505 milligauss (mG; 50.5 microteslas [µT]) (NOAA 2022).

When electric energy is transported, a certain amount gets lost as heat, leading to an increased temperature of the cable surface and subsequent warming of the surrounding environment (OSPAR 2009). As described in Taormina et al. (2018), the only published field measurement study results are from the 166 MW Nysted wind energy project in the Baltic Sea (maximal production capacity of about 166 MW), in the proximity of two 33 and 132 kV AC cables buried approximately 1 m deep in a medium sand area. In situ monitoring showed a maximal temperature increase of about 2.5 ºC at 50 cm directly below the cable and did not exceed 1.4°C in 20 cm depth above the cable (Meißner et al., 2007). Taormina et al. caution that application of these results to other locations is difficult, considering the large number of factors affecting thermal radiation including cable voltage, sediment type, burial depth, and shielding. The authors note that the expected impacts of submarine cables would be a change in benthic community makeup with species that have higher temperature tolerances becoming more common. Taormina et al. conclude at the end of their review of available information on thermal effects of submarine cables that considering the narrowness of cable corridors and the expected weakness of thermal radiation, impacts are not considered to be significant. Based on the available information summarized here, and lacking any site-specific predictions of thermal radiation from the Ocean Wind 1 Wind Farm inter-array cable and Ocean Wind 1 export cable, we expect that any impacts will be limited to a change in species composition of the infaunal benthic invertebrates immediately surrounding the cable corridor. As such, we do not anticipate thermal radiation to change the abundance, distribution, or availability of potential prey for any species. As any increase in temperature will be limited to areas within the sediment around the cable where listed species do not occur, we do not anticipate any exposure of listed species to an increase in temperature associated with the cable.

Atlantic sturgeon
Sturgeons are electrosensitive and use electric signals to locate prey. Information on the impacts of magnetic fields on fish is limited. A number of fish species, including sturgeon, are suspected of being sensitive to such fields because they have magnetosensitive or electrosensitive tissues, have been observed to use electrical signals in seeking prey, or use the Earth's magnetic field for navigation during migration (EPRI 2013). Atlantic sturgeon have specialized electrosensory organs capable of detecting electrical fields on the order of 0.5 millivolts per meter (mV/m) (Normandeau et al. 2011). Exponent Engineering, P.C. (2018) calculated that the maximum induced electrical field strength from the Ocean Wind 1 Wind Farm inter-array cable and the Ocean Wind 1 export cable would be 0.43 mV/m or less, which is slightly below the detection threshold for this species. However, this analysis only considered EMF associated with buried cable segments. Based on relative magnetic field strength, the induced electrical field in cable segments that are covered by electrical armoring is expected to exceed the 0.5-mV/m threshold. This suggests that Atlantic sturgeon would be able to detect the induced electrical fields in immediate proximity to those cable segments.

Bevelhimer *et al*. 2013 examined the behavioral responses of Lake Sturgeon to electromagnetic fields. The authors also report on a number of studies, which examined magnetic fields associated with AC cables consistent with the characteristics of the cables proposed by South Fork Wind and report that in all cases magnetic field strengths are predicted to decrease to near-background levels at a distance of 10 m from the cable. Like Atlantic sturgeon, Lake Sturgeon are benthic oriented species that can utilize electroreceptor senses to locate prey; therefore, they are a reasonable surrogate for Atlantic sturgeon in this context. Bevelhimer et al. 2013 carried out lab experiments examining behavior of individual lake sturgeon while in tanks with a continuous exposure to an electromagnetic source mimicking an AC cable and examining behavior with intermittent exposure (i.e., turning the magnetic field on and off). Lake sturgeon consistently displayed altered swimming behavior when exposed to the variable magnetic field. By gradually decreasing the magnet strength, the authors were able to identify a threshold level (average strength ~ 1,000–2,000 μT) below which short-term responses disappeared. The anticipated maximum exposure of an Atlantic sturgeon to the proposed cable would range from 13.7 to 76.6 milligauss (mG) (1.37 to 7.66 μT) on the bed surface above the buried and exposed

Ocean Wind 1 cable, and 9.1 to 65.3 mG (.91 to 6.53 µT) above the buried and exposed inter-array cable, respectively. This is several orders of magnitude below the levels that elicited a behavioral response in the Bevelhimer et al. (2013) study. Induced field strength would decrease effectively to 0 mG within 25 feet of each cable (Exponent Engineering, P.C. 2018). By comparison, the earth's natural magnetic field is more than five times the maximum potential EMF effect from the Project. Background electrical fields in the action area are on the order of 1 to 10 mG from the natural field effects produced by waves and currents; this is several times higher than the EMF anticipated to result from the project's cables. As such, it is extremely unlikely that there will be any effects to Atlantic sturgeon due to exposure to the electromagnetic field from the proposed cable.

ESA-Listed Whales
The current literature suggests that cetaceans can sense the Earth's geomagnetic field and use it to navigate during migrations but not for directional information (Normandeau et al. 2011). It is not clear whether they use the geomagnetic field solely or in addition to other regional cues. It is also not known which components of the geomagnetic field cetaceans are sensing (i.e. the horizontal or vertical component, field intensity or inclination angle). Marine mammals appear to have a detection threshold for magnetic intensity gradients (i.e. changes in magnetic field levels with distance) of 0.1 percent of the earth's magnetic field or about 0.05 microtesla (µT) (Kirschvink 1990). Assuming a 50-mG (5 µT) sensitivity threshold (Normandeau 2011), marine mammals could theoretically be able to detect EMF effects from the inter-array and Ocean Wind 1 export cables, but only in close proximity to cable segments lying on the bed surface. Individual marine mammals would have to be within 3 feet or less of those cable segments to encounter EMF above the 50-mG detection threshold.

As described in Normandeau et al. (2011), there is no scientific evidence as to what the response to exposures to the detectable magnetic field would be. However, based on the evidence that magnetic fields have a role in navigation it is reasonable to expect that any effects would be related to migration and movement. Given the limited distance from the cable that the magnetic field will be detectable, the potential for effects is extremely limited. Even if listed whales did avoid the corridor along the cable route in which the magnetic field is detectable, the effects would be limited to minor deviations from normal movements. As such, any effects are likely to be so small that they cannot be meaningfully measured, detected, or evaluated and are therefore insignificant.

Sea Turtles
Sea turtles are known to possess geomagnetic sensitivity (but not electro sensitivity) that is used for orientation, navigation, and migration. They use the Earth's magnetic fields for directional or compass-type information to maintain a heading in a particular direction and for positional or hemap-type information to assess a position relative to a specific geographical destination (Lohmann et al. 1997). Multiple studies have demonstrated magneto sensitivity and behavioral responses to field intensities ranging from 0.0047 to 4000 µT for loggerhead turtles, and 29.3 to 200 µT for green turtles (Normandeau et al. 2011). While other species have not been studied, anatomical, life history, and behavioral similarities suggest that they could be responsive at similar threshold levels. For purposes of this analysis, we will assume that leatherback and Kemp's ridley sea turtles are as sensitive as loggerhead sea turtles.

Sea turtles are known to use multiple cues (both geomagnetic and nonmagnetic) for navigation and migration. However, conclusions about the effects of magnetic fields from power cables are still hypothetical, as it is not known how sea turtles detect or process fluctuations in the earth's magnetic field. In addition, some experiments have shown an ability to compensate for "miscues," so the absolute importance of the geomagnetic field is unclear.

Based on the demonstrated and assumed magneto sensitivity of sea turtle species that occur in the action area, we expect that loggerhead, leatherback, and Kemp's ridley sea turtles will be able to detect the magnetic field. As described in Normandeau et al. (2011), there is no scientific evidence as to what the response to exposures to the detectable magnetic field would be. However, based on the evidence that magnetic fields have a role in navigation it is reasonable to expect that effects would be related to migration and movement; however, the available information indicates that any such impact would be very limited in scope. As noted in Normandeau (2011), while a localized perturbation in the geomagnetic field caused by a power cable could alter the course of a turtle, it is likely that the maximum response would be some, probably minor, deviation from a direct route to their destination. Based on the available information, effects to sea turtles from the magnetic field associated with the Ocean Wind 1 Wind Farm inter-array cable and Ocean Wind export cables are expected to be so small that they cannot be meaningfully measured, detected, or evaluated and are, therefore, insignificant.

Effects to Prey

We have considered whether magnetic fields associated with the operation of the transmission line could impact benthic organisms that serve as sturgeon and sea turtle prey. Effects to forage fish, jellyfish, copepods, and krill are extremely unlikely to occur given the limited distance into the water column that any magnetic field associated with the transmission line is detectable. Information presented in the BA summarizes a number of studies on the effects of exposure of benthic resources to magnetic fields. According to these studies, the survival and reproduction of benthic organisms are not thought to be affected by long-term exposure to static magnetic fields (Bochert and Zettler 2004, Normandeau *et al*. 2011). Results from the 30-month post-installation monitoring for the Cross Sound Cable Project in Long Island Sound indicated that the benthos within the transmission line corridor for this project continues to return to pre-installation conditions. The presence of amphipod and worm tube mats at a number of stations within the transmission line corridor suggest construction and operation of the transmission line did not have a long-term negative effect on the potential for benthic recruitment to surface sediments (Ocean Surveys 2005). Therefore, no impacts (short-term or long-term) of magnetic fields on prey for any listed species in the action area are expected.

7.4.2 Lighting and Marking of Structures

To comply with FAA and USCG regulations, the WTGs and OSS will be marked with distinct lettering/numbering scheme and with lighting. The USCG requires that offshore wind lessees obtain permits for private aids to navigation (PATON, see 33 CFR part 67) for all structures located in or near navigable waters of the United States (see 33 CFR part 66) and on the OCS. PATON regulations require that individuals or organizations mark privately owned marine obstructions or other similar hazards. No additional buoys or markers will be installed in association with the PATON.

In general, lights will be required on offshore platforms and structures, vessels, and construction equipment during O&M and decommissioning of the Ocean Wind 1 Wind Farm. O&M and support vessels would be required to display lights when operating at night and deck lights would be required to illuminate work areas. However, lights would be down shielded to illuminate the deck, and would not intentionally illuminate surrounding waters. If sea turtles, Atlantic sturgeon, whales, or their prey, are attracted to the lights, it could increase the potential for interaction with equipment or associated turbidity. However, due to the nature of project activities and associated seafloor disturbance, turbidity, and noise, listed species and their prey are not likely to be attracted by lighting because they are disturbed by these other factors. As such, we have determined that any effects of project lighting on sea turtles, sturgeon, or whales are extremely unlikely.

In addition to vessel lighting, the WTGs will be lit for navigational and aeronautical safety. Lighting may also be required at on shore areas, such as where the cables will make landfall. Many of the onshore areas used for staging will be part of an industrial port where artificial lighting already exists. Sea turtle hatchlings are known to be attracted to lights and artificial beach lighting is known to disrupt proper orientation towards the sea. However, due to the distance from the nearest nesting beach to the project area (the straight-line distance through the Atlantic Ocean from Virginia Beach, VA, the northernmost area where successful nesting has occurred, and the WFA is approximately 300 km), there is no potential for project lighting to impact the orientation of any sea turtle hatchlings.

7.4.3 WTG and OSS Foundations

The physical presence of structures in the water column has the potential to disrupt the movement of listed species but also serve as an attractant for prey resources and subsequently listed species. Structures may also provide habitat for some marine species, creating a reef effect. The foundations and generation of wind energy may affect the in-water and in-air conditions, which can result in changes to ecological conditions in the marine environment. Here, we consider the best available data that is currently available to address the potential effects on ESA listed species from the Ocean Wind 1 project.

7.4.3.1 Consideration of the Physical Presence of Structures on Movements of Listed Species

The only wind turbines currently in operation in U.S. waters are the five WTGs that make up the Block Island Wind Farm and the two WTGs that are part of the Coastal Virginia Offshore Wind pilot project. We have not identified any reports or publications that have examined or documented any changes in listed species distribution or abundance at the Block Island or Virginia wind projects and have no information to indicate that the presence of these WTGs has resulted in any change in distribution of any ESA listed species.

As explained in section 6 of this Opinion, the WFA is used by Atlantic sturgeon for migration and potentially for opportunistic foraging. Consistent with information from other coastal areas that are not aggregation areas, we expect individual Atlantic sturgeon to be present in the WFA for short periods of time (<2 days; Ingram et al. 2019, Rothermal et al. 2020). Because Atlantic sturgeon carry out portions of their life history in rivers, they are frequently exposed to structures in the water such as bridge piers and pilings. There is ample evidence demonstrating that sturgeon routinely swim around and past large and small structures in waterways, often placed significantly closer together than even the minimum distance of the closest WTGs (see e.g., AKRF 2012). As such, we do not anticipate that the presence of the WTGs or the OSS will affect the distribution of Atlantic sturgeon in the action area or their ability to move through the action area.

Given their distribution largely in the open ocean, whales and sea turtles may rarely encounter large fixed structures in the water column such as the turbine foundations; thus, there is little information to evaluate the effects that these structures will have on the use of the area by these species. Sea turtles are often sighted around oil and gas platforms and fishing piers in the Gulf of Mexico which demonstrates they do not have an aversion to structures and may utilize them to forage or rest (Lohoefener 1990, Rudloe and Rudloe 2005). Given the monopiles' large size (11 m diameter) and presence above and below water, we expect that whales and sea turtles will be able to visually detect the structures and, as a result, we do not expect whales or sea turtles to collide with the stationary foundations. Listed whales are the largest species that may encounter the foundations in the water column. Of the listed whales, blue whales are the largest species at up to 90 ft. Based on the spacing of the foundations (1 x 1 nm grid) relative to the sizes of the listed species that may be present in the WFA, we do not anticipate that the foundations would create a barrier or restrict the ability of any listed species to move through the area freely.

While there is currently no before/after data for any of the ESA listed species that occur in the action area in the context of wind farm development, data is available for monitoring of harbor porpoises before, during, and after construction of three offshore wind projects in Europe. We consider that data here.

Horns Rev 1 in the North Sea consists of 80 WTGs laid out as an oblique rectangle of 5 km x 3.8 km (8 horizontal and 10 vertical rows). The distance between turbines is 560 m in both directions. The project was installed in 2002 (Tougaard et al. 2006). The turbines used at the Horns Rev 1 project are older geared WTGs and not more modern direct-drive turbines, which are quieter (Elliot et al. 2019; Tougaard et al. 2020). The Horns Rev 1 project has a similar number of foundations to the Ocean Wind 1 project (80 foundations) but turbine spacing is significantly closer together (0.5 km compared to at least 1.8 km). Pre-construction baseline data was collected with acoustic recorders and with ship surveys beginning in 1999; post-construction acoustic and ship surveys continued until the spring of 2006. In total, there were seven years of visual/ship surveys and five years of acoustic data. Both sets of data indicate a weak negative effect on harbor porpoise abundance and activity during construction, which has been tied to localized avoidance behavior during pile driving, and no effects on activity or abundance linked to the operating wind farm (Tougaard et al. 2006).

Teilmann et al. (2007) reports on continuous acoustic harbor porpoise monitoring at the Nysted wind project (Baltic Sea) before, during, and after construction. The results show that echolocation activity significantly declined inside Nysted Offshore Wind Farm since the pre-construction baseline during and immediately after construction. Teilmann and Carstensen (2012) update the dataset to indicate that echolocation activity continued to increase as time went by after operations began. Thompson et al. (2010) reported similar results for the Beatrice Demonstrator Project, where localized (1-2 km) responses of harbor porpoises were found through PAM, but no long term changes were found. Scheidat et al. (2011) reported results of acoustic monitoring of harbor porpoise activity for one year prior to construction and for two years during operation of the Dutch offshore wind farm Egmond aan Zee. The results show an overall increase in acoustic activity from baseline to operation, which the authors note is in line with a general increase in porpoise abundance in Dutch waters over that period. The authors also note that acoustic activity was significantly higher inside the wind farm than in the reference areas, indicating that the occurrence of porpoises in the wind farm area increased during the operational period, possibly due to an increase in abundance of prey in this area or as refuge from heavy vessel traffic outside of the wind farm area. Teilmann and Carstensen (2012) discuss the results of these three studies and are not able to determine why harbor porpoises reacted differently to the Nysted project. One suggestion is that as the area where the Nysted facility occurs is not particularly important to harbor porpoises, animals may be less tolerant of disturbance associated with the operations of the wind farm. It is important to note that the only ESA listed species that may occur within the WFA that uses echolocation is the sperm whale. Baleen whales, which includes North Atlantic right whales, fin, blue, and sei whales, do not echolocate. Sperm whales use echolocation primarily for foraging and social communication (NMFS 2010, NMFS 2015, Miller et al. 2004, Watwood et al. 2006); sperm whales are expected to be rare in the WFA due to the shallow depths and more typical distribution near the continental shelf break and further offshore. Sperm whale foraging is expected to be limited in the lease area because sperm whale prey occurs in deeper offshore waters (500-1,000m) (NMFS 2010). Therefore, even if there was a potential for the presence of the WTGs or foundations to affect echolocation, it is extremely unlikely that this would have any effect on sperm whales given their rarity in the WFA. Consideration of the effects of operational noise on whale communication is presented in section 7.1 of this Opinion.

Absent any information on the effects of wind farms or other foundational structures on the local abundance or distribution of whales and sea turtles, it is difficult to predict how listed whales and sea turtles will respond to the presence of the foundations in the water column. However, considering just the physical structures themselves, given the spacing between the turbines we do not expect that the physical presence of the foundations alone will affect the distribution of whales or sea turtles in the action area or affect how these animals move through the area. Additionally, the available data on harbor porpoises supports the conclusion that if there are decreases in abundance during wind farm construction those are not sustained during the operational period. As explained in section 7.1, we have determined that effects of operational noise will be insignificant and are not likely to disturb or displace whales, sea turtles, or Atlantic sturgeon. In the sections below, we consider the potential for the reef effect to affect species distribution in the WFA and the potential for the foundations and WTGs to affect habitat conditions and prey that could influence the abundance and distribution of listed species in the WFA.

7.4.3.2 Habitat Conversion and Reef Effect Due to the Presence of Physical Structures

As described in the BA, long-term habitat alteration would result from the installation of the foundations, scour protection around the WTG and OSS foundations, as well as cable protection along any portions of the inter-array and export cables that could not be buried to depth. Scour protection would be a maximum of 8.2 feet (2.5 meters) in height, would extend away from the foundations as far as 43 feet (13.1 meters), and would have a volume of 8,657 cubic yards (yd^3)

per monopile. The maximum conversion from soft to hardened substrate through scour protection for the Ocean Wind 1 Project is 439.4 acres.

The footprint of 98 WTGs foundations and three OSS foundations and associated scour protection in the form of boulders and concrete mats would permanently modify approximately 61 acres of seabed. In addition, approximately 171 acres of the seabed would be permanently modified in order to protect inter-array, export, and interconnection cables. In total, permanent habitat disturbance of 439.4 acres is anticipated to result from the project. The addition of the WTGs and an OSS, spaced 1.0 nautical mile apart, is expected to result in a habitat shift in the area immediately surrounding each monopile from soft sediment, open water habitat system to a structure-oriented system, including an increase in fouling organisms. Overall, construction of the Ocean Wind 1 foundations, cables, and associated scour protection would transform 439.4 acres (1.8 km^2) (of soft bottom habitat into coarse, hard bottom habitat (the entire Ocean Wind 1 WFA is approximately 78,720 acres (319 km^2). Over time (weeks to months), the areas with scour protection are likely to be colonized by sessile or mobile organisms (e.g., sponges, hydroids, crustaceans). This results in a modification of the benthic community in these areas from primarily infaunal organisms (e.g., amphipods, polychaetes, bivalves).

Hard-bottom and vertical structures in a soft-bottom habitat can create artificial reefs, thus inducing the 'reef' effect (Taormina et al. 2018). The reef effect is usually considered a beneficial impact, associated with higher densities and biomass of fish and decapod crustaceans in the area immediately surrounding the new structure (Taormina et al. 2018). This could provide a potential increase in available forage items for sea turtles compared to the surrounding soft-bottoms; however, this change in distribution/aggregation of some species does not necessarily increase overall biomass. In the North Sea, Coolen et al. (2018) sampled epifouling organisms at offshore oil and gas platforms and compared data to samples from the Princess Amalia Wind Farm (PAWF) and natural rocky reef areas. The 60 PAWF monopile turbine foundations with rock scour protection were deployed between November 2006 and March 2007 and surveys were carried out in October 2011 and July 2013. This study demonstrated that the WTG foundations and rocky scour protection acted as artificial reef with a rich abundance and diversity of epibenthic species, comparable to that of a natural rocky reef.

Stenburg et al. (2015) studied the long-term effects of the Horns Rev 1 offshore wind farm (North Sea) on fish abundance, diversity, and spatial distribution. Gillnet surveys were conducted in September 2001, before the WTGs were installed, and again in September 2009, 7 years post-construction at the wind farm site and at a control site 6 km away. The three most abundant species in the surveys were whiting (*Merlangius merlangus*), dab (*Limanda limanda*), and sand lance (*Ammodytidae spp*.). Overall fish abundance increased slightly in the area where the wind farm was established but declined in the control area 6 km away. None of the key fish species or functional fish groups showed signs of negative long-term effects due to the wind farm. Whiting and the fish group associated with rocky habitats showed different distributions relative to the distance to the artificial reef structures introduced by the turbines. Rocky habitat fishes were most abundant close to the turbines while whiting was most abundant away from them. The authors also note that the wind farm development did not appear to affect the sand-dwelling species dab and sand lance, suggesting that the direct loss of habitat (<1% of the area around the wind farm) and indirect effects (e.g. sediment composition) were too low to influence their abundance. Species diversity was significantly higher close to the turbines. The authors conclude that the results indicate that the WTG foundations were large enough to attract fish species with a preference for rocky habitats, but not large enough to have adverse negative effects on species inhabiting the original sand bottom between the turbines. However, more research is still needed within offshore wind farm areas because each offshore wind farm area contains different environmental characteristics. For instance, research from Daewel et al. (2022) suggest changes in organic sediment distribution and quantity could have an effect on the habitat quality for benthic species such as Ammodytes spp. (e.g., sand lance) that live in the sediments within wind farm areas.

Methratta and Dardick (2019) carried out a meta-analysis of studies in Europe to examine finfish abundance inside wind farms compared to nearby reference sites. The overall effect size was positive and significantly different from zero, indicating greater abundance of fish inside of wind farm areas compared to the reference sites. More specifically, the study determined increases were experienced for species associated with both soft-bottom and complex-bottom habitat but changes in abundance for pelagic species were not significantly different from zero. The authors report that no significant negative effects on abundance were identified.

Hutchison et al. (2020) describes benthic monitoring that took place within the Block Island Wind Farm (BIWF, Rhode Island) to assess spatiotemporal changes in sediment grain size, organic enrichment, and macrofauna, as well as the colonization of the jacket foundation structures, up to four years post-installation. The greatest benthic modifications occurred within the footprint of the foundation structures through the development of mussel aggregations. Additionally, based on the presence of juvenile crabs (Cancer sp.),the authors conclude that the BIWF potentially serves as a nursery ground, as suggested from increased production rates for crabs (*Cancer pagurus*) at European OWFs (Krone et al., 2017). The dominant mussel community created three-dimensional habitat complexity on an otherwise smooth structure, benefiting small reef species such as cunner (*Tautogolabrus adspersus*), while at a larger scale, the turbine structures hosted abundant black sea bass (*Centropristis striata*) and other indigenous bentho-pelagic fish.

For the Ocean Wind 1 project, effects to listed species from the loss of soft bottom habitat and conversion of soft bottom habitat to hard bottom habitat may occur if this habitat shift resulted in changes in use of the area (considered below) by listed species or resulted in changes in the availability, abundance, or distribution of forage species.

The only forage fish species we expect to be impacted by the loss of soft-bottom habitat would be sand lance (*Ammodytes spp.).* The ESA listed species in the WDA that may forage on sand lance include Atlantic sturgeon, fin, and sei whales. As sand lance are strongly associated with sandy substrate, and the project would result in a loss of such soft bottom, 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 action area. However, even just considering the WFA, which is dominated by sandy substrate, the loss or conversion of soft bottom habitat is very small, less than 0.3% (and less than 0.000% of the action area). The results from Stenburg et al. (2015; summarized above) suggest that this loss of habitat is not great enough to impact abundance in the area and that there may be an increase in abundance of sand lance despite this small loss of habitat. However, even in a worst case scenario assuming that the reduction in the abundance of sand lance is directly proportional to the amount of soft substrate lost, we would expect a 0.3% reduction in availability of sand lance in the lease area and a 0.0001% reduction in the sand lance available as forage for fin and sei whales and Atlantic sturgeon in the action area. Given this small, localized reduction in sand lance and that sand lance are only one of many species the fin and sei whales and Atlantic sturgeon may feed on in the action area, any effects to these species are expected to be so small that they cannot be meaningfully measured, evaluated, or detected and are, therefore, insignificant.

Based on the available information (e.g., Methratta and Dardick 2019, Stenburg et al. 2015), we expect that there may be an increase in abundance of schooling fish in the WFA that sei or fin whales may prey on but that this increase may be a result of redistribution of species to the WFA rather than a true increase in abundance. Either way, at the scale of the action area, the effects of any increase in abundance of schooling fish resulting from the reef effect will be so small that the effects to sei or fin whales cannot be meaningfully measured, evaluated, or detected. Similarly, we expect that there may be an increase in jellyfish and other gelatinous organism prey of leatherback sea turtles but that at the scale of the action area, any effects to leatherback sea turtles will be so small that they cannot be meaningfully measured, evaluated, or detected. Because we expect sperm whale foraging to be limited in the WFA (due to the shallow depths and location inshore of the shelf break), any effects to sperm whale foraging as a result of localized changes in the abundance or distribution of potential prey items are extremely unlikely.

Atlantic sturgeon would experience a reduction in infaunal benthic organisms, such as polychaete worms, in areas where soft substrate is lost or converted to hard substrate. As explained above, the action area is not an aggregation area or otherwise known to be a high use area for foraging. Any foraging by Atlantic sturgeon is expected to be limited to opportunistic occurrences. Similar to the anticipated reduction in sand lance, the conversion of soft substrate to hard substrate may result in a proportional reduction in infaunal benthic organisms that could serve as forage for Atlantic sturgeon. Assuming that the reduction in the abundance of infaunal benthic organisms in the action area is directly proportional to the amount of soft substrate lost, we would expect an extremely small (0.3% of the lease area and an even smaller percentage of the total action area) reduction in the abundance of these species as forage for Atlantic sturgeon in the action area. Given that any reduction in potential prey items for Atlantic sturgeon will be small, localized, and patchy and that the WDA is not an area that sturgeon are expected to be dependent on for foraging, any effects to Atlantic sturgeon are expected to be so small that they cannot be meaningfully measured, evaluated, or detected and are, therefore, insignificant. Also, to the extent that epifaunal species richness is increased in the WFA due to the reef effect of the WTGs and their scour protection, and to the extent that sturgeon may feed on some of these benthic invertebrates, any negative effects may be offset.

The available information suggests that the prey base for Kemp's ridley and loggerhead sea turtles may increase in the action area due to the reef effect of the WTGs, associated scour protection, and an increase in crustaceans and other forage species. However, given the small size of the area impacted and any potential resulting increase in available forage, any effects of this patchy and localized increase in abundance are likely to be so small that they cannot be meaningfully measured, evaluated, or detected. No effects to the forage base of green sea turtles are anticipated as no effects on marine vegetation are anticipated.

No effects to copepods that serve as the primary prey for right whales are anticipated to result from the reef effect considered here. In section 7.4.3.3 below, we explain how the physical presence of the foundations may affect ecological conditions that could impact the distribution, abundance, or availability of copepods.

7.4.3.3 Effects to Oceanic and Atmospheric Conditions due to Presence of Structures and Operation of WTGs

As explained in section 6.0 (*Environmental Baseline*), the Ocean Wind 1 WFA is located within multiple defined marine areas. Here, we consider the best available information on how the presence and operation of WTGs and the OSSs from the proposed Ocean Wind 1 Wind Farm project may affect the oceanographic and atmospheric conditions in the action area and whether there will be any consequences to listed species. A number of theoretical, model-based, and observational studies have been conducted to help inform the potential effects offshore wind farms may have on the oceanic and atmospheric environment; summaries of several of these studies are described in this section. In 2022, NMFS contracted with EA Engineering to prepare a literature review on this topic. Much of the information in this section of the Opinion is based on that review. In general, most of these studies discuss local scale effects (within the area of the windfarm) and are focused in Europe where commercial-scale offshore wind farms are already in operation. At various scales, documented effects include increased turbulence, changes in sedimentation, reduced water flow, and changes in hydrodynamics, wind fields, stratification, water temperature, nutrient upwelling, and primary productivity.

Two turbines were installed offshore Virginia in the summer of 2020 where the weather and hydrodynamic conditions were measured during the installation period; however, no additional reports or literature about oceanographic or atmospheric impacts during operation has been published (HDR 2020). Similarly, no reports or literature about oceanographic or atmospheric impacts during operation of the five turbines at the Block Island Wind Farm have been published.

Background Information on Oceanic and Atmospheric Conditions in the Project Area

The broadest area, the U.S. Northeast Shelf Large Marine Ecosystem, extends from the Gulf of Maine to Cape Hatteras, North Carolina (Kaplan 2011). The WDA is located within the Southern Mid-Atlantic Bight sub-region of the Northeast U.S. Shelf Ecosystem, which is distinct from other regions based on differences in productivity, species assemblages and structure, and habitat features (Cook and Auster 2007). The physical oceanography of this region is influenced by the seafloor, freshwater input from multiple rivers and estuaries, large-scale weather patterns, and tropical or winter coastal storm events. Weather-driven surface currents, tidal mixing, and estuarine outflow all contribute to driving water movement through the area (Kaplan 2011).

A variety of existing oceanographic research and monitoring is conducted in the region by state and federal agencies, academic institutions, and non-governmental organizations using an array of platforms including ships, autonomous vehicles, buoys, moorings, and satellites. Research and monitoring efforts include measuring the physical and biological structure of the ocean environment including variables such as temperature, chlorophyll, and salinity at a range of depths as well as long-term shelf-wide surveys that provide data used to estimate spawning stock biomass, overall fish biodiversity, zooplankton abundance, information on the timing and location of spawning events, and insight to detect changes in the environment. In the waters of the WFA and further south and east along the continental shelf, the broad, year-round pattern of currents are generally understood. Shelf currents in the Ocean Wind I project area generally flow in a southerly direction (WHOI 2016). These bottom currents are influenced by local bathymetry and regional density gradients. Prominent bottom features of the Mid-Atlantic Bight include a series of ridges and troughs. On the OCS off the coast of New Jersey, the largest slopes are associated with sand ridges, which are generally parallel to the shoreline and are actively modified by ocean currents (Goff et al 2005). While the WFA is a generally flat expanse of soft sediments with seafloor slopes that are typically less than 1°, geophysical surveys in and near portions of the lease area identified ridges of up to 15m (49 ft.) above the surrounding seabed (Guida et al 2017, Ocean Wind 2022). From the coastline to the WFA along the export cable routes, there is a shallow slope with an average gradient of less than 1°.

On a seasonal scale, the greater Mid-Atlantic Bight region experiences one of the largest transitions in stratification in the entire ocean (Castelao, Glenn, and Schofield, 2010). Starting in the late spring, a strong thermocline develops at approximately 20 m depth across the middle to outer shelf, and forms a thermally isolated body of water known as the "cold pool" which shifts annually but generally extends from the waters of southern New England (in some years, the WFA is on the northern edge of the cold pool) to Cape Hatteras. Starting in the fall, the cold pool breaks down and transitions to cold and well-mixed conditions that last through the winter (Houghton et al. 1982). The cold pool is particularly important to a number of demersal and pelagic fish and shellfish species in the region, but also influences regional biological oceanography as wind-assisted transport and stratification have been documented to be important components of plankton transport in the region (Checkley et al. 1988, Cowen at al. 1993, Hare et al. 1996, Grothues et al. 2002, Sullivan et al. 2006, Narvaez et al. 2015, Munroe et al. 2016).

The region also experiences upwelling in the summer driven by southwest winds associated with the Bermuda High (Glenn & Schofield 2003; Glenn et al. 2004). Cold nutrient-rich water from the cold pool can be transported by upwelling events to surface and nearshore waters. At the surface, this cold water can form large phytoplankton blooms, which support many higher trophic species (Sha et al. 2015).

The cold pool supports prey species for ESA-listed species, both directly through providing habitat and indirectly through its influence on regional biological oceanography, which supports a productive ecosystem (Kane 2005, Chen et al. 2018, Winton et al. 2018). Lower-trophic plankton species are well adapted to take advantage of the variable seasonality of the regional ecosystem, and support the upper food web for species such as pelagic fish, sea turtles, and marine mammals (Kenney and Vigness-Raposa 2010, Pershing and Stamieszkin 2019). Though plankton exhibit movement behavior, physical and oceanographic features (e.g. tidal mixing fronts, thermal fronts, freshwater plumes, internal waves, stratification, horizontal and vertical currents, and bathymetry) are the primary drivers that control aggregations and concentrate them by orders of magnitude (Pershing and Stamieszkin 2019, Kraus et al. 2019).

Many marine species including fish, sea turtles, and marine mammals forage around these physical and oceanographic features where prey is concentrated. Physical and oceanographic features are the primary drivers that control aggregations and concentrations of plankton. ESA-listed species in the region primarily feed on five prey resources - zooplankton, pelagic fish, gelatinous organisms, marine vegetation, and benthic mollusks. Of the listed species in the area, North Atlantic right whales and blue whales are the only obligate zooplanktivores (i.e., they eat only zooplankton). Blue whale presence in the WFA is expected to be rare and foraging is not anticipated. Sei and fin whales may be present in the WFA, however in addition to plankton both species eat small schooling fish.

As described in the Environmental Baseline, North Atlantic right whales have been observed in or near New Jersey waters during all four seasons; however, they are most common in spring when they are migrating north and in fall during their southbound migration (Kenney and Vigness-Raposa 2010, Roberts et al. 2016, Roberts et al. 2020). These seasonal occurrence observations are aligned with more recent findings from aerial survey data collected from 2017-2020, where North Atlantic right whales were seen in waters adjacent to New York during all seasons except summer (Zoidis et al. 2021). Additionally, buoys and gliders have detected North Atlantic right whale calls in the vicinity of the Ocean Wind Farm (WHOI 2021). A single North Atlantic right whale sighting occurred in the Study Corridor during Ocean Wind's Geotechnical 1A Survey in winter 2017-2018 (Smultea Environmental Sciences 2018), but no North Atlantic right whales were observed during the Ocean Wind Offshore Wind Farm Survey in summer 2017 in the Study Corridor (Alpine 2017). Three North Atlantic right whale sightings within the Ocean Wind survey area were reported between 13 and 14 December 2018 (NOAA Right Whale Sighting and Advisory System 2019).

Whitt et al. (2013) reported behaviors for two juvenile right whales that were sighted together including skim-feeding behavior offshore of Barnegat Bay. Although feeding could not be confirmed by prey samples or evidence of prey patches, the authors surmise that the nearshore waters of New Jersey may be utilized as more than just a migratory pathway; and that feeding may occur outside of the typical feeding period of spring through early fall and in areas farther south than the main feeding grounds (Winn et al. 1986, Gaskin 1987, 1991, Hamilton and Mayo 1990, Kenney et al. 1995, Whitt et al 2013). The May 2019 sighting of a single North Atlantic right whale skim feeding at the shelf break in adjacent New York Bight waters, supplement and update what is currently known about the distribution and habitat use patterns of North Atlantic right whales in the larger Mid-Atlantic Bight.

Based on the best available scientific information, North Atlantic right whales may opportunistically forage in the Ocean Wind WDA when suitably dense patches of prey are present. However, this is not a primary foraging area, an area where individuals are expected to be resident, and it is not known or expected to routinely support sustained foraging behavior.

Effects on Water Temperature

A modeling study was conducted for the Great Lakes region of the U.S. to simulate the impact of 432 9.5 MW (4.1 GW total) offshore wind turbines on Lake Erie's dynamic and thermal structure. Model results showed that the wind farms did have an impact on the area they were built in by reducing wind speed and wind stress, which led to less mixing, lower current speeds and higher surface water temperature (Afsharian et al. 2020). The model demonstrated reduced wind speed and stress leading to less mixing, lower current speeds, and higher surface water temperatures (1-2.8°C, depending on the month). No changes to temperatures below the surface are reported. The authors note that these impacts were limited to the vicinity of the wind farm. Though modeled in a lake environment, these results may be informative for predicting effects in the marine environment as the presence of structures and interactions with wind and water may act similarly; however, given the scale of the model and specificity of the modeled conditions and outputs to Lake Erie it is not possible to directly apply the results to an offshore wind project in the action area generally or the Ocean Wind 1 project in particular.

Some literature is available that considers the potential impacts of wind power development on temperature. Miller and Keith (2018) developed a model to better understand climatic impacts due to wind power extraction; however, the paper addresses how a modeled condition would affect average surface temperatures over the continental U.S. and does not address offshore wind turbines or any effects on ocean water temperatures. Wang and Prinn (2010 and 2011) carried out modeling to simulate the potential climatic effects of onshore and offshore wind power installations; they found that while models of large scale onshore wind projects resulted in localized increases in surface temperature (consistent with the pattern observed in the Miller and Keith paper), the opposite was true for models of offshore wind projects. The authors found a local cooling effect, of up to 1°C, from similarly sized offshore wind installations. The authors provide an explanation for why onshore and offshore turbines would result in different localized effects.

Golbazi et al. 2022 simulated the potential changes to near-surface atmospheric properties caused by large offshore wind farms equipped with offshore wind turbines of 10 and 15 MW. In the model, they simulated 30 GW of offshore wind turbines located in identified lease and planning areas in the U.S. Atlantic. The model results show that, at hub height, an average wind speed deficit of 0.5 m/s extends up to 50 km downwind from the edge of the farms with an average wind speed reduction at the surface that is 0.5 m s/1 or less (a 10% maximum reduction) within the project footprint. This results in a slight cooling, up to −0.06 K, at the surface in the summer. The authors conclude that, on average, meteorological changes at the surface induced by 10-15 MW offshore wind turbines will be nearly imperceptible in the summer. They also note that future research is needed to explore changes in other seasons.

If the effects predicted by the model in Golbazi et al. and Wang and Prinn are realized as a result of the Ocean Wind 1 project, minor cooling of waters in the action area in the summer months would be expected. We do not anticipate that any minor cooling of waters in the action area in the summer months would have any effects to the abundance or distribution of listed species or the abundance or distribution of prey. Based on the available information, any effects to listed species from any changes in water temperature (if there are any at all) will be so small that they cannot be meaningfully measured, evaluated, or detected and are therefore, insignificant.

Ocean-Atmosphere and Wind Field Interactions
Studies have examined the wind wakes produced by turbines and the subsequent turbulence and reductions in wind speed, both in the atmosphere and at the ocean surface. Alterations to wind fields and the ocean–atmosphere interface have the potential to modify both atmospheric and

hydrodynamic patterns, potentially on large spatial scales up to dozens of miles from the offshore wind facility (Dorrell et al. 2022, Gill et al. 2020, Christiansen et al. 2022). Interactions between the ocean and the atmosphere in the presence of wind turbine structures are highly variable based on ambient wind speed, the degree of atmospheric stability, and the number of turbines in operation. In general, as an air current moves towards and past a turbine, the structure reduces air velocities downstream and has the potential to generate turbulence near the ocean surface. This relative velocity deficit and increased turbulence near turbine structures create a cone-shaped wake of wind change (known as wind wake) in the downstream region. Studies elucidating the relationship between offshore wind facilities and the atmospheric boundary layer, meteorology, downstream areas, and the interface with the ocean are still emerging. As noted above, no in-situ studies have been carried out in the U.S. to date.

Generally, a wind energy facility is expected to reduce average wind speeds both upstream and downstream; however, studies report a wide range of values for average wind speed deficits, in terms of both magnitude and spatial extent. Upstream of a large, simulated offshore wind facility, Fitch et al. (2012) found wind blocking effects to reduce average wind speeds by 1% as far as 9 miles (15 kilometers) ahead of the facility. Downstream of an offshore wind facility, wind speeds may be reduced up to 46%, with wind wakes ranging from 3 to 43 miles (5 to 70 kilometers) from the turbine or array (Christiansen and Hasager 2005; Carpenter et al. 2016; Platis et al. 2018; Cañadillas et al. 2020; van Berkel et al. 2020; Floeter et al. 2022). Wind speed deficit is greatest at hub height downstream of the facility, with the deficit decreasing closer to the ocean surface (Golbazi et al. 2022). Simulations of multiple clustered, large offshore wind facilities in the North Sea suggest that wind wake may extend as far as 62 miles (100 kilometers) (Siedersleben et al. 2018). In the northeast shelf, wind wakes emerging from simulations of full lease area buildouts were shown to combine and extend as far as 93 miles (150 kilometers) on certain days (Golbazi et al. 2022). Wind speed reduction may occur in an area up to 100 times larger than the offshore wind facility itself (van Berkel et al. 2020). A recent study has investigated long-range wind wake deficit potential in the New York Bight offshore development area using weather research and forecasting (WRF) offshore wind facility parameterization. ArcVera Renewables (2022) determined that expert literature that used engineering wake loss models has under-predicted wind wakes, and their study describes wind wakes that extend up to or greater than 62 miles (100 kilometers) downstream of large offshore wind facilities.

A study on the effect of large offshore wind farms (~ 80 turbines) in Europe on the local wind climate using satellite synthetic aperture radar found that a decrease of the mean wind speed is found as the wind flows through the wind farms, leaving a velocity deficit of 8–9% on average, immediately downstream of the wind turbine arrays. Wind speed was found to recover to within 2% of the free stream velocity over a distance of 5–20 km past the wind farm, depending on the ambient wind speed, the atmospheric stability, and the number of turbines in operation (Christiansen & Hasager 2005). Using an aircraft to measure wind speeds around turbines, Platis et al. (2018) found a reduction in wind speed within 10km of the turbine.

Ocean-Atmosphere Responses to Wind Field Interactions

The disturbance of wind speed and wind wakes from wind farms can cause oceanic responses such as upwelling, downwelling, and desertification (van Berkel et al. 2020; Dorrell et al. 2022; Floeter et al. 2022). According to Broström (2008), a windfarm can cause a divergence/convergence in the upper ocean due to a strong horizontal shear in the wind stress and resulting curl of the wind stress. This divergence and convergence of wind wakes can cause upwelling and downwelling. Upwelling can have significant impacts on local ecosystems due to the influx of nutrient rich, cold, deep, water that increases biological productivity and forms the basis of the lower trophic level. Broström 2008 indicates that the induced upwelling by a wind farm will likely increase primary production, which may affect the local ecosystem. Oceanic response to an altered wind field is predicted to extend several kilometers around offshore wind facilities and to be strong enough to influence the local pelagic ecosystem (Broström 2008; Ludewig 2015; Floeter et al. 2022). Floeter et al. (2022) conducted the first observations of wind wake-induced upwelling/downwelling dipoles and vertical mixing downstream of offshore wind facilities in the North Sea. The study identified two characteristic hydrographic signatures of wind wake-induced dipoles. First, distinct changes in mixed layer depth and water column potential energy anomaly were observed over more than 3 miles (5 kilometers). Second, the thermocline exhibited diagonal excursions, with maximum vertical displacement of 46 feet (14 meters) over a dipole dimension of 6–7 miles (10–12 kilometers). Additionally, preliminary research by Daewel et al. (2022) suggests that ongoing offshore wind energy developments can have a significant impact on coastal marine ecosystems. This study deduced that wind wakes of large offshore wind energy clusters in the North Sea cause large-scale changes in annual primary production with local changes of up to 10%. These changes occur within the immediate vicinity of the offshore wind energy cluster and travel over a wider region (up to 1–2 kilometers outside the cluster of projects).

Wave amplitude within and surrounding offshore wind energy facilities may be altered by changes to the wind field. A decrease in surface roughness can be observed in optical and radar images at considerable distances down-wind of a wind farm under certain conditions (Forster 2018). Johnson et al. (2021b) analyzed localized turbulence effects of various proposed offshore wind build-out scenarios using a three-dimensional model from Cape Hatteras to offshore Cape Cod, with a finer mesh embedded in the Massachusetts/Rhode Island wind energy area. Results of the hydrodynamic modeling suggested that the extraction of wind energy by offshore wind facilities in the Massachusetts/Rhode Island wind energy area could reduce current magnitude and wave height. By modifying the sea surface wind shear stress, wind energy extraction affected the wind field within and beyond the modeled facility (comprising a full build-out of the wind energy area with 1,063 turbines, each 12-MW). Relative to the modeled baseline, significant wave height was reduced by up to 2.46 feet (0.75 meter) inside the facility, by up to 1.48 feet (0.45 meter), just outside the facility, and up to 0.49 foot (0.15 meter) at the coast.

The regional impact of wind wakes is challenging to quantify due to natural spatiotemporal variability of wind fields, sea levels, and local ocean surface currents in the northeast shelf (Floeter et al. 2022). Individual dipole patterns can either superimpose or decrease airflow velocities, for example depending on the spatial orientation of the tidal ellipse in relation to the direction of the wind wake (Floeter et al. 2022). Increased airflow velocities near the water surface result in decreased water surface elevation of a 2-millimeter magnitude, while decreased airflow velocities result in increased water surface elevation of a similar magnitude (Christiansen et al. 2022). This magnitude may be negligible in the context of the substantial year-to-year changes in annually averaged coastal sea level in the northeast shelf (i.e., 650 millimeters), which is attributed to the region's existing along-shelf wind stress (Andres et al. 2013; Li et al.

2014). Christiansen et al. (2022) modeled sea surface velocity changes downstream of multiple offshore arrays in the North Sea and found that induced changes equated to a "substantial" 10–25% of the interannual and decadal sea surface velocity variability in the region.

Hydrodynamic Interactions

The introduction of offshore wind energy facilities into ocean waters influences adjacent ocean flow characteristics, as turbine foundation structures and currents, tides, etc. interact. The dynamics of ocean flow past vertical structures has received relatively more study in well-mixed seas than in strongly stratified seas (Dorrell et al. 2022). Most studies on wake and turbulence caused by foundation structures are gleaned from modeled simulations, as field studies are challenging due to the numerous variables and natural variability in flow (Schultze et al. 2020). Only two studies to date have observed in situ the response of stratified waters to the presence of offshore wind energy facilities (Floeter et al. 2017; Schultze et al. 2020).

Hydrodynamic effects of offshore wind facilities and their secondary effects are only beginning to be studied within United States shelf waters. Johnson et al. (2021b) prepared a hydrodynamic modeling study investigating the potential impacts of offshore wind energy development on oceanographic conditions in the northeast shelf, assessing the changes in hydrodynamic conditions resulting from a theoretical modeled offshore wind facility in the Massachusetts-Rhode Island offshore wind energy area. The results suggest that introduction of 1,063 12 MW WTGs would influence the thermal stratification by introducing additional mixing. The model suggests a relative deepening in the thermocline compared to baseline temperatures of approximately 3.3 to 6.6 feet (1 to 2 meters) and retention of colder water within the footprint of the modeled wind facility through the summer months (Johnson et al. 2021b). The study also suggested that the thermocline would on average move deeper in both the spring and summer models, with more cold water retained within the footprint of the offshore wind facility (Johnson et al. 2021b). The results of Johnson et al. (2021b) contrast with a European field study by Floeter et al. (2017) in the German North Sea, which found a doming of the thermocline and enhanced mixing, or more uniform temperatures, in the layer below the thermocline. While the Floeter et al. (2017) study observed changes in vertical mixing, and enhanced local upwelling, these changes may be due to natural variability. Additionally, there are numerous differences between the sites in Southern New England and the German North Sea. First, the climate setting and hydrodynamic conditions differ (e.g., offshore wind facility locations relative to the shelf, general circulation around the offshore wind facilities, temperature and stratification regime, depth, and solar radiation and heat transfer). Second, the operational status of the actual and modeled offshore wind facilities differs (i.e., there being no current speed reduction due to wind wake loss in the German North Sea study) (Johnson et al. 2021b). Additionally, while Johnson et al. (2021b) conclude that the introduction of the offshore wind energy structures modifies temperature stratification by introducing additional mixing, the model did not include influences from strong storms, which are a primary component of mixing in the Southern New England region. The authors acknowledge that the model's single year of simulations would require additional years to assess year-to-year variability of the model parameters and that modeling of this nature is more suited for a review of differences between scenarios rather than absolute accuracy of individual scenarios.

Using remote sensing, Vanhellemont and Ruddick (2014), showed that offshore wind farms can have impacts on suspended sediments. Wakes of turbidity from individual foundations were observed to be in the same direction as tidal currents, extending 30–150 m wide, and several km in length. However, the authors indicate the environmental impact of these wakes and the source of the suspended material were unknown. Potential effects could include decreased underwater light field, sediment transport, and downstream sedimentation (Vanhellemont and Ruddick 2014).

The primary structure-induced hydrodynamic effects of wind turbine foundations are friction and blocking, which increase turbulence, eddies, sediment erosion, and turbidity in the water column (van Berkel et al. 2020). A number of studies have investigated the impacts of offshore wind farms on stratification and turbulence (Carpenter et al. 2016, Dorrell et al. 2022; Schultz et al. 2020). As water moves past wind turbine foundations the foundations generate a turbulent wake that will contribute to a mixing of a stratified water column or may disperse aggregations of plankton. These studies have demonstrated decreased flow and increased turbulence extending hundreds of meters from turbine foundations. However, the magnitude is highly dependent on the local conditions (e.g. current speed, tides, and wind speed), with faster flow causing greater turbulence and extending farther from the foundation. Carpenter et al. (2016) used a combination of numerical models and in situ measurements from two windfarms (Bard 1 and Global Tech 1) to conduct an analysis of the impact of increased mixing in the water column due to the presence of offshore wind structures on the seasonal stratification of the North Sea. Based on the model results and field measurements, estimates of the time scale for how long a complete mixing of the stratification takes was found to be longer, though comparable to, the summer stratification period in the North Sea. The authors concluded that it is unlikely the two windfarms would alter seasonal stratification dynamics in the region. The estimates of mixing were found to be influenced by the pycnocline thickness and drag of the foundations of the wind turbines. For there to be a significant impact on stratification from the hydrodynamic impacts of turbine foundations over a large area, large regions (length of 100 km) of the North Sea would need to be covered with wind farms; however the actual threshold was not defined (Carpenter et al. 2016). Schultz et al. 2020 found similar results in the same area of the German Bight of the North Sea.

Monopiles were found to increase localized vertical mixing due to the turbulence from the wakes generated from monopiles, which in turn could decrease localized seasonal stratification and could affect nutrient cycling on a local basis. Using both observational and modeling methods to study impacts of turbines on turbulence, Schultze et al. (2020) found through modeling simulations that turbulent effects remained within the first 100 m of the turbine foundation under a range of stratified conditions. Field measurements at the OWF DanTysk in the German Bight of the southern North Sea, observed a wake area 70 m wide and 300 m long from a single monopile foundation during weak stratification (0.5°C surface-to bottom temperature difference). No wake or turbulence was detected in stronger thermal stratification (~3°C surface-to-bottom temperature difference) (Schultze et al. 2020). The OWF DanTysk is composed of 6 m diameter monopiles. Similarly, a laboratory study measured peak turbulence within 1 monopile diameter distance from the foundation and that downstream effects (greater than 5% of background) persisted for 8–10 monopile diameters distances from the foundation (Miles, Martin, and Goddard 2017).

Impacts on stratification and turbulence could lead to changes in the structure, productivity, and circulation of the oceanic regions; however, the scale and degree of those effects is dependent in part on location. If wind farms are constructed in areas of tidal fronts, the physical structure of wind turbine foundations may alter the structure of fronts, which could affect distribution of prey and lead to effects to the marine vertebrates that use these oceanic structures for foraging (Cazenave et al. 2016). As areas of frontal activity are often pelagic biodiversity hotspots, altering their structure may decrease efficient foraging opportunities for listed species. In an empirical bio-physical study, Floeter et al. (2017) used a remotely operated vehicle to record conductivity, temperature, depth, oxygen, and chlorophyll-a measurements of an offshore wind farm. Vertical mixing was found to be increased within the wind farm, leading to a doming of the thermocline and a subsequent transport of nutrients into the surface mixed layer. Though discerning a wind farm-induced relationship from natural variability is difficult, wind farms may cause enhanced mixing, and due to the interaction between turbulence levels and the growth of phytoplankton, this could have cascading effects on nutrient levels, ecosystems, and marine vertebrates (Carpenter et al. 2016, Floeter et al. 2017). Water flowing around turbine foundations may also cause eddies to spawn, potentially resulting in more retention of plankton in the region when combined daily vertical migration of the plankton (Chen et al. 2016, Nagel et al. 2018). However, it is important to note that these conclusions from Chen et al. (2016) are hypothesized based on a modeling study and not observed in the region.

Van Berkel et al (2020) investigated available information on the effects of offshore wind farms on hydrodynamics and implications for fish. The authors report that changes in the demersal community have been observed close to wind farms (within 50 m) and that those changes are related to structure-based communities at the wind farm foundations (e.g., mussels). The authors also report on long-term studies of fish species at the Horns Reef project (North Sea) and state that no significant changes in abundance or distribution patterns of pelagic and demersal fish have been documented between control sites and wind farm sites or inside/between the foundations at wind farm sites. They report that any observed changes in density were consistent with changes in the general trend of species reflected in larger scale stock assessment reports (see also Stenberg et al. 2015).

Modeling experiments have demonstrated that the introduction of monopiles could have an impact on the M2 amplitude (semidiurnal tidal component due to the moon) and phase duration. Modeling showed the amplitude increased between 0.5-7% depending on the preexisting amphidrome, defined as the geographical location, which has zero tidal amplitude for one harmonic constituent of the tide. Changes in the tidal amplitude may increase the chances of coastal flooding in low-lying areas. However, we have no information to suggest that any potential effects on M2 amplitude would have any effects on marine resources generally or ESA-listed species specifically.

Primary Production and Plankton Distribution

As water flows around turbine and OSS foundations there is the potential that aggregations of planktonic prey may be dispersed due to the increased mixing caused by water moving around foundations; however, it is also possible that foundations act to trap prey if eddies form in the wake of turbine foundations or concentrate prey in a convergent current situation. However, decreased mixing could also cause increased stratification and subsequently affect the exchange of nutrients, heat, and trap prey.

A few studies have been conducted to evaluate how altered hydrodynamic patterns around offshore wind projects could affect primary production as well as upper trophic levels. Floeter et al., 2017 demonstrated with empirical data from the southern North Sea that increased vertical mixing at an offshore wind farm resulted in the transport of nutrients to the surface mixed layer and subsequent uptake by phytoplankton in the photic zone. Increased primary production could increase the productivity of bivalves and other macrobenthic suspension feeders that are expected to be a major component of artificial reef communities that form on turbine foundations (Slavik et al., 2019, Mavraki et al., 2020; Daewel et al. 2022). The results of analyses conducted by Floeter et al. 2017 and Friedland et al. 2021 suggest that wind farm effects on phytoplankton and zooplankton might extend to upper trophic level impacts, potentially modifying the distribution and abundance of finfish and invertebrates. However, the spatial scale of these effects remains unknown but could range from localized within individual farms to broader spatial scales (Carpenter et al., 2016; Bakhoday-Paskyabi et al., 2018).

Wang et al. 2018 evaluated pre and post-construction water column properties (water temperature, dissolved oxygen, and suspended matter concentration) and zooplankton community structure at an offshore wind farm in China. The wind farm consisted of 70 WTGS (232 MW total) located in the intertidal zone less than 11 km from the shore in the Yellow Sea. The goal of this study was to examine the responses of the zooplankton community to the establishment of an OWF, the causes of any observed effects, and their relation to environmental factors in the study area. The analysis documented changes in the zooplankton community (e.g., seasonal increases and decreases in marco and microzooplankton). However, given that there are significant differences in the location and conditions between the site in China and the Ocean Wind location (e.g., tidal flat/intertidal zone vs. well offshore) and the layout of the site (WTGs are much closer together at the China site) it is not clear that the results of this study will be informative for the Ocean Wind project.

Daewel et al. 2022 used modeling to demonstrate the effects of wind wake from offshore wind projects in the North Sea on primary productivity. The model results show that the systematic modifications of stratification and currents alter the spatial pattern of ecosystem productivity; annual net primary production (netPP) changes in response to OWF wind wake effects in the southern North Sea show both areas with a decrease and areas with an increase in netPP of up to 10%. There was a decrease in netPP in the center of the large OWF clusters in the inner German Bight and at Dogger Bank, which are both situated in highly productive frontal areas, and an increase in areas around these clusters in the shallow, near-coastal areas of the German Bight and at Dogger Bank. The authors note that additional work is needed to identify the robustness of these patterns with respect to different weather conditions and interannual variations. They also note that when integrated over a larger area, the estimated positive and negative changes tend to even out. Besides the changes in the pelagic ecosystem, the model results highlight a substantial impact on sedimentation and seabed processes. The overall, large-scale reduction in average current velocities results in reduced bottom-shear stress to up to 10% locally; however, averaged over larger areas the effect is less pronounced with only a 0.2% increase North Sea wide. The model also indicates an impact of OWF on bottom water oxygen in the southern North Sea. In an area with a bathymetric depression (Oyster Grounds), the dissolved oxygen concentrations in late summer and autumn were further reduced by about 0.3 mg l^{-1} on average and up to 0.68 mg l^{-1} locally. In other areas of the southern North Sea, the effect was estimated to be less severe, or even showing an increase in dissolved oxygen concentration, like e.g., along the edges of Dogger Bank.

Consideration of Potential Effects of the Ocean Wind 1 Wind Farm
In general, the studies referenced above describe varying scales of impacts on the oceanographic and atmospheric processes as a resultant effect of offshore wind turbine development. These impacts include increased turbulence generated by the presence of turbine foundations, extraction of wind by turbine operations reducing surface wind stress and altering water column turbulence, and upwelling and downwelling caused by the divergence and convergence of wind wakes (Miles et al. 2021). Oceanographic and atmospheric effects are possible at a range of temporal and spatial scales, based on regional and local oceanographic and atmospheric conditions as well as the size and locations of wind farms. However, discerning a wind farm-induced relationship from natural variability is difficult and very specific to local environmental conditions where the wind farm is located. As described above, the particular effects and magnitudes can vary based on a number of parameters, including model assumptions and inputs, study site, oceanographic and atmospheric conditions, turbine size, and wind farm size and orientation (Miles et al. 2021). Here, we consider the information presented above, incorporate the layout and parameters of the Ocean Wind 1 Wind Farm and local oceanographic and atmospheric conditions and evaluate effects to ESA-listed species. We note that while we are using the best available information to assess effects of the Ocean Wind 1 project, there is significant uncertainty about how offshore wind farms in the action area may alter oceanographic processes and the biological systems that rely on them. The available information suggests that some impacts require very large scale wind development before they would be realized; as such, we note that the conclusions reached here are specific to the scope of the Ocean Wind 1 project (98 WTGs and their foundations, up to three OSSs and their foundations, and total approximate capacity of 1,100 MW) and may not be reflective of the consequences of larger scale development in the region or even a single project in a different location.

As explained above, based on the available information, we do not see any evidence that installation of 98 WTGs and their foundations and up to three OSSs and their foundations for the Ocean Wind 1 project would lead to ocean warming that could affect ESA-listed whales, sea turtles or fish or that there is the potential for the Ocean Wind 1 project to contribute to or exacerbate warming ocean conditions; if anything, the project may result in minor, localized cooling. The available information suggests that the Ocean Wind 1 project will produce wind wake from operation of the turbines and that the foundations themselves will lead to disruptions in local conditions. The scale of these effects is expected to range in distance, with effects to turbulence, eddies, and turbidity extending around a hundred meters (van Berkel et al. 2020) and changes in mixed layer depth and thermocline conditions extending up to 12 km (Floeter et al. 2022), while alterations to wind fields and the ocean–atmosphere interface have the potential to modify both atmospheric and hydrodynamic patterns, potentially on large spatial scales up to dozens of miles (Gill et al. 2020; Christiansen et al. 2022). As noted above, oceanic response to an altered wind field is predicted to extend several kilometers around offshore wind facilities and to be strong enough to influence the local pelagic ecosystem (Brostrom 2008, Ludewig 2015, Floeter et al. 2022).

When applying studies conducted outside the Mid-Atlantic Bight region to our consideration of the potential effects of the Ocean Wind 1 project on environmental conditions, it should be noted that the seasonal stratification over the summer, particularly in the studies conducted in the North Sea, is much less than the peak stratification seen in the summer over the Mid-Atlantic Bight. The conditions in the North Sea are more representative of weaker stratification, similar to conditions seen in the Mid-Atlantic Bight during the spring or fall. Because of the weaker stratification during the spring and fall, the Mid-Atlantic Bight ecosystem may be more susceptible to changes in hydrodynamics due to the presence of structures during the spring and fall than during highly stratified conditions in the summer.

Offshore wind energy development has the potential to alter the atmospheric and the physical and biological oceanographic environment due to the influence of the wind turbines on the wind stress at the ocean surface and the physical presence of the in-water turbine foundations could influence the flow and mixing of water. Resultant, increased stratification could affect the timing and rate of breakdown of the cold pool in the fall, which could have cascading effects on species in the region. However, as described above, the available information (Carpenter et al. 2016, Schultz et al. 2020) indicates that in order to see significant impacts on stratification, large regions had to be covered by wind turbines. Given the scale of the Ocean Wind 1 project (101 foundations), any effects of stratification are not expected to reach the scale that they would affect the timing and rate of breakdown of the cold pool in the fall.

Due to the linkages between oceanography and food webs, lower-tropic level prey species that support protected species may be affected by changes in stratification and vertical mixing. Information on which to base an assessment of the degree that the proposed project will result in any such impacts is limited. No utility scale offshore wind farms exist in the region nor along either coast of the United States to evaluate potential impacts of the proposed Project, thus we primarily have results from research conducted on offshore wind projects in other countries available to evaluate potential impacts on the oceanographic and atmospheric environment, and potential subsequent effects on protected species and their prey.

Results of in-situ research, and modeling and simulation studies, show that offshore wind farms can reduce wind speed and wind stress which can lead to less mixing, lower current speeds, and higher surface water temperature (Afsharian et al. 2020); increase localized vertical mixing due to the turbulence from the wakes produced from water flowing around turbine foundations (Miles, Martin, and Goddard 2017, Schultz et al. 2020); cause wind wakes that will result in detectable changes in vertical motion and/or structure in the water column (upwelling and downwelling) (Christiansen & Hasager 2005, Broström 2008); and result in detectable sediment wakes downstream from a wind farm by increased turbidity (Vanhellemont and Ruddick, 2014). We have considered if these factors could result in disruption of prey aggregations, primarily of planktonic organisms transported by currents such as copepods and gelatinous organisms (salps, ctenophores, and jellyfish medusa).

This possible effect is primarily relevant to North Atlantic right whales and leatherback sea turtles as their planktonic prey (calanoid copepods and gelatinous organisms) are the only listed species' prey in the region whose aggregations are primarily driven by hydrodynamic processes. As aggregations of plankton, which provide a dense food source for listed species to efficiently feed upon, are concentrated by physical and oceanographic features, increased mixing may disperse aggregations and may decrease efficient foraging opportunities for listed species. Potential effects of hydrodynamic changes in prey aggregations are specific to listed species that feed on plankton, whose movement is largely controlled by water flow, as opposed to other listed species which eat fish, cephalopods, crustaceans, and marine vegetation, which are either more stationary on the seafloor or are more able to move independent of typical ocean currents. Prey aggregations may also be influenced by the physical presence of turbine foundations and subsequent reef effect; this is considered in Section 7.4.3.2.

Relative to the Mid-Atlantic Bight as a whole, the scale of the proposed Project (no more than 98 WTG foundations and 48 pin pile foundations for the three OSSs) and the footprint of the WFA (68,450-acres, 277km^2) with project foundations occupying only a small fraction of that) is small. Based on the available information, we do not expect the scope of hydrodynamic effects to be large enough to influence regional conditions that could affect the distribution of prey, mainly plankton, or conditions that aggregate prey in the local area off the coast of New Jersey or broader Mid-Atlantic Bight. However, we do expect localized impacts to oceanic conditions that would extend 5-12 km from the border of the lease area.

Although uncertainty remains as to the magnitude and intensity of effects offshore wind farms may have on altering oceanographic processes, studies demonstrate increased turbulence may occur in the wake of turbine (and OSS) foundations. These turbulence wakes have been detected up to 300 m from the turbine foundation (Miles, Martin, and Goddard 2017, Schultz et al. 2020). Peak turbulence area is expected within the distance equivalent to the diameter of a single monopole, with turbulence measurable (greater than 5% above background) within a distance equivalent to 8-10 times the diameter of a single monopole (Miles, Martin and Goddard 2017), for the Ocean Wind 1 project that would be a distance of 88 to 110 m. We would expect that any effects on the distribution of prey due to turbulence from the foundation would be limited to the area where changes in turbulence would be experienced. These anticipated localized changes at the WFA and waters down-current of the foundations of the wind turbines could result in localized changes in plankton distribution and abundance. Given the available information, we expect these changes to be limited to the area within approximately 1 km of any single foundation (Floeter et al. 2017). Based on the spacing of the turbines (1.8 km x 1.8km), the available information suggests limited opportunity for these areas to interact and overlap which may limit the impact of the distribution of plankton to largely the WFA and up to 1 km around its border. Based on the available information, we do not expect the changes from the Ocean Wind 1 project to affect the oceanographic forces transporting zooplankton into the area; therefore, while there may be changes in the distribution of plankton within the WFA, we do not expect any overall reduction in biomass of plankton. Thus, because we do not anticipate any change in the biomass of zooplankton, we do not anticipate any higher trophic level impacts; that is, we do not anticipate any associated effects to gelatinous organisms, pelagic fish, or benthic invertebrates that depend on plankton as forage.

Right whales are the only ESA-listed obligate zooplanktivores in the project area, feeding exclusively on copepods, which are primarily aggregated by physical and oceanographic features. While we do not expect the Ocean Wind 1 WTGs and the foundations to affect the abundance of copepods in the WFA area or any broader area, the distribution of copepods in the WFA footprint may be affected; however, given the limited foraging by right whales in the WFA and surrounding area that may be affected by changes in ecological conditions, any limited impacts on the distribution of copepods would have effects on right whales that are so small that they cannot be meaningfully measured, evaluated, or detected. Similarly, we do not expect any changes in the abundance of leatherback sea turtle's jellyfish prey, and anticipate that any changes in distribution of jellyfish would have effects on leatherbacks that are so small that they cannot be meaningfully measured, evaluated, or detected. We do not anticipate a larger disruption to conditions that would aggregate prey in the lease area due to the small scale of the project and the distance from frontal features.

Given the localized and patchy effects anticipated to the distribution and aggregation of prey, and that we do not expect any overall reduction in the amount of prey in the action area, any effects to foraging individual right whales or leatherback sea turtles are expected to be so small that they cannot be meaningfully measured, evaluated, or detected and are therefore, insignificant. Additionally, as Atlantic sturgeon in the marine environment primarily feed on benthic invertebrates and small fish such as sand lance, which are either free swimming or live on the seafloor, hydrodynamic effects are not likely to impact the distribution or availability of their prey, and any effects to Atlantic sturgeon are extremely unlikely to occur. Effects to the benthic prey base of green, Kemp's ridley, and loggerhead sea turtles are also extremely unlikely to occur. We do not expect any impacts to the abundance or distribution of the cephalopods on which sperm whales forage. As a result, any effects to sperm whales are extremely unlikely to occur.

We note that as the scale of offshore wind development in the Mid-Atlantic Bight increases and the area occupied by wind turbines increases, the scope and scale of potential hydrodynamic impacts may also increase and influence the environmental baselines for future projects. Such impacts may require additional research and analysis to support future assessments. Biological Opinions prepared for the Vineyard Wind 1 and South Fork Projects assessed the construction, operation, and decommissioning of the project and concluded that there may be localized changes at the Vineyard Wind 1 and South Fork wind farm and waters within a few hundred meters down-current of the foundations of the wind turbines. The Vineyard Wind 1 project that will consist of up to 100 WTGs located approximately 370 km from the proposed Ocean Wind 1 project. The South Fork project will consist of 14 WTGs located approximately 370 km from the proposed Ocean Wind 1 project. Given the distance between the Vineyard Wind 1 and South Fork projects and the proposed Ocean Wind 1 project (about 370 km), it is not likely any oceanographic or atmospheric effects from the two projects would be magnified, interact, or overlap with the Ocean Wind 1 project.

7.5 Effects of Marine Resource Survey and Monitoring Activities

In this section we consider the effects of the marine resource survey and monitoring activities on listed species in the action area by describing the effects of interactions between listed species, and proposed fishing gear (trawl, chevron traps, clam dredge, and fishing lines with baited hooks) and the other sampling methodologies (benthic sampling, eDNA sampling, glider deployments, video imagery, acoustic telemetry, and PAM), and then analyze risk and determine likely effects to sea turtles, listed whales, and Atlantic sturgeon. Activities will be conducted in and near the WDA and will include: trawl surveys, chevron trap, rod-and-reel fishing, BRUV, acoustic telemetry, and clam surveys to characterize fisheries resources in the WDA; glider deployments to characterize oceanographic conditions; benthic monitoring to document the disturbance and recovery of marine benthic habitat and communities resulting from the construction and installation of Project components in the WDA and along the offshore export cable corridors; moored PAM systems and mobile PAM platforms such as gliders and autonomous surface vehicles (ASVs) to record ambient noise and characterize the presence of protected species, specifically marine mammals; drop video, towed video, and visual observations to characterize baseline SAV conditions and document post-construction impacts to SAV beds associated with cable installation activities. Activities will be conducted for a nine-year period beginning before construction and up to six years post-construction. Section 7.1 of the Opinion addresses the effects of noise during surveys, including HRG surveys. Section 3 of the Opinion describes the proposed activities over all phases of the project in detail and is not repeated here. Effects of Project vessels, including the ones that will be used for survey and monitoring activities are considered in section 7.2, above, and are not repeated here.

7.5.1 Assessment of Effects of Benthic Monitoring, Acoustic Telemetry Monitoring, PAM, and SAV Monitoring

Benthic Sampling
Ocean Wind is proposing to conduct benthic monitoring to document the disturbance and recovery of marine benthic habitat and communities resulting from the construction and installation of Project components, including WTGs, OSSs, WTG scour protection as well as the inter-array cabling and offshore export cable corridors from the WDA to shore. Monitoring will be conducted using a combination of high-resolution video and photographic imaging methods suited for each habitat type. One of the three OSS foundations, three WTG locations, and three cable protection areas will be randomly selected for benthic monitoring. All survey equipment will be deployed from contracted scientific research vessels. Sediment profile and plan view imaging (SPI/PV) will be used to characterize existing conditions and changes in soft-bottom benthic habitat prior to and following construction. The SPI/PV equipment consists of a camera frame that is lowered onto the seabed by a cable, penetrating the bed surface to collect a plan view image of subsurface substrate composition. Following construction, high-resolution imaging collected by remotely operated vehicle (ROV) will be used to monitor changes in benthic community composition on introduced hard surfaces (i.e., WTG/OSS foundations, scour protection layers, and cable protection layers).

The ROV video and SPI/PV surveys will result in temporary disturbance of the benthos and a potential temporary loss of benthic resources. ROV operation and SPI/PV surveys will affect an extremely small area at each survey location. After the ROV is lifted and lowered into the water, a pilot controls the ROV's dive to and movements along the seafloor using its thrusters. Once it reaches the seafloor, the pilot will aim to maintain the ROV at a constant height above the seabed that maintains a good field of view while attempting to avoid disturbing the substratum (sediment clouds will obscure the images; Hitchin et al. 2015, JNCC 2018). Once lowered to the seafloor, the frame of the SPI/PV will rest on the seafloor while the camera will penetrate the seafloor to capture a profile image; because of the small size of the frame (~1.5 m^2) and the nature of the image capture (i.e., shallow penetration of the camera) there is little disturbance to the seafloor and little chance for any increase in suspended sediment to result from the activity. While there may be some loss of benthic and bentho-pelagic species at the survey sites, including potential forage items for listed species that feed on benthic and pelagic resources, the amount of resources potentially lost will be extremely small. Any loss of benthic resources will be small, temporary, and localized. These temporary, isolated reductions in the amount of benthic resources are not likely to have a measurable effect on any foraging activity or any other behavior of listed species; this is due to the small size of the affected areas and the temporary nature of any disturbance. As effects to listed species will be so small that they cannot be meaningfully measured, detected, or evaluated, effects are insignificant.

Acoustic Telemetry Monitoring
Ocean Wind proposes to monitor for tagged fish, elasmobranchs, and invertebrates during bottom trawl and multi-method sampling. Surveys would record the presence of nearby tagged animals by employing a combination of fixed hydrophone receivers attached to piers, bulkheads, and floating docks, deployed from a vessel during the structure-associated fishes survey, and attached to a glider during the pelagic fish surveys. No effects to ESA-listed species are anticipated to result from acoustic telemetry surveys. This is because no listed species will be tagged and this activity only involves monitoring previously tagged summer flounder, black sea bass, smooth dogfish, horseshoe crabs, and clearnose skate, and there are no effects to ESA-listed species from this type of passive monitoring.

Passive Acoustic Monitoring
Passive acoustic monitoring (PAM) is used to measure, monitor, record, and determine the sources of sound in underwater environments. Moored PAM systems and mobile PAM platforms such as towed PAM, autonomous surface vehicles (ASVs), or autonomous underwater vehicles (AUVs) will be used prior to, during, and following Ocean Wind 1 Offshore Wind Farm construction. PAM will be used to characterize the presence of marine mammals through passive detection of vocalizations, and will be used to record ambient noise, project vessel noise, pile driving noise, and WTG operational noise. Moored PAM systems are stationary and may include platforms that reside completely underwater with no surface expression (i.e., HARPs, high-frequency acoustic recording packages) or may consist of buoys (at the surface) connected via a data and power cable to an anchor or bottom lander on the seafloor. Moored PAM systems will use the best available technology to reduce any potential risks of entanglement and deployment will comply with best management practices designed to reduce the risk of entanglement in anchored monitoring gear (see Appendix B of NMFS 2021a as appended to this Opinion). For moored PAM systems, there are cables connecting the hydrophones and/or buoy to the anchor or lander; however, entanglement is extremely unlikely to occur. The cables associated with moored systems have a minimum bend radius that minimizes entanglement risks and does not create loops during deployments, further minimizing entanglement risks. There are no records of any entanglement of listed species in moored PAM systems, and we do not anticipate any such entanglement will occur.

Mobile systems may include ASVs (i.e. wave gliders) that operate at the surface and AUVs (i.e. Slocum gliders) that operate throughout the water column. These vehicles produce virtually no self-generated noise and travel at slow operational speeds as they collect data. Towed hydrophone arrays may also be employed which consist of a series of hydrophones that are towed behind a vessel while it is moving along a survey trackline at slow speeds. Moored and mobile systems will be deployed and retrieved by vessels; maintenance will also be carried out from vessels. Potential effects of vessel traffic for all activities considered in this consultation are addressed in section 7.2.

The small size and slow operational speeds of mobile PAM systems make the risk of a collision between the system and a listed species extremely unlikely to occur. Even in the extremely unlikely event that a whale, sea turtle, or Atlantic sturgeon bumped into the mobile PAM system, it is extremely unlikely that there would be any consequences to the individual because of the relative lightweight of the mobile PAM system, slow operating speeds, small size, and rounded shape. Based on the analysis herein, it is extremely unlikely that any ESA-listed species will interact with any PAM system; any effects to ESA-listed species of the PAM monitoring are extremely unlikely to occur.

SAV Monitoring
Ocean Wind proposes to implement a SAV Monitoring Plan (Inspire 2022) that will consist of a pre-construction mapping survey, as well as pre- and post-construction SAV characterization surveys to characterize baseline SAV conditions and any potential impacts to SAV beds associated with cable installation activities. The pre-construction mapping survey will identify and map the shallowest and deepest points of SAV habitat within the influence of the Project, with a focus on the location and water depth of the perimeters of SAV habitat. The mapping survey will use a combination of drop camera, towed-video imagery collection, and visual observations from boat or on foot.

Towed-video imagery collection involves a stereo-camera system that will be continuously towed in a detailed grid pattern over the sampling site (Method 3 in Colarusso and Verkade 2016). The camera system will be towed behind a small vessel capable of transiting through waters as shallow as 2 feet. The short soak time, slow vessel speed, and limited number of vertical lines associated with towed-video imagery collection makes the risk of interaction with ESA-listed species extremely unlikely to occur. In very shallow waters, the landward edges of the SAV beds will be delineated on-foot using visual inspection and a handheld GPS (Method 1 in Colarusso and Verkade 2016). No effects to ESA-listed species are anticipated to result from this survey method. This is because this activity will involve a human operator that will be able to readily detect ESA-listed species and avoid any interaction.

The pre- and post-construction SAV characterization surveys will use divers and/or snorkelers to collect shoot density measurements from within a 1-m^2 quadrat at sampling stations along transects that are located perpendicular to the open trench cable route and perpendicular to the HDD exit location (i.e., at the landfall on the western side of Barnegat Bay). No effects to ESA-listed species are anticipated to result from this survey method. This is because this activity will involve a human operator that will be able to readily detect ESA-listed species and avoid interactions. In the unlikely event that a sea turtle or Atlantic sturgeon is encountered during these surveys, we expect it will swim away with no consequences. Based on the analysis herein, there will be no effects to listed species, or at most, it is extremely unlikely that any ESA-listed species will interact with SAV monitoring survey activities. Effects to ESA-listed species because of the SAV monitoring survey activities are extremely unlikely to occur.

7.5.2 Assessment of Risk of Interactions with Bottom Trawl Gear

Ocean Wind will conduct up to four years of post–ROD trawl surveys (2 years pre/during construction and 2 years post-construction) to assess the finfish community in the Ocean Wind 1 WDA and adjacent control area. Additionally, in order to expand the pre-construction survey period, they may also carry out trawl surveys in 2023 (following issuance of this Opinion). The surveys will be adapted to Northeast Area Monitoring and Assessment Program (NEAMAP) protocols. Twenty tows will be conducted in the Ocean Wind 1 WDA and an additional 20 tows will occur in the adjacent control area per season. Tows will be conducted four times per year (April, July, late September or early October, and January), during daylight hours (after sunrise and before sunset) for 20 minutes each with a target tow speed of 2.9 to 3.3 knots. Tows will be completed using 400 x 12 centimeters (cm), three-bridle four-seam bottom trawl with Thyboron, Type IV 66-inch doors and 1-inch knotless codend.

ESA-Listed Whales

Factors Affecting Interactions and Existing Information on Interactions
Entanglement or capture of ESA-listed North Atlantic right, fin, sei, blue, and sperm whales in beam or bottom otter trawl gear is extremely unlikely. While these species may occur in the study area where survey activities will take place, beam and bottom otter trawl gear is not expected to directly affect right, fin, sei, blue, and sperm whales given that these large cetaceans have the speed and maneuverability to get out of the way of oncoming gear, which is towed behind a slow moving vessel (less than 4 knots). There have been no observed or reported interactions of right, fin, sei, blue, or sperm whales with beam or bottom otter trawl gear (NEFSC observer/sea sampling database, unpublished data; GAR Marine Animal Incident database, unpublished data). The slow speed of the trawl gear being towed and the short tow times to be implemented further reduce the potential for entanglement or any other interaction. As a result, we have determined that it is extremely unlikely that any large whale would interact with the trawl survey gear.

Effects to Prey
The proposed bottom trawl survey activities will not have any effects on the availability of prey for right, fin, sei, blue and sperm whales. Right whales and sei whales feed on copepods (Perry et al. 1999). Copepods are very small organisms that will pass through trawl gear rather than being captured in it. In addition, copepods will not be affected by turbidity created by the gear moving through the water. Fin whales feed on krill and small schooling fish (e.g., sand lance, herring, mackerel) (Aguilar 2002). Blue whales feed on krill. The trawl gear to be used in the Ocean Wind 1 survey activities operates on or very near the bottom, while schooling fish such as herring and mackerel occur higher in the water column. Sand lance inhabit both benthic and pelagic habitats, however, they typically bury into the benthos and would not be caught in the trawl. Sperm whales feed on deep water species that do not occur in the area to be surveyed.

Sea Turtles

Factors Affecting Interactions and Existing Information on Interactions
Sea turtles forcibly submerged in any type of restrictive gear can eventually suffer fatal consequences from prolonged anoxia and/or seawater infiltration of the lung (Lutcavage and Lutz 1997; Lutcavage et al. 1997). A study examining the relationship between tow time and sea turtle mortality in the shrimp trawl fishery showed that mortality was strongly dependent on trawling duration, with the proportion of dead or comatose sea turtles rising from 0% for the first 50 minutes of capture to 70% after 90 minutes of capture (Henwood and Stuntz 1987). Following the recommendations of the NRC to reexamine the association between tow times and sea turtle deaths, the data set used by Henwood and Stuntz (1987) was updated and re-analyzed (Epperly et al. 2002; Sasso and Epperly 2006). Seasonal differences in the likelihood of mortality for sea turtles caught in trawl gear were apparent. For example, the observed mortality exceeded 1% after 10 minutes of towing in the winter (defined in Sasso and Epperly (2006) as the months of December-February), while the observed mortality did not exceed 1% until after 50 minutes in the summer (defined as March-November; Sasso and Epperly 2006). In general, tows of short duration (<10 minutes) in either season have little effect on the likelihood of mortality for sea turtles caught in the trawl gear and would likely achieve a negligible mortality rate (defined by the NRC as <1%). Longer tow times (up to 200 minutes in summer and up to 150 minutes in winter) result in a rapid escalation of mortality, and eventually reach a plateau of high mortality, but will not equal 100%, as a sea turtle caught within the last hour of a long tow will likely survive (Epperly et al. 2002; Sasso and Epperly 2006). However, in both seasons, a rapid escalation in the mortality rate did not occur until after 50 minutes (Sasso and Epperly 2006) as had been found by Henwood and Stuntz (1987). Although the data used in the NRC reanalysis were specific to bottom otter trawl gear in the U.S. south Atlantic and Gulf of Mexico shrimp fisheries, the authors considered the findings to be applicable to the impacts of forced submergence in general (Sasso and Epperly 2006).

Sea turtle behaviors may influence the likelihood of them being captured in bottom trawl gear. Video footage recorded by the NMFS, Southeast Fisheries Science Center (SEFSC), Pascagoula Laboratory indicated that sea turtles will keep swimming in front of an advancing shrimp trawl, rather than deviating to the side, until they become fatigued and are caught by the trawl or the trawl is hauled up (NMFS 2002). Sea turtles have also been observed to dive to the bottom and hunker down when alarmed by loud noise or gear (Memo to the File, L. Lankshear, December 4, 2007), which could place them in the path of bottom gear such as a bottom otter trawl. There are very few reports of sea turtles dying during research trawls. Based on the analysis by Sasso and Epperly (2006) and Epperly et al. (2002) as well as information on captured sea turtles from past state trawl surveys and the NEAMAP and NEFSC bottom trawl surveys, tow times less than 30 minutes are expected to eliminate the risk of death from forced submergence for sea turtles caught in the beam and bottom otter trawl survey gear.

During the spring and fall bottom trawl surveys conducted by the NEFSC from 1963-2017, a total of 85 loggerhead sea turtles were captured. Only one of the 85 loggerheads suffered injuries (cracks to the carapace) causing death. All others were alive and returned to the water unharmed. One leatherback and one Kemp's ridley sea turtle have also been captured in the NEFSC bottom trawl surveys and both were released alive and uninjured. NEFSC bottom trawl survey tows are approximately 30 minutes in duration. All 20 loggerhead, 28 Kemp's ridley, and one green sea turtles captured in the NEAMAP surveys since 2007 have also been released alive and uninjured. NEAMAP surveys operate with a 20-minute tow time. Swimmer et al. (2014) indicates that there are few reliable estimates of post-release mortality for sea turtles because of the many challenges and costs associated with tracking animals released at sea. We assume that post-release mortality for sea turtles in bottom otter trawl gear where tow times are short (less than 30 minutes) is minimal to non-existent unless the turtle is already compromised to begin with. In that case, however, the animal would likely be retained onboard the vessel and transported to a rehabilitation center rather than released back into the water.

Estimating Interactions with and Mortality of Sea Turtles
As the Ocean Wind 1 trawl survey activities will use similar gear to the NEAMAP surveys, which have historically overlapped the Ocean Wind study area, the historic NEAMAP data was used for bycatch estimation. The NEFSC and Virginia Institute of Marine Science (VIMS) have recorded all sea turtle interactions since the NEFSC and NEAMAP bottom trawl survey programs began, which allows us to predict future interactions as demonstrated in Table 7.5.1. Data from 2008-2021 from the NEAMAP Near Shore Trawl Program – Southern Segment was used to estimate a capture rate of sea turtles per tow that was then applied to the operations of the Ocean Wind 1 trawl survey in the WDA to create an annual capture estimate. We calculate 1.371 loggerhead sea turtles, 1.219 Kemp's ridley sea turtles, 0.0381 green sea turtles, and 0 leatherback sea turtles will be incidentally caught in the trawl survey activities in the WDA each year that the survey takes place.

Based on the analysis by Sasso and Epperly (2006) and Epperly et al. (2002) discussed previously, as well as information on captured sea turtles from past state trawl surveys and the NEAMAP and NEFSC trawl surveys (no mortalities or serious injuries), a 20-minute tow time for the bottom trawl gear to be used in the proposed Ocean Wind 1 surveys is expected to eliminate the risk of serious injury and mortality from forced submergence for sea turtles caught in the bottom trawl gear. We expect that effects to sea turtles captured in the trawl survey will be limited to minor abrasions from the nets and that these injuries will be fully recoverable. No mortality of any sea turtle is anticipated to occur as a result of the trawl surveys.

Using the above annual estimates and the five-year duration of the trawl surveys, and rounding up any fractions of sea turtles to whole animals, we estimate the following captures over the entirety of the remaining survey period (Table 7.5.1). We anticipate that all sea turtles will be returned to the water alive and without injury.

Table 7.5.1. Estimated captures of sea turtles by species from Ocean Wind 1 trawl surveys over the five-year duration

Species	Total estimated captures over the 5-year survey period
Loggerhead	7

Species	Total estimated captures over the 5-year survey period
Kemp's ridley	6
Green	1
Leatherback	0

Effects to Prey
Sea turtle prey items such as horseshoe crabs, other crabs, whelks, and fish are removed from the marine environment as bycatch in bottom trawls. None of these are typical prey species of leatherback sea turtles or of neritic juvenile or adult green sea turtles. Therefore, the Ocean Wind 1 trawl surveys will not affect the availability of prey for leatherback and green sea turtles 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 will shortly die. Injured or deceased bycatch would still be available as prey for sea turtles, particularly loggerheads, which are known to eat a variety of live prey as well as scavenge dead organisms. Given this information, any effects on sea turtles from collection of potential sea turtle prey in the trap/pot gear will be so small that they cannot be meaningfully measured, detected, or evaluated and, therefore, effects are insignificant.

Atlantic Sturgeon

Factors Affecting Interactions and Existing Information on Interactions
While migrating, Atlantic sturgeon may be present throughout the water column and could interact with trawl gear while it is moving through the water column. Atlantic sturgeon interactions with beam and bottom trawl gear are likely at times when and in areas where their distribution overlaps with the operation of the gear. Adult and subadult Atlantic sturgeon may be present in the action area year-round. In the marine environment, Atlantic sturgeon are most often captured in depths less than 50 meters. Some information suggests that captures in otter trawl gear are most likely to occur in waters with depths less than 30 meters (ASMFC TC 2007). The capture of Atlantic sturgeon in otter trawls used for commercial fisheries is well documented (see for example, Stein et al. 2004b and ASMFC TC 2007).

NEFOP data from Miller and Shepherd (2011) indicates that mortality rates of Atlantic sturgeon caught in otter trawl gear is approximately 5 percent. Atlantic sturgeon are also captured incidentally in trawls used for scientific studies, including the standard Northeast Fisheries Science Center bottom trawl surveys and both the spring and fall NEAMAP bottom trawl surveys. The shorter tow durations and careful handling of any sturgeon once on deck during fisheries research surveys is likely to result in an even lower potential for mortality, as commercial fishing trawls tend to be significantly longer in duration. None of the hundreds of Atlantic and shortnose sturgeon captured in past state ocean, estuary, and inshore trawl surveys have had any evidence of serious injury and there have been no recorded mortalities. 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. To date, no serious injuries or mortalities of any sturgeon have been recorded in those surveys.

Estimating Interactions with and Mortality of Sturgeon
As the Ocean Wind 1 trawl survey activities will use similar gear to the NEAMAP surveys which have historically overlapped the Ocean Wind 1 study area, the historic NEAMAP data was used for bycatch estimation. The NEFSC and Virginia Institute of Marine Science have recorded all Atlantic sturgeon interactions since the NEFSC and NEAMAP bottom trawl survey programs began, which allows us to predict future interactions as demonstrated in Table 7.5.2. Data from 2008-2021 from the NEAMAP Near Shore Trawl Program – Southern Segment was used to estimate a capture rate of sturgeon per tow that was then applied to the operations of the Ocean Wind 1 trawl surveys to create a capture estimate.

As explained in the Status of Species section, the range of all five DPSs overlaps and extends from Canada through Cape Canaveral, Florida. Atlantic sturgeon originating from all five DPSs use the area where trawl gear will be set. We have considered the best available information from a recent mixed stock analysis done by Kazyak et al. (2021) to determine from which DPSs individuals in the action area are likely to have originated. The authors used 12 microsatellite markers to characterize the stock composition of 1,704 Atlantic sturgeon encountered across the U.S. Atlantic Coast and provide estimates of the percent of Atlantic sturgeon in a number of geographic areas that belong to each DPS. The Ocean Wind 1 survey area falls within the "MID Offshore" area described in that paper. Using that data, we expect that Atlantic sturgeon in the area of the WDA where trawl surveys will occur likely originate from the five DPSs at the following frequencies: New York Bight (55.3%), Chesapeake (22.9%), South Atlantic (13.6%), Carolina (5.8%), and Gulf of Maine (1.6%) DPSs (Table 7.5.2). It is possible that a small fraction (0.7%) of Atlantic sturgeon in the action area may be Canadian origin (Kazyak et al. 2021); Canadian-origin Atlantic sturgeon are not listed under the ESA. This represents the best available information on the likely genetic makeup of individuals occurring throughout the action area. Based on the information presented above, we do not anticipate the mortality of any Atlantic sturgeon captured in the trawl gear. The DPS breakdown for annual captures for the trawl surveys are provided in Table 7.5.2.

Table 7.5.2. Estimated capture of Atlantic sturgeon by DPS in Ocean Wind 1 trawl survey. DPS percentages listed are the percentage values representing the genetics mixed stock analysis results (Kazyak et al. 2021). Fractions of animals are rounded up to whole animals to generate the total estimate.

Bottom Trawl	Captures per Year	Total Estimated Captures Over Five Years
Total	14.9714	75
New York Bight (55.3%)	8.2792	42
Chesapeake (22.9%)	3.4285	18
South Atlantic (13.6%)	2.0361	10
Carolina (5.8%)	0.8683	4
Gulf of Maine (1.6%)	0.2395	1

Estimates derived from NEAMAP Near Shore Trawl Program – Southern Segment data

Effects to Prey

The effects of bottom trawls on benthic community structure have been the subject of a number of studies. In general, the severity of the impacts to bottom communities is a function of three variables: (1) energy of the environment, (2) type of gear used, and (3) intensity of trawling. High-energy and frequently disturbed environments are inhabited by organisms that are adapted to this stress and/or are short-lived and are unlikely to be severely affected, while stable environments with long-lived species are more likely to experience long-term and significant changes to the benthic community (Johnson 2002, Kathleen A. Mirarchi Inc. and CR Environmental Inc. 2005, Stevenson et al. 2004). While there may be some changes to the benthic communities on which Atlantic sturgeon feed as a result of bottom trawling, there is no evidence the bottom trawl activities will have a negative impact on availability of Atlantic sturgeon prey; therefore, effects to Atlantic sturgeon are extremely unlikely to occur.

7.5.3 Assessment of Risk of Interactions with Structure-Associated Fishes Surveys

Ocean Wind proposes to conduct a multi-method survey that will occur concurrent with the trawl survey. To assess structure-associated fishes in the Ocean Wind 1 WDA, 12 to 15 sampling locations will be selected between the WDA and an adjacent control area. Sampling at each location will include the use of chevron traps, rod-and-reel fishing, and BRUV. Each location will consist of a total of six traps spaced 656 feet (200 meters) apart. Each trap will have a vertical buoy line (6 total) and a soak time of 90 minutes. The BRUV method will occur concurrently at the same location as the chevron traps for 60 minutes. The BRUV equipment consists of a weighted line attached to surface and subsurface buoys that will hold a stereo-camera system in the water column and a system at the seafloor. At each sampling location, four to five anglers will complete four to five 3-minute timed fishing “drops” using baited hooks for a total of 16 to 25 drops at each location. For all structure-associated fish surveys, a 15-minute monitoring period will be conducted to reduce the risk of interaction between ESA-listed species and research gear. If ESA-listed species are sighted during the survey, then the sampling station will either be moved or cancelled or the activity suspended until there are no sightings of any ESA-listed species for 15 minutes within 1 nm (1,852 meters) of the survey location.

Chevron trap surveys will result in temporary disturbance of the benthos and a potential temporary loss of benthic resources. Chevron trap surveys will affect an extremely small area at each survey location, with survey locations spaced 656 feet (200 meters) apart. Once lowered to the seafloor, each chevron trap will rest on the seabed; because traps are a stationary gear, there is little disturbance to the seafloor and little chance for any increase in suspended sediment to result from this activity. While there may be some loss of benthic and bentho-pelagic species at the survey sites, including potential forage items for ESA-listed species that feed on benthic and pelagic resources, the amount of resources potentially lost will be extremely small. Any loss of benthic resources will be small, temporary, and localized. These temporary, isolated reductions in the amount of benthic resources are not likely to have a measurable effect on the availability of prey items for ESA-listed species.

ESA-listed whales and sea turtles are too large to be caught in the chevron traps themselves since the entrance funnels are far smaller than either of these species. However, due to the baited gear, chevron traps pose a risk of capture for Atlantic sturgeon. Even so, fish traps and pots were not recorded as potential sources for capture of Atlantic sturgeon in NEFOP data (Dunton *et al.* 2015). Because NEFOP has a long history of gear-based monitoring, it is reasonable to rely on a lack of Atlantic sturgeon captures in traps in the past to indicate that captures during the proposed chevron trap surveys are also unlikely.

Chevron trap surveys and BRUVs will result in the temporary presence of seven vertical lines deployed at each sampling station with one buoy line for each of the six chevron traps and one buoy line for the pelagic and benthic BRUVs. Despite the general concerns about the risk of entanglement for ESA-listed species due to buoy and anchor lines, we have determined that entanglement of ESA-listed species in vertical lines associated with chevron trap surveys and BRUVs is extremely unlikely to occur. This is because the limited number of vertical lines (7 total), the short soak times (90 minutes for chevron traps and 60 minutes for BRUVs), and pre-deployment and continued observation for ESA-listed species makes it extremely unlikely that any ESA-listed species will encounter vertical lines associated with chevron traps or BRUVs. Risk reduction measures including the use of weak link and weak rope (engineered to break at 17, 000 pounds [771 kg] or less) for all lines used in the mixed-method survey further reduce entanglement risks for ESA-listed species.

No effects to ESA-listed whales and sea turtles are anticipated to result from rod-and-reel sampling. However, rod-and-reel sampling poses a risk of capture for Atlantic sturgeon due to the baited hooks. Despite general concerns about the risk of capture via rod-and-reel for Atlantic sturgeon, we have determined that capture is extremely unlikely to occur. This is because of the limited amount of gear (4 to 5 baited hooks), the short soak time (3 minutes per drop), and the normal behavior of Atlantic sturgeon as benthic oriented fish which results in limited occurrence in the water column where reel drops are expected to occur. Based on the analysis herein, it is extremely unlikely that any ESA-listed species will interact with the structure-associated fishes survey activities, and any effects to ESA-listed species because of structure-associated fishes surveys are extremely unlikely to occur.

7.5.4 Assessment of Risk of Interactions with Clam, Oceanography, and Pelagic Fish Surveys

Ocean Wind proposes to conduct clam surveys in the Project area and at two control sites in August to collect data on quahog and surf clam resources. A towed modified sampling dredge will be pulled by a contracted scientific research vessel at 10 stations within the Project area and five stations at each of the 2 control sites. Tows will be conducted for 2 minutes at a speed of 3 knots (1.5 m/s) for a total of 40 minutes of dredging per survey trip (i.e., 20 minutes in the Project area and 10 minutes at each control sites). The clam survey will result in temporary disturbance of the benthos and a potential temporary loss of benthic resources. Tows for the clam survey will affect an extremely small area at each of the survey locations. The vessel will pull the dredge approximately 607 feet (185 meters) before being raised and deployed to the next survey location, totaling 12,140 feet (3,700 meters) per sampling event. The hydraulic clam dredge used during clam surveys will inject highly pressurized water into the sediment to a depth of 8-10 inches, depending on the coarseness of the sediment and the amount of water pressure needed to dislodge the clams from the bottom. The clam dredge creates a trench that is as wide as the dredge (10’ 7”) with mounds along the sides. Fine sediments are re-suspended in the water column, creating a turbidity cloud that dissipates quickly. We expect the trenches to degrade within a few months to the point when they are no longer visible. While there may be some loss of benthic and bentho-pelagic species at the survey sites, including potential forage items for listed species that feed on benthic and pelagic resources, the amount of resources potentially lost will be extremely small. Any loss of benthic forage items for ESA-listed species will be small, temporary, and localized. These temporary, isolated reductions in the amount of benthic resources are not likely to have a measurable effect on the availability of prey items for ESA-listed species.

For all clam surveys, a 15-minute monitoring period will be conducted to reduce the risk of interaction between ESA-listed species and the research gear. If ESA-listed species are sighted during the survey, then the sampling station will either be moved or canceled or the activity suspended until there are no sightings of any ESA-listed species for 15 minutes within 0.5 nm (926 meters) of the survey location. In the Greater Atlantic Region (Maine through Virginia), formal ESA section 7 consultations have been conducted on the effects of clam surveys carried out by NEFSC. In each of the Opinions for these clam surveys, we did not expect captures of ESA-listed species. Additionally, NMFS authorizes the operations of the surf clam/ocean quahog fishery in the Lease Area under the authority of the Magnuson-Stevens Fishery Conservation and Management Act and through Fishery Management Plans and their implementing regulations. We have completed Biological Opinions on the operations of the surf clam/ocean quahog fishery, and in each of these Opinions, we determined that the fishery does not adversely affect any ESA-listed species or their designated critical habitats (NMFS 2010b, 2017h, 2020e). To date, there have been no observed or documented interactions of any ESA-listed species with hydraulic clam dredges. Because the NEFSC clam surveys and the Atlantic surf clam/ocean quahog fishery have a long history, it is reasonable to rely on a lack of captures in the past to indicate that captures in Ocean Wind’s proposed Fishery Monitoring Plan are also unlikely.

The short soak time, slow vessel speed, and the pre-deployment and continued observation for ESA-listed species makes the risk of interaction with ESA-listed species extremely unlikely to occur. Based on the analysis herein, it is extremely unlikely that any ESA-listed species will interact with the clam survey activities; and any effects to ESA-listed species because of the clam surveys are extremely unlikely to occur.

Ocean Wind proposes to conduct oceanographic surveys by deploying a glider to collect oceanographic data. No effects to ESA-listed species are anticipated to result from this survey activity. This is because gliders produce virtually no self-generated noise and are slow-moving vehicles operating at approximately half a knot. In addition, gliders do not pose an entanglement risk for ESA-listed species as they operate throughout the water column because they are not tethered to equipment aboard the survey vessel.

Ocean Wind proposes to conduct non-extractive pelagic fish surveys to investigate the habitat use of larger more mobile pelagic species that will not be well sampled using a trawl. The pelagic fish survey will employ two methods, towed BRUVs and autonomous gliders. As explained above for oceanographic surveys, we do not anticipate any effects to ESA-listed species because of gliders. The BRUV equipment consists of a baited stereo-camera system that will be towed through the water column behind the research vessel along a survey line for less than 90 minutes. BRUVs will not be deployed if ESA-listed species are sighted near the proposed sampling location.

The short soak time, slow vessel speed, limited number of vertical lines, and the pre-deployment and continued observation for ESA-listed species makes the risk of interaction with ESA-listed species extremely unlikely to occur. Based on the analysis herein, it is extremely unlikely that any ESA-listed species will interact with the pelagic fish survey activities, and any effects to ESA-listed species because of the pelagic fish surveys are extremely unlikely to occur.

7.5.5 Impacts to Habitat

Here we consider any effects of the proposed marine resource survey and monitoring activities on habitat of listed species. The SPI/PV equipment and chevron traps will be set on the ocean floor, which could result in disturbance of benthic resources. Similarly, BRUVs will use a subsurface buoy to hold a stereo-camera system at the seafloor. Moored PAM systems may include a lander or anchor that would rest on the seafloor. However, the size of the area that would be disturbed by setting this gear is extremely small and any effects to benthic resources would be limited to temporary disturbance of the bottom in the immediate area where the gear is set. Although chevron traps will rest on the seafloor, Carmichael *et al.* (2015) found that chevron traps have little or low impact on bottom habitat. In an analysis of effects to habitat from fishing gears, mud and sand habitats were found to recover more quickly than courser substrates (see Appendix D in NEFMC 2016, NEFMC 2020). No effects to any ESA listed species are anticipated to result from this small, temporary, intermittent, disturbance of the bottom sediments.

An assessment of fishing gear impacts found that mud, sand, and cobble features are more susceptible to disturbance by trawl gear, while granule-pebble and scattered boulder features are less susceptible (see Appendix D in NEFMC 2016, NEFMC 2020). Geological structures generally recovered more quickly from trawling on mud and sand substrates than on cobble and boulder substrates; while biological structures (i.e. sponges, corals, hydroids) recovered at similar rates across substrates. Susceptibility was defined as the percentage of habitat features encountered by the gear during a hypothetical single pass event that had their functional value reduced, and recovery was defined as the time required for the functional value to be restored (see Appendix D in NEFMC 2016, NEFMC 2020). The clam dredging and bottom trawl gear will also interact with the ocean floor and may affect bottom habitat in the areas surveyed. However, given the infrequent survey effort, the limited duration of the surveys, and the very small footprint, any effects to ESA listed species resulting from these minor effects to benthic habitat will be so small that they cannot be meaningfully measured, evaluated, or detected.

7.6 Consideration of Potential Shifts or Displacement of Fishing Activity

As described in section 7.2 (*Effects of Project Vessels*) the lease area and the area along the cable corridors support commercial and recreational fishing activity throughout the year at low to moderate levels compared to the larger surrounding region (COP 2022). Fishing activity includes a variety of fixed gear (e.g. gillnets, pot/traps) and mobile gear fisheries (e.g. trawl (bottom and mid-water), dredge (clam and scallop), hook and line) including American lobster (limited extent), Atlantic sea scallop, bluefish, Jonah crab, monkfish, squid, butterfish, skates, summer flounder, scup, black sea bass, small-mesh multispecies, shark species, and spiny dogfish (BOEM 2022) as well as surfclam, menhaden and conch. Fishing effort is highly variable due to factors including target species distribution and abundance, environmental conditions, fishing regulations, season, and market value. Within the New Jersey Wind Energy Study Area, which includes the Ocean Wind lease area, the clam dredge, targeting Atlantic surfclam and ocean quahog, was the primary commercial fishing gear utilized in terms of value and landings. The primary landed commercial species in tonnage was the Atlantic surfclam, whereas the Atlantic sea scallop was the most economically valuable species within the New Jersey Wind Energy Study Area (NJDEP 2010b). As described in the COP, based on the VMS data for the most recent set of years commercial species harvested in the lease area consist primarily of Atlantic sea scallop, surfclam, and ocean quahog; based on the VMS data, for all of these target species most of the commercial fishing activity, including the scallop fishery, is located outside the Ocean Wind Lease Area, typically in waters further offshore. As addressed in sections 5 (*Status of the Species*) and 6 (*Environmental Baseline*) of this Opinion, interactions between fishing gear (e.g., bycatch, entanglement) and listed whales, sea turtles, and Atlantic sturgeon occur throughout their range and may occur in the action area.

Here, we consider how the potential shift or displacement of fishing activity from the lease area and cable corridors, because of the proposed project, may affect ESA-listed whales, sea turtles, and Atlantic sturgeon. As described in section 3.9.3.1 of the DEIS, potential impacts to fishing activities in the lease area and along the cable corridors during the construction phase of the proposed project are primarily related to accessibility (BOEM 2022). During the construction and decommissioning phases, potential effects to fishing operations include displacement of vessel transit routes and shifts in fishing effort due to disruption in access to fishing grounds in the areas where construction activities will occur due to the presence of Project vessels and construction activities. Impacts to fishing operations during the operational phase may result from changes in habitat conditions and perceived or real access challenges.

While changes in distribution and abundance of species targeted by commercial fisheries could occur during construction due to exposure to increased sediment, noise, and vibration, these effects are anticipated to be short-term and localized and not result in any changes in abundance or distribution of target species that would be great enough to result in changes in patterns of fishing activity. To the extent that construction has negative effects on the reproductive success of commercial fish species (e.g., longfin squid spawning), there is the potential for a decrease in fish abundance and future consequences on fishing activity. Impacts during the decommissioning phase of the Project are expected to be similar. Displacement of fishing vessels and shifts in operations during the construction and decommissioning phases that are related to a shift or change in target species distribution and abundance are expected. Although the magnitude of the shifts is unknown based on the naturally variability of the fisheries,

fisheries impacts related to habitat impacts are likely to be related to the footprint of temporary and permanent disturbance (4,556 acres of temporary disturbance and 171 acres of permanent disturbance) impacted by construction or decommissioning and short construction and decommissioning periods (2-3 years each) (BOEM 2022).

During the operational phase of the project, the potential impacts to fishing activity are primarily anticipated from potential accessibility issues due to the presence and spacing of WTGs and the OSSs as well as potential avoidance of the inter-array and export cable routes due to concerns related to avoiding the potential for snags or other interactions with the cable or cable protection. Additionally, there may be localized impacts on the abundance and distribution of some target species due to changes in habitat conditions (e.g., foundations and scour protection, noise and vibration associated with turbine operations, consequences of reef effect resulting in changes in localized species composition). While there are no restrictions proposed for fishing activity in the WDA, the presence and spacing of structures (less than 1x1 nautical miles) may impede fishing operations for certain gear types. Additionally, as explained in section 7.4, the structures will provide new hard bottom habitat in the WDA creating a "reef effect" that may attract fish and, as a result, fishermen, particularly recreational anglers and party/charter vessels. This could create vessel congestion and could dissuade commercial vessels from fishing among the structures.

The potential for shifts in fishing effort due to the proposed project is expected to vary by gear type and vessel size. Of the gear types that fish within the lease area and cable corridors, bottom tending mobile gear is more likely to be displaced than fixed gear, with larger fishing vessels using dredges and trawl gear, including mid-water trawl gear, more likely to be displaced compared to smaller fishing vessels using similar gear types that may be easier to maneuver. However, even without any area use restrictions, there may be different risk tolerances among vessel captains that could lead to at least a temporary reduction in fishing effort in the lease area and along the cable corridors during construction and decommissioning activities, and longer-term reduction of fishing effort during the operational phase of the project. Space use conflicts due to displacement of commercial fishing activity from the lease area to surrounding waters could cause a temporary or permanent reduction in such fishing activities within the lease area and an increase in fishing activities elsewhere. Additionally, there could be increased potential for gear conflicts within the lease area as commercial fisheries and for-hire and private recreational fishing compete for space between turbines, especially if there is an increase in recreational fishing for structure-affiliated species attracted to the foundations (e.g., black sea bass). Fixed gear fisheries, such as the monkfish and spiny dogfish gillnet fishery, may resume or even increase fishing activity in the lease area and along the cable corridors shortly after construction because these fisheries are relatively static (i.e.,. relatively stationery in location), though there may be small shifts in gear placement to avoid areas very close to project infrastructure. Mobile fisheries, such as surfclam and sea scallop dredging and squid trawl fisheries may take longer to resume fishing activity within the lease area or along the cable corridors as the physical presence of the new Project infrastructure may alter the habitat, behavior of fishing vessels, and target species. However, for all fisheries, any changes in fishing location are expected to be limited to moves to nearby, geographically adjacent areas, particularly on the fringes of the lease area, given the distribution of target species and distance from home ports, all of which limit the potential for significant geographic shifts in distribution of fishing effort. For example, if fishing effort were to shift for surfclams, effort may shift northeast outside of the lease area to other areas of similar surfclam availability east of Cape May and Atlantic City.

Fishing vessel activity (transit and active fishing) is high throughout the Mid-Atlantic Bight as a whole, with higher levels of effort occurring outside of the WDA than within the WDA (see section 2.3.4 of the COP). The scale of the proposed Project (no more than 101 foundations) and the footprint of the lease area (68,450 acres, with project foundations and associated scour protection occupying only a small fraction of that) relative to the size of available fishing area are small. Fishing activity will not be legally restricted within the lease area and the proposed spacing of the turbines could allow for fishing activity to occur, depending on the risk tolerance of the operator and weather conditions. Any reduction in fishing effort in the lease area would reduce the potential for interactions between listed species and fishing gear in the lease area, yet any beneficial effect would be expected to be so small that it cannot be meaningfully measured, evaluated, or detected. Similarly, any effects to listed species from shifts of fishing effort to areas outside of the WDA are also expected to be so small that they cannot be meaningfully measured, evaluated, or detected. This is because any potential shifts are expected to be limited to small changes in geographic area and any difference in the risk of interaction between fishing gear and listed species is expected to be so small that it cannot be meaningfully measured, detected, or evaluated.

As explained in Section 7.4 above, the presence of new structures (e.g., WTGs and OSS foundations) may also act as artificial reefs and could theoretically attract a range of species, including listed species such as sea turtles and sturgeon if the foundations serve to aggregate their prey. As explained in section 7.4, any changes in biomass around the foundations are expected to be so small and localized that they would have insignificant effects on the distribution, abundance, and use of the lease area by listed sea turtles or Atlantic sturgeon. We do not expect that any reef effect would result in any increase in species preyed on by North Atlantic right, fin or sei whales and note that sperm and blue whales are generally not expected to forage in the shallow waters of the lease area. As noted previously, we do not expect any effects on the distribution, abundance, or use of the lease area by ESA listed whales that would be attributable to the physical presence of the foundations.

This potential increase in biomass around the new structures of the Ocean Wind 1 Wind Farm may result in an increase in recreational anglers targeting structure affiliated fish species and subsequently may increase incidental interactions between recreational anglers and listed species. At the Block Island Wind Farm (Rhode Island), and other offshore wind farms in Europe, recreational fishermen have expressed a generally positive sentiment about the wind farm as an enhanced fishing location due to the structures as there are no other offshore structures or artificial reefs in surrounding waters (Hooper, Hattam & Austern 2017, ten Brink & Dalton 2018, Smythe, Bidwell & Tyler 2021). Interactions between listed species, particularly sea turtles, and recreational fishing do occur, especially in areas where target species and listed species co-occur (Rudloe & Rudloe 2005, Seney 2016, Swingle et al. 2017, Cook, Dunch & Coleman 2020). Listed sea turtles may be attracted to the structures of the foundations to forage and seek refuge and also may be attracted to bait used by anglers, depending on species.

The area where the proposed Ocean Wind 1 Wind Farm is planned to be built is comprised of three sub-regions including Shoal Massif, Great Egg Valley, and Ridge and Swale areas (COP 2022). The habitat is primarily composed of medium to coarse-grained sediments with smaller areas of coarser sediments and cobble, and it supports a moderate level of recreational fishing activity, primarily in the summer (BOEM 2022). If there is an increase in recreational fishing in the lease area, it is likely that this will represent a shift in fishing effort from areas outside the lease to within the lease and/or an increase in overall effort. Given the limited number of foundations (101) proposed to be installed and vessel safety concerns regarding being too close to foundations and other vessels, the likelihood of a significant number of recreational fishermen aggregating around the same turbine foundation at the same time is low. It is not likely that targeted recreational fishing pressure will increase to a point of causing a heightened risk of negative impact for any listed species; that is, effects will be so small that they cannot be meaningfully measured, evaluated, or detected and are, therefore, insignificant.

Whales colliding/hitting vessels, primarily recreational vessels engaged in fishing activities is uncommon to begin with, but can happen[45], primarily when prey of whales and species targeted by fishermen co-occur. As mentioned in section 7.4.3.1, it is expected whales will be able to transit the lease area freely given the spacing between turbine foundations and as explained in section 7.4.3.2, turbine foundations are not expected to cause an increase in prey that would then result in greater co-occurrence of prey, target species, whales, and vessels and thus risk of whales colliding with vessels engaged in fishing. We expect the risk posed to protected species from any shifts and/or displacement of recreational fishing effort caused by the action to be so small that they cannot be meaningfully measured, evaluated, or detected and are therefore, insignificant. For the same reasons, we do not expect any increased vessel strike risk from fishing vessels and Atlantic sturgeon or sea turtles.

In summary, we expect the risks of entanglement, bycatch, or incidental hooking interactions due to any shifts or displacement of recreational or commercial fishing activity caused by the proposed Project to be so small that they cannot be meaningfully measured, evaluated, or detected.

7.7 Repair and Maintenance Activities

Ocean Wind 1 personnel conducting O&M activities would access the lease area on an as-needed basis. With no personnel living offshore, the WTGs and OSS would be remotely monitored and controlled by the Supervisory Control and Data Acquisition (SCADA) system, which connects the WTGs to the OSS and the OSS to the Ocean Wind 1 Export Cable-Interconnection Facility with fiber optic cables that would be embedded in the inter-array and export cables. Personnel would not be required to be present except to inspect equipment and conduct repairs. Effects of vessel traffic associated with repairs and maintenance during the operations phase is considered in the *Effects of Project Vessels* section above. Effects of noise associated with project vessels and aircraft are addressed in the acoustics section above; these effects were determined to be insignificant.

[45] https://boston.cbslocal.com/2021/07/13/block-island-whale-boat-rescue/

Project components would be inspected within a 5-year timeframe. Underwater inspection would include visuals and eddy current tests conducted by divers or remotely operated vehicles. Effects of inspections and associated surveys are considered in sections 7.1 and 7.5 above. Ocean Wind 1 expects that each WTG will require approximately one week of planned maintenance during the summer and one week of unplanned maintenance per year to address issues that cannot be resolved remotely.

BOEM has indicated that given the burial depth of the inter-array cable and the Ocean Wind 1 Export Cable-Offshore, displacement, or damage by vessel anchors or fishing gear is unlikely. Mechanical inspections of the Ocean Wind 1 Export Cable would include a cable burial assessment and debris field inspection. Ocean Wind 1 would perform mechanical inspections on a 5-year basis or following a storm event that may necessitate an unplanned inspection. In the event that cable repair was necessary due to mechanical damage, it could be necessary to remove a portion of the cable and splice in a new section. We determined that acoustic and habitat based effects of cable installation would be insignificant or extremely unlikely to occur; as any cable repair will essentially follow the same process as cable installation except in only a small portion of the cable route and for a shorter period of time, we expect that the effects will be the same or less and therefore would also be insignificant.

Based on our review of the planned repair and maintenance activities described in the BA, DEIS, and COP, no additional effects beyond those considered in the previous sections of this Opinion are anticipated to result from repair and maintenance activities over the life of the project (COP 2022).

7.8 Unexpected/Unanticipated Events

In this section, we consider the "low probability events" that were identified by Ocean Wind 1 in the DEIS (section 2.2). These events, while not part of the proposed action, include collisions between vessels, allisions (defined as a strike of a moving vessel against a stationary object) between vessels and WTGs or the OSS, and accidental spills.

7.8.1 Vessel Collision/Allision with Foundation

A vessel striking a wind turbine theoretically could result in a spill or catastrophic failure/collapse of the turbine. However, there are several measures in place that ensure such an event is extremely unlikely to occur and not reasonably certain to occur. These include: inclusion of project components on nautical charts which would limit the likelihood of a vessel operator being unaware of the project components while navigating in the area; compliance with lighting and marking required by the USCG which is designed to allow for detection of the project components by vessels in the area; and, spacing of turbines to allow for safe navigation through the project area. Because of these measures, a vessel striking a turbine foundation or the OSS is extremely unlikely to occur. The Navigational Risk Assessment prepared for the project reaches similar conclusions and determined that it is highly unlikely that a vessel will strike a foundation and even in the unlikely event that such a strike did occur, the collapse of the foundation is highly unlikely even considering the largest/heaviest vessels that could transit the lease area. Therefore, based on this information, any effects to listed species that could theoretically result from a vessel collision/allision are extremely unlikely.

7.8.2 Failure of WTGs due to Weather Event

As explained in the COP (2022) and DEIS (section 2.2), Ocean Wind 1 designed the proposed Project components to withstand severe weather events. The WTGs are equipped with safety devices to ensure safe operation during their lifetime. These safety devices may vary depending on the WTG selected and may include vibration protection, over speed protection, and aerodynamic and mechanical braking systems, as well as electrical protection devices.

Few hurricanes pass through the Mid-Atlantic, and according to the historical record, a hurricane comes within 90-170 miles of New Jersey every 3-4 years (BOEM 2022). The area is subjected to frequent Nor'easters that form offshore between Georgia and New Jersey, and typically reach maximum intensity in New England. These storms are usually characterized by winds from the Northeast, heavy precipitation, wind, storm surges, and rough seas. As described in the Navigational Risk Assessment (DNV GL 2021), a 10-year time series of hourly wind speed indicates a mean wind speed of 15.5 knots (8.0 m/s) at 33 feet (10 m) with the highest wind speeds occurring between November and February. DNV GL found this to be consistent with other wind speed data sets reviewed in this region. Although hurricanes are relatively infrequent in the Mid-Atlantic, wave heights in the region of the lease area average at 3.9 feet (1.2 m) with a maximum wave height of 28 feet (8.4 m) (DNV GL 2021). Ocean Wind 1 does not foresee a hazard to the integrity of WTGs due to ice accumulation because, should ice accumulate on WTG blades, the weight and center of mass of the blade would change causing an imbalance in the rotor. Should the rotor continue to rotate, it would vibrate, and vibrational sensors installed in the WTG would automatically trigger the WTG to shut down.

BOEM has indicated that the proposed WTGs will meet design criteria to withstand extreme weather conditions that may be faced in the future and include consideration of 50 and 100-year 10 minute wind speed values and ocean forces. The 50-year 10 minute wind speed is estimated to be 96 knots and the 100-year 10 minute wind speed is estimated to be 105 knots. (A 100-year 10-minute wind speed means there is a 1-percent chance of that event occurring in any given year, similarly a 50-year wind speed means there is a 2% chance of that happening in any given year.). The design will also be in accordance with various standards including International Electrotechnical Commission (IEC) 61400-1 and 61400-3. These standards require designs to withstand forces based on a 50-year return interval for the turbines, and 100-year return interval for electrical substation platforms. The requirements for extreme metocean loading are based on 50-yr return interval site-specific conditions for most operating load cases with a 500-yr abnormal "robustness" load case check (a 500-year event has a 0.2% chance of occurring in any given year). In the DEIS, BOEM states that the design standards are adequate even considering the predicted increase in hurricane activity that is anticipated to result from climate change (BOEM 2022).

Given that the project components are designed to endure wind and wave conditions that are far above the maximum wind and wave conditions recorded at the nearest weather monitoring buoy to the project, and exceed conditions for which there is only a 1% chance of occurring in any year (100-year event), it is not reasonable to conclude that project components will experience a catastrophic failure due to a weather event over the next 25 years. In other words, project components have been designed to withstand conditions that are not expected to occur more than once over the next 100 years (e.g., exceeding 100-year 10 minute wind speed values and ocean forces). As a catastrophic failure would require conditions that are extremely unlikely to occur, even considering projections of increased hurricane activity related to climate change projections over the next 25 years, any associated potential impacts to listed species are also extremely unlikely.

7.8.3 Failure of WTGs due to Seismic Activity

There are multiple fault lines within the vicinity of New Jersey; however, the largest and most prominent is the Ramapo Fault. Running southwest to northeast, it spans the northern portion of the state and has approximate endings near Schaefferstown, PA and Haverstraw, NY. The most significant earthquake in New Jersey was in 1783, with a magnitude of 5.3 and had an epicenter west of New York City. Earthquakes have occurred as far south as Salem County (Michael Baker International 2019), which is located in the western portion of the state and approximately 107 km from the project area. Since 1783, the recorded earthquakes within 160 km of the project area have been below a 4.0 in magnitude, meaning that while they are sufficient to be felt, they are unlikely to cause damage (BOEM 2022). The distance between the project area and local fault lines is such that events such as fault rupture, where fault movements are significant enough to breach the surface (which only occurs in a portion of earthquakes) are unlikely to occur in the lease area; therefore, effects to listed species are extremely unlikely to occur.

7.8.4 Oil Spill/Chemical Release

As explained in the Oil Spill Response Plan (OSRP) (COP, Appendix A), the worst-case discharge scenario would be a structural failure of the offshore substation. A structural collapse would cause a subsequent rupture of the transformers oil reservoir (79,252 gallons) and the generator's diesel tank (52,834 gallons) for a total release of 132,086 gallons. Similarly, the structural failure of a WTG resulting in collapse and damage that released oil products would in the worst case, release 6,947 gallons of oil products in the ocean. The risk of a spill in the extremely unlikely event of a collapse is limited by the containment built into the structures. Both the WTGs and OSSs have been designed with a minimum of 110% of secondary containment of all identified oils, grease, and lubricants (COP, Appendix A). As explained above, catastrophic loss of any of the structures is not reasonably certain to occur; therefore, the spill of oil from these structures is also not reasonably certain to occur. Modeling presented by BOEM in the BA (from Bejarano et al. 2013) indicates that there is a .01% chance of a "catastrophic release" of oil from the wind facility in any given year. Given the 25-year life of this project, the modeling supports our determination that such a release is not reasonably certain to occur.

The Bejarano et al. (2013) modeling indicates the only incidents calculated to occur within the life of the Proposed Action are spills of up to 90 to 440 gallons (340.7 to 1,665.6 liters) of WTG fluid or a diesel fuel spill of up to 2,000 gallons (7,570.8) with model results suggesting that such spills would occur no more frequently than once in 10 years and once in 10-50 years, respectively. However, this modeling assessment does not account for any of the spill prevention plans that will be in place for the project which are designed to reduce risk of accidental spills/releases. Considering the predicted frequency of such events (i.e., no more than 3 WTG fluid spills over the 25-year life of the WTGs and no more than one diesel spill over the life of the project), and the reduction in risk provided by adherence to USCG and BSEE requirements as well as adherence to the spill prevention plan both of which are designed to eliminate the risk of a spill of any substance to the marine environment, we have determined that any fuel or WTG fluid spill is extremely unlikely; as such, any exposure of listed species to any such spill is also extremely unlikely.

We also note that in the unlikely event that there was a spill, if a response was required by the US EPA or the USCG, there would be an opportunity for NMFS to conduct a consultation with the lead Federal agency on the oil spill response which would allow NMFS to consider the effects of any oil spill response on listed species in the action area.

7.9 Project Decommissioning

According to 30 CFR Part 585 and other BOEM requirements, Ocean Wind 1 would be required to remove or decommission all installations and clear the seabed of all obstructions created by the proposed Project within 2 years of the termination of its lease. All facilities would need to be removed 15 feet (4.6 meters) below the mudline (30 CFR § 585.910(a)). The portion buried below 15 feet (4.6 meters) would remain, and the depression refilled with the temporarily removed sediment. BOEM expects that WTGs and the OSS would be disassembled and the piles cut below the mudline. Ocean Wind 1 would clear the area after all components have been decommissioned to ensure that no unauthorized debris remains on the seabed. A cable-laying vessel would be used to remove as much of the inter-array and Ocean Wind 1 Export Cable transmission cables from the seabed as practicable to recover and recycle valuable metals. Cable segments that cannot be easily recovered would be left buried below the seabed or rock armoring.

Information on the proposed decommissioning is very limited and the information available to us in the BA, DEIS, and COP limits our ability to carry out a thorough assessment of effects on listed species. Here, we evaluate the information that is available on the decommissioning. We note that prior to decommissioning, Ocean Wind 1 would be required to submit a decommissioning plan to BOEM. According to BOEM, this would be subject to an approval process that is independent of the proposed COP approval. BOEM indicates in the DEIS that the approval process will include an opportunity for public comment and consultation with municipal, state, and federal management agencies. Ocean Wind 1 would need to obtain separate and subsequent approval from BOEM to retire any portion of the Proposed Action in place. Given that approval of the decommissioning plan will be a discretionary Federal action, albeit one related to the present action, we anticipate that a determination will be made based on the best available information at that time whether reinitiation of this consultation is necessary to consider effects of decommissioning that are different from those considered here.

As described in section 6.3 of the COP, it is anticipated that the equipment and vessels used during decommissioning will likely be similar to those used during construction and installation (COP 2022). For offshore work, vessels would likely include cable laying vessels, crane barges, jack-up barges, larger support vessels, tugboats, crew transfer vessels, and possibly a vessel specifically built for erecting WTG structures. Effects of the vessel traffic anticipated for decommissioning are addressed in the vessel effects section of this Opinion. As described below, we have determined that all other effects of decommissioning will be insignificant.

As described in the COP (2022), if cable removal is required, the first step of the decommissioning process would involve disconnecting the inter-array 170kV cables from the WTGs. Next, the inter-array cables would be pulled out of the J-tubes or similar connection and extracted from their embedded position in the seabed. In some places, in order to remove the cables, it may be necessary to jet plow the cable trench to fluidize the sandy sediments covering the cables. Then, the cables will be reeled up onto barges. Lastly, the cable reels will then be transported to the port area for further handling and recycling. The same general process will likely be followed for the 275 kV offshore export cable. If protective concrete mattresses or rocks were used for portions of the cable run, they will be removed prior to recovering the cable. We determined that acoustic and habitat based effects of cable installation would be insignificant or extremely unlikely to occur; as the cable removal will essentially follow the same process as cable installation except in reverse, we expect that effects will be the same and therefore would also be insignificant or extremely unlikely to occur.

Prior to dismantling the WTGs, they would be properly drained of all lubricating fluids, according to the established operations and maintenance procedures and the OSRP. Removed fluids would be brought to the port area for proper disposal and/or recycling. Next, the WTGs would be deconstructed (down to the transition piece at the base of the tower) in a manner closely resembling the installation process. The blades, rotor, nacelle, and tower would be sequentially disassembled and removed to port for recycling using vessels and cranes similar to those used during construction. It is anticipated that almost all of the WTG will be recyclable, except possibly for any fiberglass components. After removing the WTGs, the steel transition pieces and foundation components would be decommissioned.

Sediments inside the monopile could be suctioned out and temporarily stored on a barge to allow access for cutting. Because this sediment removal would occur within the hollow base of the monopile, no listed species would be exposed to effects of this operation. The foundation and transition piece assembly is expected to be cut below the seabed in accordance with the BOEM's removal standards (30 C.F.R. 250.913). The portion of the foundation below the cut will likely remain in place. Depending upon the available crane's capacity, the foundation/transition piece assembly above the cut may be further cut into several more manageable sections to facilitate handling. Then, the cut piece(s) would be lifted out of the water and placed on a barge for transport to an appropriate port area for recycling.

The steel foundations would likely be cut below the mudline using one or a combination of: underwater acetylene cutting torches, mechanical cutting, or a high pressure water jet. The OSS foundation piles will likely be removed according to the same procedures used in the removal of the WTG foundations.

BOEM did not provide any estimates of underwater noise associated with pile cutting, and we did not identify any reports of underwater noise monitoring of pile cutting with the proposed methods. Hinzmann et al. (2017) reports on acoustic monitoring of removal of a met-tower monopile associated with the Amrumbank West offshore wind project in the North Sea off the coast of Germany. Internal jet cutting (i.e., the cutter was deployed from inside the monopile) was used to cut the monopile approximately 2.5 m below the mudline. The authors report that the highest sound levels were between 250 and 1,000 Hz. Frequent stopping and starting of the noise suggests that this is an intermittent, rather than continuous noise source. The authors state that values of 160 dB SELcum and 190 dB Peak were not exceeded during the jet cutting process. At a distance of 750 m from the pile, noise attenuated to 150.6 dB rms. For purposes of this consultation, and absent any other information to rely on, we assume that these results are predictive of the underwater noise that can be expected during pile removal during project decommissioning. As such, using these numbers, we would not expect any injury to any listed species because the expected noise levels are below the injury thresholds for whales, sea turtles, and Atlantic sturgeon. We also do not expect any exposure to noise that could result in behavioral disturbance of sea turtles or whales because the noise is below the levels that may result in behavioral disturbance.

Any Atlantic sturgeon within 750 m of the pile being cut would be exposed to underwater noise that is expected to elicit a behavioral response. Exposure to that noise could result in short-term behavioral or physiological responses (e.g., avoidance, stress). Exposure would be brief, just long enough to detect and swim away from the noise, and consequences limited to avoidance of the area within 750 m of the pile during. As such, effects to Atlantic sturgeon will be so small that they cannot be meaningfully measured, evaluated, or detected, and would be insignificant.

The sediments previously removed from the inner space of the pile would be returned to the depression left once the pile is removed. To minimize sediment disturbance and turbidity, a vacuum pump and diver or ROV-assisted hoses would likely be used. This, in combination with the removal of the stones used for scour protection and any concrete mattresses used along the cable route, would reverse the conversion of soft bottom habitat to hard bottom habitat that would occur as a result of project construction. Removal of the foundations would remove the potential for reef effects in the lease area. As we determined that effects of habitat conversion due to construction would be insignificant, we expect the reverse to also be true and would expect that effects of habitat conversion back to pre-construction conditions would also be insignificant.

7.10 Consideration of the Effects of the Action in the Context of Predicted Climate Change due to Past, Present, and Future Activities

Climate change is relevant to the Status of the Species, Environmental Baseline, Effects of the Action, and Cumulative Effects sections of this Opinion. In the Status of the Species section, climate change as it relates to the status of particular species is addressed. Rather than include partial discussion in several sections of this Opinion, we are synthesizing our consideration of the effects of the proposed action in the context of anticipated climate change here.

In general, waters in the Mid-Atlantic are warming and are expected to continue to warm over the 25-to-30-year life of the Ocean Wind 1 project. However, waters in the North Atlantic Ocean have warmed more slowly than the global average or slightly cooled. This is because of the Gulf Stream's role in the Atlantic Meridional Overturning Circulation (AMOC). Warm water in the Gulf Stream cools, becomes dense, and sinks, eventually becoming cold, deep waters that travel back equatorward, spilling over features on the ocean floor and mixing with other deep Atlantic waters to form a southward current approximately 1500 m beneath the Gulf Stream (IPCC 2021). Globally averaged surface ocean temperatures are projected to increase by approximately 0.7 °C by 2030 and 1.4 °C by 2060 compared to the 1986-2005 average (IPCC 2014), with increases of closer to 2°C predicted for the geographic area that includes the action area. Data from the NOAA weather buoy closest to the lease area (44009) collected from 1984-2008 indicate a mean temperature range from a low of 5°C in the winter to a high of 24°C in the summer, and boat based surveys in the Lease Area had a minimum temperature of 2°C in the winter and a maximum of 26°C in the summer (BOEM 2022). Based on current predictions (IPCC 2014[46]), this could shift to a range of 7.9°C in the winter to 23.8°C in the summer. Ocean acidification is also expected to increase over the life of the project (Hare et al. 2016) which may affect the prey of a number of ESA listed species. Ocean acidification is contributing to reduced growth or the decline of zooplankton and other invertebrates that have calcareous shells (Pacific Marine Environmental Laboratory [PMEL] 2020).

We have considered whether it is reasonable to expect ESA listed species whose northern distribution does not currently overlap with the action area to occur in the action area over the project life due to a northward shift in distribution. We have determined that it is not reasonable to expect this to occur. This is largely because water temperature is only one factor that influences species distribution. Even with warming waters we do not expect hawksbill sea turtles to occur in the action area because there will still not be any sponge beds or coral reefs that hawksbills depend on and are key to their distribution (NMFS and USFWS 2013). We also do not expect giant manta ray or oceanic whitetip shark to occur in the lease area. Oceanic whitetip shark are a deep-water species (typically greater than 184 m) that occurs beyond the shelf edge on the high seas (Young et al. 2018). Giant manta ray also occur in deeper, offshore waters and occurrence in shallower nearshore waters is coincident with the presence of coral reefs that they rely on for important life history functions (Miller et al. 2016). Smalltooth sawfish do not occur north of Florida. Their life history depends on shallow estuarine habitats fringed with vegetation, usually red mangroves (Norton et al. 2012); such habitat does not occur in the lease area and would not occur even with ocean warming over the course of the proposed action. As such, regardless of the extent of ocean warming that may be reasonably expected in the action area over the life of the project, the habitat will remain inconsistent with habitats used by ESA listed species that currently occur south of the lease area. Therefore, we do not anticipate that any of these species will occur in the lease area over the life of the proposed action.

We have also considered whether climate change will result in changes in the use of the action area by Atlantic sturgeon or the ESA listed turtles and whales considered in this consultation. In a climate vulnerability analysis, Hare et al. (2016) concluded that Atlantic sturgeon are relatively invulnerable to distribution shifts. Given the extensive range of the species along nearly the entire U.S. Atlantic Coast and into Canada, it is unlikely that Atlantic sturgeon would shift out of the action area over the life of the project. If there were shifts in the abundance or distribution of sturgeon prey, it is possible that use of lease area by foraging sturgeon could become more or less common. However, even if the frequency and abundance of use of the lease area by Atlantic sturgeon increased over time, we would not expect any different effects to Atlantic sturgeon than

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[46] IPCC 2014 is used as a reference here consistent with NMFS 2016 Revised Guidance for Treatment of Climate Change in NMFS Endangered Species Act Decisions (Available at: *https://www.fisheries.noaa.gov/national/endangered-species-conservation/endangered-species-act-guidance-policies-and-regulations*, last accessed March 2, 2023).

those considered based on the current distribution and abundance of Atlantic sturgeon in the action area.

Use of the action area by sea turtles is driven at least in part by sea surface temperature, with sea turtles absent from the lease area and cable corridors from the late fall through mid-spring due to colder water temperatures. An increase in water temperature could result in an expansion of the time of year that sea turtles are present in the action area and could increase the frequency and abundance of sea turtles in the action area. However, even with a 2°C increase in water temperatures, winter and early spring mean sea surface temperatures in the lease area are still too cold to support sea turtles. Therefore, any expansion in annual temporal distribution in the action area is expected to be small and on the order of days or potentially weeks, but not months. Any changes in distribution of prey would also be expected to affect distribution and abundance of sea turtles and that could be a negative or positive change. It has been speculated that the nesting range of some sea turtle species may shift northward as water temperatures warm. Currently, nesting in the mid-Atlantic is extremely rare. In order for nesting to be successful, fall and winter temperatures need to be warm enough to support the successful rearing of eggs and sea temperatures must be warm enough for hatchlings to survive when they enter the water. Predicted increases in water temperatures over the life of the project are not great enough to allow successful rearing of sea turtle hatchlings in the action area. Therefore, we do not expect that over the time-period considered here, that there would be any nesting activity or hatchlings in the action area. Based on the available information, we expect that any increase in the frequency and abundance of use of the lease area by sea turtles due to increases in mean sea surface temperature would be small. Regardless of this, we would not expect any different effects to sea turtles than those considered based on the current distribution and abundance of sea turtles in the action area. Further, given that any increase in frequency or abundance of sea turtles in the action area is expected to be small we do not expect there to be an increase in risk of vessel strike above what has been considered based on current known distribution and abundance.

The distribution, abundance and migration of baleen whales reflects the distribution, abundance and movements of dense prey patches (e.g., copepods, euphausiids or krill, amphipods, shrimp), which have in turn been linked to oceanographic features affected by climate change (Learmonth et al. 2006). Changes in plankton distribution, abundance, and composition are closely related to ocean climate, including temperature. Changes in conditions may directly alter where foraging occurs by disrupting conditions in areas typically used by species and can result in shifts to areas not traditionally used that have lower quality or lower abundance of prey.

Climate change is unlikely to affect the frequency or abundance of sperm or blue whales in the action area. The species rarity in the lease area is expected to continue over the life of the project due to the depths in the area being shallower than the open ocean deep-water areas typically frequented by sperm whales and their prey. Two of the significant potential prey species for fin whales in the lease area are sand lance and Atlantic herring. Hare et al. (2016) concluded that climate change is likely to negatively impact sand lance and Atlantic herring but noted that there was a high degree of uncertainty in this conclusion. The authors noted that higher temperatures may decrease productivity and limit habitat availability. A reduction in small schooling fish such as sand lance and Atlantic herring in the lease area could result in a decrease in the use of the area by foraging fin whales. The distribution of copepods in the North Atlantic, including in the lease area, is driven by a number of factors that may be impacted by climate change. Record et al. (2019) suggests that recent changes in the distribution of North Atlantic right whales are related to recent rapid changes in climate and prey and notes that while right whales may be able to shift their distribution in response to changing oceanic conditions, the ability to forage successfully in those new habitats is also critically important. Warming in the deep waters of the Gulf of Maine is negatively impacting the abundance of *Calanus finmarchicus*, a primary prey for right whales. *C. finmarchicus* is vulnerable to the effects of global warming, particularly on the Northeast U.S. Shelf, which is in the southern portion of its range (Grieve et al. 2017). Grieve et al. (2017) used models to project *C. finmarchicus* densities into the future under different climate scenarios considering predicted changes in water temperature and salinity. Based on their results, by the 2041–2060 period, 22 – 25% decreases in *C. finmarchicus* density are predicted across all regions of the Northeast U.S. shelf. A decrease in abundance of right whale prey in the WDA could be expected to result in a similar decrease in abundance of right whales in the WDA over the same time scale; however, whether the predicted decline in *C. finmarchicus* density is great enough to result in a decrease in right whale presence in the action area over the life of the project is unknown.

Right whale calving occurs off the coast of the Southeastern U.S. In the final rule designating critical habitat, the following features were identified as essential to successful calving: (1) calm sea surface conditions associated with Force 4 or less on the Beaufort Scale, (2) sea surface temperatures from 7 °C through 17 °C; and, (3) water depths of 6 to 28 meters where these features simultaneously co-occur over contiguous areas of at least 231 km^2 during the months of November through April. Even with a 2°C shift in mean sea surface temperature, waters off New England in the November to April period will not be warm enough to support calving. While there could be a northward shift in calving over this period, it is not reasonable to expect that over the life of the project that calving would occur in the WDA. Further, given the thermal tolerances of young calves (Garrison 2007) we do not expect that the distribution of young calves would shift northward into the action area such that there would be more or younger calves in the action area.

Based on the available information, it is difficult to predict how the use of the action area by large whales may change over the operational life of the project. However, we do not expect changes in use by sperm or blue whales. Changes in habitat used by sei, fin, and right whales may be related to a northward shift in distribution due to warming waters and a decreased abundance of prey. However, it is also possible that reductions in prey in other areas, including the Gulf of Maine, result in persistence of foraging in the WDA over time. Based on the information available at this time, it seems most likely that the use of the WDA by large whales will decrease or remain stable. As such, we do not expect any changes in abundance or distribution that would result in different effects of the action than those considered in the Effects of the Action section of this Opinion. To the extent new information on climate change, listed species, and their prey becomes available in the future, reinitiation of this consultation may be necessary.

8.0 CUMULATIVE EFFECTS

"Cumulative effects" are those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 C.F.R. §402.02). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA. It is important to note that, while there may be some overlap, the ESA definition of cumulative effects is not equivalent to the definition of "cumulative impacts" as described in the Ocean Wind 1 DEIS. Under NEPA, "cumulative effects…are the impact on the environment resulting from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions. Actions by federal, non-federal agencies, and private parties must be considered" (see 40 CFR 1508.7).

We reviewed the list of cumulative impacts identified by BOEM in the Ocean Wind 1 DEIS and determined that most (other offshore wind energy development activities; undersea transmission lines, gas pipelines, and other submarine cables (e.g., telecommunications); tidal energy projects; marine minerals use and ocean-dredged material disposal; military use; Federal fisheries use and management, and, oil and gas activities) do not meet the ESA definition of cumulative effects because we expect that if any of these activities were proposed in the action area, or proposed elsewhere yet were to have future effects inside the action area, they would require at least one Federal authorization or permit and would therefore require their own ESA section 7 consultation. BOEM identifies global climate change as a cumulative impact in the DEIS. Because global climate change is not a future state or private activity, we do not consider it a cumulative effect for the purposes of this consultation. Rather, future state or private activities reasonably certain to occur and contribute to climate change's effects in the action area are relevant. However, given the difficulty of parsing out climate change effects due to past and present activities from those of future state and private activities, we discussed the effects of the action in the context of climate change due to past, present, and future activities in the Effects of the Action section above. The remaining cumulative impacts identified in the DEIS and FEIS (marine transportation, coastal development, and state and private fisheries use and management) are addressed below.

It is important to note that because any future offshore wind project will require section 7 consultation, these future wind projects do not fit within the ESA definition of cumulative effects and none of them are considered in this Opinion. However, in each successive consultation, the effects on listed species of other offshore wind projects under construction or completed would be considered to the extent they influence the status of the species and/or environmental baseline according to the best available scientific information. We have presented information on the South Fork and Vineyard Wind projects in the Environmental Baseline of this Opinion.

During this consultation, we searched for information on future state, tribal, local, or private (non-Federal) actions reasonably certain to occur in the action area or have effects in the action area. We did not find any information about non-Federal actions other than what has already been described in the *Environmental Baseline*. The primary non-Federal activities that will continue to have effects in the action area are: Recreational fisheries, fisheries authorized by states, use of the action area by private vessels, discharge of wastewater and associated pollutants, and coastal development authorized by state and local governments. Any coastal development that requires a Federal authorization, inclusive of a permit from the USACE, would require future section 7 consultation and would not be considered a cumulative effect. We do not have any information to indicate that effects of these activities over the life of the proposed action will have different effects than those considered in the Status of the Species and Environmental Baseline sections of this Opinion, inclusive of how those activities may contribute to climate change.

9.0 INTEGRATION AND SYNTHESIS OF EFFECTS

The *Integration and Synthesis* section is the final step in our assessment of the risk posed to species as a result of implementing the proposed action. In Section 4, we determined that the project will have no effect on the Gulf of Maine DPS of Atlantic salmon or critical habitat designated for the North Atlantic right whale, Carolina DPS of Atlantic sturgeon, or the Northwest Atlantic DPS of loggerhead sea turtles. We concur with BOEM's determination that the proposed action is not likely to adversely affect giant manta rays, hawksbill sea turtles, the Northeast Atlantic DPS of loggerhead sea turtles, and oceanic whitetip sharks. In this section, we add the *Effects of the Action* (Section 7) to the *Environmental Baseline* (Section 6) and the *Cumulative Effects* (Section 8), while also considering effects in context of climate change and the status of the species (Section 5), to formulate the agency's biological opinion as to whether the proposed action "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 its numbers, reproduction, or distribution" (50 CFR §402.02; the definition of "jeopardize the continued existence"). The purpose of this analysis in this Opinion is to determine whether the action is likely to jeopardize the continued existence of North Atlantic right, fin, sei, blue, or sperm whales, five DPSs of Atlantic sturgeon, shortnose sturgeon, the Northwest Atlantic DPS of loggerhead sea turtles, North Atlantic DPS of green sea turtles, or leatherback or Kemp's ridley sea turtles. The purpose of this analysis is also to determine whether the action is likely to destroy or adversely modify critical habitat designated for the New York Bight DPS of Atlantic sturgeon. As defined by NMFS and USFWS, destruction or adverse modification "means a direct or indirect alteration that appreciably diminishes the value of critical habitat for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features." (81 FR 7214; Feb.11, 2016).

Below, for the listed species that may be adversely affected by the proposed action (i.e. those species affected by the action and for which *all* effects are not extremely unlikely and/or insignificant) we summarize the status of the species and consider whether the action will result in reductions in reproduction, numbers, or distribution of these species. We then consider whether any reductions in reproduction, numbers, or distribution resulting from the action would reduce appreciably the likelihood of both the survival and recovery of these species, as those terms are defined for purposes of the federal Endangered Species Act and its implementing regulations (50 C.F.R. §402.02).

In addition, we use the following guidance and regulatory definitions related to survival and recovery to guide our jeopardy analysis. In the NMFS/USFWS Section 7 Handbook, for the purposes of determining whether jeopardy is likely, survival is defined as, "the species' persistence as listed or as a recovery unit, beyond the conditions leading to its endangerment, with sufficient resilience to allow for the potential recovery from endangerment. Said in another way, survival is the condition in which a species continues to exist into the future while retaining the potential for recovery. This condition is characterized by a species with a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring, which exists in an environment providing all requirements for completion of the species' entire life cycle, including reproduction, sustenance, and shelter." Recovery is defined in regulation as, "Improvement in the status of listed species to the point at which listing is no longer appropriate under the criteria set out in Section 4(a)(1) of the Act." 50 C.F.R. §402.02

9.1 Shortnose Sturgeon

The only portion of the action area that overlaps with the distribution of shortnose sturgeon is the Delaware River where vessels transiting to/from the Paulsboro Marine Terminal and New Jersey Wind Port will travel. NMFS completed ESA consultation on the construction and operation of those port facilities in 2022; these consultations considered effects of all vessels using these ports over a 10-year and 25-year period, respectively, and the risk of vessel strike to Atlantic and shortnose sturgeon from those vessel operations. In both of those Opinions, NMFS concluded that the proposed actions were likely to adversely affect, but not likely to jeopardize the continued existence of shortnose sturgeon. In this Opinion, we identify the portion of the take (i.e., lethal vessel strike) identified in the Paulsboro and NJWP Opinions that would be attributable to the Ocean Wind vessels. As described in sections 2, 6, and 7 of this Opinion, based on the number of vessel trips to these ports identified in BOEM's BA, we have determined that Ocean Wind 1 vessels utilizing the Paulsboro Marine Terminal will strike and kill no more than one shortnose sturgeon while transiting the Delaware River. Similarly, we have determined that Ocean Wind 1 vessels utilizing the New Jersey Wind Port will strike and kill no more than one shortnose sturgeon while transiting the Delaware River. The effects of these vessel trips are included in the Environmental Baseline for the Ocean Wind 1 project. We have not identified any effects of the Ocean Wind 1 project on shortnose sturgeon that are beyond what was considered in the Paulsboro and New Jersey Wind Port consultations. As such, consistent with the conclusions of the Paulsboro and New Jersey Wind Port consultations we have determined that the proposed actions considered here are likely to adversely affect but not likely to jeopardize the continued existence of shortnose sturgeon.

9.2 Critical Habitat Designated for the New York Bight DPS of Atlantic Sturgeon

The critical habitat designation for the New York Bight DPS is for habitats that support successful Atlantic sturgeon reproduction and recruitment. The Delaware River critical habitat unit extends from the Trenton-Morrisville Route 1 Toll Bridge at approximately RKM 213.5, downstream to where the main stem river discharges into Delaware Bay at approximately RKM 78. The action area overlaps with a portion of the Delaware River critical habitat unit designated for the New York Bight DPS. The only project activity that may affect this critical habitat is the transit of project vessels to or from the Paulsboro Marine Terminal in Paulsboro, NJ (approximately RKM 139) and the New Jersey Wind Port in Hope Creek, NJ (approximately RKM 84).

The Biological Opinions prepared by NMFS for the Paulsboro and New Jersey Wind Ports considered effects of construction of these port facilities and the effects of all vessels transiting between the mouth of Delaware Bay and these ports on critical habitat designated for the New York Bight DPS of Atlantic sturgeon. In the July 19, 2022, Biological Opinion NMFS concluded that the construction and subsequent use of the Paulsboro Marine Terminal was not likely to adversely affect critical habitat designated for the New York Bight DPS of Atlantic sturgeon. In the February 25, 2022, Biological Opinion NMFS concluded that the construction and subsequent use of the New Jersey Wind Port was likely to adversely affect but not likely to destroy or adversely modify critical habitat designated for the New York Bight DPS of Atlantic sturgeon. As explained in that Opinion, NMFS determined that there would be temporary and permanent effects as a result of construction and mitigation activities and that the subsequent use of the NJWP channels by deep draft vessels and periodic maintenance dredging will continue to reduce the value of the habitat over the 25-year expected life-time of the NJWP operations. As explained in sections 6 and 7 of this Opinion, we are not able to determine the proportional effects of Ocean Wind 1 vessel use of these port facilities on critical habitat, but we determined it is within the scope of effects considered in that Opinion. The effects of these vessel trips on critical habitat designated for the New York Bight DPS of Atlantic sturgeon are included in the Environmental Baseline for the Ocean Wind 1 project. We have not identified any effects of the Ocean Wind 1 project that are beyond what was considered in the Paulsboro and New Jersey Wind Port consultations. As such, consistent with the conclusions of the New Jersey Wind Port consultation we have determined that the proposed actions considered here, and specifically the use of the NJWP by Ocean Wind 1 vessels, are likely to adversely affect but not likely to destroy or adversely modify critical habitat designated for the New York Bight DPS of Atlantic sturgeon.

9.3 Atlantic sturgeon

In the *Effects of the Action* section above, we determined that 75 Atlantic sturgeon (1 Gulf of Maine, 42 New York Bight, 18 Chesapeake Bay, 10 South Atlantic, and 4 Carolina) are likely to be captured and released alive with only minor, recoverable injuries over the six years of trawl surveys. While exposure to pile driving noise and/or UXO detonations may result in a behavioral response from individuals close enough to the noise source to be disturbed, we determined that effects of that noise exposure will be insignificant; no take of any type including injury or mortality is expected to result from exposure to project noise, inclusive of UXO detonations. We determined that all effects to habitat and prey would be insignificant or extremely unlikely to occur. All effects of project operations, including operational noise and the physical presence of the turbine foundations and electric cable, and effects to Atlantic sturgeon from changes to ecological conditions are extremely unlikely to occur or insignificant.

As described in sections 2, 6, and 7 of this Opinion, based on the number of vessel trips to the Paulsboro Marine Terminal identified in BOEM's BA, we have determined that Ocean Wind 1 vessels utilizing the Paulsboro Marine Terminal will strike and kill no more than two New York Bight DPS Atlantic sturgeon while transiting the Delaware River. Similarly, based on the number of vessel trips to the New Jersey Wind Port identified in BOEM's BA, we have determined that Ocean Wind 1 vessels utilizing the New Jersey Wind Port will strike and kill no more than three Atlantic sturgeon; we expect that two of these would be from the New York Bight DPS with one from the Chesapeake Bay, South Atlantic, or Gulf of Maine DPS. The effects of these vessel trips and the loss of these individuals from these DPSs are included in the Environmental Baseline for the Ocean Wind project.

9.3.1 Gulf of Maine DPS of Atlantic sturgeon

The Gulf of Maine DPS is listed as threatened. While Atlantic sturgeon occur in several rivers in the Gulf of Maine DPS, recent spawning has only been documented in the Kennebec River. There are no abundance estimates for the Gulf of Maine DPS as a whole. The estimated effective population size of the Kennebec River is less than 70 adults, which suggests a relatively small spawning population (NMFS 2022). NMFS estimated adult and subadult abundance of the Gulf of Maine DPS based on available information for the genetic composition and the estimated abundance of Atlantic sturgeon in marine waters (Damon-Randall et al. 2013, Kocik et al. 2013) and concluded that subadult and adult abundance of the Gulf of Maine DPS was 7,455 sturgeon (NMFS 2013). This number encompasses many age classes since, across all DPSs, subadults can be as young as one year old when they first enter the marine environment, and adults can live as long as 64 years (Balazik et al. 2012a; Hilton et al. 2016).

Gulf of Maine origin Atlantic sturgeon are subject to numerous sources of human induced mortality and habitat disturbance throughout the riverine and marine portions of their range. There is currently not enough information to establish a trend for any life stage or for the DPS as a whole. The ASMFC stock assessment concluded that the abundance of the Gulf of Maine DPS is "depleted" relative to historical levels. The Commission also noted that the Gulf of Maine is particularly data poor among all five DPSs. The assessment concluded that there is a 51 percent probability that the abundance of the Gulf of Maine DPS has increased since implementation of the 1998 fishing moratorium. The Commission also concluded that there is a relatively high likelihood (74 percent probability) that mortality for the Gulf of Maine DPS exceeds the mortality threshold used for the assessment (ASMFC 2017). However, the Commission noted that there was considerable uncertainty related to these numbers, particularly concerning trends data for the Gulf of Maine DPS. For example, the stock assessment notes that it was not clear if: (1) the percent probability for the trend in abundance for the Gulf of Maine DPS is a reflection of the actual trend in abundance or of the underlying data quality for the DPS; and, (2) the percent probability that the Gulf of Maine DPS exceeds the mortality threshold actually reflects lower survival or was due to increased tagging model uncertainty owing to low sample sizes and potential emigration.

As described in the 5-Year Review for the Gulf of Maine DPS (NMFS 2022), the demographic risk for the DPS is "moderate"[47] because of its low productivity (i.e., relatively few adults compared to historical levels), low abundance (i.e., only one known spawning population and low DPS abundance, overall), and limited spatial distribution (i.e., limited spawning habitat within the one river known to support spawning). There is also new information indicating genetic bottlenecks as well as low levels of inbreeding. However, the recovery potential is considered high.

The effects of the action are in addition to ongoing threats in the action area, which include incidental capture in state and federal fisheries, boat strikes, coastal development, habitat loss, contaminants, and climate change. Entanglement in fishing gear and vessel strikes as described in the *Environmental Baseline* may occur in the action area over the life of the proposed action. This includes the mortality of no more than one Gulf of Maine DPS Atlantic sturgeon resulting from Ocean Wind 1 vessels transiting in the Delaware River to/from the New Jersey Wind Port l.

[47] 84 FR 18243; April 30, 2019 - Listing and Recovery Priority Guidelines.

As noted in the Cumulative Effects section of this Opinion, we have not identified any cumulative effects different from those considered in the *Status of the Species* and *Environmental Baseline* sections of this Opinion, inclusive of how those activities may contribute to climate change. As described in section 7.10, climate change may result in changes in the distribution or abundance of Atlantic sturgeon in the action area over the life of this project; however, we have not identified any different or exacerbated effects of the action due to anticipated climate change.

We have considered effects of the Ocean Wind 1 project over the construction, operations, and decommissioning periods in consideration of the effects already accounted for in the Environmental Baseline and in consideration of Cumulative Effects and climate change. With the exception of effects of vessel traffic in the Delaware River from Ocean Wind vessels transiting to the New Jersey Wind Port, which are included in the Environmental Baseline, the only adverse effects of the proposed action on Atlantic sturgeon are the non-lethal capture of 1 Gulf of Maine DPS Atlantic sturgeon in the trawl survey. We do not anticipate any adverse effects to result from exposure to pile driving, UXO detonation, or any other noise source including HRG surveys and operational noise. We do not expect any Atlantic sturgeon to be struck by any project vessels operating outside of the Delaware River. We do not expect the operation or existence of the turbines and other facilities, including the electric cables, to result in any changes in the abundance, reproduction, or distribution of Atlantic sturgeon in the action area. All effects to Atlantic sturgeon from impacts to habitat and prey will be insignificant.

Live sturgeon captured and released in the trawl survey may experience minor injuries (i.e., scrapes, abrasions); however, they are expected to make a complete recovery without any impairment to future fitness. Capture will temporarily prevent these individuals from carrying out essential behaviors such as foraging and migrating. However, these behaviors are expected to resume as soon as the sturgeon are returned to the water; for trawls the length of capture will be no more than the 20 minute tow time plus a short handling period on board the vessel. The capture of live sturgeon will not reduce the numbers of Atlantic sturgeon in the action area or the numbers of Gulf of Maine DPS Atlantic sturgeon as a whole. Similarly, as the capture of live Atlantic sturgeon will not affect the fitness of any individual, no effects to reproduction are anticipated. The capture of live Atlantic sturgeon is also not likely to affect the distribution of Atlantic sturgeon in the action area or affect the distribution of Atlantic sturgeon throughout their range. As any effects to individual live Atlantic sturgeon removed from the trawl gear will be minor and temporary without any mortality or effects on reproduction, we do not anticipate any population level impacts.

The proposed project will not result in the mortality of any Atlantic sturgeon beyond what is considered in the Environmental Baseline (inclusive of the mortality of no more than one Gulf of Maine DPS Atlantic sturgeon resulting from Ocean Wind 1 vessel traffic in the Delaware River). There will be no effects on reproduction other than the loss of the potential future reproductive output of one individual already addressed in the Baseline. The proposed action is not likely to reduce distribution, because the action will not impede Gulf of Maine DPS Atlantic sturgeon from accessing any seasonal aggregation areas, including foraging, spawning, or overwintering grounds. Any consequences to distribution will be minor and temporary and limited to the temporary avoidance of areas with increased noise during pile driving.

Based on the information provided above, the proposed action will not appreciably reduce the likelihood of survival of the Gulf of Maine DPS (i.e., it will not decrease the likelihood that the species will continue to persist into the future with sufficient resilience to allow for the potential recovery from endangerment). The action will not affect the Gulf of Maine DPS Atlantic sturgeon in a way that prevents the species from having a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring, and it will not result in consequences to the environment which would prevent Atlantic sturgeon from completing their entire life cycle or completing essential behaviors including reproducing, foraging and sheltering. This is the case because: (1) the proposed action will not result in any mortality and associated potential future reproduction beyond what has been accounted for in the Environmental Baseline (death of 1 subadult or adult Gulf of Maine DPS Atlantic sturgeon, which represents an extremely small percentage of the species); (2) the proposed action will not change the status or trends of the species as a whole; (3) there will be no effect on the levels of genetic heterogeneity in the population; (4) the action will have only a minor and temporary consequence on the distribution of Gulf of Maine DPS Atlantic sturgeon in the action area and no consequence on the distribution of the species throughout its range; and, (5) the action will have only an insignificant effect on individual foraging or sheltering Gulf of Maine DPS Atlantic sturgeon.

In rare instances, an action that does not appreciably reduce the likelihood of a species' survival might appreciably reduce its likelihood of recovery. As explained above, we have determined that the proposed action will not appreciably reduce the likelihood that the Gulf of Maine DPS of Atlantic sturgeon will survive in the wild, which includes consideration of recovery potential. Here, we consider whether the action will appreciably reduce the likelihood of recovery from the perspective of ESA Section 4. As noted above, recovery is defined as the improvement in status such that listing under Section 4(a) as "in danger of extinction throughout all or a significant portion of its range" (endangered) or "likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range…" (threatened) is no longer appropriate. Thus, we have considered whether the proposed action will appreciably reduce the likelihood that Gulf of Maine DPS Atlantic sturgeon can rebuild to a point where the Gulf of Maine DPS of Atlantic sturgeon is no longer likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

No Recovery Plan for the Gulf of Maine DPS has been published. The Recovery Plan will outline the steps necessary for recovery and the demographic criteria, which once attained would allow the species to be delisted. In January 2018, we published a Recovery Outline for the five DPSs of Atlantic sturgeon (NMFS 2018[48]). This outline is meant to serve as an interim guidance document to direct recovery efforts, including recovery planning, until a full recovery plan is developed and approved. The outline provides a preliminary strategy for recovery of the species. We know that in general, to recover, a listed species must have a sustained positive trend of increasing population over time. To allow that to happen for sturgeon, individuals must have access to enough habitat in suitable condition for foraging, resting and spawning. Conditions must be suitable for the successful development of early life stages. Mortality rates must be low

[48] Available online at: https://media.fisheries.noaa.gov/dam-migration/ats_recovery_outline.pdf; last accessed March 17, 2023

enough to allow for recruitment to all age classes so that successful spawning can continue over time and over generations. There must be enough suitable habitat for spawning, foraging, resting, and migrations of all individuals. For Gulf of Maine DPS Atlantic sturgeon, habitat conditions must be suitable both in the natal river and in other rivers and estuaries where foraging by subadults and adults will occur and in the ocean where subadults and adults migrate, overwinter and forage. Habitat connectivity must also be maintained so that individuals can migrate between important habitats without delays that impact their fitness. As described in the vision statement in the Recovery Outline, subpopulations of all five Atlantic sturgeon DPSs must be present across the historical range. These subpopulations must be of sufficient size and genetic diversity to support successful reproduction and recovery from mortality events. The recruitment of juveniles to the sub-adult and adult life stages must also increase and that increased recruitment must be maintained over many years. Recovery of these DPSs will require conservation of the riverine and marine habitats used for spawning, development, foraging, and growth by abating threats to ensure a high probability of survival into the future. Here, we consider whether this proposed action will reduce the Gulf of Maine DPS likelihood of recovery.

This action will not change the status or trend of the Gulf of Maine DPS. The proposed action will not affect the distribution of Atlantic sturgeon across the historical range. The proposed action will not result in mortality or reduction in future reproductive output beyond what was considered in the Environmental Baseline and will not impair the species' resiliency, genetic diversity, recruitment, or year class strength. The proposed action will have only insignificant effects on habitat and forage and will not impact habitat in a way that makes additional growth of the population less likely, that is, it will not reduce the habitat's carrying capacity. This is because impacts to forage will be insignificant or extremely unlikely, and the area that sturgeon may avoid is small. Any avoidance will be temporary and limited to the period of time when pile driving or UXO detonation is occurring. For these reasons, the action will not reduce the likelihood that the Gulf of Maine DPS can recover. Therefore, the proposed action will not appreciably reduce the likelihood that the Gulf of Maine DPS of Atlantic sturgeon can be brought to the point at which they are no longer listed as threatened; that is, the proposed action will not appreciably reduce the likelihood of recovery of the Gulf of Maine DPS. Based on the analysis presented herein, the proposed action is not likely to appreciably reduce the likelihood of both the survival and recovery of this species. These conclusions were made in consideration of the status of the Gulf of Maine DPS of Atlantic sturgeon, other stressors that individuals are exposed to within the action area as described in the *Environmental Baseline* and *Cumulative Effects*, and any anticipated effects of climate change on the abundance, reproduction, and distribution of the Gulf of Maine DPS of Atlantic sturgeon in the action area.

9.3.2 New York Bight DPS of Atlantic sturgeon

The New York Bight DPS is listed as endangered. While Atlantic sturgeon occur in several rivers in the New York Bight, recent spawning has only been documented in the Hudson and Delaware Rivers. The essential physical features necessary to support spawning and recruitment are also present in the Connecticut and Housatonic Rivers (82 FR 39160; August 17, 2017). However, there is no current evidence that spawning is occurring nor are there studies underway to investigate spawning occurrence in those rivers; except one recent study where young of year (YOY) fish of were captured in the Connecticut River (Savoy *et al.* 2017). Genetic analysis suggests that the YOY belonged to the South Atlantic DPS and at this time, we do not know if these fish were the result of a single spawning event due to unique straying of the adults from the South Atlantic DPS's spawning rivers. NMFS estimated adult and subadult abundance of the New York Bight DPS based on available information for the genetic composition and the estimated abundance of Atlantic sturgeon in marine waters (Damon-Randall et al. 2013, Kocik et al. 2013) and concluded that subadult and adult abundance of the New York Bight DPS was 34,566 sturgeon (NMFS 2013). This number encompasses many age classes since, across all DPSs, subadults can be as young as one year old when they first enter the marine environment, and adults can live as long as 64 years (Balazik et al. 2012a; Hilton et al. 2016).

The 2017 ASMFC stock assessment determined that abundance of the New York Bight DPS is "depleted" relative to historical levels (ASMFC 2017). The assessment also determined there is a relatively high probability (75 percent) that the New York Bight DPS abundance has increased since the implementation of the 1998 fishing moratorium, and a 31 percent probability that mortality for the New York Bight DPS exceeds the mortality threshold used for the assessment (ASMFC 2017). The Commission noted, however, there is significant uncertainty in relation to the trend data. Moreover, new information suggests that the Commission's conclusions primarily reflect the status and trend of only the DPS's Hudson River spawning population.

New York Bight DPS origin Atlantic sturgeon are subject to numerous sources of human induced mortality and habitat disturbance throughout the riverine and marine portions of their range. The largest single source of mortality appears to be capture as bycatch in commercial fisheries operating in the marine environment. Because early life stages and juveniles do not leave the river, they are not impacted by fisheries occurring in federal waters. Bycatch and mortality also occur in state fisheries; however, the primary fishery that impacted juvenile sturgeon (the shad fishery) has now been closed and there is no indication that it will reopen soon. New York Bight DPS Atlantic sturgeon are killed as a result of other anthropogenic activities in the Hudson, Delaware, and other rivers within the New York Bight as well; sources of potential mortality include vessel strikes and entrainment in dredges.

The effects of the action are in addition to ongoing threats in the action area, which include incidental capture in state and federal fisheries, boat strikes, coastal development, habitat loss, contaminants, and climate change. Entanglement in fishing gear and vessel strikes as described in the *Environmental Baseline* may occur in the action area over the life of the proposed action. This includes the mortality of no more than four New York Bight DPS Atlantic sturgeon resulting from Ocean Wind 1 vessels transiting in the Delaware River to/from the New Jersey Wind Port (2) and Paulsboro Marine Terminal (2). As noted in the *Cumulative Effects* section of this Opinion, we have not identified any cumulative effects different from those considered in the Status of the Species and Environmental Baseline sections of this Opinion, inclusive of how those activities may contribute to climate change. As described in section 7.10, climate change may result in changes in the distribution or abundance of Atlantic sturgeon in the action area over the life of this project; however, we have not identified any different or exacerbated effects of the action due to anticipated climate change.

We have considered effects of the Ocean Wind 1 project over the construction, operations, and decommissioning periods in consideration of the effects already accounted for in the Environmental Baseline and in consideration of Cumulative Effects and climate change. With the exception of effects of vessel traffic in the Delaware River from Ocean Wind vessels transiting to the New Jersey Wind Port and Paulsboro Marine Terminal, which are included in the Environmental Baseline, the only adverse effects of the proposed action on Atlantic sturgeon are the non-lethal capture of 42 New York Bight DPS Atlantic sturgeon in the trawl survey. We do not anticipate any adverse effects to result from exposure to pile driving, UXO detonation, or any other noise source including HRG surveys and operational noise. We do not expect any Atlantic sturgeon to be struck by any project vessels operating outside of the Delaware River. We do not expect the operation or existence of the turbines and other facilities, including the electric cables, to result in any changes in the abundance, reproduction, or distribution of Atlantic sturgeon in the action area. All effects to Atlantic sturgeon from impacts to habitat and prey will be insignificant.

Live sturgeon captured and released in the trawl survey may experience minor injuries (i.e., scrapes, abrasions); however, they are expected to make a complete recovery without any impairment to future fitness. Capture will temporarily prevent these individuals from carrying out essential behaviors such as foraging and migrating. However, these behaviors are expected to resume as soon as the sturgeon are returned to the water; for trawls the length of capture will be no more than the 20 minute tow time plus a short handling period on board the vessel. The capture of live sturgeon will not reduce the numbers of Atlantic sturgeon in the action area or the numbers of New York Bight DPS Atlantic sturgeon as a whole. Similarly, as the capture of live Atlantic sturgeon will not affect the fitness of any individual, no effects to reproduction are anticipated. The capture of live Atlantic sturgeon is also not likely to affect the distribution of Atlantic sturgeon in the action area or affect the distribution of Atlantic sturgeon throughout their range. As any effects to individual live Atlantic sturgeon removed from the trawl gear will be minor and temporary without any mortality or effects on reproduction, we do not anticipate any population level impacts.

The proposed project will not result in the mortality of any Atlantic sturgeon beyond what is considered in the Environmental Baseline (inclusive of the mortality of no more than four New York Bight DPS Atlantic sturgeon resulting from Ocean Wind 1 vessel traffic in the Delaware River). There will be no effects on reproduction other than the loss of the potential future reproductive output of one individual already addressed in the Baseline. The proposed action is not likely to reduce distribution because the action will not impede New York Bight DPS Atlantic sturgeon from accessing any seasonal aggregation areas, including foraging, spawning, or overwintering grounds. Any consequences to distribution will be minor and temporary and limited to the temporary avoidance of areas with increased noise during pile driving.

Based on the information provided above, the proposed action will not appreciably reduce the likelihood of survival of the New York Bight DPS (*i.e.*, it will not decrease the likelihood that the species will continue to persist into the future with sufficient resilience to allow for the potential recovery from endangerment). The action will not affect the New York Bight DPS Atlantic sturgeon in a way that prevents the species from having a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring, and it will not result in consequences to the environment which would prevent Atlantic sturgeon from completing their entire life cycle or completing essential behaviors including reproducing, foraging and sheltering. This is the case because: (1)

the proposed action will not result in any mortality and associated potential future reproduction beyond what has been accounted for in the Environmental Baseline (death of 4 subadult or adult New York Bight DPS Atlantic sturgeon, which represents an extremely small percentage of the species); (2) the proposed action will not change the status or trends of the species as a whole; (3) there will be no effect on the levels of genetic heterogeneity in the population; (4) the action will have only a minor and temporary consequence on the distribution of New York Bight DPS Atlantic sturgeon in the action area and no consequence on the distribution of the species throughout its range; and, (5) the action will have only an insignificant effect on individual foraging or sheltering New York Bight DPS Atlantic sturgeon.

In rare instances, an action that does not appreciably reduce the likelihood of a species' survival might appreciably reduce its likelihood of recovery. As explained above, we have determined that the proposed action will not appreciably reduce the likelihood that the New York Bight DPS of Atlantic sturgeon will survive in the wild, which includes consideration of recovery potential. Here, we consider whether the action will appreciably reduce the likelihood of recovery from the perspective of ESA Section 4. As noted above, recovery is defined as the improvement in status such that listing under Section 4(a) as "in danger of extinction throughout all or a significant portion of its range" (endangered) or "likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range…" (threatened) is no longer appropriate. Thus, we have considered whether the proposed action will appreciably reduce the likelihood that New York Bight DPS Atlantic sturgeon can rebuild to a point where the New York Bight DPS of Atlantic sturgeon is no longer likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

No Recovery Plan for the New York Bight DPS has been published. The Recovery Plan will outline the steps necessary for recovery and the demographic criteria, which once attained would allow the species to be delisted. In January 2018, we published a Recovery Outline for the five DPSs of Atlantic sturgeon (NMFS 2018). This outline is meant to serve as an interim guidance document to direct recovery efforts, including recovery planning, until a full recovery plan is developed and approved. The outline provides a preliminary strategy for recovery of the species. We know that in general, to recover, a listed species must have a sustained positive trend of increasing population over time. To allow that to happen for sturgeon, individuals must have access to enough habitat in suitable condition for foraging, resting and spawning. Conditions must be suitable for the successful development of early life stages. Mortality rates must be low enough to allow for recruitment to all age classes so that successful spawning can continue over time and over generations. There must be enough suitable habitat for spawning, foraging, resting, and migrations of all individuals. For New York Bight DPS Atlantic sturgeon, habitat conditions must be suitable both in the natal river and in other rivers and estuaries where foraging by subadults and adults will occur and in the ocean where subadults and adults migrate, overwinter and forage. Habitat connectivity must also be maintained so that individuals can migrate between important habitats without delays that impact their fitness. As described in the vision statement in the Recovery Outline, subpopulations of all five Atlantic sturgeon DPSs must be present across the historical range. These subpopulations must be of sufficient size and genetic diversity to support successful reproduction and recovery from mortality events. The recruitment of juveniles to the sub-adult and adult life stages must also increase and that increased recruitment must be maintained over many years. Recovery of these DPSs will require conservation of the riverine and marine habitats used for spawning, development, foraging, and growth by abating threats to ensure a high probability of survival into the future. Here, we consider whether this proposed action will reduce the New York Bight DPS likelihood of recovery.

This action will not change the status or trend of the New York Bight DPS. The proposed action will not affect the distribution of Atlantic sturgeon across the historical range. The proposed action will not result in mortality or reduction in future reproductive output beyond what was considered in the Environmental Baseline and will not impair the species' resiliency, genetic diversity, recruitment, or year class strength. The proposed action will have only insignificant effects on habitat and forage and will not impact habitat in a way that makes additional growth of the population less likely, that is, it will not reduce the habitat's carrying capacity. This is because impacts to forage will be insignificant or extremely unlikely, and the area that sturgeon may avoid is small. Any avoidance will be temporary and limited to the period of time when pile driving or UXO detonation is occurring. For these reasons, the action will not reduce the likelihood that the New York Bight DPS can recover. Therefore, the proposed action will not appreciably reduce the likelihood that the New York Bight DPS of Atlantic sturgeon can be brought to the point at which they are no longer listed as threatened; that is, the proposed action will not appreciably reduce the likelihood of recovery of the New York Bight DPS. Based on the analysis presented herein, the proposed action is not likely to appreciably reduce the likelihood of both the survival and recovery of this species. These conclusions were made in consideration of the status of the New York Bight DPS of Atlantic sturgeon, other stressors that individuals are exposed to within the action area as described in the *Environmental Baseline* and *Cumulative Effects*, and any anticipated effects of climate change on the abundance, reproduction, and distribution of the New York Bight DPS of Atlantic sturgeon in the action area.

9.3.3 Chesapeake Bay DPS of Atlantic sturgeon

The Chesapeake Bay DPS is listed as endangered. While Atlantic sturgeon occur in several rivers in the Chesapeake Bay DPS, at the time of listing spawning was only known to occur in the James River. Since the listing, there is evidence of additional spawning populations in the Chesapeake Bay DPS, including the Pamunkey River, a tributary of the York River, and in Marshyhope Creek, a tributary of the Nanticoke River (Hager et al. 2014, Kahn et al. 2014, Richardson and Secor 2016, Secor et al. 2021). Detections of acoustically-tagged adult Atlantic sturgeon along with historical evidence suggests that Atlantic sturgeon belonging to the Chesapeake Bay DPS may be spawning in the Mattaponi and Rappahannock rivers as well (Hilton et al. 2016, ASMFC 2017, Kahn et al. 2019). However, information for these populations is limited and the research is ongoing.

Chesapeake Bay origin Atlantic sturgeon are affected by numerous sources of human induced mortality and habitat disturbance throughout the riverine and marine portions of their range. There is currently no census nor enough information to establish a trend, for any life stage, for the James River spawning population, or for the DPS as a whole. However, the NEAMAP data indicates that the estimated ocean population of Chesapeake Bay DPS Atlantic sturgeon is 8,811 sub-adult and adult individuals (2,203 adults and 6,608 subadults). The ASMFC (2017) stock assessment determined that abundance of the Chesapeake Bay DPS is "depleted" relative to historical levels. The assessment, while noting significant uncertainty in trend data, also determined that there is a relatively low probability (36 percent) that abundance of the Chesapeake Bay DPS has increased since the implementation of the 1998 fishing moratorium, and a 30 percent probability that mortality for the Chesapeake Bay DPS exceeds the mortality threshold used for the assessment (ASMFC 2017).

As described in the 5-Year Review for the Chesapeake Bay DPS (NMFS 2022), the demographic risk for the DPS is "High" because of its low productivity (e.g., relatively few adults compared to historical levels and irregular spawning success), low abundance (e.g., only three known spawning populations and low DPS abundance, overall), and limited spatial distribution (e.g. limited spawning habitat within each of the few known rivers that support spawning). There is also new information indicating genetic bottlenecks as well as low levels of inbreeding. However, the recovery potential is considered high.

The effects of the action are in addition to ongoing threats in the action area, which include incidental capture in state and federal fisheries, boat strikes, coastal development, habitat loss, contaminants, and climate change. Entanglement in fishing gear and vessel strikes as described in the *Environmental Baseline* may occur in the action area over the life of the proposed action. This includes the mortality of no more than one Chesapeake Bay DPS Atlantic sturgeon resulting from Ocean Wind 1 vessels transiting in the Delaware River to/from the New Jersey Wind Port. As noted in the Cumulative Effects section of this Opinion, we have not identified any cumulative effects different from those considered in the Status of the Species and Environmental Baseline sections of this Opinion, inclusive of how those activities may contribute to climate change. As described in section 7.10, climate change may result in changes in the distribution or abundance of Atlantic sturgeon in the action area over the life of this project; however, we have not identified any different or exacerbated effects of the action due to anticipated climate change.

We have considered effects of the Ocean Wind 1 project over the construction, operations, and decommissioning periods in consideration of the effects already accounted for in the Environmental Baseline and in consideration of Cumulative Effects and climate change. With the exception of effects of vessel traffic in the Delaware River from Ocean Wind vessels transiting to the New Jersey Wind Port, which are included in the Environmental Baseline, the only adverse effects of the proposed action on Atlantic sturgeon are the non-lethal capture of 18 Chesapeake Bay DPS Atlantic sturgeon in the trawl survey. We do not anticipate any adverse effects to result from exposure to pile driving, UXO detonation, or any other noise source including HRG surveys and operational noise. We do not expect any Atlantic sturgeon to be struck by any project vessels operating outside of the Delaware River. We do not expect the operation or existence of the turbines and other facilities, including the electric cables, to result in any changes in the abundance, reproduction, or distribution of Atlantic sturgeon in the action area. All effects to Atlantic sturgeon from impacts to habitat and prey will be insignificant.

Live sturgeon captured and released in the trawl survey may experience minor injuries (i.e., scrapes, abrasions); however, they are expected to make a complete recovery without any impairment to future fitness. Capture will temporarily prevent these individuals from carrying out essential behaviors such as foraging and migrating. However, these behaviors are expected to resume as soon as the sturgeon are returned to the water; for trawls the length of capture will

be no more than the 20 minute tow time plus a short handling period on board the vessel. The capture of live sturgeon will not reduce the numbers of Atlantic sturgeon in the action area or the numbers of Chesapeake Bay DPS Atlantic sturgeon as a whole. Similarly, as the capture of live Atlantic sturgeon will not affect the fitness of any individual, no effects to reproduction are anticipated. The capture of live Atlantic sturgeon is also not likely to affect the distribution of Atlantic sturgeon in the action area or affect the distribution of Atlantic sturgeon throughout their range. As any effects to individual live Atlantic sturgeon removed from the trawl gear will be minor and temporary without any mortality or effects on reproduction, we do not anticipate any population level impacts.
The proposed project will not result in the mortality of any Atlantic sturgeon beyond what is considered in the Environmental Baseline (inclusive of the mortality of no more than one Chesapeake Bay DPS Atlantic sturgeon resulting from Ocean Wind 1 vessel traffic in the Delaware River). There will be no effects on reproduction other than the loss of the potential future reproductive output of one individual already addressed in the Baseline. The proposed action is not likely to reduce distribution, because the action will not impede Chesapeake Bay DPS Atlantic sturgeon from accessing any seasonal aggregation areas, including foraging, spawning, or overwintering grounds. Any consequences to distribution will be minor and temporary and limited to the temporary avoidance of areas with increased noise during pile driving.

Based on the information provided above, the proposed action will not appreciably reduce the likelihood of survival of the Chesapeake Bay DPS (*i.e.*, it will not decrease the likelihood that the species will continue to persist into the future with sufficient resilience to allow for the potential recovery from endangerment). The action will not affect the Chesapeake Bay DPS Atlantic sturgeon in a way that prevents the species from having a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring, and it will not result in consequences to the environment which would prevent Atlantic sturgeon from completing their entire life cycle or completing essential behaviors including reproducing, foraging and sheltering. This is the case because: (1) the proposed action will not result in any mortality and associated potential future reproduction beyond what has been accounted for in the Environmental Baseline (death of 1 subadult or adult Chesapeake Bay DPS Atlantic sturgeon, which represents an extremely small percentage of the species); (2) the proposed action will not change the status or trends of the species as a whole; (3) there will be no effect on the levels of genetic heterogeneity in the population; (4) the action will have only a minor and temporary consequence on the distribution of Chesapeake Bay DPS Atlantic sturgeon in the action area and no consequence on the distribution of the species throughout its range; and, (5) the action will have only an insignificant effect on individual foraging or sheltering Chesapeake Bay DPS Atlantic sturgeon.

In rare instances, an action that does not appreciably reduce the likelihood of a species' survival might appreciably reduce its likelihood of recovery. As explained above, we have determined that the proposed action will not appreciably reduce the likelihood that the Chesapeake Bay DPS of Atlantic sturgeon will survive in the wild, which includes consideration of recovery potential. Here, we consider whether the action will appreciably reduce the likelihood of recovery from the perspective of ESA Section 4. As noted above, recovery is defined as the improvement in status such that listing under Section 4(a) as "in danger of extinction throughout all or a significant portion of its range" (endangered) or "likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range…" (threatened) is no longer appropriate. Thus, we have considered whether the proposed action will appreciably reduce the likelihood that Chesapeake Bay DPS Atlantic sturgeon can rebuild to a point where the Chesapeake Bay DPS of Atlantic sturgeon is no longer likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

No Recovery Plan for the Chesapeake Bay DPS has been published. The Recovery Plan will outline the steps necessary for recovery and the demographic criteria, which once attained would allow the species to be delisted. In January 2018, we published a Recovery Outline for the five DPSs of Atlantic sturgeon (NMFS 2018). This outline is meant to serve as an interim guidance document to direct recovery efforts, including recovery planning, until a full recovery plan is developed and approved. The outline provides a preliminary strategy for recovery of the species. We know that in general, to recover, a listed species must have a sustained positive trend of increasing population over time. To allow that to happen for sturgeon, individuals must have access to enough habitat in suitable condition for foraging, resting and spawning. Conditions must be suitable for the successful development of early life stages. Mortality rates must be low enough to allow for recruitment to all age classes so that successful spawning can continue over time and over generations. There must be enough suitable habitat for spawning, foraging, resting, and migrations of all individuals. For Chesapeake Bay DPS Atlantic sturgeon, habitat conditions must be suitable both in the natal river and in other rivers and estuaries where foraging by subadults and adults will occur and in the ocean where subadults and adults migrate, overwinter and forage. Habitat connectivity must also be maintained so that individuals can migrate between important habitats without delays that impact their fitness. As described in the vision statement in the Recovery Outline, subpopulations of all five Atlantic sturgeon DPSs must be present across the historical range. These subpopulations must be of sufficient size and genetic diversity to support successful reproduction and recovery from mortality events. The recruitment of juveniles to the sub-adult and adult life stages must also increase and that increased recruitment must be maintained over many years. Recovery of these DPSs will require conservation of the riverine and marine habitats used for spawning, development, foraging, and growth by abating threats to ensure a high probability of survival into the future. Here, we consider whether this proposed action will reduce the Chesapeake Bay DPS likelihood of recovery.

This action will not change the status or trend of the Chesapeake Bay DPS. The proposed action will not affect the distribution of Atlantic sturgeon across the historical range. The proposed action will not result in mortality or reduction in future reproductive output beyond what was considered in the Environmental Baseline and will not impair the species' resiliency, genetic diversity, recruitment, or year class strength. The proposed action will have only insignificant effects on habitat and forage and will not impact habitat in a way that makes additional growth of the population less likely, that is, it will not reduce the habitat's carrying capacity. This is because impacts to forage will be insignificant or extremely unlikely, and the area that sturgeon may avoid is small. Any avoidance will be temporary and limited to the period of time when pile driving or UXO detonation is occurring. For these reasons, the action will not reduce the likelihood that the Chesapeake Bay DPS can recover. Therefore, the proposed action will not appreciably reduce the likelihood that the Chesapeake Bay DPS of Atlantic sturgeon can be brought to the point at which they are no longer listed as threatened; that is, the proposed action will not appreciably reduce the likelihood of recovery of the Chesapeake Bay DPS. Based on the analysis presented herein, the proposed action is not likely to appreciably reduce the likelihood of both the survival and recovery of this species. These conclusions were made in consideration of the status of the Chesapeake Bay DPS of Atlantic sturgeon, other stressors that individuals are exposed to within the action area as described in the *Environmental Baseline* and *Cumulative Effects*, and any anticipated effects of climate change on the abundance, reproduction, and distribution of the Chesapeake Bay DPS of Atlantic sturgeon in the action area.

9.3.4 Carolina DPS of Atlantic sturgeon

The Carolina DPS is listed as endangered. Atlantic sturgeon from the Carolina DPS spawn in the rivers of North Carolina south to the Cooper River, South Carolina. There are currently seven spawning subpopulations within the Carolina DPS: Roanoke River, Tar-Pamlico River, Neuse River, Northeast Cape Fear and Cape Fear Rivers, Waccamaw and Great Pee Dee Rivers, Black River, Santee and Cooper Rivers. NMFS estimated adult and subadult abundance of the Carolina DPS based on available information for the genetic composition and the estimated abundance of Atlantic sturgeon in marine waters (Damon-Randall et al. 2013, Kocik et al. 2013) and concluded that subadult and adult abundance of the Carolina DPS was 1,356 sturgeon (339 adults and 1,017 subadults) (NMFS 2013). This number encompasses many age classes since, across all DPSs, subadults can be as young as two years old when they first enter the marine environment, and adults can live as long as 64 years (Balazik et al. 2012; Hilton et al. 2016).

Very few data sets are available that cover the full potential life span of an Atlantic sturgeon. The ASMFC concluded for the Stock Assessment that it could not estimate abundance of the Carolina DPS or otherwise quantify the trend in abundance because of the limited available information. However, the Stock Assessment was a comprehensive review of the available information, and used multiple methods and analyses to assess the status of the Carolina DPS and the coast wide stock of Atlantic sturgeon. For example, the Stock Assessment Subcommittee defined a benchmark, the mortality threshold, against which mortality for the coast wide stock of Atlantic sturgeon as well as for each DPS were compared[49] to assess whether the current mortality experienced by the coast wide stock and each DPS is greater than what it can sustain. This information informs the current trend of the Carolina DPS.

In the Stock Assessment, the ASMFC concluded that abundance of the Carolina DPS is "depleted" relative to historical levels and there is a relatively low probability (36 percent) that abundance of the Carolina DPS has increased since the implementation of the 1998 fishing moratorium. The ASMFC also concluded that there is a relatively low likelihood (25 percent probability) that mortality for the Carolina DPS does not exceed the mortality threshold used for the Stock Assessment (ASMFC 2017).

The effects of the action are in addition to ongoing threats in the action area, which include incidental capture in state and federal fisheries, boat strikes, coastal development, habitat loss,

[49]The analysis considered both a coast wide mortality threshold and a region-specific mortality threshold to evaluate the sensitivity of the model to differences in life history parameters among the different DPSs (e.g., Atlantic sturgeon in the northern region are slower growing, longer lived; Atlantic sturgeon in the southern region are faster growing, shorter lived).

contaminants, and climate change. Entanglement in fishing gear and vessel strikes as described in the *Environmental Baseline*, may occur in the action area over the life of the proposed action. As noted in the Cumulative Effects section of this Opinion, we have not identified any cumulative effects different from those considered in the Status of the Species and Environmental Baseline sections of this Opinion, inclusive of how those activities may contribute to climate change. As described in section 7.10, climate change may result in changes in the distribution or abundance of Atlantic sturgeon in the action area over the life of this project; however, we have not identified any different or exacerbated effects of the action due to anticipated climate change.

We have considered effects of the Ocean Wind 1 project over the construction, operations, and decommissioning periods in consideration of the effects already accounted for in the Environmental Baseline and in consideration of Cumulative Effects and climate change. The only adverse effects of the proposed action on Carolina DPS Atlantic sturgeon are the non-lethal capture of 4 Carolina DPS Atlantic sturgeon in the trawl survey. We do not anticipate any adverse effects to result from exposure to pile driving, UXO detonation, or any other noise source including HRG surveys and operational noise. We do not expect any Atlantic sturgeon to be struck by any project vessels operating outside of the Delaware River. We do not expect the operation or existence of the turbines and other facilities, including the electric cables, to result in any changes in the abundance, reproduction, or distribution of Atlantic sturgeon in the action area. All effects to Atlantic sturgeon from impacts to habitat and prey will be insignificant.

Live sturgeon captured and released in the trawl survey may experience minor injuries (i.e., scrapes, abrasions); however, they are expected to make a complete recovery without any impairment to future fitness. Capture will temporarily prevent these individuals from carrying out essential behaviors such as foraging and migrating. However, these behaviors are expected to resume as soon as the sturgeon are returned to the water; for trawls the length of capture will be no more than the 20 minute tow time plus a short handling period on board the vessel. The capture of live sturgeon will not reduce the numbers of Atlantic sturgeon in the action area or the numbers of Carolina DPS Atlantic sturgeon as a whole. Similarly, as the capture of live Atlantic sturgeon will not affect the fitness of any individual, no effects to reproduction are anticipated. The capture of live Atlantic sturgeon is also not likely to affect the distribution of Atlantic sturgeon in the action area or affect the distribution of Atlantic sturgeon throughout their range. As any effects to individual live Atlantic sturgeon removed from the trawl gear will be minor and temporary without any mortality or effects on reproduction, we do not anticipate any population level impacts.

The proposed project will not result in the mortality of any Carolina DPS Atlantic sturgeon. There will be no effects on reproduction of any Carolina DPS Atlantic sturgeon. The proposed action is not likely to reduce distribution, because the action will not impede Carolina DPS Atlantic sturgeon from accessing any seasonal aggregation areas, including foraging, spawning, or overwintering grounds. Any consequences to distribution will be minor and temporary and limited to the temporary avoidance of areas with increased noise during pile driving.

Based on the information provided above, the proposed action will not appreciably reduce the likelihood of survival of the Carolina DPS (*i.e.*, it will not decrease the likelihood that the species will continue to persist into the future with sufficient resilience to allow for the potential recovery from endangerment). The action will not affect the Carolina DPS Atlantic sturgeon in a way that prevents the species from having a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring, and it will not result in consequences to the environment which would prevent Atlantic sturgeon from completing their entire life cycle or completing essential behaviors including reproducing, foraging and sheltering. This is the case because: (1) the proposed action will not result in any mortality and associated potential future reproduction; (2) the proposed action will not change the status or trends of the species as a whole; (3) there will be no effect on the levels of genetic heterogeneity in the population; (4) the action will have only a minor and temporary consequence on the distribution of Carolina DPS Atlantic sturgeon in the action area and no consequence on the distribution of the species throughout its range; and, (5) the action will have only an insignificant effect on individual foraging or sheltering Carolina DPS Atlantic sturgeon.

In rare instances, an action that does not appreciably reduce the likelihood of a species' survival might appreciably reduce its likelihood of recovery. As explained above, we have determined that the proposed action will not appreciably reduce the likelihood that the Carolina DPS of Atlantic sturgeon will survive in the wild, which includes consideration of recovery potential. Here, we consider whether the action will appreciably reduce the likelihood of recovery from the perspective of ESA Section 4. As noted above, recovery is defined as the improvement in status such that listing under Section 4(a) as "in danger of extinction throughout all or a significant portion of its range" (endangered) or "likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range…" (threatened) is no longer appropriate. Thus, we have considered whether the proposed action will appreciably reduce the likelihood that Carolina DPS Atlantic sturgeon can rebuild to a point where the Carolina DPS of Atlantic sturgeon is no longer likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

No Recovery Plan for the Carolina DPS has been published. The Recovery Plan will outline the steps necessary for recovery and the demographic criteria, which once attained would allow the species to be delisted. In January 2018, we published a Recovery Outline for the five DPSs of Atlantic sturgeon (NMFS 2018). This outline is meant to serve as an interim guidance document to direct recovery efforts, including recovery planning, until a full recovery plan is developed and approved. The outline provides a preliminary strategy for recovery of the species. We know that in general, to recover, a listed species must have a sustained positive trend of increasing population over time. To allow that to happen for sturgeon, individuals must have access to enough habitat in suitable condition for foraging, resting and spawning. Conditions must be suitable for the successful development of early life stages. Mortality rates must be low enough to allow for recruitment to all age classes so that successful spawning can continue over time and over generations. There must be enough suitable habitat for spawning, foraging, resting, and migrations of all individuals. For Carolina DPS Atlantic sturgeon, habitat conditions must be suitable both in the natal river and in other rivers and estuaries where foraging by subadults and adults will occur and in the ocean where subadults and adults migrate, overwinter and forage. Habitat connectivity must also be maintained so that individuals can migrate between important habitats without delays that impact their fitness. As described in the vision statement in the Recovery Outline, subpopulations of all five Atlantic sturgeon DPSs must be present across the historical range. These subpopulations must be of sufficient size and genetic diversity to support successful reproduction and recovery from mortality events. The recruitment of juveniles to the sub-adult and adult life stages must also increase and that increased recruitment must be maintained over many years. Recovery of these DPSs will require conservation of the riverine and marine habitats used for spawning, development, foraging, and growth by abating threats to ensure a high probability of survival into the future. Here, we consider whether this proposed action will reduce the Carolina DPS likelihood of recovery.

This action will not change the status or trend of the Carolina DPS. The proposed action will not affect the distribution of Atlantic sturgeon across the historical range. The proposed action will not result in mortality or reduction in future reproductive output of the Carolina DPS and will not impair the species' resiliency, genetic diversity, recruitment, or year class strength. The proposed action will have only insignificant effects on habitat and forage and will not impact habitat in a way that makes additional growth of the population less likely, that is, it will not reduce the habitat's carrying capacity. This is because impacts to forage will be insignificant or extremely unlikely, and the area that sturgeon may avoid is small. Any avoidance will be temporary and limited to the period of time when pile driving or UXO detonation is occurring. For these reasons, the action will not reduce the likelihood that the Carolina DPS can recover. Therefore, the proposed action will not appreciably reduce the likelihood that the Carolina DPS of Atlantic sturgeon can be brought to the point at which they are no longer listed as threatened; that is, the proposed action will not appreciably reduce the likelihood of recovery of the Carolina DPS. Based on the analysis presented herein, the proposed action is not likely to appreciably reduce the likelihood of both the survival and recovery of this species. These conclusions were made in consideration of the status of the Carolina DPS of Atlantic sturgeon, other stressors that individuals are exposed to within the action area as described in the *Environmental Baseline* and *Cumulative Effects*, and any anticipated effects of climate change on the abundance, reproduction, and distribution of the Carolina DPS of Atlantic sturgeon in the action area.

9.3.5 South Atlantic DPS of Atlantic sturgeon

The South Atlantic DPS Atlantic sturgeon is listed as endangered and Atlantic sturgeon originate from at least six rivers where spawning potentially still occurs. Secor (2002) estimates that 8,000 adult females were present in South Carolina prior to 1890. In Georgia, prior to the collapse of the fishery in the late 1800s, the sturgeon fishery was the third largest fishery. Secor (2002) estimated from U.S. Fish Commission landing reports that approximately 11,000 spawning females were likely present in Georgia prior to 1890. At the time of listing, only six spawning subpopulations were thought to have existed in the South Atlantic DPS: Combahee River, Edisto River, Savannah River, Ogeechee River, Altamaha River (including the Oconee and Ocmulgee tributaries), and the Satilla River. Three of the spawning subpopulations in the South Atlantic DPS are relatively robust and are considered the second (Altamaha River) and third (Combahee/Edisto River) largest spawning subpopulations across all five DPSs. Peterson *et al.* (2008) estimated the number of spawning adults in the Altamaha River was 324 (95 percent CI: 143-667) in 2004 and 386 (95 percent CI: 216-787) in 2005. Bahr and Peterson (2016) estimated the age-1 juvenile abundance in the Savannah River from 2013-2015 at 528 in 2013, 589 in 2014, and 597 in 2015. No census of the number of Atlantic sturgeon in any of the other spawning rivers or for the DPS as a whole is available. However, the NEAMAP data indicates that the estimated ocean population of South Atlantic DPS Atlantic sturgeon sub-adults and adults is 14,911 individuals (3,728 adults and 11,183 subadults).

The 2017 ASMFC stock assessment determined that abundance of the South Atlantic DPS is "depleted" relative to historical levels (ASMFC 2017). Due to a lack of suitable indices, the assessment was unable to determine the probability that the abundance of the South Atlantic DPS has increased since the implementation of the 1998 fishing moratorium. However, it was estimated that there is a 40 percent probability that mortality for the South Atlantic DPS exceeds the mortality threshold used for the assessment (ASMFC 2017). We note that the Commission expressed significant uncertainty in relation to the trends data.

The effects of the action are in addition to ongoing threats in the action area, which include incidental capture in state and federal fisheries, boat strikes, coastal development, habitat loss, contaminants, and climate change. Entanglement in fishing gear and vessel strikes as described in the *Environmental Baseline*, may occur in the action area over the life of the proposed action. This includes the mortality of no more than one South Atlantic DPS Atlantic sturgeon resulting from Ocean Wind 1 vessels transiting in the Delaware River to/from the New Jersey Wind Port. As noted in the Cumulative Effects section of this Opinion, we have not identified any cumulative effects different from those considered in the Status of the Species and Environmental Baseline sections of this Opinion, inclusive of how those activities may contribute to climate change. As described in section 7.10, climate change may result in changes in the distribution or abundance of Atlantic sturgeon in the action area over the life of this project; however, we have not identified any different or exacerbated effects of the action due to anticipated climate change.

We have considered effects of the Ocean Wind 1 project over the construction, operations, and decommissioning periods in consideration of the effects already accounted for in the Environmental Baseline and in consideration of Cumulative Effects and climate change. With the exception of effects of vessel traffic in the Delaware River from Ocean Wind vessels transiting to the New Jersey Wind Port, which are included in the Environmental Baseline, the only adverse effects of the proposed action on Atlantic sturgeon are the non-lethal capture of 1 South Atlantic DPS Atlantic sturgeon in the trawl survey. We do not anticipate any adverse effects to result from exposure to pile driving, UXO detonation, or any other noise source including HRG surveys and operational noise. We do not expect any Atlantic sturgeon to be struck by any project vessels operating outside of the Delaware River. We do not expect the operation or existence of the turbines and other facilities, including the electric cables, to result in any changes in the abundance, reproduction, or distribution of Atlantic sturgeon in the action area. All effects to Atlantic sturgeon from impacts to habitat and prey will be insignificant.

Live sturgeon captured and released in the trawl survey may experience minor injuries (i.e., scrapes, abrasions); however, they are expected to make a complete recovery without any impairment to future fitness. Capture will temporarily prevent these individuals from carrying out essential behaviors such as foraging and migrating. However, these behaviors are expected to resume as soon as the sturgeon are returned to the water; for trawls the length of capture will be no more than the 20 minute tow time plus a short handling period on board the vessel. The capture of live sturgeon will not reduce the numbers of Atlantic sturgeon in the action area or the numbers of South Atlantic DPS Atlantic sturgeon as a whole. Similarly, as the capture of live Atlantic sturgeon will not affect the fitness of any individual, no effects to reproduction are anticipated. The capture of live Atlantic sturgeon is also not likely to affect the distribution of Atlantic sturgeon in the action area or affect the distribution of Atlantic sturgeon throughout their range. As any effects to individual live Atlantic sturgeon removed from the trawl gear will be minor and temporary without any mortality or effects on reproduction, we do not anticipate any population level impacts.

The proposed project will not result in the mortality of any Atlantic sturgeon beyond what is considered in the Environmental Baseline (inclusive of the mortality of no more than one South Atlantic DPS Atlantic sturgeon resulting from Ocean Wind 1 vessel traffic in the Delaware River). There will be no effects on reproduction other than the loss of the potential future reproductive output of one individual already addressed in the Baseline. The proposed action is not likely to reduce distribution, because the action will not impede South Atlantic DPS Atlantic sturgeon from accessing any seasonal aggregation areas, including foraging, spawning, or overwintering grounds. Any consequences to distribution will be minor and temporary and limited to the temporary avoidance of areas with increased noise during pile driving.

Based on the information provided above, the proposed action will not appreciably reduce the likelihood of survival of the South Atlantic DPS (*i.e.*, it will not decrease the likelihood that the species will continue to persist into the future with sufficient resilience to allow for the potential recovery from endangerment). The action will not affect the South Atlantic DPS Atlantic sturgeon in a way that prevents the species from having a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring, and it will not result in consequences to the environment which would prevent Atlantic sturgeon from completing their entire life cycle or completing essential behaviors including reproducing, foraging and sheltering. This is the case because: (1) the proposed action will not result in any mortality and associated potential future reproduction beyond what has been accounted for in the Environmental Baseline (death of 1 subadult or adult South Atlantic DPS Atlantic sturgeon, which represents an extremely small percentage of the species); (2) the proposed action will not change the status or trends of the species as a whole; (3) there will be no effect on the levels of genetic heterogeneity in the population; (4) the action will have only a minor and temporary consequence on the distribution of South Atlantic DPS Atlantic sturgeon in the action area and no consequence on the distribution of the species throughout its range; and, (5) the action will have only an insignificant effect on individual foraging or sheltering South Atlantic DPS Atlantic sturgeon.

In rare instances, an action that does not appreciably reduce the likelihood of a species' survival might appreciably reduce its likelihood of recovery. As explained above, we have determined that the proposed action will not appreciably reduce the likelihood that the South Atlantic DPS of Atlantic sturgeon will survive in the wild, which includes consideration of recovery potential. Here, we consider whether the action will appreciably reduce the likelihood of recovery from the perspective of ESA Section 4. As noted above, recovery is defined as the improvement in status such that listing under Section 4(a) as "in danger of extinction throughout all or a significant portion of its range" (endangered) or "likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range…" (threatened) is no longer appropriate. Thus, we have considered whether the proposed action will appreciably reduce the likelihood that South Atlantic DPS Atlantic sturgeon can rebuild to a point where the South Atlantic DPS of Atlantic sturgeon is no longer likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

No Recovery Plan for the South Atlantic DPS has been published. The Recovery Plan will outline the steps necessary for recovery and the demographic criteria, which once attained would allow the species to be delisted. In January 2018, we published a Recovery Outline for the five DPSs of Atlantic sturgeon (NMFS 2018). This outline is meant to serve as an interim guidance document to direct recovery efforts, including recovery planning, until a full recovery plan is developed and approved. The outline provides a preliminary strategy for recovery of the species. We know that in general, to recover, a listed species must have a sustained positive trend of increasing population over time. To allow that to happen for sturgeon, individuals must have access to enough habitat in suitable condition for foraging, resting and spawning. Conditions must be suitable for the successful development of early life stages. Mortality rates must be low enough to allow for recruitment to all age classes so that successful spawning can continue over time and over generations. There must be enough suitable habitat for spawning, foraging, resting, and migrations of all individuals. For South Atlantic DPS Atlantic sturgeon, habitat conditions must be suitable both in the natal river and in other rivers and estuaries where foraging by subadults and adults will occur and in the ocean where subadults and adults migrate, overwinter and forage. Habitat connectivity must also be maintained so that individuals can migrate between important habitats without delays that impact their fitness. As described in the vision statement in the Recovery Outline, subpopulations of all five Atlantic sturgeon DPSs must be present across the historical range. These subpopulations must be of sufficient size and genetic diversity to support successful reproduction and recovery from mortality events. The recruitment of juveniles to the sub-adult and adult life stages must also increase and that increased recruitment must be maintained over many years. Recovery of these DPSs will require conservation of the riverine and marine habitats used for spawning, development, foraging, and growth by abating threats to ensure a high probability of survival into the future. Here, we consider whether this proposed action will reduce the South Atlantic DPS likelihood of recovery.

This action will not change the status or trend of the South Atlantic DPS. The proposed action will not affect the distribution of Atlantic sturgeon across the historical range. The proposed action will not result in mortality or reduction in future reproductive output beyond what was considered in the *Environmental Baseline* and will not impair the species' resiliency, genetic diversity, recruitment or year class strength. The proposed action will have only insignificant effects on habitat and forage and will not impact habitat in a way that makes additional growth of the population less likely, that is, it will not reduce the habitat's carrying capacity. This is because impacts to forage will be insignificant or extremely unlikely, and the area that sturgeon may avoid is small. Any avoidance will be temporary and limited to the period of time when pile driving or UXO detonation is occurring. For these reasons, the action will not reduce the likelihood that the South Atlantic DPS can recover. Therefore, the proposed action will not appreciably reduce the likelihood that the South Atlantic DPS of Atlantic sturgeon can be brought to the point at which they are no longer listed as threatened; that is, the proposed action will not appreciably reduce the likelihood of recovery of the South Atlantic DPS. Based on the analysis presented herein, the proposed action is not likely to appreciably reduce the likelihood of both the survival and recovery of this species. These conclusions were made in consideration of the status of the South Atlantic DPS of Atlantic sturgeon, other stressors that individuals are exposed to within the action area as described in the *Environmental Baseline* and *Cumulative Effects*, and any anticipated effects of climate change on the abundance, reproduction, and distribution of the South Atlantic DPS of Atlantic sturgeon in the action area.

9.4 Sea Turtles

Our effects analysis determined that impact pile driving and UXO detonation is likely to adversely affect a number of individual ESA-listed sea turtles in the action area and cause temporary threshold shift, behavioral response, and stress but that no injury or mortality is anticipated. We determined that impacts to hearing (TTS and masking) and avoidance behavior would not increase the risk of vessel strike or entanglement or capture in fishing gear. We determined that exposure to other project noise, including HRG surveys and operational noise, will have effects that are insignificant or extremely unlikely to occur. We expect that project vessels will strike and kill no more than 1 leatherback, 9 loggerhead, 1 green, and 1 Kemp's ridley sea turtle over the 39-year life of the project, inclusive of the construction, operation, and decommissioning period. We expect that a number of sea turtles will be captured in the trawl surveys and be released alive. We do not expect the entanglement or capture of any sea turtles in any other fisheries surveys. We also determined that effects to habitat and prey are insignificant or extremely unlikely to occur. In this section, we discuss the likely consequences of these effects to individual sea turtles, the populations those individuals represent, and the species those populations comprise.

While this biological opinion relies on the best available scientific and commercial information, our analysis and conclusions include uncertainty about the basic hearing capabilities of sea turtles, such as how they use sound to perceive and respond to environmental cues, and how temporary changes to their acoustic soundscape could affect the normal physiology and behavioral ecology of these species. Vessel strikes are expected to result in more significant effects on individuals than other stressors considered in this Opinion because these strikes are expected to result in serious injury or mortality. Those that are killed and removed from the population would decrease reproductive rates, and those that sustain non-lethal injuries and permanent hearing impairment could have fitness consequences during the time it takes to fully recover, or have long lasting impacts if permanently harmed. Temporary hearing impairment and significant behavioral disruption from harassment could have similar effects, but given the duration of exposures, these impacts are expected to be temporary and a sea turtle's hearing is expected to return to normal shortly after the exposure ends. Therefore, these temporary effects are expected to exert significantly less adverse effects on any individual than severe injuries and permanent non-lethal injuries.

In this section we assess the likely consequences of these effects to the sea turtles that have been exposed, the populations those individuals represent, and the species those populations comprise. Section 5.2 described current sea turtle population statuses and the threats to their survival and recovery. Most sea turtle populations have undergone significant to severe reduction by human harvesting of both eggs and sea turtles, loss of beach nesting habitats, as well as severe bycatch pressure in worldwide fishing industries. The *Environmental Baseline* identified actions expected to generally continue for the foreseeable future for each of these species of sea turtle that may affect sea turtles in the action area. As described in section 7.10, climate change may result in a northward distribution of sea turtles, which could result in a small change in the abundance, and seasonal distribution of sea turtles in the action area over the 39-year life of the Ocean Wind project. However, as described there, given the cool winter water temperatures in the action area and considering the amount of warming that is anticipated, any shift in seasonal distribution is expected to be small (potential additional weeks per year, not months) and any increase in abundance in the action area is expected to be small. As noted in the *Cumulative Effects* section of this Opinion, we have not identified any cumulative effects different from those considered in the *Status of the Species* and *Environmental Baseline* sections of this Opinion, inclusive of how those activities may contribute to climate change.

9.4.1 Northwest Atlantic DPS of Loggerhead Sea Turtles

The Northwest Atlantic DPS of loggerhead sea turtles is listed as threatened. Based on nesting data and population abundance and trends at the time, NMFS and USFWS determined in 2011 that the Northwest Atlantic DPS should be listed as threatened and not endangered based on: (1) the large size of the nesting population, (2) the overall nesting population remains widespread, (3) the trend for the nesting population appears to be stabilizing, and (4) substantial conservation efforts are underway to address threats (76 FR 58868, September 22, 2011).

It takes decades for loggerhead sea turtles to reach maturity. Once they have reached maturity, females typically lay multiple clutches of eggs within a season, but do not typically lay eggs every season (NMFS and USFWS 2008). There are many natural and anthropogenic factors affecting the survival of loggerheads prior to their reaching maturity as well as for those adults who have reached maturity. As described in the *Status of the Species*, *Environmental Baseline*, and *Cumulative Effects* sections above, loggerhead sea turtles in the action area continue to be affected by multiple anthropogenic impacts including bycatch in commercial and recreational fisheries, habitat alteration, vessel interactions, and other factors that result in mortality of individuals at all life stages. Negative impacts causing death of various age classes occur both on land and in the water. Many actions have been taken to address known negative impacts to loggerhead sea turtles. However, others remain unaddressed, have not been sufficiently addressed, or have been addressed in some manner but whose success cannot be quantified.

There are five subpopulations of loggerhead sea turtles in the western North Atlantic (recognized as recovery units in the 2008 recovery plan for the species). These subpopulations show limited evidence of interbreeding. As described in the *Status of the Species*, recent assessments have evaluated the nesting trends for each recovery unit. Nesting trends are based on nest counts or nesting females; they do not include non-nesting adult females, adult males, or juvenile males or females in the population. Nesting trends for each of the loggerhead sea turtle recovery units in the Northwest Atlantic Ocean DPS are variable. Overall, short-term trends have shown increases, however, over the long-term the DPS is considered stable.

Estimates of the total loggerhead population in the Atlantic are not currently available. However, there is some information available for portions of the population. From 2004-2008, the loggerhead adult female population for the Northwest Atlantic ranged from 20,000 to 40,000 or more individuals (median 30,050), with a large range of uncertainty in total population size (NMFS SEFSC 2009). The estimate of Northwest Atlantic adult loggerhead females was considered conservative for several reasons. The number of nests used for the Northwest Atlantic was based primarily on U.S. nesting beaches. Thus, the results are a slight underestimate of total nests because of the inability to collect complete nest counts for many non-U.S. nesting beaches within the DPS. In estimating the current population size for adult nesting female loggerhead sea turtles, the report simplified the number of assumptions and reduced uncertainty by using the minimum total annual nest count (i.e., 48,252 nests) over the five years. This was a particularly conservative assumption considering how the number of nests and nesting females can vary widely from year to year (e.g., the 2008 nest count was 69,668 nests, which would have increased the adult female estimate proportionately to between 30,000 and 60,000). In addition, minimal assumptions were made about the distribution of remigration intervals and nests per female parameters, which are fairly robust and well known. A loggerhead population estimate using data from 2001-2010 estimated the loggerhead adult female population in the Northwest Atlantic at 38,334 individuals (SD =2,287) (Richards et al. 2011).

The AMAPPS surveys and sea turtle telemetry studies conducted along the U.S. Atlantic coast in the summer of 2010 provided preliminary regional abundance estimate of about 588,000 loggerheads along the U.S. Atlantic coast, with an inter-quartile range of 382,000-817,000 (NMFS 2011c). The estimate increases to approximately 801,000 (inter-quartile range of 521,000-1,111,000) when based on known loggerheads and a portion of unidentified sea turtle sightings (NMFS 2011c). Although there is much uncertainty in these population estimates, they provide some context for evaluating the size of the likely population of loggerheads in the Atlantic.

The impacts to loggerhead sea turtles from the proposed action are expected to result in the mortality of 9 individuals due to vessel strike over the 39-year construction, operations and decommissioning period and the capture of up to 7 loggerheads over the 4-year survey period during the pre- and post-construction trawl surveys, we expect these individuals will be released alive with only minor, recoverable injuries (minor scrapes and abrasions). Additionally, we expect the exposure of a number of loggerhead sea turtles to noise that will result in TTS and/or behavioral disturbance under either of the two piling scenarios. For a full monopile scenario (WTG and OSS), we expect no more than 175 loggerhead sea turtles to be exposed to impact pile driving noise that could result in harassment (inclusive of TTS) during the construction period. For the joint foundation approach (WTG use monopiles; OSSs use jackets with pin piles), we expect no more than 184 loggerhead sea turtles to be exposed to impact pile driving noise that could result in harassment (inclusive of TTS) during the construction period. No loggerhead sea turtles are expected to be exposed to potentially disturbing or injurious levels of noise during UXO detonations due to distances to PTS and TTS being smaller than clearance zone and very short duration of exposure to noise above behavioral threshold (one second). We determined that all other effects of the action would be insignificant or extremely unlikely to occur. In total, we expect the proposed action to result in the mortality of 9 loggerheads over the 39-year life of the project.

The 175 or 184 loggerhead sea turtles that experience harassment under either of the two piling scenarios could suffer temporary hearing impairment (TTS), and we assume these turtles would have physiological stress. TTS will resolve within one week while behavioral disturbance and stress will cease after exposure to pile driving noise ends (no more than four hours). While TTS will temporarily affect the hearing of an individual sea turtle it is not expected to affect their ability to hear in a way that would impact their ability to sense or react to threats. As explained in section 7.1, temporary alterations in behavior of loggerheads exposed to disturbing levels of noise are not likely to reduce the overall fitness of individual turtles. The energetic consequences of the evasive behavior and delay in resting or foraging are not expected to 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 nesting. Additionally, avoidance behavior is not expected to result in displacement to areas with increased risk of vessel strike or capture or entanglement in fishing gear.

In general, based upon what we know about sound effects on sea turtles, we do not anticipate exposure to these acoustic stressors to have long-term effects on an individual nor alter critical life functions. Therefore, we do not anticipate loggerhead sea turtles to have population level consequences from acoustic stressors.

The mortality of 9 loggerhead sea turtles in the action area over the 39 year life of the project (inclusive of 1.5 years of construction, 35 years of operations, and 2 years of decommissioning) would reduce the number of loggerhead sea turtles from the recovery unit of which they originated as compared to the number of loggerheads that would have been present in the absence of the proposed actions (assuming all other variables remained the same). The Peninsula Florida Recovery Unit and the Northern Recovery Unit represent approximately 87% and 10%, respectively of all nesting effort in the Northwest Atlantic DPS (Ceriani and Meylan 2017, NMFS and USFWS 2008). We expect that the majority of loggerheads in the action area originated from the Northern Recovery Unit (NRU) or the Peninsular Florida Recovery Unit (PFRU).

The Northern Recovery Unit, from the Florida-Georgia border through southern Virginia, is the second largest nesting aggregation in the DPS, with an average of 5,215 nests from 1989-2008, and approximately 1,272 nesting females (NMFS and U.S. FWS 2008). For the Northern recovery unit, nest counts at loggerhead nesting beaches in North Carolina, South Carolina, and Georgia declined at 1.9% annually from 1983 to 2005 (NMFS and U.S. FWS 2007). Recently, the trend has been increasing. Ceriani and Meylan (2017) reported a 35% increase for this recovery unit from 2009 through 2013. A longer- term trend analysis based on data from 1983 to 2019 indicates that the annual rate of increase is 1.3 percent (Bolten et al. 2019).

Annual nest totals for the PFRU averaged 64,513 nests from 1989-2007, representing approximately 15,735 females per year (NMFS and USFWS 2008). Nest counts taken at index beaches in Peninsular Florida showed a significant decline in loggerhead nesting from 1989 to 2007, most likely attributed to mortality of oceanic-stage loggerheads caused by fisheries bycatch (Witherington et al. 2009). From 2009 through 2013, a 2 percent decrease for the Peninsular Florida Recovery Unit was reported (Ceriani and Meylan 2017). Using a longer time series from 1989-2018, there was no significant change in the number of annual nests; however, an increase in the number of nests was observed from 2007 to 2018 (Bolten et al. 2019).

The loss of 9 loggerheads over the 39 years of the project represents an extremely small percentage of the number of sea turtles in the PFRU or NRU. Even if the total population of the PFRU was limited to 15,735 loggerheads (the number of nesting females), the loss of 9 individuals would represent approximately 0.06% of the population. If the total NRU population was limited to 1,272 sea turtles (the number of nesting females), and all 9 individuals originated from that population, the loss of those individuals would represent approximately 0.7% of the population. Even just considering the number of adult nesting females this loss is extremely small and would be even smaller when considered for the total recovery unit and represents an even smaller percentage of the DPS as a whole.

As noted in the *Environmental Baseline*, the status of loggerhead sea turtles in the action area is expected to be the same as that of each recovery unit over the life of the project (stable to increasing). The loss of such a small percentage of the individuals from any of these recovery units represents an even smaller percentage of the DPS as a whole. Considering the extremely small percentage of the populations that will be killed, it is unlikely that these deaths will have a detectable effect on the numbers and population trends of loggerheads in these recovery units or the number of loggerheads in the Northwest Atlantic DPS. We make this conclusion in consideration of the status of the species as a whole, the status of loggerhead sea turtles in the action area, and in consideration of the threats experienced by loggerheads in the action area as described in the *Environmental Baseline* and *Cumulative Effects* sections of this Opinion. As described in section 7.10, climate change may result in changes in the distribution or abundance of loggerheads in the action area over the life of this project; however, we have not identified any different or exacerbated effects of the action in the context of anticipated climate change.

Any effects on reproduction are limited to the future reproductive output of the individuals that die. Even assuming that all of these losses were reproductive female (which is unlikely given the expected even sex ratio in the action area), given the number of nesting adults in each of these populations, it is unlikely that the expected loss of loggerheads would affect the success of nesting in any year. Additionally, this extremely small reduction in potential nesters is expected to result in a similarly small reduction in the number of eggs laid or hatchlings produced in future years and similarly, an extremely small effect on the strength of subsequent year classes with no detectable effect on the trend of any recovery unit or the DPS as a whole. The proposed actions will not affect nesting beaches in any way or disrupt migratory movements in a way that hinders access to nesting beaches or otherwise delays nesting. Additionally, given the small percentage of the species that will be killed as a result of the proposed actions, there is not likely to be any loss of unique genetic haplotypes and no loss of genetic diversity.

The proposed action is not likely to reduce distribution because while the action will temporarily affect the distribution of individual loggerheads through behavioral disturbance changes in distribution will be temporary and limited to movements to nearby areas in the WDA. As explained in section 7, we expect the project to have insignificant effects on use of the action area by loggerheads.

While generally speaking, the loss of a small number of individuals from a subpopulation or species may have an appreciable reduction on the numbers, reproduction and distribution of the species this is likely to occur only when there are very few individuals in a population, the individuals occur in a very limited geographic range or the species has extremely low levels of genetic diversity. This situation is not likely in the case of loggerheads because the species is widely geographically distributed, it is not known to have low levels of genetic diversity, there are several thousand individuals in the population and the number of loggerheads is likely to be stable or increasing over the time period considered here.

Based on the information provided above, the death of 9 loggerheads over the 39 year life span of the project will not appreciably reduce the likelihood of survival (i.e., it will not decrease the likelihood that the species will continue to persist into the future with sufficient resilience to allow for recovery and eventual delisting). The actions will not affect loggerheads in a way that prevents the species from having a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring and it will not result in effects to the environment which would prevent loggerheads from completing their entire life cycle, including reproduction, sustenance, and shelter. This is the case because: (1) the death of 9 loggerheads represents an extremely small percentage of the species as a whole; (2) the death of 9 loggerheads will not change the status or trends of any recovery unit or the DPS as a whole; (3) the loss of 9 loggerheads is not likely to have an effect on the levels of genetic heterogeneity in the population; (4) the loss of 9 loggerheads is likely to have an extremely small effect on reproductive output that will be insignificant at the recovery unit or DPS level; (5) the actions will have only a minor and temporary effect on the distribution of loggerheads in the action area and no effect on the distribution of the species throughout its range; and, (6) the actions will have no effect on the ability of loggerheads to shelter and only an insignificant effect on individual foraging loggerheads.

In certain instances, an action may not appreciably reduce the likelihood of a species survival (persistence) but may affect its likelihood of recovery or the rate at which recovery is expected to occur. As explained above, we have determined that the proposed actions will not appreciably reduce the likelihood that loggerhead sea turtles will survive in the wild. Here, we consider the potential for the actions to reduce the likelihood of recovery. As noted above, recovery is defined as the improvement in status such that listing is no longer appropriate. Thus, we have considered whether the proposed actions will affect the likelihood that the NWA DPS of loggerheads can rebuild to a point where listing is no longer appropriate. In 2008, NMFS and the USFWS issued a recovery plan for the Northwest Atlantic population of loggerheads (NMFS and USFWS 2008). The plan includes demographic recovery criteria as well as a list of tasks that must be accomplished. Demographic recovery criteria are included for each of the five recovery units. These criteria focus on sustained increases in the number of nests laid and the number of nesting females in each recovery unit, an increase in abundance on foraging grounds, and ensuring that trends in neritic strandings are not increasing at a rate greater than trends in in-water abundance. The recovery tasks focus on protecting habitats, minimizing and managing predation and disease, and minimizing anthropogenic mortalities.

Loggerheads have a stable trend; as explained above, the loss of 9 loggerheads over the life span of the proposed actions will not affect the population trend. The number of loggerheads likely to die as a result of the proposed actions is an extremely small percentage of any recovery unit or the DPS as a whole. This loss will not affect the likelihood that the population will reach the size necessary for recovery or the rate at which recovery will occur. As such, the proposed actions will not affect the likelihood that the demographic criteria will be achieved or the timeline on which they will be achieved. The action area does not include nesting beaches; all effects to habitat will be insignificant or extremely unlikely to occur; therefore, the proposed actions will have no effect on the likelihood that habitat based recovery criteria will be achieved. The proposed actions will also not affect the ability of any of the recovery tasks to be accomplished.

The effects of the proposed actions will not hasten the extinction timeline or otherwise increase the danger of extinction; further, the actions will not prevent the species from growing in a way that leads to recovery and the actions will not change the rate at which recovery can occur. This is the case because while the actions may result in a small reduction in the number of loggerheads and a small reduction in the amount of potential reproduction due to the loss of these individuals, these effects will be undetectable over the long-term and the actions are not expected to have long term impacts on the future growth of the DPS or its potential for recovery. Therefore, based on the analysis presented above, the proposed actions will not appreciably reduce the likelihood that the NWA DPS of loggerhead sea turtles can be brought to the point at which they are no longer listed as threatened; that is, the proposed action will not appreciably reduce the likelihood of recovery of the NWA DPS of loggerhead sea turtles.

Based on the analysis presented herein, the proposed actions are not likely to appreciably reduce the likelihood of both the survival and recovery of the NWA DPS of loggerhead sea turtles. These conclusions were made in consideration of the threatened status of NWA DPS loggerhead sea turtles, other stressors that individuals are exposed to within the action area as described in the *Environmental Baseline* and *Cumulative Effects*, and any anticipated effects of climate change on the abundance, reproduction, and distribution of loggerhead sea turtles in the action area.

9.4.2 North Atlantic DPS of Green Sea Turtles

The North Atlantic DPS of green sea turtles is listed as threatened under the ESA. As described in the *Status of the Species*, the North Atlantic DPS of green sea turtles is the largest of the 11 green turtle DPSs with an estimated abundance of over 167,000 adult females from 73 nesting sites. All major nesting populations demonstrate long-term increases in abundance (Seminoff et al. 2015b). In 2021, green turtle nest counts on the 27-core index beaches in Florida reached more than 24,000 nests recorded. Green sea turtles face numerous threats on land and in the water that affect the survival of all age classes. While the threats of pollution, habitat loss through coastal development, beachfront lighting, and fisheries bycatch continue for this DPS, the DPS appears to be somewhat resilient to future perturbations. As described in the *Environmental Baseline* and *Cumulative Effects*, green sea turtles in the action area are exposed to pollution and experience vessel strike and fisheries bycatch. As noted in the *Cumulative Effects* section of this Opinion, we have not identified any cumulative effects different from those considered in the Status of the Species and Environmental Baseline sections of this Opinion, inclusive of how those activities may contribute to climate change. As described in section 7.10, climate change may result in changes in the distribution or abundance of green sea turtles in the action area over the life of this project; however, we have not identified any different or exacerbated effects of the action in the context of anticipated climate change.

There are four regions that support high nesting concentrations in the North Atlantic DPS: Costa Rica (Tortuguero), Mexico (Campeche, Yucatan, and Quintana Roo), United States (Florida), and Cuba. Using data from 48 nesting sites in the North Atlantic DPS, nester abundance was estimated at 167,528 total nesters (Seminoff et al. 2015). The years used to generate the estimate varied by nesting site but were between 2005 and 2012. The largest nesting site (Tortuguero, Costa Rica) hosts 79 percent of the estimated nesting. It should be noted that not all female turtles nest in a given year (Seminoff et al. 2015). Nesting in the area has increased considerably since the 1970s, and nest count data from 1999-2003 suggested that 17,402-37,290 females nested there per year (Seminoff et al. 2015). In 2010, an estimated 180,310 nests were laid at Tortuguero, the highest level of green sea turtle nesting estimated since the start of nesting track surveys in 1971. This equated to somewhere between 30,052 and 64,396 nesters in 2010 (Seminoff et al. 2015). Nesting sites in Cuba, Mexico, and the United States were either stable or increasing (Seminoff et al. 2015). More recent data is available for the southeastern United States. Nest counts at Florida's core index beaches have ranged from less than 300 to almost 41,000 in 2019. The Index Nesting Beach Survey (INBS) is carried out on a subset of beaches surveyed during the Statewide Nesting Beach Survey (SNBS) and is designed to measure trends in nest numbers. The nest trend in Florida shows the typical biennial peaks in abundance and has been increasing (https://myfwc.com/research/wildlife/sea- turtles/nesting/beach-survey-totals/). The SNBS is broader but is not appropriate for evaluating trends. In 2019, approximately 53,000 green turtle nests were recorded in the SNBS (https://myfwc.com/research/wildlife/sea-turtles/nesting/). Seminoff et al. (2015) estimated total nester abundance for Florida at 8,426 turtles.

NMFS recognizes that the nest count data available for green sea turtles in the Atlantic indicates increased nesting at many sites. However, we also recognize that the nest count data, including data for green sea turtles in the Atlantic, only provides information on the number of females currently nesting, and is not necessarily a reflection of the number of mature females available to nest or the number of immature females that will reach maturity and nest in the future.

The impacts to green sea turtles from the proposed action are expected to result in the harassment (inclusive of TTS) of 1 individual due to exposure to pile driving noise under either of the two piling scenarios; the mortality of 1 individual due to vessel strike over the 39-year life of the project inclusive of construction, operations, and decommissioning; and, the capture of up to 1 green sea turtle over the 4-year survey period during the pre- and post-construction trawl surveys, we expect this individual will be released alive with only minor, recoverable injuries (minor scrapes and abrasions). No green sea turtles are expected to be exposed to potentially disturbing levels of noise during UXO detonations due to distances to PTS and TTS being smaller than the clearance zone and very short duration of exposure to noise above the behavioral threshold (one second). We determined that all other effects of the action would be insignificant or extremely unlikely. In total, we anticipate the proposed action will result in the mortality of one green sea turtle over the 39-year life of the project.

The one green sea turtle that experiences harassment could suffer temporary hearing impairment (TTS), and we also assume this turtle would have physiological stress. These temporary conditions are expected to return to normal over a short period of time. TTS will resolve within one week while behavioral disturbance and stress will cease after exposure to pile driving noise ends (no more than two to four hours). These temporary alterations in behavior are not likely to reduce the overall fitness of individual turtles. The energetic consequences of the evasive behavior and delay in resting or foraging are not expected to 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 nesting.

The death of one green sea turtle, whether a male or female, immature or mature, would reduce the number of green sea turtles as compared to the number of green that would have been present in the absence of the proposed actions assuming all other variables remained the same. The loss of one green sea turtle represents a very small percentage of the species as a whole. Even compared to the number of nesting females (17,000-37,000), which represent only a portion of the number of greens worldwide, the mortality of one green represents less than 0.003% of the nesting population. The loss of this sea turtle would be expected to reduce the reproduction of green sea turtles as compared to the reproductive output of green sea turtles in the absence of the proposed action. As described in the "Status of the Species" section above, we consider the trend for green sea turtles to be stable. As noted in the Environmental Baseline, the status of green sea turtles in the action area is expected to be the same as that of each recovery unit over the life of the project. As explained below, the death of these green sea turtles will not appreciably reduce the likelihood of survival for the species for the reasons outlined below. We make this conclusion in consideration of the status of the species as a whole, the status of green sea turtles in the action area, and in consideration of the threats experienced by green sea turtles in the action area as described in the Environmental Baseline and Cumulative Effects sections of this Opinion.

While generally speaking, the loss of a small number of individuals from a subpopulation or species may have an appreciable reduction on the numbers, reproduction and distribution of the species this is likely to occur only when there are very few individuals in a population, the individuals occur in a very limited geographic range or the species has extremely low levels of genetic diversity. This situation is not likely in the case of greens because: the species is widely geographically distributed, it is not known to have low levels of genetic diversity, there are several thousand individuals in the population and the number of greens is likely to be increasing and at worst is stable. These actions are not likely to reduce distribution of greens because the actions will not cause more than a temporary disruption to foraging and migratory behaviors.

Based on the information provided above, the death of one green sea turtles over the 39 year life of the project, will not appreciably reduce the likelihood of survival (i.e., it will not decrease the likelihood that the species will continue to persist into the future with sufficient resilience to allow for the potential recovery from endangerment). The action will not affect green sea turtles in a way that prevents the species from having a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring and it will not result in effects to the environment which would prevent green sea turtles from completing their entire life cycle, including reproduction, sustenance, and shelter. This is the case because: (1) the species' nesting trend is increasing; (2) the death of 1 green sea turtles represents an extremely small percentage of the species as a whole; (3) the loss of 1 green sea turtles will not change the status or trends of the species as a whole; (4) the loss of 1 green sea turtles is not likely to have an effect on the levels of genetic heterogeneity in the population; (5) the loss of 1 green sea turtles is likely to have an undetectable effect on reproductive output of the species as a whole; (6) the action will have insignificant and temporary effects on the distribution of greens in the action area and no effect on its distribution throughout its range; and (7) the action will have no effect on the ability of green sea turtles to shelter and only an insignificant effect on individual foraging green sea turtles.

In rare instances, an action may not appreciably reduce the likelihood of a species survival (persistence) but may affect its likelihood of recovery or the rate at which recovery is expected to occur. As explained above, we have determined that the proposed actions will not appreciably reduce the likelihood that green sea turtles will survive in the wild. Here, we consider the potential for the actions to reduce the likelihood of recovery. As noted above, recovery is defined as the improvement in status such that listing is no longer appropriate. Thus, we have considered whether the proposed actions will affect the likelihood that the species can rebuild to a point where listing is no longer appropriate. A Recovery Plan for Green sea turtles was published by NMFS and USFWS in 1991. The plan outlines the steps necessary for recovery and the criteria, which, once met, would ensure recovery. In order to be delisted, green sea turtles must experience sustained population growth, as measured in the number of nests laid per year, over time. Additionally, "priority one" recovery tasks must be achieved, nesting habitat must be protected (through public ownership of nesting beaches), and stage class mortality must be reduced.

The proposed actions will not appreciably reduce the likelihood of survival of green sea turtles. Also, it is not expected to modify, curtail or destroy the range of the species since it will result in an extremely small reduction in the number of green sea turtles in any geographic area and since it will not affect the overall distribution of green sea turtles other than to cause minor temporary adjustments in movements in the action area. As explained above, the proposed actions are likely to result in the mortality of one green sea turtle; however, as explained above, the loss of this individual over this time period is not expected to affect the persistence of green sea turtles or the species trend. The actions will not affect nesting habitat and will have only an extremely small effect on mortality. The effects of the proposed actions will not hasten the extinction timeline or otherwise increase the danger of extinction; further, the actions will not prevent the species from growing in a way that leads to recovery, and the actions will not change the rate at which recovery can occur. This is the case because while the actions may result in a small reduction in the number of greens and a small reduction in the amount of potential reproduction due to the loss of one individual, these effects will be undetectable over the long-term, and the action is not expected to have long term impacts on the future growth of the population or its potential for recovery. Therefore, based on the analysis presented above, the proposed actions will not appreciably reduce the likelihood that green sea turtles can be brought to the point at which they are no longer listed as endangered or threatened; that is, the proposed action will not appreciably reduce the likelihood of recovery of green sea turtles.

Despite the threats faced by individual green sea turtles inside and outside of the action area, the proposed actions will not increase the vulnerability of individual sea turtles to these additional threats and exposure to ongoing threats will not increase susceptibility to effects related to the proposed actions. We have considered the effects of the proposed actions in light of the status of the species rangewide and in the action area, the environmental baseline, cumulative effects explained above, including climate change, and have concluded that even in light of the ongoing impacts of these activities and conditions, the conclusions reached above do not change. Based on the analysis presented herein, the proposed actions, resulting in the mortality of 1 green sea turtle over 39 years, is not likely to appreciably reduce the likelihood of both the survival and recovery of green sea turtles. These conclusions were made in consideration of the threatened status of green sea turtles, other stressors that individuals are exposed to within the action area as described in the *Environmental Baseline* and *Cumulative Effects*, and any anticipated effects of climate change on the abundance, reproduction, and distribution of green sea turtles in the action area.

9.4.3 Leatherback Sea Turtles

Leatherback sea turtles are listed as endangered under the ESA. Leatherbacks are widely distributed throughout the oceans of the world and are found in waters of the Atlantic, Pacific, and Indian Oceans, the Caribbean Sea, Mediterranean Sea, and the Gulf of Mexico (Ernst and Barbour 1972). Leatherback nesting occurs on beaches of the Atlantic, Pacific, and Indian Oceans as well as in the Caribbean (NMFS and USFWS 2013). Leatherbacks face a multitude of threats that can cause death prior to and after reaching maturity. Some activities resulting in leatherback mortality have been addressed.

The most recent published assessment, the leatherback status review, estimated that the total index of nesting female abundance for the Northwest Atlantic population of leatherbacks is 20,659 females (NMFS and USFWS 2020). This abundance estimate is similar to other estimates. The TEWG estimated approximately 18,700 (range 10,000 to 31,000) adult females using nesting data from 2004 and 2005 (TEWG 2007). The IUCN Red List assessment for the NW Atlantic Ocean subpopulation estimated 20,000 mature individuals (male and female) and approximately 23,000 nests per year (data through 2017) with high inter-annual variability in annual nest counts within and across nesting sites (Northwest Atlantic Leatherback Working Group 2018). The estimate in the status review is higher than the estimate for the IUCN Red List assessment, likely due to a different remigration interval, which has been increasing in recent years (NMFS and USFWS 2020). For this analysis, we found that the status review estimate of 20,659 nesting females represents the best available scientific information given that it uses the most comprehensive and recent demographic trends and nesting data.

In the 2020 status review, the authors identified seven leatherback populations that met the discreteness and significance criteria of DPSs (NMFS and USFWS 2020). These include the Northwest Atlantic, Southwest Atlantic, Southeast Atlantic, Southwest Indian, Northeast Indian, West Pacific, and East Pacific. The population found within the action area is that identified in the status review as the Northwest Atlantic DPS. While NMFS and USFWS concluded that seven populations met the criteria for DPSs, the species continues to be listed at the global level (85 FR 48332, August 10, 2020) as the agency has taken no action to list one or more DPSs. Therefore, this analysis considers the range-wide status of the species as listed.

Previous assessments of leatherbacks concluded that the Northwest Atlantic population was stable or increasing (TEWG 2007, Tiwari et al. 2013b). However, as described in the *Status of the Species,* more recent analyses indicate that the overall trends are negative (NMFS and USFWS 2020, Northwest Atlantic Leatherback Working Group 2018, 2019). At the stock level, the Working Group evaluated the NW Atlantic – Guianas-Trinidad, Florida, Northern Caribbean, and the Western Caribbean stocks. The NW Atlantic – Guianas-Trinidad stock is the largest stock and declined significantly across all periods evaluated, which was attributed to an exponential decline in abundance at Awala-Yalimapo, French Guiana as well as declines in Guyana; Suriname; Cayenne, French Guiana; and Matura, Trinidad. Declines in Awala-Yalimapo were attributed, in part, due to beach erosion and a loss of nesting habitat (Northwest Atlantic Leatherback Working Group 2018). The Florida stock increased significantly over the long-term, but declined from 2008-2017 (Northwest Atlantic Leatherback Working Group 2018). Slight increases in nesting were seen in 2018 and 2019, however, nest counts remain low compared to 2008-2015 (https://myfwc.com/research/wildlife/sea-turtles/nesting/beach-survey-totals/). The Northern Caribbean and Western Caribbean stocks have also declined. The Working Group report also includes trends at the site-level, which varied depending on the site and time period, but were generally negative especially in the recent period.

Similarly, the leatherback status review concluded that the Northwest Atlantic DPS exhibits decreasing nest trends at nesting aggregations with the greatest indices of nesting female abundance. Though some nesting aggregations indicated increasing trends, most of the largest ones are declining. This trend is considered to be representative of the DPS (NMFS and USFWS 2020). Data also indicated that the Southwest Atlantic DPS is declining (NMFS and USFWS 2020).

Populations in the Pacific have shown dramatic declines at many nesting sites (Mazaris et al. 2017, Santidrián Tomillo et al. 2017, Santidrián Tomillo et al. 2007, Sarti Martínez et al. 2007, Tapilatu et al. 2013). The IUCN Red List assessment estimated the number of total mature individuals (males and females) at Jamursba-Medi and Wermon beaches to be 1,438 turtles (Tiwari et al. 2013a). More recently, the leatherback status review estimated the total index of nesting female abundance of the West Pacific DPS at 1,277 females for the West Pacific DPS and 755 females for the East Pacific DPS (NMFS and USFWS 2020). The East Pacific DPS has exhibited a decreasing trend since monitoring began with a 97.4 percent decline since the 1980s or 1990s, depending on nesting beach (Wallace et al. 2013). Population abundance in the Indian Ocean is difficult to assess due to lack of data and inconsistent reporting. Most recently, the 2020 status review estimated that the total index of nesting female abundance for the SW Indian DPS is 149 females and that the DPS is exhibiting a slight decreasing nest trend (NMFS and USFWS 2020). While data on nesting in the Northeast Indian Ocean DPS is limited, the DPS is estimated at 109 females. This DPS has exhibited a drastic population decline with extirpation of the largest nesting aggregation in Malaysia (NMFS and USFWS 2020).

The primary threats to leatherback sea turtles include fisheries bycatch, harvest of nesting females, and egg harvesting; of these, as described in the *Environmental Baseline* and *Cumulative Effects*, fisheries bycatch occurs in the action area. Leatherback sea turtles in the action area are also at risk of vessel strike. As noted in the Cumulative Effects section of this Opinion, we have not identified any cumulative effects different from those considered in the *Status of the Species* and *Environmental Baseline* sections of this Opinion, inclusive of how those activities may contribute to climate change. As described in section 7.10, climate change may result in changes in the distribution or abundance of leatherback sea turtles in the action area over the life of this project; however, we have not identified any different or exacerbated effects of the action in the context of anticipated climate change.

The impacts to leatherback sea turtles from the proposed action are expected to result in the harassment of 7 individuals due to exposure to impact pile driving noise under either of the two piling scenarios. No leatherback sea turtles are expected to be exposed to potentially disturbing levels of noise during UXO detonations due to distances to PTS and TTS thresholds being smaller than clearance zone and very short duration of exposure to noise above behavioral threshold (one second). We also expect that 1 leatherback will be struck and killed by a project vessel over the 39-year life of the project inclusive of construction, operations, and decommissioning. We do not expect the capture of any leatherbacks in the trawl surveys. We determined that all other effects of the action would be insignificant or extremely unlikely to occur. In total, we anticipate the proposed action will result in the mortality of 1 leatherback sea turtle over the 39-year life of the project.

The seven leatherback sea turtles that experience harassment would experience behavioral disturbance and could suffer temporary hearing impairment (TTS); we also assume these turtles would have physiological stress. These temporary conditions are expected to return to normal over a short period of time. TTS will resolve within one week while behavioral disturbance and stress will cease after exposure to pile driving noise ends (no more than two to four hours to install a single pile). These temporary alterations in behavior are not likely to reduce the overall fitness of individual turtles. The energetic consequences of the evasive behavior and delay in resting or foraging are not expected to 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 nesting.

The death of 1 leatherback over the life span of the project represents an extremely small percentage of the number of leatherbacks in the North Atlantic, just 0.005% even considering the lowest population estimate of nesting females (20,659; NMFS and USFWS 2020) and an even smaller percentage of the species as a whole. Considering the extremely small percentage of the population that will be killed, it is unlikely that this death will have a detectable effect on the numbers and population trends of leatherbacks in the North Atlantic or the species as a whole.

Any effects on reproduction are limited to the future reproductive output of the individual killed. Even assuming that the mortality is to a reproductive female, given the number of nesting females in this population (20,659), it is unlikely that the expected loss of no more than one leatherback per year would affect the success of nesting in any year. Additionally, this extremely small reduction in a potential nester is expected to result in a similarly small reduction in the number of eggs laid or hatchlings produced in future years and similarly, an extremely small effect on the strength of subsequent year classes with no detectable effect on the trend of any nesting beach or the population as a whole. The proposed action will not affect nesting beaches in any way or disrupt migratory movements in a way that hinders access to nesting beaches or otherwise delays nesting. Additionally, given the small percentage of the species that will be killed as a result of the proposed action, there is not likely to be any loss of unique genetic haplotypes and no loss of genetic diversity.

The proposed action is not likely to reduce distribution because while the action will temporarily affect the distribution of individual leatherbacks through behavioral disturbance, changes in distribution will be temporary and limited to movements to nearby areas in the WDA. As explained in section 7, we expect the project to have insignificant effects on use of the action area by leatherbacks.

While generally speaking, the loss of a small number of individuals from a subpopulation or species may have an appreciable reduction on the numbers, reproduction and distribution of the species this is likely to occur only when there are very few individuals in a population, the individuals occur in a very limited geographic range or the species has extremely low levels of genetic diversity. This situation is not likely in the case of leatherbacks because: the species is widely geographically distributed, it is not known to have low levels of genetic diversity, there are several thousand individuals in the population and the number of leatherbacks is likely to be stable or increasing over the period considered here.

Based on the information provided above, the death of 1 leatherback over the 39-year life of the project will not appreciably reduce the likelihood of survival (i.e., it will not decrease the likelihood that the species will continue to persist into the future with sufficient resilience to allow for recovery and eventual delisting). The actions will not affect leatherbacks in a way that prevents the species from having a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring and it will not result in effects to the environment which would prevent leatherbacks from completing their entire life cycle, including reproduction, sustenance, and shelter. This is the case because: (1) the death of 1 leatherback represents an extremely small percentage of the Northwest Atlantic population and an even smaller percentage of the species as a whole; (2) the death of 1 leatherback will not change the status or trends of any nesting beach, the Northwest Atlantic population or the species as a whole; (3) the loss of 1 leatherback is not likely to have an effect on the levels of genetic heterogeneity in the population; (4) the loss of 1 leatherback is likely to have an extremely small effect on reproductive output that will be insignificant at the nesting beach, population, or species level; (5) the actions will have only a minor and temporary effect on the distribution of leatherbacks in the action area and no effect on the distribution of the species throughout its range; and, (6) the actions will have no effect on the ability of leatherbacks to shelter and only an insignificant effect on individual foraging leatherbacks.

In certain instances, an action may not appreciably reduce the likelihood of a species survival (persistence) but may affect its likelihood of recovery or the rate at which recovery is expected to occur. As explained above, we have determined that the proposed actions will not appreciably reduce the likelihood that leatherback sea turtles will survive in the wild. Here, we consider the potential for the actions to reduce the likelihood of recovery. As noted above, recovery is defined as the improvement in status such that listing is no longer appropriate. Thus, we have considered whether the proposed actions will affect the likelihood that leatherbacks can rebuild to a point where listing is no longer appropriate. In 1992, NMFS and the USFWS issued a recovery plan for leatherbacks in the U.S. Caribbean, Atlantic, and Gulf of Mexico (NMFS and USFWS 1992). The plan includes three recovery objectives:

1) The adult female population increases over the next 25 years, as evidenced by a statistically significant trend in the number of nests at Culebra, Puerto Rico, St. Croix, USVI, and along the east coast of Florida.
2) Nesting habitat encompassing at least 75 percent of nesting activity in USVI, Puerto Rico and Florida is in public ownership.

3) All priority one tasks have been successfully implemented.

The recovery tasks focus on protecting habitats, minimizing and managing predation and disease, and minimizing anthropogenic mortalities.

Because the death of 1 leatherback over the 39-year life of the project is such a small percentage of the population and is not expected to affect the status or trend of the species, it will not affect the likelihood that the adult female population of loggerheads increases over time. This loss will not affect the likelihood that the population will reach the size necessary for recovery or the rate at which recovery will occur. As such, the proposed actions will not affect the likelihood that the demographic criteria will be achieved or the timeline on which they will be achieved. The action area does not include nesting beaches; all effects to habitat will be insignificant or extremely unlikely to occur; therefore, the proposed actions will have no effect on the likelihood that habitat based recovery criteria will be achieved. The proposed actions will also not affect the ability of any of the recovery tasks to be accomplished.

The effects of the proposed actions will not hasten the extinction timeline or otherwise increase the danger of extinction; further, the actions will not prevent the species from growing in a way that leads to recovery and the actions will not change the rate at which recovery can occur. This is the case because while the actions may result in a small reduction in the number of leatherbacks and a small reduction in the amount of potential reproduction due to the loss of this individual, these effects will be undetectable over the long-term and the actions are not expected to have long term impacts on the future growth of the species or its potential for recovery. Therefore, based on the analysis presented above, the proposed actions will not appreciably reduce the likelihood that leatherback sea turtles can be brought to the point at which they are no longer listed as endangered Despite the threats faced by individual leatherback sea turtles inside and outside of the action area, the proposed actions will not increase the vulnerability of individual sea turtles to these additional threats and exposure to ongoing threats will not increase susceptibility to effects related to the proposed actions. We have considered the effects of the proposed actions in light of the status of the species rangewide and in the action area, the environmental baseline, cumulative effects explained above, including climate change, and have concluded that even in light of the ongoing impacts of these activities and conditions; the conclusions reached here do not change.

Based on the analysis presented herein, the proposed actions are not likely to appreciably reduce the survival and recovery of leatherback sea turtles. These conclusions were made in consideration of the endangered status of leatherback sea turtles, other stressors that individuals are exposed to within the action area as described in the Environmental Baseline and Cumulative Effects, and any anticipated effects of climate change on the abundance and distribution of leatherback sea turtles in the action area; that is, the proposed action will not appreciably reduce the likelihood of recovery of leatherback sea turtles.

Despite the threats faced by individual green sea turtles inside and outside of the action area, the proposed actions will not increase the vulnerability of individual sea turtles to these additional threats and exposure to ongoing threats will not increase susceptibility to effects related to the proposed actions. We have considered the effects of the proposed actions in light of the status of the species rangewide and in the action area, the environmental baseline, cumulative effects explained above, including climate change, and have concluded that even in light of the ongoing impacts of these activities and conditions, the conclusions reached above do not change. Based on the analysis presented herein, the proposed actions, resulting in the mortality of 1 leatherback sea turtle over 39 years, is not likely to appreciably reduce the likelihood of both the survival and recovery of leatherback sea turtles. These conclusions were made in consideration of the threatened status of green sea turtles, other stressors that individuals are exposed to within the action area as described in the *Environmental Baseline* and *Cumulative Effects*, and any anticipated effects of climate change on the abundance, reproduction, and distribution of leatherback sea turtles in the action area.

9.4.4 Kemp's Ridley Sea Turtles

Kemp's ridley sea turtles are listed as a single species classified as endangered under the ESA. They occur in the Atlantic Ocean and Gulf of Mexico, the only major nesting site for Kemp's ridleys is a single stretch of beach near Rancho Nuevo, Tamaulipas, Mexico (Carr 1963, NMFS and USFWS 2015, USFWS and NMFS 1992).

Nest count data provides the best available information on the number of adult females nesting each year. As is the case with other sea turtles species, nest count data must be interpreted with caution given that these estimates provide a minimum count of the number of nesting Kemp's ridley sea turtles. In addition, the estimates do not account for adult males or juveniles of either sex. Without information on the proportion of adult males to females and the age structure of the population, nest counts cannot be used to estimate the total population size (Meylan 1982, Ross 1996). Nevertheless, the nesting data does provide valuable information on the extent of Kemp's ridley nesting and the trend in the number of nests laid. It is the best proxy we have for estimating population changes.

Following a significant, unexplained one-year decline in 2010, Kemp's ridley sea turtle nests in Mexico reached a record high of 21,797 in 2012 (Gladys Porter Zoo nesting database, unpublished data). In 2013 and 2014, there was a second significant decline in Mexico nests, with only 16,385 and 11,279 nests recorded, respectively. In 2015, nesting in Mexico improved to 14,006 nests, and in 2016 overall numbers increased to 18,354 recorded nests. There was a record high nesting season in 2017, with 24,570 nests recorded (J. Pena, pers. comm. to NMFS SERO PRD, August 31, 2017 as cited in NMFS 2020(c) and decreases observed in 2018 and again in 2019). In 2019, there were 11,140 nests in Mexico. It is unknown whether this decline is related to resource fluctuation, natural population variability, effects of catastrophic events like the Deepwater Horizon oil spill affecting the nesting cohort, or some other factor. A small nesting population is also emerging in the United States, primarily in Texas. From 1980-1989, there were an average of 0.2 nests/year at Padre Island National Seashore (PAIS), rising to 3.4 nests/year from 1990-1999, 44 nests/year from 2000-2009, and 110 nests per year from 2010-2019. There was a record high of 353 nests in 2017 (NPS 2020). It is worth noting that nesting in Texas has paralleled the trends observed in Mexico, characterized by a significant decline in 2010, followed by a second decline in 2013-2014, but with a rebound in 2015-2017 (NMFS 2020c) and decreases in nesting in 2018 and 2019 (NPS 2020).

Estimates of the adult female nesting population reached a low of approximately 250-300 in 1985 (NMFS and USFWS 2015, TEWG 2000). Gallaway et al. (2016) developed a stock assessment model for Kemp's ridley to evaluate the relative contributions of conservation efforts and other factors toward this species' recovery. Terminal population estimates for 2012 summed over ages 2 to 4, ages 2+, ages 5+, and ages 9+ suggest that the respective female population sizes were 78,043 (SD = 14,683), 152,357 (SD = 25,015), 74,314 (SD =10,460), and 28,113 (SD = 2,987) (Gallaway et al. 2016). Using the standard IUCN protocol for sea turtle assessments, the number of mature individuals was recently estimated at 22,341 (Wibbels and Bevan 2019). The calculation took into account the average annual nests from 2016-2018 (21,156), a clutch frequency of 2.5 per year, a remigration interval of 2 years, and a sex ratio of 3.17 females: 1 male. Based on the data in their analysis, the assessment concluded the current population trend is unknown (Wibbels and Bevan 2019). However, some positive outlooks for the species include recent conservation actions, including the expanded TED requirements in the shrimp fishery (84 FR 70048, December 20, 2019) and a decrease in the amount of shrimping off the coast of Tamaulipas and in the Gulf of Mexico (NMFS and USFWS 2015).

Genetic variability in Kemp's ridley turtles is considered to be high, as measured by nuclear DNA analyses (i.e., microsatellites) (NMFS et al. 2011). If this holds true, then rapid increases in population over one or two generations would likely prevent any negative consequences in the genetic variability of the species (NMFS et al. 2011). Additional analysis of the mtDNA taken from samples of Kemp's ridley turtles at Padre Island, Texas, showed six distinct haplotypes, with one found at both Padre Island and Rancho Nuevo (Dutton et al. 2006).

Fishery interactions are the main threat to the species. The species' limited range and low global abundance make its resilience to future perturbation low. The status of Kemp's ridley sea turtles in the action area is the same as described in the Status of the Species. As described in the Environmental Baseline and Cumulative Effects, fisheries bycatch and vessel strike are likely to continue to occur in the action area over the life of the project. As noted in the *Cumulative Effects* section of this Opinion, we have not identified any cumulative effects different from those considered in the *Status of the Species* and *Environmental Baseline* sections of this Opinion, inclusive of how those activities may contribute to climate change. As described in section 7.10, climate change may result in changes in the distribution or abundance of Kemp's ridley sea turtles in the action area over the life of this project; however, we have not identified any different or exacerbated effects of the action in the context of anticipated climate change.

The impacts to Kemp's ridley sea turtles from the proposed action are expected to result in the harassment of 16 individuals due to exposure to impact pile driving noise under either of the two piling scenarios. No Kemp's ridley sea turtles are expected to be exposed to potentially disturbing levels of noise during UXO detonations due to distances to PTS and TTS thresholds being smaller than clearance zone and very short duration of exposure to noise above behavioral threshold (one second). We also expect that 1 Kemp's ridley will be struck and killed by a project vessel over the 39-year life of the project inclusive of construction, operations, and decommissioning. We expect the capture of up to 6 Kemp's ridley sea turtles over the 4-year survey period during the pre- and post-construction trawl surveys; we expect these individuals will be released alive with only minor, recoverable injuries (minor scrapes and abrasions). We determined that all other effects of the action would be insignificant or extremely unlikely to occur. In total, we expect the proposed action to result in the mortality of one Kemp's ridley sea turtle over the 39-year life of the project.

The 16 Kemp's ridley sea turtles that experience harassment could suffer temporary hearing impairment (TTS), and we also assume these turtles would have physiological stress. These temporary conditions are expected to return to normal over a short period of time. TTS will resolve within one week while behavioral disturbance and stress will cease after exposure to pile driving noise ends (no more than the two to four hours it takes to install a pile). These temporary alterations in behavior are not likely to reduce the overall fitness of individual turtles. The energetic consequences of the evasive behavior and delay in resting or foraging are not expected to 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 nesting.

The mortality of one Kemp's ridley over a 39 year time period represents a very small percentage of the Kemp's ridleys worldwide. Even taking into account just nesting females (7-8,000), the death of one Kemp's ridley represents less than 0.013% of the population. While the death of one Kemp's ridley will reduce the number of Kemp's ridleys compared to the number that would have been present absent the proposed actions, it is not likely that this reduction in numbers will change the status of this species or its stable to increasing trend as this loss represents a very small percentage of the population. Reproductive potential of Kemp's ridleys is not expected to be affected in any other way other than through a reduction in numbers of individuals.

A reduction in the number of Kemp's ridleys would have the effect of reducing the amount of potential reproduction, as any dead Kemp's ridleys would have no potential for future reproduction. In 2006, the most recent year for which data is available, there were an estimated 7-8,000 nesting females. While the species is thought to be female biased, there are likely to be several thousand adult males as well. Given the number of nesting adults, it is unlikely that the loss of one Kemp's ridley over 39 years would affect the success of nesting in any year. Additionally, this small reduction in potential nesters is expected to result in a small reduction in the number of eggs laid or hatchlings produced in future years and similarly, a very small effect on the strength of subsequent year classes. Even considering the potential future nesters that would be produced by the individual that would be killed as a result of the proposed action, any effect to future year classes is anticipated to be very small and would not change the stable to increasing trend of this species. Additionally, the proposed action will not affect nesting beaches in any way or disrupt migratory movements in a way that hinders access to nesting beaches or otherwise delays nesting.

The proposed action is not likely to reduce distribution because the action will not impede Kemp's ridleys from accessing foraging grounds or cause more than a temporary disruption to other migratory behaviors. Additionally, given the small percentage of the species that will be killed as a result of the proposed action, there is not likely to be any loss of unique genetic haplotypes and no loss of genetic diversity.

While generally speaking, the loss of a small number of individuals from a subpopulation or species may have an appreciable reduction on the numbers, reproduction and distribution of the species this is likely to occur only when there are very few individuals in a population, the individuals occur in a very limited geographic range or the species has extremely low levels of genetic diversity. This situation is not likely in the case of Kemp's ridleys because: the species is widely geographically distributed, it is not known to have low levels of genetic diversity, there are several thousand individuals in the population and the number of Kemp's ridleys is likely to be increasing and at worst is stable.

Based on the information provided above, the death of one Kemp's ridley sea turtles over 39 years will not appreciably reduce the likelihood of survival (i.e., it will not decrease the likelihood that the species will continue to persist into the future with sufficient resilience to allow for the potential recovery from endangerment). The proposed action will not affect Kemp's ridleys in a way that prevents the species from having a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring and it will not result in effects to the environment which would prevent Kemp's ridleys from completing their entire life cycle, including reproduction, sustenance, and shelter. This is the case because: (1) the species' nesting trend is increasing; (2) the death of one Kemp's ridley represents an extremely small percentage of the species as a whole; (3) the death of one Kemp's ridley will not change the status or trends of the species as a whole; (4) the loss of this Kemp's ridley is not likely to have an effect on the levels of genetic heterogeneity in the population; (5) the loss of this Kemp's ridley is likely to have such a small effect on reproductive output that the loss of this individual will not change the status or trends of the species; (5) the actions will have only a minor and temporary effect on the distribution of Kemp's ridleys in the action area and no effect on the distribution of the species throughout its range; and, (6) the actions will have no effect on the ability of Kemp's ridleys to shelter and only an insignificant effect on individual foraging Kemp's ridleys.

In rare instances, an action may not appreciably reduce the likelihood of a species survival (persistence) but may affect its likelihood of recovery or the rate at which recovery is expected to occur. As explained above, we have determined that the proposed action will not appreciably reduce the likelihood that Kemp's ridley sea turtles will survive in the wild. Here, we consider the potential for the actions to reduce the likelihood of recovery. As noted above, recovery is defined as the improvement in status such that listing is no longer appropriate. Thus, we have considered whether the proposed action will affect the likelihood that Kemp's ridleys can rebuild to a point where listing is no longer appropriate. In 2011, NMFS and the USFWS issued a recovery plan for Kemp's ridleys (NMFS et al. 2011). The plan includes a list of criteria necessary for recovery. These include:

1. An increase in the population size, specifically in relation to nesting females[50];
2. An increase in the recruitment of hatchlings[51];
3. An increase in the number of nests at the nesting beaches;
4. Preservation and maintenance of nesting beaches (i.e. Rancho Nuevo, Tepehuajes, and Playa Dos); and,

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[50]A population of at least 10,000 nesting females in a season (as measured by clutch frequency per female per season) distributed at the primary nesting beaches in Mexico (Rancho Nuevo, Tepehuajes, and Playa Dos) is attained in order for downlisting to occur; an average of 40,000 nesting females per season over a 6-year period by 2024 for delisting to occur

[51] Recruitment of at least 300,000 hatchlings to the marine environment per season at the three primary nesting beaches in Mexico (Rancho Nuevo, Tepehuajes, and Playa Dos).

5. Maintenance of sufficient foraging, migratory, and inter-nesting habitat.

Kemp's ridleys have an increasing trend; as explained above, the loss of one Kemp's ridley over the 39-year life of the project will not affect the population trend. The number of Kemp's ridleys likely to die as a result of the proposed actions is an extremely small percentage of the species. This loss will not affect the likelihood that the population will reach the size necessary for recovery or the rate at which recovery will occur. As such, the proposed action will not affect the likelihood that criteria one, two or three will be achieved or the timeline on which they will be achieved. The action area does not include nesting beaches; therefore, the proposed actions will have no effect on the likelihood that recovery criteria four will be met. All effects to habitat will be insignificant or extremely unlikely to occur; therefore, the proposed actions will have no effect on the likelihood that criteria five will be met.

The effects of the proposed action will not hasten the extinction timeline or otherwise increase the danger of extinction. Further, the actions will not prevent the species from growing in a way that leads to recovery and the actions will not change the rate at which recovery can occur. This is the case because while the actions may result in a small reduction in the number of Kemp's ridleys and a small reduction in the amount of potential reproduction, these effects will be undetectable over the long-term and the actions are not expected to have long term impacts on the future growth of the population or its potential for recovery. Therefore, based on the analysis presented above, the proposed action will not appreciably reduce the likelihood that Kemp's ridley sea turtles can be brought to the point at which they are no longer listed as endangered or threatened; that is, the proposed action will not appreciably reduce the likelihood of recovery of Kemp's ridley sea turtles.

Despite the threats faced by individual Kemp's ridley sea turtles inside and outside of the action area, the proposed action will not increase the vulnerability of individual sea turtles to these additional threats and exposure to ongoing threats will not increase susceptibility to effects related to the proposed actions. We have considered the effects of the proposed action in light of the status of the species, Environmental Baseline and cumulative effects explained above, including climate change, and have concluded that even in light of the ongoing impacts of these activities and conditions; the conclusions reached above do not change. Based on the analysis presented herein, the proposed action, resulting in the mortality of one Kemp's ridleys, is not likely to appreciably reduce the likelihood of both the survival and recovery of this species. These conclusions were made in consideration of the endangered status of Kemp's ridley sea turtles, other stressors that individuals are exposed to within the action area as described in the *Environmental Baseline* and *Cumulative Effects*, and any anticipated effects of climate change on the abundance and distribution of Kemp's ridleys in the action area.

9.5 Marine Mammals

Our effects analysis determined that pile driving is likely to adversely affect ESA-listed marine mammals in the action area and cause temporary threshold shift (TTS), behavioral response, and stress in a small number of individual North Atlantic right, fin, sei, and sperm whales. Pile driving is also likely to result in permanent threshold shift (PTS; auditory injury) in one fin and one sei whale. Animals exposed to sufficiently intense sound exhibit an increased hearing threshold (i.e., poorer sensitivity) for some period of time following exposure; this is called a noise-induced threshold shift (TS). The magnitude of TS normally decreases over time following cessation of the noise exposure, TS that eventually returns to zero (i.e., the threshold returns to the pre-exposure value), is called TTS (Southall et al. 2007). TTS represents primarily tissue fatigue and is reversible (Southall et al., 2007). In addition, other investigators have suggested that TTS is within the normal bounds of physiological variability and tolerance and does not represent physical injury (*e.g.*, Ward, 1997). Therefore, NMFS does not consider TTS to constitute auditory injury.

No non-auditory injury, serious injury of any kind, or mortality is anticipated. We determined that exposure to other project noise will have effects that are insignificant or are extremely unlikely to occur. We also determined that effects to habitat and prey are also insignificant or extremely unlikely to occur and concluded that with the incorporation of vessel strike risk reduction measures that are part of the proposed action, strike of an ESA listed whale by a project vessel is extremely unlikely to occur and that entanglement or capture in fisheries surveys is extremely unlikely to occur. In this section, we discuss the likely consequences of these effects to the individual whales that have been exposed, the populations those individuals represent, and the species those populations comprise.

Our analyses identified the likely effects of the Ocean Wind project, which requires authorizations from a number of federal agencies as described in section 3 of this Opinion, on the ESA-listed individuals that will be exposed to these actions. We measure effects to individuals of endangered or threatened marine mammals using changes in the individual's "fitness" or the individual's growth, survival, annual reproductive success, and lifetime reproductive success. When we do not expect listed marine mammals exposed to an action's effects to experience reductions in fitness, we would not expect the action to impact that animal's health or future reproductive success. Therefore, we would not expect adverse consequences on the overall reproduction, abundance, or distribution of the populations those individuals represent or the species those populations comprise. As a result, if we conclude that listed animals are not likely to experience reductions in their fitness, we would conclude our assessment. If, however, we conclude that listed animals are likely to experience reductions in their fitness, we would assess the consequences of those fitness reductions for the population or populations the individuals in an action area represent.

As documented in section 7 of this Opinion, the adverse effects anticipated on North Atlantic right, fin, sei, and sperm whales resulting from the proposed action are from sounds produced during pile driving in the action area. While this Opinion relies on the best available scientific and commercial information, our analysis and conclusions include uncertainty about the basic hearing capabilities of some marine mammals; how these animals use sounds as environmental cues; how they perceive acoustic features of their environment; the importance of sound to the normal behavioral and social ecology of species; the mechanisms by which human-generated sounds affect the behavior and physiology (including the non-auditory physiology) of exposed individuals; and the circumstances that could produce outcomes that have adverse consequences for individuals and populations of exposed species. Based on the best available information, we expect most exposures and potential responses of ESA-listed cetaceans to acoustic stressors associated with the Ocean Wind project to have little effect on the exposed animals. As is evident from the available literature cited herein, responses are expected to be short-term, with the animal returning to normal behavior patterns shortly after the exposure is over (e.g., Goldbogen et al. 2013a; Silve et al. 2015). However, Southall et al. (2016) suggested that even minor, sub-lethal behavioral changes may still have significant energetic and physiological consequences given sustained or repeated exposure. We do not expect such sustained or repeated exposure of any individuals in this case.

9.5.1 North Atlantic Right Whales

As described in the *Status of the Species*, the endangered North Atlantic right whale is currently in decline in the western North Atlantic (Pace et al. 2017b; Pace et al. 2021) and experiencing an unusual mortality event (Daoust et al. 2017). The population estimate in the most recent Stock Assessment Report (Hayes et al. 2022) is 368 individuals (95% CI: 403-424); this is based on information through November 2019. The draft 2022 SAR (Hayes et al. 2023 draft) uses data from the photo-ID database as it existed in December 2021 and included photographic information up through November 2020. Using the hierarchical, state-space Bayesian open population model of these histories produced a median abundance value (N_{est}) as of November 30, 2020 of 338 individuals (95%CI: 325–350) and a minimum population estimate of 332. Modeling indicates that low female survival, a male-biased sex ratio, and low calving success are contributing to the population's current decline (Pace et al. 2017b). The species has low genetic diversity, as would be expected based on its low abundance, and the species' resilience to future perturbations (i.e., its ability to recover from declines in numbers of reductions) is expected to be very low (Hayes et al. 2018). Vessel strikes and entanglement of right whales in U.S. and Canadian waters continue to occur. Entanglement in fishing gear appears to have had substantial health and energetic costs that affect both survival and reproduction of right whales (van der Hoop et al. 2017a). Due to the declining status of North Atlantic right whales, the resilience of this population to stressors that would impact the distribution, abundance, and reproductive potential of the population is low. The species faces a high risk of extinction and the population size is small enough for the death of any individuals to have measurable effects in the projections on its population status, trend, and dynamics.

As described in the *Environmental Baseline* and *Climate Change* sections, ongoing effects in the action area (e.g., global climate change, decreased prey abundance, vessel strikes, and entanglements in U.S. state and federal fisheries) have contributed to concern for the species' persistence. Sublethal effects from entanglement cannot be separated out from other stressors (e.g., prey abundance, climate variation, reproductive state, vessel collisions) which co-occur and affect calving rates. Entanglement in fishing gear and vessel strikes are currently understood to be the most significant threats to the species and, as described in the *Environmental Baseline* may occur in the action area over the life of the proposed action. As noted in the *Cumulative Effects* section of this Opinion, we have not identified any cumulative effects different from those considered in the Status of the Species and Environmental Baseline sections of this Opinion, inclusive of how those activities may contribute to climate change. As described in section 7.10, climate change is expected to negatively affect right whales throughout their range, including in the action area, over the life of this project; however, we have not identified any different or exacerbated effects of the action in the context of anticipated climate change. As noted in the *Environmental Baseline*, a number of offshore wind leases have been issued in the action area but section 7 consultation has not yet been initiated or completed on the proposed approval of any construction and operations plans for projects in the action area.

As explained in the section 7 of this Opinion, the only adverse effects to North Atlantic right whales expected to result from the Ocean Wind 1 project are temporary behavioral disturbance and/or temporary threshold shift (minor and temporary hearing impairment); these adverse effects meet NMFS interim ESA definition of harassment. These adverse effects will be experienced by up to 7 individual right whales as a result of exposure to noise from pile driving or UXO detonation (4-5 from impact pile driving, 1 from vibratory pile driving, 1 from UXO detonation). No injury (auditory or other), serious injury, or mortality is expected due to exposure to any aspect of the proposed action during the construction, operations, or decommissioning phases of the project.

The distribution of right whales overlaps with some parts of the vessel transit routes that will be used through the 39-year life of the project. A number of measures designed to reduce the risk of vessel strike, including deploying lookouts and traveling at reduced speeds in areas where right whales are most likely to occur, are part of the proposed action. As explained in section 7.2, we have determined that strike of a right whale by a project vessel is extremely unlikely to occur. As such, vessel strike of a right whale and any associated injury or mortality is not an expected outcome of the Ocean Wind 1 project.

Based on the type of survey gear that will be deployed, we do not expect any effects to right whales from the surveys of fishery resources planned by Ocean Wind and considered as part of the proposed action. As such, capture or entanglement of a right whale and any associated injury or mortality is not an expected outcome of the Ocean Wind 1 project.

As explained in section 7.1, the effects of exposure to WTG operational noise and noise associated with other project activities (e.g., HRG surveys, vessels) are expected to be insignificant. We also determined that effects of construction, operation, and decommissioning, inclusive of project noise, will have insignificant effects on right whale prey. As right whales do not echolocate, there is no potential for noise or other project effects to affect echolocation. The area around operating WTGs where operational noise may be above ambient noise is expected to be very small (50 m or less) and any effects to right whales from avoiding that very small area would be insignificant. For HRG surveys, the best available data (Crocker and Fratantonio 2016) indicates that the area with noise above the level that would be disturbing to right whales is very small (no more than 500 m from the sound source). Given the small area, the shutdown and clearance requirements, and that we only expect a whale exposed to that noise to swim just far enough way to avoid it (less than 500 m), effects are insignificant.

No right whales are expected to be exposed to noise from pile driving or UXO detonation that could result in PTS or any other injury. Only a small number of right whales (no more than seven) are expected to be exposed to pile driving or UXO detonation noise that will be loud enough to result in TTS or behavioral disturbance that would meet the NMFS interim definition of ESA harassment. A number of measures that are part of the proposed action, including a seasonal restriction on impact pile driving, requirements to use noise attenuation devices, minimum visibility requirements, and clearance and shutdown measures during pile driving monitored by PSOs on multiple platforms, reduce the potential for exposure of right whales to pile driving noise. Similarly, measures that will be in place for any UXO detonations, including requirements to use noise attenuation devices, minimum visibility requirements, and clearance measures that include aerial surveys of the clearance zone, reduce the potential for exposure of right whales to UXO detonations. With these measures in place, we do not anticipate the exposure of any right whales to noise that could result in PTS, other injury, or mortality. However, even with these minimization measures in place, we expect 4 or 5 North Atlantic right whales (depending on the construction scenario) to experience TTS, temporary behavioral disturbance (no more than 4 hours), and associated temporary physiological stress during the construction period due to exposure to impact pile driving noise and 1 North Atlantic right whale to experience TTS, temporary behavioral disturbance (no more than 12 hours), and physiological stress due to exposure to vibratory pile driving noise during cofferdam installation or removal. We also expect no more than 1 right whale to experience TTS as a result of exposure to noise from UXO detonation. As explained in the *Effects of the Action* section, all of these impacts, including TTS, are expected to be temporary with normal behaviors resuming quickly after the noise ends (see Goldbogen et al. 2013a; Melcon et al. 2012). Any TTS will resolve within a week of exposure (that is, hearing sensitivity will return to normal within one week of exposure) and is not expected to affect the health of any whale or its ability to migrate, forage, breed, or calve (Southall et al. 2007).

As explained in section 7.1, we have also considered whether TTS, masking, or avoidance behaviors experienced by the 7 right whales exposed to noise above the MMPA Level B harassment threshold would be likely to increase the risk of vessel strike or entanglement in fishing gear. We would not expect the TTS to span the entire communication or hearing range of right whales given the frequencies produced by pile driving do not span entire hearing ranges for right whales. Additionally, though the frequency range of TTS that right whales might sustain would overlap with some of the frequency ranges of their vocalization types, the frequency range of TTS from Ocean Wind's pile driving activities would not span the entire frequency range of one vocalization type, much less span all types of vocalizations or other critical auditory cues for any given species. As such, we do not expect TTS to affect the ability of a right whale to communicate with other right whales or to detect audio cues to the extent they rely on audio cues to avoid vessels or other threats. As such, we do not expect masking to affect the ability of a right whale to avoid a vessel. These risks are lowered even further by the short duration of TTS (resolving within a week) and masking (limited only to the time that the whale is exposed to the pile driving noise). In addition, as explained in section 7.1, we do not expect that avoidance of pile driving noise would result in right whales moving to areas with higher risk of vessel strike or entanglement in fishing gear; increased risk of vessel strike or entanglement in fishing gear as a result of exposure to pile driving noise is extremely unlikely to occur. This determination was made in consideration of the distance a whale is expected to travel to avoid disturbing levels of noise and the distribution of vessel traffic and fishing activity in the WDA and surrounding waters.

We have considered if pile driving noise may mask right whale calls and could have effects on mother-calf communication and behavior. As noted in section 7.1, presence of mother-calf pairs is unlikely in the WDA during the May – December pile driving window. However, even if a mother-calf pair was exposed to pile driving noise, we do not anticipate that masking would result in fitness consequences given their short-term nature. As noted in section 7.1, when calves leave the foraging grounds off the coast of the southeastern U.S. at around four months of age,

they are expected to be more robust and less susceptible to a missed or delayed nursing opportunity. Any masking of communications or any delays in nursing due to swimming away from the pile driving noise would only last for the duration of the exposure to pile driving noise, which in all cases would be no more than four hours. This temporary disruption is not expected to have any health consequences to the calf or mother due to its short-term duration and the ability to resume normal behaviors as soon as they are out of range of the disturbance.
We expect that right whales in the WDA are migrating. Foraging is expected to only occur occasionally and would be opportunistic; the WDA is not a known foraging habitat or an area where right whales persist or aggregate due to the presence of prey. Based on the best available information that indicates whales resume normal behavior quickly after the cessation of sound exposure (e.g., Goldbogen et al. 2013a; Melcon et al. 2012), we anticipate that the up to 7 right whales exposed to harassing levels of noise will return to normal behavioral patterns after the exposure ends. As such, even if a right whale exposed to pile driving noise was foraging, this disruption would be short term and impact no more than one foraging event. This disruption in an area where foraging is not expected to regularly occur is expected to have insignificant effects on the affected individual.

A single impact pile driving event will take no more than four hours; therefore, even in the event that the 4 or 5 right whales expected to be exposed to impact pile driving noise were exposed to disturbing levels of noise for the entirety of a pile driving event, that disturbance would last no more than four hours. The one right whale we expect to be exposed to vibratory pile driving noise will be exposed to that noise for up to 12 hours. Exposure to noise from the UXO detonation will last one second. If an animal exhibits an avoidance response to pile driving noise, it would experience a cost in terms of the energy associated with traveling away from the acoustic source. Studies of marine mammal avoidance of sonar, which like pile driving is an impulsive sound source, demonstrate clear, strong, and pronounced behavioral changes, including sustained avoidance with associated energetic swimming and cessation of feeding behavior (Southall et al. 2016) suggesting that it is reasonable to assume that a whale exposed to noise above the MMPA Level B harassment threshold would take a direct path to get outside of the noisy area. As explained in section 7.1, during impact pile driving of monopiles, the area with noise above the MMPA Level B harassment threshold extends no more than 2.98 km in May-November and 3.35 km in December from the pile being driven, with much smaller areas during impact pile driving of pin piles (1.72 and 2.11 km). As such, a right whale that was at the pile driving location when pile driving starts (i.e., at the center of the area with a 1.72-3.35 km radius that will experience noise above the 160 dB re 1uPa threshold), we would expect a right whale swimming at maximum speed (9 kph) would escape from the area with noise above 160 dB re 1uPa the noise in about 11-22 minutes, but at the median speed observed in Hatin et al. (1.3 kph, 2013), it would take the animal approximately 1.3-2.5 hours to move out of the noisy area. However, given the requirements for ensuring an area extending 5 km from the pile is clear of right whales before pile driving begins, such a scenario is unlikely to occur. Rather, it is far more likely that any exposure and associated disturbance would be for a significantly shorter period of time as a right whale would be much further from the pile being driven when pile driving started. Considering the one right whale expected to be exposed to vibratory pile driving noise above the MMPA Level B harassment threshold, a right whale located at the edge of the 150 m clearance zone would need to swim 10 km from the cofferdam being installed to clear the area with noise above the 120 dB re 1uPa threshold. Based on swimming speed, it would need to travel for less than an hour to up to 8 hours to move outside the noisy area.

There would likely be an energetic cost associated with any temporary displacement or change in migratory route, but unless disruptions occur over long durations or over subsequent days, which we do not expect, we do not anticipate this movement to be consequential to the animal over the long term (see Southall et al. 2007a). The energetic consequences of the evasive behavior and delay in resting are not expected to 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 future breeding or calving. Stress responses are also anticipated with each of these instances of disruption. However, the available literature suggests these acoustically induced stress responses will be of short duration (similar to the duration of exposure), and not result in a chronic increase of stress that could result in physiological consequences to the animal (Southall et al. 2007). Given the short period of time during which elevated noise will be experienced, we do not anticipate long duration exposures to occur, and we do not anticipate the associated stress of exposure to result in significant costs to affected individuals.

As described in greater detail in Section 7.1, we do not anticipate these instances of behavioral harassment, including TTS, to result in fitness consequences to any of the up to seven individual North Atlantic right whales to which this will occur. Our analysis considered the overall number of exposures to acoustic stressors that are expected to result in harassment, inclusive of behavioral responses, TTS, and stress, the duration and scope of the proposed activities expected to result in such impacts, the expected behavioral state of the animals at the time of exposure, and the expected condition of those animals. Instances of North Atlantic right whale exposure to acoustic stressors are expected to be short-term, with the animal returning to its previous behavioral state shortly thereafter. As described previously, information is not available to conduct a quantitative analysis to determine the likely fitness consequences of these exposures and associated responses because we do not have information from wild cetaceans that links short-term behavioral responses to vital rates and animal health. Harris et al. (2017a) summarized the research efforts conducted to date that have attempted to understand the ways in which behavioral responses may result in long-term consequences to individuals and populations. Efforts have been made to try to quantify the potential consequences of such responses, and frameworks have been developed for this assessment (e.g., Population Consequences of Disturbance). However, models that have been developed to date to address this question require many input parameters and, for most species, there are insufficient data for parameterization (Harris et al. 2017a). Nearly all studies and experts agree that infrequent exposures of a single day or less are unlikely to impact an individual's overall energy budget (Farmer et al. 2018; Harris et al. 2017b; King et al. 2015b; NAS 2017; New et al. 2014; Southall et al. 2007d; Villegas-Amtmann et al. 2015). Based on best available information, we expect this to be the case for North Atlantic right whales exposed to acoustic stressors associated with this project even for animals that may already be in a stressed or compromised state due to factors unrelated to the Ocean Wind project.

We do not expect any injury (auditory or otherwise), serious injury, or mortality of any right whale to result from the proposed action. We do not expect effects of the action to affect the health of any right whale. We also do not anticipate fitness consequences to any individual

North Atlantic right whales; that is, we do not expect any effects on any individual's ability to reproduce or generate viable offspring. Because we do not anticipate any reduction in fitness, we do not anticipate any future effects on reproductive success to result from the proposed action. While many right whales in the action area are in a stressed state that is thought to contribute to a decreased calving interval, the short-term (no more than a few hours) exposure to pile driving noise experienced by a single individual is not anticipated to have any lingering effects and is not expected to have any effect on future reproductive output. As such, we do not expect any reductions in reproduction. Any effects to distribution will be limited to short-term alterations to normal movements by individuals to avoid disturbing levels of noise. Based on the information provided here, the proposed action will not appreciably reduce the likelihood of survival of the North Atlantic right whale (*i.e.*, it will not decrease the likelihood that the species will continue to persist into the future with sufficient resilience to allow for the potential recovery from endangerment).

The proposed action is not likely to affect the recovery potential of North Atlantic right whales (i.e. affect the likelihood that North Atlantic right whales can rebuild to a point where it is downlisted and ultimately listing is no longer appropriate). In making this determination we have considered generalized needs for species recovery and the goals and criteria identified in the 2005 Recovery Plan for North Atlantic right whales. We know that in general, to recover, a listed species must have a sustained positive trend of increasing population over time. In general, mortality rates must be low enough to allow for recruitment to all age classes so that successful calving can continue over time and over generations. The 2005 Recovery Plan (NMFS 2005) states that North Atlantic right whales may be considered for reclassifying to threatened when all of the following have been met: 1) The population ecology (range, distribution, age structure, and gender ratios, etc.) and vital rates (age-specific survival, age-specific reproduction, and lifetime reproductive success) of right whales are indicative of an increasing population; 2) The population has increased for a period of 35 years at an average rate of increase equal to or greater than 2% per year; 3) None of the known threats to Northern right whales (summarized in the five listing factors) are known to limit the population's growth rate; and, 4) Given current and projected threats and environmental conditions, the right whale population has no more than a 1% chance of quasi-extinction in 100 years. The proposed action will not result in any condition that impacts the time it will take to reach these goals or the likelihood that these goals will be met. This is because the proposed action will not result in any mortality or have any effect on the health or reproductive success of any individuals; therefore, it will not affect the trend of the species or prevent or delay it from achieving an increasing population or otherwise affect its growth rate and will not affect the chance of quasi-extinction. That is, the proposed action will not appreciably reduce the likelihood of recovery of North Atlantic right whales.

The proposed action will not affect the abundance of right whales; because no serious injury or mortality is anticipated, the project will not cause there to be fewer right whales. The only effects to distribution of right whales will be minor changes in the movements of up to six individuals exposed to pile driving noise and 1 individual exposed to UXO detonation; there will be no changes in the distribution of the species in the action area or throughout its range. The proposed action will have no effect on reproduction because it will not affect the health of any potential mothers or the potential for successful breeding or calving; the project will not cause any reduction in reproduction. As explained above, the proposed action will not affect the recovery potential of the species. For these reasons, the effects of the proposed action is not likely to appreciably reduce the likelihood of both the survival and recovery of North Atlantic right whales in the wild. These conclusions were made in consideration of the endangered status of North Atlantic right whales, other stressors that individuals are exposed to within the action area as described in the *Environmental Baseline* and *Cumulative Effects* section of this Opinion, and any anticipated effects of climate change on the abundance, reproduction, and distribution of right whales in the action area.

9.2.2 Fin Whales

The best available current abundance estimate for fin whales in the North Atlantic stock is 6,802 (CV=0.24), sum of the 2016 NOAA shipboard and aerial surveys and the 2016 NEFSC and Department of Fisheries and Oceans Canada (DFO) surveys; the minimum population estimate for the western North Atlantic fin whale is 5,573 (Hayes et al. 2021). Fin whales in the North Atlantic compromise one of the three to seven stocks in the North Atlantic. According to the latest NMFS stock assessment report for fin whales in the Western North Atlantic, information is not available to conduct a trend analysis for this population (Hayes et al. 2021). Rangewide, there are over 100,000 fin whales occurring primarily in the North Atlantic Ocean, North Pacific Ocean, and Southern Hemisphere.

Entanglement in fishing gear and vessel strikes as described in the *Environmental Baseline* may occur in the action area over the life of the proposed action. As noted in the *Cumulative Effects* section of this Opinion, we have not identified any cumulative effects different from those considered in the *Status of the Species* and *Environmental Baseline* sections of this Opinion, inclusive of how those activities may contribute to climate change. As described in section 7.10, climate change may result in changes in the distribution or abundance of fin whales in the action area over the life of this project; however, we have not identified any different or exacerbated effects of the action in the context of anticipated climate change.

As explained in the section 7 of this Opinion, with the exception of four fin whales expected to experience PTS, the only adverse effects to fin whales expected to result from the Ocean Wind 1 project are temporary behavioral disturbance and/or temporary threshold shift (minor and temporary hearing impairment); We consider these adverse effects to occur at a level meeting NMFS's interim ESA definition of harassment. These adverse effects will be experienced by up to 15 individual fin whales as a result of exposure to noise from pile driving or UXO detonation. With the exception of the four fin whales experiencing PTS, no injury (auditory or other), serious injury or mortality is expected due to exposure to any aspect of the proposed action during the construction, operations, or decommissioning phases of the project.

The distribution of fin whales overlaps with some parts of the vessel transit routes that will be used through the 39-year life of the project. A number of measures designed to reduce the risk of vessel strike, including deploying lookouts and traveling at reduced speeds in areas where fin whales are most likely to occur, are part of the proposed action. As explained in section 7.2, we have determined that strike of a fin whale by a project vessel is extremely unlikely to occur. As such, vessel strike of a fin whale and any associated injury or mortality is not an expected outcome of the Ocean Wind 1 project.

Based on the type of survey gear that will be deployed, we do not expect any effects to fin whales from the surveys of fishery resources planned by Ocean Wind and considered as part of the proposed action. As such, capture or entanglement of a fin whale and any associated injury or mortality is not an expected outcome of the Ocean Wind 1 project.

As explained in section 7.1, the effects of exposure to WTG operational noise and noise associated with other project activities (e.g., HRG surveys, vessels) are expected to be insignificant. We also determined that effects of construction, operation, and decommissioning, inclusive of project noise, will have insignificant effects on fin whale prey. As fin whales do not echolocate, there is no potential for noise or other project effects to affect echolocation. The area around operating WTGs where operational noise may be above ambient noise is expected to be very small (50 m or less) and any effects to fin whales from avoiding that very small area would be insignificant. For HRG surveys, the best available data (Crocker and Fratantonio 2016) indicates that the area with noise above the level that would be disturbing to fin whales is very small (no more than 500 m from the sound source). Given the small area, the shutdown and clearance requirements, and that we only expect a whale exposed to that noise to swim just far enough way to avoid it (less than 500 m), effects are insignificant.

PTS is permanent, meaning the effects of PTS last well beyond the duration of the proposed action and outside of the action area as animals migrate. As such, PTS has the potential to affect aspects of affected animal's life functions that do not overlap in time and space with the proposed action. As explained in section 7.1, we expect that the four fin whales estimated to be exposed to pile driving noise above the MMPA Level A harassment threshold would experience slight PTS, *i.e.* minor long-term or permanent degradation of hearing capabilities within regions of hearing that align most completely with the energy produced by pile driving (*i.e.* the low-frequency region below 2 kHz), not severe hearing impairment. If hearing impairment occurs, it is most likely that the affected animal would lose a few decibels in its hearing sensitivity, which in most cases is not likely to meaningfully affect its ability to forage and communicate with conspecifics, much less impact reproduction or survival (87 FR 64868; October 26, 2022). No severe hearing impairment or serious injury is expected because of the received levels of noise anticipated and the short duration of exposure. The PTS anticipated is considered a minor auditory injury. As discussed previously in Section 7.1, permanent hearing impairment has the potential to affect individual whale survival and reproduction, although data are not readily available to evaluate how permanent hearing threshold shifts directly relate to individual whale fitness. Our exposure and response analyses indicate that no more than four fin whales would experience PTS, but this PTS is expected to be minor. With this minor degree of PTS, we do not expect it to affect the individuals' overall health, reproductive capacity, or survival. The four individual fin whales could be less efficient at locating conspecifics or have decreased ability to detect threats at long distances, but these animals are still expected to be able to locate conspecifics to socialize and reproduce, and will still be able to detect threats with enough time to avoid injury. For this reason, we do not anticipate that the instances of PTS will result in changes in the number, distribution, or reproductive potential of fin whales in the North Atlantic.

Up to 15 fin whales are expected to be exposed to pile driving or UXO detonation noise that will be loud enough to result in TTS or behavioral disturbance that would meet the NMFS interim definition of ESA harassment. A number of measures that are part of the proposed action, including a seasonal restriction on impact pile driving, requirements to use noise attenuation devices, minimum visibility requirements, and clearance and shutdown measures during pile driving monitored by PSOs on multiple platforms, reduce the potential for exposure of fin whales to pile driving noise. Similarly, measures that will be in place for any UXO detonations, including requirements to use noise attenuation devices, minimum visibility requirements, and clearance measures that include aerial surveys of the clearance zone, reduce the potential for exposure of fin whales to UXO detonations. However, even with these minimization measures in place, we expect 9 or 10 fin whales (depending on the construction scenario) to experience TTS, temporary behavioral disturbance (no more than 4 hours), and associated temporary physiological stress during the construction period due to exposure to impact pile driving noise and 2 fin whales to experience TTS, temporary behavioral disturbance (no more than 12 hours), and physiological stress due to exposure to vibratory pile driving noise during cofferdam installation or removal. We also expect no more than 3 fin whales to experience TTS as a result of exposure to noise from UXO detonation. As explained in the *Effects of the Action* section, all of these impacts, including TTS, are expected to be temporary with normal behaviors resuming quickly after the noise ends (see Goldbogen et al. 2013a; Melcon et al. 2012). Any TTS will resolve within a week of exposure (that is, hearing sensitivity will return to normal within one week of exposure) and is not expected to affect the health of any whale or its ability to migrate, forage, breed, or calve (Southall et al. 2007).

As explained in section 7.1, we have also considered whether TTS, masking, or avoidance behaviors experienced by the 15 fin whales exposed to noise above the MMPA Level B harassment threshold would be likely to increase the risk of vessel strike or entanglement in fishing gear. We would not expect the TTS to span the entire communication or hearing range of fin whales given the frequencies produced by pile driving do not span entire hearing ranges for fin whales. Additionally, though the frequency range of TTS that fin whales might sustain would overlap with some of the frequency ranges of their vocalization types, the frequency range of TTS from Ocean Wind's pile driving activities would not span the entire frequency range of one vocalization type, much less span all types of vocalizations or other critical auditory cues for any given species. As such, we do not expect TTS to affect the ability of a fin whale to communicate with other fin whales or to detect audio cues to the extent they rely on audio cues to avoid vessels or other threats. As such, we do not expect masking to affect the ability of a fin whale to avoid a vessel. These risks are lowered even further by the short duration of TTS (resolving within a week) and masking (limited only to the time that the whale is exposed to the pile driving noise). Also, as explained in section 7.1, we do not expect that avoidance of pile driving noise would result in fin whales moving to areas with higher risk of vessel strike or entanglement in fishing gear; increased risk of vessel strike or entanglement in fishing gear as a result of exposure to pile driving noise is extremely unlikely to occur. This determination was made in consideration of the distance a whale is expected to travel to avoid disturbing levels of noise and the distribution of vessel traffic and fishing activity in the WDA and surrounding waters.

We have considered if pile driving noise may mask fin whale calls and could have effects on mother-calf communication and behavior. If a mother-calf pair was exposed to pile driving noise, we do not anticipate that masking would result in fitness consequences given their short-term nature. Any masking of communications or any delays in nursing due to swimming away from the pile driving noise would only last for the duration of the exposure to pile driving noise, which in all cases would be no more than four hours. This temporary disruption is not expected to have any health consequences to the calf or mother due to its short-term duration and the ability to resume normal behaviors as soon as they are out of range of the disturbance.

Fin whales in the WDA are migrating and may also forage opportunistically. Based on the best available information that indicates whales resume normal behavior quickly after the cessation of sound exposure (e.g., Goldbogen et al. 2013a; Melcon et al. 2012), we anticipate that the up to 15 fin whales exposed to harassing levels of noise will return to normal behavioral patterns after the exposure ends. As such, even if a fin whale exposed to pile driving noise was foraging, this disruption would be short term and impact no more than one foraging event. This disruption in an area where foraging is not expected to regularly occur is expected to have insignificant effects on the affected individual.

A single impact pile driving event will take no more than four hours; therefore, even in the event that the 8 or 10 fin whales expected to be exposed to impact pile driving noise were exposed to disturbing levels of noise for the entirety of a pile driving event, that disturbance would last no more than four hours. The two fin whales we expect to be exposed to vibratory pile driving noise will be exposed to that noise for up to 12 hours. Exposure to noise from the UXO detonation will last one second. If an animal exhibits an avoidance response to pile driving noise, it would experience a cost in terms of the energy associated with traveling away from the acoustic source. Studies of marine mammal avoidance of sonar, which like pile driving is an impulsive sound source, demonstrate clear, strong, and pronounced behavioral changes, including sustained avoidance with associated energetic swimming and cessation of feeding behavior (Southall et al. 2016) suggesting that it is reasonable to assume that a whale exposed to noise above the Level B harassment threshold would take a direct path to get outside of the noisy area. As explained in section 7.1, during impact pile driving of monopiles, the area with noise above the MMPA Level B harassment threshold extends no more than 2.98 km in May-November and 3.35 km in December from the pile being driven, with much smaller areas during impact pile driving of pin piles (1.72 and 2.11 km). As such, a fin whale that was at the pile driving location when pile driving starts (i.e., at the center of the area with a 1.72-3.35 km radius that will experience noise above the 160 dB re 1uPa threshold), we would expect a fin whale swimming at maximum speed (35 kph) would escape from the area with noise above 160 dB re 1uPa the noise in less than 10 minutes, at the normal cruising speed of 10 kph, it would take the animal less than 20 minutes to move out of the noisy area. Considering the two fin whales expected to be exposed to vibratory pile driving noise above the MMPA Level B harassment threshold, a whale located at the edge of the 150 m clearance zone would need to swim 10 km from the cofferdam being installed to clear the area with noise above the 120 dB re 1uPa threshold. Based on swimming speed, it would need to travel for less than an hour to move outside the noisy area.

There would likely be an energetic cost associated with any temporary displacement or change in migratory route, but unless disruptions occur over long durations or over subsequent days, which we do not expect, we do not anticipate this movement to be consequential to the animal over the long term (see Southall et al. 2007a). The energetic consequences of the evasive behavior and delay in resting are not expected to 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 future breeding or calving. Stress responses are also anticipated with each of these instances of disruption. However, the available literature suggests these acoustically induced stress responses will be of short duration (similar to the duration of exposure), and not result in a chronic increase in stress that could result in physiological consequences to the animal (Southall et al. 2007). Given the short period of time during which individuals will be exposed to elevated noise, we do not anticipate long duration exposures to occur, and we do not anticipate the associated stress of exposure to result in significant costs to affected individuals**.**

As described in greater detail in Section 7.1, we do not anticipate these instances of TTS and behavioral harassment to result in fitness consequences to the up to 15 individual fin whales to which this will occur. Our analysis considered the overall number of exposures to acoustic stressors that are expected to result in harassment, inclusive of behavioral responses, TTS, and stress, the duration and scope of the proposed activities expected to result in such impacts, the expected behavioral state of the animals at the time of exposure, and the expected condition of those animals. Instances of fin whale exposure to acoustic stressors are expected to be short-term, with the animal returning to its previous behavioral state shortly thereafter. As described previously, information is not available to conduct a quantitative analysis to determine the likely fitness consequences of these exposures and associated responses because we do not have information from wild cetaceans that links short-term behavioral responses to vital rates and animal health. Harris et al. (2017a) summarized the research efforts conducted to date that have attempted to understand the ways in which behavioral responses may result in long-term consequences to individuals and populations. Efforts have been made to try to quantify the potential consequences of such responses, and frameworks have been developed for this assessment (e.g., Population Consequences of Disturbance). However, models that have been developed to date to address this question require many input parameters and, for most species, there are insufficient data for parameterization (Harris et al. 2017a). Nearly all studies and experts agree that infrequent exposures of a single day or less are unlikely to impact an individual's overall energy budget (Farmer et al. 2018; Harris et al. 2017b; King et al. 2015b; NAS 2017; New et al. 2014; Southall et al. 2007d; Villegas-Amtmann et al. 2015). Based on best available information, we expect this to be the case for fin whales exposed to acoustic stressors associated with this project even for animals that may already be in a stressed or compromised state due to factors unrelated to the Ocean Wind project. Because we do not anticipate fitness consequences to individual fin whales to result from instances of TTS and behavioral harassment due to acoustic stressors, we do not expect these stressors to cause reductions in overall reproduction, abundance, or distribution of the fin whale population in the North Atlantic or rangewide.

The proposed action will not result in any reduction in the abundance or reproduction of fin whales. Any effects to distribution will be limited to short-term alterations to normal movements by individuals to avoid disturbing levels of noise. There will be no change to the overall distribution of fin whales in the action area or throughout their range. Based on the information provided here, the proposed action will not appreciably reduce the likelihood of survival of the fin whale (*i.e.*, it will not decrease the likelihood that the species will continue to persist into the future with sufficient resilience to allow for the potential recovery from endangerment).

The proposed action is not likely to affect the recovery potential of fin whales. In making this determination we have considered generalized needs for species recovery and the goals and criteria identified in the 2010 Recovery Plan for fin whales. We know that in general, to recover, a listed species must have a sustained positive trend of increasing population over time. In general, mortality rates must be low enough to allow for recruitment to all age classes so that successful calving can continue over time and over generations. The 2010 Recovery Plan for fin whales included two criteria for consideration for reclassifying the species from endangered to threatened:

1. Given current and projected threats and environmental conditions, the fin whale population in each ocean basin in which it occurs (North Atlantic, North Pacific and Southern Hemisphere) satisfies the risk analysis standard for threatened status (has no more than a 1% chance of extinction in 100 years) and has at least 500 mature, reproductive individuals (consisting of at least 250 mature females and at least 250 mature males) in each ocean basin. Mature is defined as the number of individuals known, estimated, or inferred to be capable of reproduction. Any factors or circumstances that are thought to substantially contribute to a real risk of extinction that cannot be incorporated into a Population Viability Analysis will be carefully considered before downlisting takes place; and,
2. None of the known threats to fin whales are known to limit the continued growth of populations. Specifically, the factors in 4(a)(l) of the ESA are being or have been addressed: A) the present or threatened destruction, modification or curtailment of a species' habitat or range; B) overutilization for commercial, recreational or educational purposes; C) disease or predation; D) the inadequacy of existing regulatory mechanisms; and E) other natural or manmade factors.

The proposed action will not result in any condition that impacts the time it will take to reach these goals or the likelihood that these goals will be met. This is because the proposed action will not affect the trend of the species or prevent or delay it from achieving an increasing population or otherwise affect the number of individuals or the species growth rate and will not affect the chance of extinction. The proposed action will not appreciably reduce the likelihood of recovery of fin whales.

The proposed action will not affect the abundance of fin whales; because no serious injury or mortality is anticipated, the project will not cause there to be fewer fin whales. The only effects to distribution of fin whales will be minor changes in the movements of up to 12 individuals exposed to pile driving noise and 3 individuals exposed to UXO detonation; there will be no changes in the distribution of the species throughout the action area or throughout its range. The proposed action will have no effect on reproduction because it will not affect the health of any potential mothers or the potential for successful breeding or calving; the project will not cause any reduction in reproduction. As explained above, the proposed action will not affect the recovery potential of the species. Based on this analysis, the proposed action is not likely to appreciably reduce the likelihood of both the survival and recovery of fin whales in the wild. These conclusions were made in consideration of the endangered status of fin whales, other stressors that individuals are exposed to within the action area as described in the *Environmental*

Baseline and *Cumulative Effects*, and any anticipated effects of climate change on the abundance, reproduction, and distribution of fin whales in the action area.

9.2.3 Sei Whales

The average spring 2010–2013 abundance estimate of 6,292 (CV=1.015) is considered the best available for the Nova Scotia stock of sei whales because it was derived from surveys covering the largest proportion of the range (Halifax, Nova Scotia to Florida), during the season when they are the most prevalent in U.S. waters (in spring), using only recent data (2010–2013), and correcting aerial survey data for availability bias (Hayes et al. 2021). However, as described in Hayes et al. 2021 (the most recent stock assessment report), there is considerable uncertainty in this estimate. As described in the Status of the Species, the most recent abundance estimate we are aware of for sei whales is 25,000 individuals worldwide (Braham 1991). According to the latest NMFS stock assessment report for sei whales in the western North Atlantic, there are insufficient data to determine population trends for sei whales (Hayes et al. 2021). Across its range, it is estimated that there are over 50,000 sei whales. In the North Pacific, an abundance estimate for the entire North Pacific population of sei whales is not available. However, in the western North Pacific, it is estimated that there are 35,000 sei whales (Cooke 2018a). In the eastern North Pacific (considered east of longitude 180^{o}), two stocks of sei whales occur in U.S. waters: Hawaii and Eastern North Pacific. Abundance estimates for the Hawaii stock are 391 sei whales (Nmin=204), and for Eastern North Pacific stock, 519 sei whales (Nmin=374) (Carretta et al. 2019a). In the Southern Hemisphere, recent abundance of sei whales is estimated at 9,800 to 12,000 whales.

Entanglement in fishing gear and vessel strikes as described in the *Environmental Baseline* may occur in the action area over the life of the proposed action. As noted in the *Cumulative Effects* section of this Opinion, we have not identified any cumulative effects different from those considered in the Status of the Species and Environmental Baseline sections of this Opinion, inclusive of how those activities may contribute to climate change. As described in section 7.10, climate change may result in changes in the distribution or abundance of sei whales in the action area over the life of this project; however, we have not identified any different or exacerbated effects of the action in the context of anticipated climate change.

As explained in the section 7 of this Opinion, with the exception of one sei whale expected to experience PTS, the only adverse effects to sei whales expected to result from the Ocean Wind 1 project are temporary behavioral disturbance and/or temporary threshold shift (minor and temporary hearing impairment); these adverse effects meet NMFS interim ESA definition of harassment. These adverse effects will be experienced by up to 4 individual sei whales as a result of exposure to noise from pile driving or UXO detonation. With the exception of the one sei whale experiencing PTS, no injury (auditory or other), serious injury, or mortality is expected due to exposure to any aspect of the proposed action during the construction, operations, or decommissioning phases of the project.

The distribution of sei whales overlaps with some parts of the vessel transit routes that will be used through the 39-year life of the project. A number of measures designed to reduce the risk of vessel strike, including deploying lookouts and traveling at reduced speeds in areas where sei whales are most likely to occur, are part of the proposed action. As explained in section 7.2, we have determined that strike of a sei whale by a project vessel is extremely unlikely to occur. As such, vessel strike of a sei whale and any associated injury or mortality is not an expected outcome of the Ocean Wind 1 project.

Based on the type of survey gear that will be deployed, we do not expect any effects to sei whales from the surveys of fishery resources planned by Ocean Wind and considered as part of the proposed action. As such, capture or entanglement of a sei whale and any associated injury or mortality is not an expected outcome of the Ocean Wind 1 project.

As explained in section 7.1, the effects of exposure to WTG operational noise and noise associated with other project activities (e.g., HRG surveys, vessels) are expected to be insignificant. We also determined that effects of construction, operation, and decommissioning, inclusive of project noise, will have insignificant effects on sei whale prey. As sei whales do not echolocate, there is no potential for noise or other project effects to affect echolocation. The area around operating WTGs where operational noise may be above ambient noise is expected to be very small (50 m or less) and any effects to sei whales from avoiding that very small area would be insignificant. For HRG surveys, the best available data (Crocker and Fratantonio 2016) indicates that the area with noise above the level that would be disturbing to sei whales is very small (no more than 500 m from the sound source). Given the small area, the shutdown and clearance requirements, and that we only expect a whale exposed to that noise to swim just far enough away to avoid it (less than 500 m), effects are insignificant.

PTS is permanent meaning the effects of PTS last well beyond the duration of the proposed action and outside of the action area as animals migrate. As such, PTS has the potential to affect aspects of affected animal's life functions that do not overlap in time and space with the proposed action. As explained in section 7.1, we expect that the one sei whale that is estimated to be exposed to pile driving noise above the MMPA Level A harassment threshold would experience slight PTS, *i.e.* minor long-term or permanent degradation of hearing capabilities within regions of hearing that align most completely with the energy produced by pile driving (*i.e.* the low-frequency region below 2 kHz), not severe hearing impairment. If hearing impairment occurs, it is most likely that the affected animal would lose a few decibels in its hearing sensitivity, which in most cases is not likely to meaningfully affect its ability to forage and communicate with conspecifics, much less impact reproduction or survival (NMFS 2021). No severe hearing impairment or serious injury is expected because of the received levels of noise anticipated and the short duration of exposure. The PTS anticipated is considered a minor auditory injury. As discussed previously in Section 7.1, permanent hearing impairment has the potential to affect individual whale survival and reproduction, although data are not readily available to evaluate how permanent hearing threshold shifts directly relate to individual whale fitness. Our exposure and response analyses indicate that no more than one sei whale would experience PTS, but this PTS is expected to be minor. With this minor degree of PTS, we do not expect it to affect the individual's overall health, reproductive capacity, or survival. This one individual sei in whale could be less efficient at locating conspecifics or have decreased ability to detect threats at long distances, but this animal is still expected to be able to locate conspecifics to socialize and reproduce, and will still be able to detect threats with enough time to avoid injury. For this reason, we do not anticipate that the instance of PTS will result in changes in the number, distribution, or reproductive potential of sei whales in the North Atlantic.

Up to four sei whales are expected to be exposed to pile driving or UXO detonation noise that will be loud enough to result in TTS or behavioral disturbance that would meet the NMFS interim definition of ESA harassment. A number of measures that are part of the proposed action, including a seasonal restriction on impact pile driving, requirements to use noise attenuation devices, minimum visibility requirements, and clearance and shutdown measures during pile driving monitored by PSOs on multiple platforms, reduce the potential for exposure of sei whales to pile driving noise. Similarly, measures that will be in place for any UXO detonations, including requirements to use noise attenuation devices, minimum visibility requirements, and clearance measures that include aerial surveys of the clearance zone, reduce the potential for exposure of sei whales to UXO detonations. However, even with these minimization measures in place, we expect 2 sei whales to experience TTS, temporary behavioral disturbance (no more than 4 hours), and associated temporary physiological stress during the construction period due to exposure to impact pile driving noise and 1 sei whale to experience TTS, temporary behavioral disturbance (no more than 12 hours), and physiological stress due to exposure to vibratory pile driving noise during cofferdam installation or removal. We also expect no more than 1 sei whale to experience TTS as a result of exposure to noise from UXO detonation. As explained in the *Effects of the Action* section, all of these impacts, including TTS, are expected to be temporary with normal behaviors resuming quickly after the noise ends (see Goldbogen et al. 2013a; Melcon et al. 2012). Any TTS will resolve within a week of exposure (that is, hearing sensitivity will return to normal within one week of exposure) and is not expected to affect the health of any whale or its ability to migrate, forage, breed, or calve (Southall et al. 2007).

As explained in section 7.1, we have also considered whether TTS, masking, or avoidance behaviors experienced by the 4 sei whales exposed to noise above the MMPA Level B harassment threshold would be likely to increase the risk of vessel strike or entanglement in fishing gear. We would not expect the TTS to span the entire communication or hearing range of sei whales given the frequencies produced by pile driving do not span entire hearing ranges for sei whales. Additionally, though the frequency range of TTS that sei whales might sustain would overlap with some of the frequency ranges of their vocalization types, the frequency range of TTS from Ocean Wind's pile driving activities would not span the entire frequency range of one vocalization type, much less span all types of vocalizations or other critical auditory cues for any given species. As such, we do not expect TTS to affect the ability of a sei whale to communicate with other sei whales or to detect audio cues to the extent they rely on audio cues to avoid vessels or other threats. As such, we do not expect masking to affect the ability of a sei whale to avoid a vessel. These risks are lowered even further by the short duration of TTS (resolving within a week) and masking (limited only to the time that the whale is exposed to the pile driving noise). Also, as explained in section 7.1, we do not expect that avoidance of pile driving noise would result in sei whales moving to areas with higher risk of vessel strike or entanglement in fishing gear; increased risk of vessel strike or entanglement in fishing gear as a result of exposure to pile driving noise is extremely unlikely to occur. This determination was made in consideration of the distance a whale is expected to travel to avoid disturbing levels of noise and the distribution of vessel traffic and fishing activity in the WDA and surrounding waters.

We have considered if pile driving noise may mask sei whale calls and could have effects on mother-calf communication and behavior. If a mother-calf pair was exposed to pile driving noise, we do not anticipate that masking would result in fitness consequences given their short-term nature. Any masking of communications or any delays in nursing due to swimming away from the pile driving noise would only last for the duration of the exposure to pile driving noise, which in all cases would be no more than four hours. This temporary disruption is not expected to have any health consequences to the calf or mother due to its short-term duration and the ability to resume normal behaviors as soon as they are out of range of the disturbance.

Sei whales in the WDA are migrating and may forage opportunistically. Based on the best available information that indicates whales resume normal behavior quickly after the cessation of sound exposure (e.g., Goldbogen et al. 2013a; Melcon et al. 2012), we anticipate that the up to 4 sei whales exposed to harassing levels of noise will return to normal behavioral patterns after the exposure ends. As such, even if a sei whale exposed to pile driving noise was foraging, this disruption would be short term and impact no more than one foraging event. This disruption in an area where foraging is not expected to regularly occur is expected to have insignificant effects on the affected individual.

A single impact pile driving event will take no more than four hours; therefore, even in the event that the 2 sei whales expected to be exposed to impact pile driving noise were exposed to disturbing levels of noise for the entirety of a pile driving event, that disturbance would last no more than four hours. The one sei whale we expect to be exposed to vibratory pile driving noise will be exposed to that noise for up to 12 hours. Exposure to noise from the UXO detonation will last one second. If an animal exhibits an avoidance response to pile driving noise, it would experience a cost in terms of the energy associated with traveling away from the acoustic source. Studies of marine mammal avoidance of sonar, which like pile driving is an impulsive sound source, demonstrate clear, strong, and pronounced behavioral changes, including sustained avoidance with associated energetic swimming and cessation of feeding behavior (Southall et al. 2016) suggesting that it is reasonable to assume that a whale exposed to noise above the Level B harassment threshold would take a direct path to get outside of the noisy area. As explained in section 7.1, during impact pile driving of monopiles, the area with noise above the Level B harassment threshold extends no more than 2.98 km in May-November and 3.35 km in December from the pile being driven, with much smaller areas during impact pile driving of pin piles (1.72 and 2.11 km). As such, a sei whale that was at the pile driving location when pile driving starts (i.e., at the center of the area with a 1.72-3.35 km radius that will experience noise above the 160 dB re 1uPa threshold), we would expect a sei whale swimming at maximum speed (55 kph) would escape from the area with noise above 160 dB re 1uPa the noise in less than 5 minutes, at the normal cruising speed of 10 kph, it would take the animal less than 20 minutes to move out of the noisy area. Considering the one sei whale expected to be exposed to vibratory pile driving noise above the MMPA Level B harassment threshold, a whale located at the edge of the 150 m clearance zone would need to swim 10 km from the cofferdam being installed to clear the area with noise above the 120 dB re 1uPa threshold. Based on swimming speed, it would need to travel for less than an hour to move outside the noisy area.

There would likely be an energetic cost associated with any temporary displacement or change in migratory route, but unless disruptions occur over long durations or over subsequent days, which we do not expect, we do not anticipate this movement to be consequential to the animal over the long term (see Southall et al. 2007a). The energetic consequences of the evasive behavior and delay in resting are not expected to 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 future breeding or calving. Stress responses are also anticipated with each of these instances of disruption. However, the available literature suggests these acoustically induced stress responses will be of short duration (similar to the duration of exposure), and not result in a chronic increase in stress that could result in physiological consequences to the animal (Southall et al. 2007). Given the short period of time during which individuals will be exposed to elevated noise, we do not anticipate long duration exposures to occur, and we do not anticipate the associated stress of exposure to result in significant costs to affected individuals.

As described in greater detail in Section 7.1, we do not anticipate these instances of TTS and behavioral harassment to result in fitness consequences to the up to 4 individual sei whales to which this will occur. Our analysis considered the overall number of exposures to acoustic stressors that are expected to result in harassment, inclusive of behavioral responses, TTS, and stress, the duration and scope of the proposed activities expected to result in such impacts, the expected behavioral state of the animals at the time of exposure, and the expected condition of those animals. Instances of sei whale exposure to acoustic stressors are expected to be short-term, with the animal returning to its previous behavioral state shortly thereafter. As described previously, information is not available to conduct a quantitative analysis to determine the likely fitness consequences of these exposures and associated responses because we do not have information from wild cetaceans that links short-term behavioral responses to vital rates and animal health. Harris et al. (2017a) summarized the research efforts conducted to date that have attempted to understand the ways in which behavioral responses may result in long-term consequences to individuals and populations. Efforts have been made to try to quantify the potential consequences of such responses, and frameworks have been developed for this assessment (e.g., Population Consequences of Disturbance). However, models that have been developed to date to address this question require many input parameters and, for most species, there are insufficient data for parameterization (Harris et al. 2017a). Nearly all studies and experts agree that infrequent exposures of a single day or less are unlikely to impact an individual's overall energy budget (Farmer et al. 2018; Harris et al. 2017b; King et al. 2015b; NAS 2017; New et al. 2014; Southall et al. 2007d; Villegas-Amtmann et al. 2015). Based on best available information, we expect this to be the case for sei whales exposed to acoustic stressors associated with this project even for animals that may already be in a stressed or compromised state due to factors unrelated to the Ocean Wind project. Because we do not anticipate fitness consequences to individual sei whales to result from instances of TTS and behavioral harassment due to acoustic stressors, we do not expect these stressors to cause reductions in overall reproduction, abundance, or distribution of the sei whale population in the North Atlantic or rangewide. Based on the information provided here, the proposed action will not appreciably reduce the likelihood of survival of the sei whale (*i.e.*, it will not decrease the likelihood that the species will continue to persist into the future with sufficient resilience to allow for the potential recovery from endangerment).

The proposed action will not result in any reduction in the abundance or reproduction of sei whales. Any effects to distribution will be limited to short-term alterations to normal movements by individuals to avoid disturbing levels of noise. There will be no change to the overall distribution of sei whales in the action area or throughout their range.

The proposed action is also not expected to affect recovery potential of the species. In the 2021 5-Year Review for sei whales, NMFS concluded that the recovery criteria outlined in the sei whale recovery plan (NMFS 2011) do not reflect the best available and most up-to-date information on the biology of the species. Therefore, we have not relied on the reclassification criteria specifically when considering the effects of the Ocean Wind 1 action on the recovery of the species. We know that in general, to recover, a listed species must have a sustained positive trend of increasing population over time. In general, mortality rates must be low enough to allow for recruitment to all age classes so that successful calving can continue over time and over generations. The Ocean Wind 1 project will not affect the status or trend of sei whales; this is because it will not result in the serious injury or mortality of any individuals or affect the ability of any individual to successfully reproduce or the ability of calves to grow to maturity. As such, the proposed action is not likely to affect the recovery potential of sei whales and is not likely to appreciably reduce the likelihood of recovery of North Atlantic right whales.

The proposed action will not affect the abundance of sei whales; this is, because no serious injury or mortality is anticipated, the project will not cause there to be fewer sei whales. The only effects to distribution of sei whales will be minor changes in the movements of up to 3 individuals exposed to pile driving noise and 1 individuals exposed to UXO detonation; there will be no changes in the distribution of the species in the action area or throughout its range. The proposed action will have no effect on reproduction because it will not affect the health of any potential mothers or the potential for successful breeding or calving; the project will not cause any reduction in reproduction. As explained above, the proposed action will not affect the recovery potential of the species. Based on this analysis, the proposed action is not likely to appreciably reduce the likelihood of both the survival and recovery of sei whales in the wild. These conclusions were made in consideration of the endangered status of sei whales, other stressors that individuals are exposed to within the action area as described in the *Environmental Baseline* and *Cumulative Effects*, and any anticipated effects of climate change on the abundance, reproduction, and distribution of sei whales in the action area.

9.2.4 Sperm Whales

As described in further detail in the Status of the Species, the most recent estimate indicated a global population of between 300,000 and 450,000 individuals (Whitehead 2009). The higher estimates may be approaching population sizes prior to commercial whaling, the reason for ESA listing. No other more recent rangewide abundance estimates are available for this species (Waring et al. 2015). Hayes et al. (2020) reports that several estimates from selected regions of sperm whale habitat exist for select time periods, however, at present there is no reliable estimate of total sperm whale abundance for the entire North Atlantic. Sightings have been almost exclusively in the continental shelf edge and continental slope areas; however, there has been little or no survey effort beyond the slope. The best recent abundance estimate for sperm whales is the sum of the 2016 surveys— 4,349 (CV=0.28) (Hayes et al. 2020).

Entanglement in fishing gear and vessel strikes as described in the *Environmental Baseline* may occur in the action area over the life of the proposed action. As noted in the *Cumulative Effects* section of this Opinion, we have not identified any cumulative effects different from those considered in the *Status of the Species* and *Environmental Baseline* sections of this Opinion, inclusive of how those activities may contribute to climate change. As described in section 7.10, climate change may result in changes in the distribution or abundance of sperm whales in the overall action area over the life of this project, but given the shallow depths of the lease area, any change in distribution of sperm whales over time is not expected to result in any change in use of the lease area. We have not identified any different or exacerbated effects of the action in the context of anticipated climate change.

As explained in the section 7 of this Opinion, the only adverse effects to sperm whales expected to result from the Ocean Wind 1 project are temporary behavioral disturbance and/or temporary threshold shift (minor and temporary hearing impairment); these adverse effects meet NMFS interim ESA definition of harassment. These adverse effects will be experienced by up to 3-6 individual sperm whales as a result of exposure to noise from impact pile driving. No injury (auditory or other), serious injury or mortality is expected due to exposure to any aspect of the proposed action during the construction, operations, or decommissioning phases of the project.

The distribution of sperm whales overlaps with some parts of the vessel transit routes that will be used through the 39-year life of the project. A number of measures designed to reduce the risk of vessel strike, including deploying lookouts and traveling at reduced speeds in areas where sperm whales are most likely to occur, are part of the proposed action. As explained in section 7.2, we have determined that strike of a sperm whale by a project vessel is extremely unlikely to occur. As such, vessel strike of a sperm whale and any associated injury or mortality is not an expected outcome of the Ocean Wind 1 project.

Based on the type of survey gear that will be deployed, we do not expect any effects to sperm whales from the surveys of fishery resources planned by Ocean Wind and considered as part of the proposed action. As such, capture or entanglement of a sperm whale and any associated injury or mortality is not an expected outcome of the Ocean Wind 1 project.

As explained in section 7.1, the effects of exposure to WTG operational noise and noise associated with other project activities (e.g., HRG surveys, vessels) are expected to be insignificant. We also determined that effects of construction, operation, and decommissioning, inclusive of project noise, will have insignificant effects on sperm whale prey. Potential effects to echolocation are also insignificant. The area around operating WTGs where operational noise may be above ambient noise is expected to be very small (50 m or less) and any effects to sperm whales from avoiding that very small area would be insignificant. For HRG surveys, the best available data (Crocker and Fratantonio 2016) indicates that the area with noise above the level that would be disturbing to sperm whales is very small (no more than 100 m from the sound source). Given the small area, the shutdown and clearance requirements, and that we only expect a whale exposed to that noise to swim just far enough away to avoid it (less than 100 m), effects are insignificant.

No sperm whales are expected to be exposed to noise from pile driving or UXO detonation that could result in PTS or any other injury. Measures that will be in place for any UXO detonations, including requirements to use noise attenuation devices, minimum visibility requirements, and clearance measures that include aerial surveys of the clearance zone, are expected to eliminate the potential for exposure of sperm whales to noise above the Level B harassment threshold during UXO detonations. Only a small number of sperm whales (no more than six) are expected to be exposed to pile driving that will be loud enough to result in TTS or behavioral disturbance that would meet the NMFS interim definition of ESA harassment. A number of measures that are part of the proposed action, including a seasonal restriction on impact pile driving, requirements to use noise attenuation devices, minimum visibility requirements, and clearance and shutdown measures during pile driving monitored by PSOs on multiple platforms, reduce the potential for exposure of sperm whales to pile driving noise. Similarly, measures that will be in place for any UXO detonations, including requirements to use noise attenuation devices, minimum visibility requirements, and clearance measures that include aerial surveys of the clearance zone, reduce the potential for exposure of sei whales to UXO detonations. With these measures in place, we do not anticipate the exposure of any sperm whales to noise that could result in PTS, other injury, or mortality. However, even with these minimization measures in place, we expect 3-6 sperm whales (depending on the construction scenario) to experience TTS, temporary behavioral disturbance (no more than 4 hours), and associated temporary physiological stress during the construction period due to exposure to impact pile driving noise. We also expect no more than 1 sei whale to experience TTS as a result of exposure to noise from UXO detonation. As explained in the Effects of the Action section, all of these impacts, including TTS, are expected to be temporary with normal behaviors resuming quickly after the noise ends (see Goldbogen et al. 2013a; Melcon et al. 2012). Any TTS will resolve within a week of exposure (that is, hearing sensitivity will return to normal within one week of exposure) and is not expected to affect the health of any whale or its ability to migrate, forage, breed, or calve (Southall et al. 2007).

As explained in section 7.1, we have also considered whether TTS, masking, or avoidance behaviors experienced by the 9 sperm whales exposed to noise above the MMPA Level B harassment threshold would be likely to increase the risk of vessel strike or entanglement in fishing gear. We would not expect the TTS to span the entire communication or hearing range of sperm whales given the frequencies produced by pile driving do not span entire hearing ranges for sperm whales. Additionally, though the frequency range of TTS that sperm whales might sustain would overlap with some of the frequency ranges of their vocalization types, the frequency range of TTS from Ocean Wind's pile driving activities would not span the entire frequency range of one vocalization type, much less span all types of vocalizations or other critical auditory cues for any given species. As such, we do not expect TTS to affect the ability of a sperm whale to communicate with other sperm whales or to detect audio cues to the extent they rely on audio cues to avoid vessels or other threats. As such, we do not expect masking to affect the ability of a sperm whale to avoid a vessel. These risks are lowered even further by the short duration of TTS (resolving within a week) and masking (limited only to the time that the whale is exposed to the pile driving noise). In addition, as explained in section 7.1, we do not expect that avoidance of pile driving noise would result in sperm whales moving to areas with higher risk of vessel strike or entanglement in fishing gear; increased risk of vessel strike or entanglement in fishing gear as a result of exposure to pile driving noise is extremely unlikely to occur. This determination was made in consideration of the distance a whale is expected to travel to avoid disturbing levels of noise and the distribution of vessel traffic and fishing activity in the WDA and surrounding waters.

We have considered if pile driving noise may mask sperm whale calls and could have effects on mother-calf communication and behavior. As noted in section 7.1, presence of mother-calf pairs is unlikely in the WDA. However, even if a mother-calf pair was exposed to pile driving noise, we do not anticipate that masking would result in fitness consequences given their short-term nature. Any masking of communications or any delays in nursing due to swimming away from the pile driving noise would only last for the duration of the exposure to pile driving noise, which in all cases would be no more than four hours. This temporary disruption is not expected to have any health consequences to the calf or mother due to its short-term duration and the ability to resume normal behaviors as soon as they are out of range of the disturbance.

We expect that sperm whales in the WDA are migrating. Foraging is unexpected due to the nearshore location and shallow depths. As such, disruption of foraging is not expected.

A single impact pile driving event will take no more than four hours; therefore, even in the event that the 3 or 6 sperm whales expected to be exposed to impact pile driving noise were exposed to disturbing levels of noise for the entirety of a pile driving event, that disturbance would last no more than four hours. If an animal exhibits an avoidance response to pile driving noise, it would experience a cost in terms of the energy associated with traveling away from the acoustic source. Studies of marine mammal avoidance of sonar, which like pile driving is an impulsive sound source, demonstrate clear, strong, and pronounced behavioral changes, including sustained avoidance with associated energetic swimming and cessation of feeding behavior (Southall et al. 2016) suggesting that it is reasonable to assume that a whale exposed to noise above the MMPA Level B harassment threshold would take a direct path to get outside of the noisy area. As explained in section 7.1, during impact pile driving of monopiles, the area with noise above the MMPA Level B harassment threshold extends no more than 2.98 km in May-November and 3.35 km in December from the pile being driven, with much smaller areas during impact pile driving of pin piles (1.72 and 2.11 km). As such, a sperm whale that was at the pile driving location when pile driving starts (i.e., at the center of the area with a 1.72-3.35 km radius that will experience noise above the 160 dB re 1uPa threshold), we would expect a sperm whale swimming at maximum speed (45 kph) would escape from the area with noise above 160 dB re 1uPa the noise in about 5 minutes, but at normal cruise speed (5-15 kph), it would take the animal approximately 20 minutes to move out of the noisy area.

There would likely be an energetic cost associated with any temporary displacement or change in migratory route, but unless disruptions occur over long durations or over subsequent days, which we do not expect, we do not anticipate this movement to be consequential to the animal over the long term (see Southall et al. 2007a). The energetic consequences of the evasive behavior and delay in resting are not expected to 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 future breeding or calving. Stress responses are also anticipated with each of these instances of disruption. However, the available literature suggests these acoustically induced stress responses will be of short duration (similar to the duration of exposure), and not result in a chronic increase in stress that could result in physiological consequences to the animal (Southall et al. 2007). Given the short period of time during which elevated noise will be experienced, we do not anticipate long duration exposures to occur, and we do not anticipate the associated stress of exposure to result in significant costs to affected individuals**.**

As described in greater detail in Section 7.1, we do not anticipate these instances of TTS and behavioral harassment to result in fitness consequences to the up to six sperm whales to which this will occur. Our analysis considered the overall number of exposures to acoustic stressors that are expected to result in harassment, inclusive of behavioral responses, TTS, and stress, the duration and scope of the proposed activities expected to result in such impacts, the expected behavioral state of the animals at the time of exposure, and the expected condition of those animals. Instances of sperm whale exposure to acoustic stressors are expected to be short-term, with the animal returning to its previous behavioral state shortly thereafter. As described previously, information is not available to conduct a quantitative analysis to determine the likely fitness consequences of these exposures and associated responses because we do not have information from wild cetaceans that links short-term behavioral responses to vital rates and animal health. Harris et al. (2017a) summarized the research efforts conducted to date that have attempted to understand the ways in which behavioral responses may result in long-term consequences to individuals and populations. Efforts have been made to try to quantify the potential consequences of such responses, and frameworks have been developed for this assessment (e.g., Population Consequences of Disturbance). However, models that have been developed to date to address this question require many input parameters and, for most species, there are insufficient data for parameterization (Harris et al. 2017a). Nearly all studies and experts agree that infrequent exposures of a single day or less are unlikely to impact an individual's overall energy budget (Farmer et al. 2018; Harris et al. 2017b; King et al. 2015b; NAS 2017; New et al. 2014; Southall et al. 2007d; Villegas-Amtmann et al. 2015). Based on best available information, we expect this to be the case for sperm whales exposed to acoustic stressors associated with this project even for animals that may already be in a stressed or compromised state due to factors unrelated to the Ocean Wind 1 project.

We do not expect any serious injury or mortality of any sperm whale to result from the proposed action. We do not expect the action to affect the health of any sperm whale. We also do not anticipate fitness consequences to any individual sperm whales; that is, we do not expect any effects on any individual's ability to reproduce or generate viable offspring. Because we do not anticipate any reduction in fitness, we do not anticipate any future effects on reproductive success. Any effects to distribution will be limited to short-term alterations to normal movements by individuals to avoid disturbing levels of noise. Based on the information provided here, the proposed action will not appreciably reduce the likelihood of survival of the sperm whale (*i.e.*, it will not decrease the likelihood that the species will continue to persist into the future with sufficient resilience to allow for the potential recovery from endangerment).

The proposed action is not likely to affect the recovery potential of sperm whales. In making this determination we have considered generalized needs for species recovery and the goals and criteria identified in the 2010 Recovery Plan for sperm whales. We know that in general, to recover, a listed species must have a sustained positive trend of increasing population over time. In general, mortality rates must be low enough to allow for recruitment to all age classes so that successful calving can continue over time and over generations. The 2010 Recovery Plan contains downlisting and delisting criteria. As sperm whales are listed as endangered, we have considered whether the proposed action is likely to affect the likelihood that these criteria will be met or the time it takes to meet these criteria. The Plan states that sperm whales may be considered for reclassifying to threatened when all of the following have been met:

1. Given current and projected threats and environmental conditions, the sperm whale population in each ocean basin in which it occurs (Atlantic Ocean/Mediterranean Sea, Pacific Ocean, and Indian Ocean) satisfies the risk analysis standard for threatened status (has no more than a 1% chance of extinction in 100 years) and the global population has at least 1,500 mature, reproductive individuals (consisting of at least 250 mature females and at least 250 mature males in each ocean basin). Mature is defined as the number of individuals known, estimated, or inferred to be capable of reproduction. Any factors or circumstances that are thought to substantially contribute to a real risk of extinction that cannot be incorporated into a Population Viability Analysis will be carefully considered before downlisting takes place; and,
2. None of the known threats to sperm whales is known to limit the continued growth of populations. Specifically, the factors in 4(a)(l) of the ESA are being or have been addressed: A) the present or threatened destruction, modification or curtailment of a species' habitat or range; B) overutilization for commercial, recreational or educational purposes; C) disease or predation; D) the inadequacy of existing regulatory mechanisms; and E) other natural or manmade factors.

The proposed action will not result in any condition that impacts the time it will take to reach these goals or the likelihood that these goals will be met. This is because the proposed action will not affect the trend of the species or prevent or delay it from achieving an increasing population or otherwise affect its growth rate and will not affect the chance of extinction. That is, the proposed action will not appreciably reduce the likelihood of recovery of sperm whales.

The proposed action will not affect the abundance of sperm whales; this is, because no serious injury or mortality is anticipated, the project will not cause there to be fewer sperm whales. The only effects to distribution of sperm whales will be minor changes in the movements of up to six individuals exposed to pile driving noise; there will be changes in the distribution of the species throughout the action area or throughout its range. The proposed action will have no effect on reproduction because it will not affect the health of any potential mothers or the potential for successful breeding or calving; the project will not cause any reduction in reproduction. As explained above, the proposed action will not affect the recovery potential of the species. For these reasons, the effects of the proposed action are not likely to appreciably reduce the likelihood of both the survival and recovery of sperm whales in the wild. These conclusions were made in consideration of the endangered status of sperm whales, other stressors that individuals are exposed to within the action area as described in the *Environmental Baseline* and *Cumulative Effects*, and any anticipated effects of climate change on the abundance, reproduction, and distribution of sperm whales in the action area.

9.2.5 Blue Whales

As described in further detail in the Status of the Species, the most recent estimate indicated a global population of between 5,000 – 12,000 individuals globally (IWC 2007). Potential threats to blue whales identified in the 2020 Recovery Plan include ship strikes, entanglement in fishing gear and marine debris, anthropogenic noise, and loss of prey base due to climate and ecosystem change (NMFS 2020). There are no recent confirmed records of anthropogenic mortality or serious injury to blue whales in the U.S. Atlantic EEZ or in Atlantic Canadian waters (Henry et al. 2020). The total level of human caused mortality and serious injury is unknown, but it is believed to be insignificant and approaching a zero mortality and serious injury rate (Hayes et al. 2020). Because populations appear to be increasing in size, the species appears to be somewhat resilient to current threats; however, the species has not recovered to pre-exploitation levels.

As noted in the *Cumulative Effects* section of this Opinion, we have not identified any cumulative effects different from those considered in the *Status of the Species* and *Environmental Baseline* sections of this Opinion, inclusive of how those activities may contribute to climate change. As described in section 7.10, climate change may result in changes in the distribution or abundance of blue whales in the overall action area over the life of this project, but given the shallow depths of the lease area, any change in distribution of blue whales over time is not expected to result in any change in use of the lease area. We have not identified any different or exacerbated effects of the action in the context of anticipated climate change.

As explained in the section 7 of this Opinion, the only adverse effects to blue whales expected to result from the Ocean Wind 1 project are temporary behavioral disturbance and/or temporary threshold shift (minor and temporary hearing impairment); these adverse effects meet NMFS interim ESA definition of harassment. These adverse effects will be experienced by up to 4 individual blue whales as a result of exposure to noise from impact pile driving. No injury (auditory or other) or mortality is expected due to exposure to any aspect of the proposed action during the construction, operations, or decommissioning phases of the project.

The distribution of blue whales overlaps with some parts of the vessel transit routes that will be used through the 39-year life of the project. A number of measures designed to reduce the risk of vessel strike, including deploying lookouts and traveling at reduced speeds in areas where blue whales are most likely to occur, are part of the proposed action. As explained in section 7.2, we have determined that strike of a blue whale by a project vessel is extremely unlikely to occur. As such, vessel strike of a blue whale and any associated injury or mortality is not an expected outcome of the Ocean Wind 1 project.

Based on the type of survey gear that will be deployed, we do not expect any effects to blue whales from the surveys of fishery resources planned by Ocean Wind and considered as part of the proposed action. As such, capture or entanglement of a blue whale and any associated injury or mortality is not an expected outcome of the Ocean Wind 1 project.

As explained in section 7.1, the effects of exposure to WTG operational noise and noise associated with other project activities (e.g., HRG surveys, vessels) are expected to be insignificant. We also determined that effects of construction, operation, and decommissioning, inclusive of project noise, will have insignificant effects on blue whale prey. The area around operating WTGs where operational noise may be above ambient noise is expected to be very small (50 m or less) and any effects to blue whales from avoiding that very small area would be insignificant. For HRG surveys, the best available data (Crocker and Fratantonio 2016) indicates that the area with noise above the level that would be disturbing to blue whales is very small (no more than 500 m from the sound source). Given the small area, the shutdown and clearance requirements, and that we only expect a whale exposed to that noise to swim just far enough away to avoid it (less than 500 m), effects are insignificant.

No blue whales are expected to be exposed to noise from pile driving or UXO detonation that could result in PTS or any other injury. Measures that will be in place for any UXO detonations, including requirements to use noise attenuation devices, minimum visibility requirements, and clearance measures that include aerial surveys of the clearance zone, are expected to eliminate the potential for exposure of blue whales to noise above the MMPA Level B harassment threshold during UXO detonations. Only a small number of blue whales (no more than 4) are expected to be exposed to pile driving that will be loud enough to result in TTS or behavioral disturbance that would meet the NMFS interim definition of ESA harassment. A number of measures that are part of the proposed action, including a seasonal restriction on impact pile driving, requirements to use noise attenuation devices, minimum visibility requirements, and clearance and shutdown measures during pile driving monitored by PSOs on multiple platforms, reduce the potential for exposure of blue whales to pile driving noise. With these measures in place we do not anticipate the exposure of any blue whales to noise that could result in PTS, other injury, or mortality. However, even with these minimization measures in place, we expect 4 blue whales to experience TTS, temporary behavioral disturbance (no more than 4 hours), and associated temporary physiological stress during the construction period due to exposure to impact pile driving noise. As explained in the Effects of the Action section, all of these impacts, including TTS, are expected to be temporary with normal behaviors resuming quickly after the noise ends (see Goldbogen et al. 2013a; Melcon et al. 2012). Any TTS will resolve within a week of exposure (that is, hearing sensitivity will return to normal within one week of exposure) and is not expected to affect the health of any whale or its ability to migrate, forage, breed, or calve (Southall et al. 2007).

As explained in section 7.1, we have also considered whether TTS, masking, or avoidance behaviors experienced by the 4 blue whales exposed to noise above the MMPA Level B harassment threshold would be likely to increase the risk of vessel strike or entanglement in fishing gear. We would not expect the TTS to span the entire communication or hearing range of blue whales given the frequencies produced by pile driving do not span entire hearing ranges for blue whales. Additionally, though the frequency range of TTS that blue whales might sustain would overlap with some of the frequency ranges of their vocalization types, the frequency range of TTS from Ocean Wind's pile driving activities would not span the entire frequency range of one vocalization type, much less span all types of vocalizations or other critical auditory cues for any given species. As such, we do not expect TTS to affect the ability of a blue whale to communicate with other blue whales or to detect audio cues to the extent they rely on audio cues to avoid vessels or other threats. As such, we do not expect masking to affect the ability of a blue whale to avoid a vessel. These risks are lowered even further by the short duration of TTS (resolving within a week) and masking (limited only to the time that the whale is exposed to the pile driving noise). Also, as explained in section 7.1, we do not expect that avoidance of pile driving noise would result in blue whales moving to areas with higher risk of vessel strike or entanglement in fishing gear; increased risk of vessel strike or entanglement in fishing gear as a result of exposure to pile driving noise is extremely unlikely to occur. This determination was made in consideration of the distance a whale is expected to travel to avoid disturbing levels of noise and the distribution of vessel traffic and fishing activity in the WDA and surrounding waters.

We have considered if pile driving noise may mask blue whale calls and could have effects on mother-calf communication and behavior. As noted in section 7.1, presence of mother-calf pairs is unlikely in the WDA. However, even if a mother-calf pair was exposed to pile driving noise, we do not anticipate that masking would result in fitness consequences given their short-term nature. Any masking of communications or any delays in nursing due to swimming away from the pile driving noise would only last for the duration of the exposure to pile driving noise, which in all cases would be no more than four hours. This temporary disruption is not expected to have any health consequences to the calf or mother due to its short-term duration and the ability to resume normal behaviors as soon as they are out of range of the disturbance.

We expect that blue whales in the WDA are migrating; opportunistic foraging may also occur. Based on the best available information that indicates whales resume normal behavior quickly after the cessation of sound exposure (e.g., Goldbogen et al. 2013a; Melcon et al. 2012), we anticipate that the up to 4 blue whales exposed to harassing levels of noise will return to normal behavioral patterns after the exposure ends. As such, even if a blue whale exposed to pile driving noise was foraging, this disruption would be short term and impact no more than one foraging event. This disruption in an area where foraging is not expected to regularly occur is expected to have insignificant effects on the affected individual.

A single impact pile driving event will take no more than four hours; therefore, even in the event that the 4 blue whales expected to be exposed to impact pile driving noise were exposed to disturbing levels of noise for the entirety of a pile driving event, that disturbance would last no more than four hours. If an animal exhibits an avoidance response to pile driving noise, it would experience a cost in terms of the energy associated with traveling away from the acoustic source. Studies of marine mammal avoidance of sonar, which like pile driving is an impulsive sound source, demonstrate clear, strong, and pronounced behavioral changes, including sustained avoidance with associated energetic swimming and cessation of feeding behavior (Southall et al. 2016) suggesting that it is reasonable to assume that a whale exposed to noise above the Level B harassment threshold would take a direct path to get outside of the noisy area. As explained in section 7.1, during impact pile driving of monopiles, the area with noise above the Level B harassment threshold extends no more than 2.98 km in May-November and 3.35 km in December from the pile being driven, with much smaller areas during impact pile driving of pin piles (1.72 and 2.11 km). As such, a blue whale that was at the pile driving location when pile driving starts (i.e., at the center of the area with a 1.72-3.35 km radius that will experience noise above the 160 dB re 1uPa threshold), we would expect a sperm whale swimming at maximum speed (32 kph) would escape from the area with noise above 160 dB re 1uPa the noise in less than 10 minutes, but at normal cruise speed (8 kph), it would take the animal approximately 25 minutes to move out of the noisy area.

There would likely be an energetic cost associated with any temporary displacement or change in migratory route, but unless disruptions occur over long durations or over subsequent days, which we do not expect, we do not anticipate this movement to be consequential to the animal over the long term (see Southall et al. 2007a). The energetic consequences of the evasive behavior and delay in resting are not expected to 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 future breeding or calving. Stress responses are also anticipated with each of these instances of disruption. However, the available literature suggests these acoustically induced stress responses will be of short duration (similar to the duration of exposure), and not result in a chronic increase in stress that could result in physiological consequences to the animal (Southall et al. 2007). Given the short period of time during which elevated noise will be experienced, we do not anticipate long duration exposures to occur, and we do not anticipate the associated stress of exposure to result in significant costs to affected individuals**.**

As described in detail in Section 7.1, we do not anticipate these instances of TTS and behavioral harassment to result in fitness consequences to the up to 4 blue whales to which this will occur. Our analysis considered the overall number of exposures to acoustic stressors that are expected to result in harassment, inclusive of behavioral responses, TTS, and stress, the duration and scope of the proposed activities expected to result in such impacts, the expected behavioral state of the animals at the time of exposure, and the expected condition of those animals. Instances of blue whale exposure to acoustic stressors are expected to be short-term, with the animal returning to its previous behavioral state shortly thereafter. As described previously, information is not available to conduct a quantitative analysis to determine the likely fitness consequences of these exposures and associated responses because we do not have information from wild cetaceans that links short-term behavioral responses to vital rates and animal health. Harris et al. (2017a) summarized the research efforts conducted to date that have attempted to understand the ways in which behavioral responses may result in long-term consequences to individuals and populations. Efforts have been made to try to quantify the potential consequences of such responses, and frameworks have been developed for this assessment (e.g., Population Consequences of Disturbance). However, models that have been developed to date to address this question require many input parameters and, for most species, there are insufficient data for parameterization (Harris et al. 2017a). Nearly all studies and experts agree that infrequent exposures of a single day or less are unlikely to impact an individual's overall energy budget (Farmer et al. 2018; Harris et al. 2017b; King et al. 2015b; NAS 2017; New et al. 2014; Southall et al. 2007d; Villegas-Amtmann et al. 2015). Based on best available information, we expect this to be the case for blue whales exposed to acoustic stressors associated with this project even for animals that may already be in a stressed or compromised state due to factors unrelated to the Ocean Wind project.

We do not expect any injury or mortality of any blue whale to result from the proposed action. We do not expect the action to affect the health of any blue whale. We also do not anticipate fitness consequences to any individual sperm whales; that is, we do not expect any effects on any individual's ability to reproduce or generate viable offspring. Because we do not anticipate any reduction in fitness, we do not anticipate any future effects on reproductive success. Any effects to distribution will be limited to short-term alterations to normal movements by individuals to avoid disturbing levels of noise. Based on the information provided here, the proposed action will not appreciably reduce the likelihood of survival of the blue whale (*i.e.*, it will not decrease the likelihood that the species will continue to persist into the future with sufficient resilience to allow for the potential recovery from endangerment).

The proposed action is not likely to affect the recovery potential of blue whales. In making this determination we have considered generalized needs for species recovery and the goals and criteria identified in the 2020 Recovery Plan for blue whales. We know that in general, to recover, a listed species must have a sustained positive trend of increasing population over time. In general, mortality rates must be low enough to allow for recruitment to all age classes so that successful calving can continue over time and over generations. The two main objectives for blue whales identified in the 2020 Recovery Plan are to:

> 1) increase blue whale resiliency and ensure geographic and ecological representation by achieving sufficient and viable populations in all ocean basins and in each recognized subspecies, and 2) increase blue whale resiliency by managing or eliminating significant anthropogenic threats. The Recovery Plan includes recovery criteria that address minimum abundance in each of the nine management units (abundance of 500 or 2,000 whales depending on the unit); stable or increasing trend in each of the nine management units; and criteria related to threat identification and minimization (NMFS 2020). The Recovery Plan also includes delisting criteria that address abundance, trends, and threat minimization/elimination (NMFS 2020).

The proposed action will not result in any condition that impacts the time it will take to reach these goals or the likelihood that these goals will be met. This is because the proposed action will not affect the trend of the species or prevent or delay it from achieving an increasing population or otherwise affect its growth rate and will not affect the chance of extinction. That is, the proposed action will not appreciably reduce the likelihood of recovery of blue whales.

The proposed action will not affect the abundance of blue whales; this is, because no mortality is anticipated, the project will not cause there to be fewer blue whales. The only effects to distribution of blue whales will be minor changes in the movements of up to 4 individuals exposed to pile driving noise; there will be changes in the distribution of the species throughout the action area or throughout its range. The proposed action will have no effect on reproduction because it will not affect the health of any potential mothers or the potential for successful breeding or calving; the project will not cause any reduction in reproduction. As explained above, the proposed action will not affect the recovery potential of the species. For these reasons, the effects of the proposed action are not likely to appreciably reduce the likelihood of both the survival and recovery of blue whales in the wild. These conclusions were made in consideration of the endangered status of blue whales, other stressors that individuals are exposed to within the action area as described in the Environmental Baseline and Cumulative Effects, and any anticipated effects of climate change on the abundance, reproduction, and distribution of blue whales in the action area.

10.0 CONCLUSION

After reviewing the current status of the ESA-listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed action, and cumulative effects, it is our biological opinion that the proposed action is likely to adversely affect but is not likely to jeopardize the continued existence of blue, fin, sei, sperm, or North Atlantic right whales or the Northwest Atlantic DPS of loggerhead sea turtles, North Atlantic DPS of green sea turtles, Kemp's ridley or leatherback sea turtles, shortnose sturgeon, or any of the five DPSs of Atlantic sturgeon. Likewise, the proposed action may adversely affect but is not likely to destroy or adversely modify critical habitat designated for the New York Bight DPS of Atlantic sturgeon. We have determined that the project will have no effect on the Gulf of Maine DPS of Atlantic salmon or critical habitat designated for the North Atlantic right whale, Carolina DPS of Atlantic sturgeon, or the Northwest Atlantic DPS of loggerhead sea turtles. The proposed action is not likely to adversely affect giant manta rays, hawksbill sea turtles, the Northeast Atlantic DPS of loggerhead sea turtles, and oceanic whitetip sharks.

11.0 INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. In the case of threatened species, section 4(d) of the ESA leaves it to the Secretary's discretion whether and to what extent to extend the statutory 9(a) ''take'' prohibitions, and directs the agency to issue regulations it considers necessary and advisable for the conservation of the species.

"Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by regulation to include significant habitat modification or degradation that results in death or injury to ESA-listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. NMFS has not yet defined "harass" under the ESA in regulation, but has 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 PD 02-110-19). We considered NMFS' interim definition of harassment in evaluating whether the proposed activities are likely to result in harassment of ESA-listed species. Incidental take statements serve a number of functions, including providing reinitiation triggers for all anticipated take, providing exemptions from the Section 9 prohibitions against take, and identifying reasonable and prudent measures that will minimize the impact of anticipated incidental take and monitor incidental take that occurs.

When an action will result in incidental take of ESA-listed marine mammals, ESA section 7(b)(4) requires that such taking be authorized under the MMPA section 101(a)(5) before the Secretary can issue an Incidental Take Statement (ITS) for ESA-listed marine mammals and that an ITS specify those measures that are necessary to comply with Section 101(a)(5) of the MMPA. Section 7(b)(4), section 7(o)(2), and ESA regulations provide that taking that is incidental to an otherwise lawful activity conducted by an action agency or applicant is not considered to be prohibited taking under the ESA if that activity is performed in compliance with the terms and conditions of this ITS, including those specified as necessary to comply with the MMPA, Section 101(a)(5). Accordingly, the terms of this ITS and the exemption from Section 9 of the ESA become effective only upon the issuance of MMPA authorization to take the marine mammals identified here. Absent such authorization, this ITS is inoperative for ESA-listed marine mammals. As described in this Opinion, Orsted/Ocean Wind 1 has applied for an MMPA ITA; a decision regarding issuance of the ITA is expected in summer 2023 following issuance of the Record of Decision for the project.

The measures described below must be undertaken by the action agencies so that they become binding conditions for the exemption in section 7(o)(2) to apply. BOEM and other action agencies have a continuing duty to regulate the activity covered by this ITS. If one or more of them: (1) fails to assume and implement the terms and conditions, or (2) fails to require the project sponsor or their contractors to adhere to the terms and conditions of the ITS through enforceable terms that are added to any COP approval, grants, permits and/or contracts, the protective coverage of section 7(o)(2) may lapse. The protective coverage of section 7(o)(2) also may lapse if the project sponsor fails to comply with the terms and conditions. In order to monitor the impact of incidental take, BOEM, other action agencies, and Ocean Wind must report the progress of the action and its impact on the species to us as specified in the ITS [50 CFR §402.14(i)(3)] (See U.S. Fish and Wildlife Service and National Marine Fisheries Service's Joint Endangered Species Act Section 7 Consultation Handbook (1998) at 4-49).

11.1 Amount or Extent of Take

Section 7 regulations require NMFS to specify the impact of any incidental take of endangered or threatened species; that is, the amount or extent of such incidental taking on the species (50 C.F.R. §402.14(i)(1)(i)). As explained in the Effects of the Action section, we anticipate pile driving during construction to result in the harassment of North Atlantic right, blue, fin, sperm, and sei whales and NWA DPS loggerhead, NA DPS green, Kemp's ridley, and leatherback sea turtles. We also anticipate pile driving during construction to result in the injury (PTS) of fin and sei whales. We anticipate the serious injury or mortality of NWA DPS loggerhead, NA DPS green, Kemp's ridley, and leatherback sea turtles due to vessel strikes during construction, operation, and decommissioning phases of the project. We also anticipate the capture and minor injury of NWA DPS loggerhead, NA DPS green, Kemp's ridley, and leatherback sea turtles and Atlantic sturgeon from the Gulf of Maine, New York Bight, Chesapeake Bay, Carolina, and South Atlantic DPSs in trawl surveys of fisheries resources. No other sources of incidental take are anticipated. There is no incidental take anticipated to result from EPA's proposed issuance of an Outer Continental Shelf Air Permit or the USCG's proposed issuance of a Private Aids to Navigation (PATON) authorization. We anticipate no more than the amount and type of take described below to result from the construction, operation, and decommissioning of the Ocean Wind project as proposed for approval by BOEM and pursuant to other permits, authorizations, and approvals by BSEE, USACE, and NMFS OPR.

Vessel Strike

We calculated the number of sea turtles likely to be struck by project vessels based on the anticipated increase in vessel traffic during the construction, operations, and decommissioning phases of the project. The following amount of incidental take is exempted over the 39-year life of the project, inclusive of all three phases:

Species	**Vessel Strike**
	Serious Injury or Mortality
NA DPS green sea turtle	1
Kemp's ridley sea turtle	1
Leatherback sea turtle	1
NWA DPS Loggerhead sea turtle	9

The incidental take (serious injury or mortality) of one shortnose sturgeon and three Atlantic sturgeon (two from the New York Bight DPS and one from the Chesapeake Bay, South Atlantic, or Gulf of Maine DPS) is expected as a result of vessels under contract to Ocean Wind 1 transiting to/from the New Jersey Wind Port. This incidental take was exempted through the issuance of the Incidental Take Statement included with the February 2022 Biological Opinion issued by NMFS GARFO to the USACE. The incidental take (serious injury or mortality) of one shortnose sturgeon and two Atlantic sturgeon from the New York Bight DPS are expected as a result of vessels under contract to Ocean Wind 1 transiting to/from the Paulsboro Marine Terminal. This incidental take was exempted through the issuance of the Incidental Take Statement included with the July 2022 Biological Opinion issued by NMFS GARFO to the USACE. We are identifying this take here (i.e. a subset of the take by vessel strike evaluated and exempted in the referenced opinions) to ensure that: All incidental take reasonably certain to occur as a result of the Ocean Wind 1 project is identified in this ITS; the effects of such take are minimized, monitored and reported over the course of this project; and this ITS contains information necessary to determine when reinitiation of consultation may be required.

Surveys of Fisheries Resources
We calculated the number of sea turtles and Atlantic sturgeon likely to be captured in trawl gear over the period that the surveys are planned based on available information on capture and injury/mortality rates in similar surveys.

The following amount of incidental take is exempted over the 9-year duration of the planned surveys:

Species	Trawl Surveys	
	Capture, Minor Injury	Serious Injury/Mortality
Gulf of Maine DPS Atlantic sturgeon	1	None
New York Bight DPS Atlantic sturgeon	42	None
Chesapeake Bay DPS Atlantic sturgeon	18	None
South Atlantic DPS Atlantic sturgeon	10	None
Carolina DPS	4	None

Species	Trawl Surveys	
	Capture, Minor Injury	Serious Injury/Mortality
Atlantic sturgeon		
NA DPS green sea turtle	1	None
Kemp's ridley sea turtle	6	None
Leatherback sea turtle	0	None
NWA DPS Loggerhead sea turtle	7	None

If any additional surveys are planned or the survey terms are extended, consultation may need to be reinitiated.

Pile Driving

We calculated the number of whales and sea turtles likely to be injured (Permanent Threshold Shift) or harassed (Temporary Threshold Shift and/or Behavioral Disturbance) due to exposure to pile driving noise based on the maximum impact scenario (i.e., 98 total monopiles and 3 OSS foundations, meeting the isopleth distances identified for 10 dB attenuation). The numbers below are the amount of take anticipated in consideration of the two construction scenarios, one of which will be implemented. This represents the maximum amount of take that is anticipated and is consistent with the amount of Level A and Level B harassment from impact and vibratory pile driving that NMFS is proposing to authorize through the MMPA ITA:

Construction Scenario 1 (101 monopiles – 98 for WTG foundations, 3 for OSS foundations)

Species	Take due to Exposure to Pile Driving Noise		
	Vibratory Pile Driving	Impact Pile Driving	
	Harassment (TTS/Behavior)	Injury (PTS)	Harassment (TTS/Behavior)
North Atlantic right whale	1	None	4
Fin whale	2	4	8
Sei Whale	1	1	2
Sperm whale	None	None	3
Blue whale	None	None	4
NA DPS green sea turtle	None	None	1
Kemp's ridley sea turtle	None	None	16
Leatherback sea turtle	None	None	7
NWA DPS Loggerhead sea turtle	None	None	175

Construction Scenario 2 (98 monopiles for WTG foundations, 3 jacket foundations (16 pin piles) for OSS foundations)

Species	Take due to Exposure to Pile Driving Noise		
	Vibratory Pile Driving	Impact Pile Driving	
	Harassment (TTS/Behavior)	Injury (PTS)	Harassment (TTS/Behavior)
North Atlantic right whale	1	None	5
Fin whale	2	4	10
Sei Whale	1	1	2
Sperm whale	None	None	6
Blue whale	None	None	4
NA DPS green sea turtle	None	None	1
Kemp's ridley sea turtle	None	None	16
Leatherback sea turtle	None	None	7
NWA DPS Loggerhead sea turtle	None	None	184

UXO Detonation

We calculated the number of whales and sea turtles likely to be injured or harassed due to exposure to UXO detonation based on the maximum impact scenario (i.e., 10 detonations, meeting the isopleth distances identified for 10 dB attenuation). The numbers below are the amount of take anticipated in consideration of 10 UXO detonations total. This represents the maximum amount of take that is anticipated and is consistent with the amount of Level A and Level B harassment from UXO detonation that NMFS is proposing to authorize through the MMPA ITA:

Species	**UXO Detonation**	
	Injury (PTS)	**Harassment (TTS)**
North Atlantic right whale	None	1
Fin whale	None	3
Sei Whale	None	1
Sperm whale	None	3
Blue whale	None	None
NA DPS green sea turtle	None	None
Kemp's ridley sea turtle	None	None
Leatherback sea turtle	None	None
NWA DPS Loggerhead sea turtle	None	None

11.2 Effects of the Take

In this opinion, we determined that the amount or extent of anticipated take, coupled with other effects of the proposed action, is not likely to jeopardize the continued existence of any ESA-listed species under NMFS' jurisdiction.

11.3 Reasonable and Prudent Measures

Section 7(b)(4) of the ESA requires that when a proposed agency action is found to be consistent with section 7(a)(2) of the ESA and the proposed action is likely to incidentally take individuals of ESA-listed species, NMFS will issue a statement that specifies the impact of any incidental taking of endangered or threatened species. To minimize such impacts, reasonable and prudent measures, and terms and conditions to implement the measures, must be provided. Only incidental take specified in this ITS that would not occur but for the agency actions described in this Opinion, and any specified reasonable and prudent measures and terms and conditions identified in the ITS, are exempt from the taking prohibition of section 9(a), provided that, pursuant to section 7(o) of the ESA, such taking is in compliance with the terms of the ITS. This

ITS for sea turtles and sturgeon is effective upon issuance, and the action agencies and applicant may receive the benefit of the sea turtle and sturgeon take exemption as long as they are complying with the relevant terms and conditions. This ITS for ESA-listed marine mammals is not effective unless and until a final MMPA ITA is effective; the action agencies and applicant may receive the benefit of the ESA-listed marine mammal take exemption as long as they are complying with the relevant terms and conditions in this ITS and the MMPA ITA.

Reasonable and prudent measures (RPMs) are measures to minimize the impact (i.e., amount or extent) of incidental take (50 C.F.R. §402.02). The RPMs and terms and conditions are specified as required by 50 CFR 402.14 (i)(1) to minimize the impact of incidental take of ESA-listed species by the proposed action, to document and report that incidental take, and to specify the procedures to be used to handle or dispose of any individuals of a species actually taken. The RPMs and their terms and conditions are nondiscretionary for the action agencies and applicant. The RPMs and terms and conditions must be undertaken by the appropriate Federal agency so that they become binding conditions of any COP approval, permit, other authorization, or approval for the exemption in section 7(o)(2) to apply.

The RPMs identified here are necessary and appropriate to minimize impacts of incidental take that might otherwise result from the proposed action, to document and report incidental take that does occur, to specify the procedures to be used to handle or dispose of any individual listed species taken. Specifically, these RPMs and their implementing terms and conditions are designed to: minimize the exposure of ESA-listed whales and sea turtles to pile driving noise, or reduce the extent of that exposure, and minimize the exposure of ESA-listed whales and sea turtles to effects of UXO detonation or reduce the extent of that exposure. These RPMs and terms and conditions also require that all incidental take that occurs is documented and reported to NMFS in a timely manner and that any incidentally taken individual specimens are properly handled, resuscitated if necessary, transported for additional care or reporting, and/or returned to the sea.

Please note that these reasonable and prudent measures and terms and conditions are in addition to the minimization and avoidance measures that Ocean Wind has included in its COP, the additional measures that BOEM has proposed to require as conditions of COP approval, and the mitigation measures identified in the proposed ITA issued by NMFS OPR, as all of these sources are considered part of the proposed action (see Section 3 above). All of the conditions identified in Table 3.3.1 are considered part of the proposed action and not repeated here, yet must be complied with for the conclusions of this Opinion and for the take exemption to apply. For example, the prohibition on impact pile driving from January 1 – April 30 is considered part of the proposed action, and it is not repeated here as an RPM or term and condition. The conditions identified in Table 3.3.1 to minimize effects to sea turtles during vessel transits and to minimize effects to ESA-listed species during survey/monitoring activities of fisheries resources are consistent with RPMs and Terms and Conditions issued by NMFS for actions similar to the Ocean Wind 1 project; we have not identified any additional RPMs and Terms and Conditions for those activities. In some cases, the RPMs and Terms and Conditions provide additional detail or clarity to measures that are part of the proposed action. A failure to implement the proposed action as identified in Section 3 of this Opinion would be a change in the action that may render the conclusions of this Opinion and the take exemption inapplicable to the activities carried out, and may necessitate reinitiation of consultation.

All of the RPMs and Terms and Conditions are reasonable and prudent and necessary and appropriate to minimize or document and report the level of incidental take associated with the proposed action. None of the RPMs or the terms and conditions that implement them alter the basic design, location, scope, duration, or timing of the action and all of them involve only minor changes (50 CFR§ 402.14(i)(2)). A copy of this ITS must be on board all survey vessels and PSO platforms.

As explained in section 2.0 and 7.2 of this Opinion, effects of vessel traffic on Atlantic and shortnose sturgeon from vessels transiting in the Delaware River and Delaware Bay to/from the Ocean Wind 1 wind development area and the Paulsboro Marine Terminal and the New Jersey Wind Port were addressed in Biological Opinions produced by NMFS GARFO for the USACE. The portion of the take assessed in that Opinion that is assigned to Ocean Wind vessels is identified above and exempted by the ITSs in the respective Opinion. The relevant RPMs and Terms and Conditions included with those Biological Opinions are incorporated below and must be adopted and complied with by this Opinion's action agencies and the applicant.

We have determined the following reasonable and prudent measures are necessary and appropriate to minimize, document, and report the impacts of incidental take of threatened and endangered species that occur during implementation of the proposed action:

1. Effects to ESA-listed whales and sea turtles must be minimized during pile driving. This includes adherence to the mitigation measures specified in the final MMPA ITA.
2. Effects to ESA-listed whales and sea turtles must be minimized during UXO detonation. This includes adherence to the mitigation measures specified in the final MMPA ITA.
3. Vessels operated by Ocean Wind or under contract to Ocean Wind or its contractors must comply with the RPMs and Terms and Conditions relevant to vessel operations within the Delaware River and Delaware Bay included in the Incidental Take Statements provided with NMFS GARFO's July 19, 2022, Paulsboro Marine Terminal Biological Opinion and February 25, 2022, New Jersey Wind Port Biological Opinion, or any subsequently issued Opinions that replace those Opinions as a result of reinitiation.
4. Effects to, or interactions with, ESA-listed Atlantic sturgeon, whales, and sea turtles must be documented during all phases of the proposed action, and all incidental take must be reported to NMFS GARFO.
5. All required plans must be submitted to NMFS GARFO with sufficient time for review, comment, and approval.
6. On-site observation and inspection must be conducted to gather information on the effectiveness and implementation of measures to minimize and monitor incidental take during activities described in this Opinion, including its Incidental Take Statement.

11.4 Terms and Conditions

To be exempt from the prohibitions of section 9 of the ESA, BOEM, BSEE, USACE, and NMFS Office of Protected Resources–consistent with their legal authority– and Ocean Wind, must comply with the following terms and conditions, which implement the RPMs above. These include the take minimization, monitoring, and reporting measures required by the section 7 regulations (50 C.F.R. §402.14(i)). These terms and conditions are non-discretionary. If the Federal agencies and/or Ocean Wind fail to ensure compliance with these terms and conditions and the RPMs they implement, the protective coverage of section 7(o)(2) may lapse.

1. To implement the requirements of RPM 1 and 2, the measures required by the final MMPA ITA must be incorporated into any project authorizations/approvals, and the relevant Federal agency must monitor Ocean Wind's compliance with these measures:
    a. BOEM must require, through an enforceable condition of their approval of Ocean Wind's Construction and Operations Plan, that Ocean Wind comply with any measures in the final MMPA ITA that are revised from, or in addition to, measures included in the proposed ITA, which already have been incorporated into the proposed action.
    b. NMFS OPR must ensure that all mitigation measures as prescribed in the final ITA are implemented by Ocean Wind.
    c. The USACE must require, through an enforceable condition of any permit issued to Ocean Wind, compliance with any measures in the final MMPA ITA that are revised from, or in addition to, measures included in the proposed ITA, which have been incorporated into the proposed action.
2. To implement the requirements of RPM 2, the following measures must be implemented by Ocean Wind:
    a. Establish a clearance zone for sea turtles extending 500 m around any planned UXO detonation. Maintain the clearance zone for at least 60 minutes prior to any UXO detonation. This requirement expands the size of the clearance zone identified by BOEM as part of the proposed action. Ocean Wind must ensure that there is sufficient PSO coverage to reliably document sea turtle presence within the clearance zone. In the event that a PSO detects a sea turtle outside the 500 m clearance zone, detonation will be delayed until the sea turtle has not been observed for 30 minutes.
    b. Provide NMFS GARFO with notification of planned UXO detonation as soon as possible but at least 48 hours prior to the planned detonation, unless this 48-hour notification would create delays to the detonation that would result in imminent risk of human life or safety. This notification must include the coordinates of the planned detonation, the estimated charge size, and any other information available on the characteristics of the UXO. NMFS GARFO will provide alerts to NMFS sea turtle and marine mammal stranding network partners consistent with best practices. Notification must be provided via email to nmfs.gar.incidental-take@noaa.gov and by phone to the NMFS GARFO Protected Resources Division (978-281-9328).
3. To implement the requirements of RPM 3, the following conditions must be implemented by vessels transiting to/from the Paulsboro Marine Terminal, consistent with the terms and conditions of the July 19, 2022 Paulsboro Biological Opinion and any subsequent Opinion or amended ITS:
    a. No later than March 1 of each year, report the number of vessel calls to the Paulsboro Marine Terminal in the previous year by month. This report must also

include the type of vessel and its draft. Reports must be filed with the USACE Philadelphia District and NMFS GARFO (nmfs.gar.incidental-take@noaa.gov). (Reference: RPM 1, Term and Condition 1 of the 2022 Paulsboro Biological Opinion)

b. Report any sturgeon observed with injuries or mortalities in the Paulsboro Marine Terminal Area to NMFS within 24 hours using the form available at: https://media.fisheries.noaa.gov/2021-07/Take%20Report%20Form%2007162021.pdf?null. Submit forms to nmfs.gar.incidental-take@noaa.gov within 24 hours. (Reference: RPM 2, Term and Condition 2 of the 2022 Paulsboro Biological Opinion).

c. Hold any dead sturgeon in cold storage until proper disposal procedures are discussed with NMFS GARFO. (Reference: RPM 3, Term and Condition 5 of the 2022 Paulsboro Biological Opinion).

d. Complete procedures for genetic sampling of any dead Atlantic sturgeon that are over 75 cm. (Reference RPM 4, Term and Condition 6 of the 2022 Paulsboro Biological Opinion). More information on submitting genetic samples is included in Term and Condition 6a below; these instructions are consistent with the requirements of the 2022 Paulsboro Opinion.

e. In the event that the 2022 Paulsboro Opinion is replaced as a result of reinitiation, or its ITS is amended, comply with the requirements of any new Incidental Take Statement relevant to vessels transiting to/from the Paulsboro Marine Terminal. NMFS GARFO will strive to provide a copy of any new Opinions or amended ITSs to BOEM, BSEE, other action agencies, and Ocean Wind within three business days of their availability.

4. To implement the requirements of RPM 3, the following conditions must be implemented by vessels transiting to/from the New Jersey Wind Port, consistent with the terms and conditions of the February 25, 2022 New Jersey Wind Port Biological Opinion and any subsequent Opinion or amended ITS:

   a. No later than March 1 of each year, report the number of vessel calls to the New Jersey Wind Terminal in the previous year by month. This report must also include the type of vessel and its draft. Reports must be filed with the USACE Philadelphia District and NMFS GARFO (nmfs.gar.incidental-take@noaa.gov). (Reference: RPM 1, Term and Condition 2 of the 2022 NJWP Biological Opinion)

   b. Report any sturgeon observed with injuries or mortalities in the Paulsboro Marine Terminal Area to NMFS within 24 hours using the form available at: https://media.fisheries.noaa.gov/2021-07/Take%20Report%20Form%2007162021.pdf?null. Submit forms to nmfs.gar.incidental-take@noaa.gov within 24 hours. (Reference: RPM 3, Term and Condition 4 of the 2022 NJWP Biological Opinion).

   c. Hold any dead sturgeon in cold storage until proper disposal procedures are discussed with NMFS GARFO. (Reference: RPM 4, Term and Condition 7 of the 2022 NJWP Biological Opinion).

   d. Complete procedures for genetic sampling of any Atlantic sturgeon over 75 cm. (Reference: RPM 3, Term and Condition 8 of the 2022 NJWP Biological Opinion). More information on submitting genetic samples is included in Term and Condition 6a below; these instructions are consistent with the requirements of the 2022 NJWP Opinion.

   e. In the event that the 2022 NJWP Opinion is replaced as a result of reinitiation or its ITS is amended, comply with the requirements of any new Incidental Take Statement relevant to vessels transiting to/from the NJWP. NMFS GARFO will strive to provide a copy of any new Opinions or amended ITSs to BOEM, BSEE, other action agencies, and Ocean Wind within three business days of their availability.

5. To implement the requirements of RPM 4, Ocean Wind must file a report with NMFS GARFO (nmfs.gar.incidental-take@noaa.gov) in the event that any ESA listed species is observed within the identified shutdown zone during active pile driving. This report must be filed within 48 hours of the incident and include the following: duration of pile driving prior to the detection of the animal, location of PSOs and any factors that impaired visibility or detection ability, time of detection of the animal, time the PSO called for shutdown, time the pile driving was stopped, and any measures implemented (e.g., reduced hammer energy) prior to shutdown. The report must also include the time that the animal was last detected and any PSO reports on the behavior of the animal. If shutdown was determined not to be feasible, the report must include an explanation for that determination and the measures that were implemented (e.g., reduced hammer energy).

6. To implement the requirements of RPM 4, BOEM, BSEE, USACE, and Ocean Wind must implement the following reporting requirements necessary to document the amount or extent of take that occurs during all phases of the proposed action:

   a. All observations or collections of injured or dead whales, sea turtles, or sturgeon must be reported within 48 hours to NMFS GARFO Protected Resources Division by email (nmfs.gar.incidental-take@noaa.gov). Take reports should reference the Ocean Wind project and include the Take Report Form available on NMFS webpage (https://media.fisheries.noaa.gov/2021-07/Take%20Report%20Form%2007162021.pdf?null). Reports of Atlantic sturgeon take must include a statement as to whether a fin clip sample for genetic sampling was taken. Fin clip samples are required in all cases with the only exception being when additional handling of the sturgeon would result in an imminent risk of injury to the fish or the PSO, we expect such incidents to be limited to capture and handling of sturgeon in extreme weather. Instructions for fin clips and associated metadata are available at: https://www.fisheries.noaa.gov/new-england-mid-atlantic/consultations/section-7-take-reporting-programmatics-greater-atlantic, under the "Sturgeon Genetics Sampling" heading.

   b. If a North Atlantic right whale is observed at any time by PSOs or personnel on any project vessels, during any project-related activity or during vessel transit, Ocean Wind or their contractors must immediately report sighting information to

NMFS (866-755-6622), the U.S. Coast Guard via channel 16 and through the WhaleAlert app (http://www.whalealert.org/).

c. In the event of a suspected or confirmed vessel strike of a sea turtle or sturgeon by any project vessel in any location, including observation of any injured sea turtle/sturgeon or sea turtle/sturgeon parts, Ocean Wind or their contractors must report the incident to NMFS GARFO (nmfs.gar.incidental-take@noaa.gov; and NMFS New England/Mid-Atlantic Regional Stranding Hotline (866-755-6622)) as soon as feasible. The report must include the following information: (A) Time, date, and location (latitude/longitude) of the incident; (B) Species identification (if known) or description of the animal(s) involved; (C) Vessel's speed during and leading up to the incident; (D) Vessel's course/heading and what operations were being conducted (if applicable); (E) Status of all sound sources in use; (F) Description of avoidance measures/requirements that were in place at the time of the strike and what additional measures were taken, if any, to avoid strike; (G) Environmental conditions (e.g., wind speed and direction, Beaufort scale, cloud cover, visibility) immediately preceding the strike; (H) Estimated size and length of animal that was struck; (I) Description of the behavior of the animal immediately preceding and following the strike; (J) Estimated fate of the animal (e.g., dead, injured but alive, injured and moving, blood or tissue observed in the water, status unknown, disappeared); and (K) To the extent practicable, photographs or video footage of the animal(s).

d. In the event that an injured or dead marine mammal or sea turtle is sighted, Ocean Wind or their contractor must report the incident to NMFS GARFO (nmfs.gar.incidental-take@noaa.gov), NMFS New England/Mid-Atlantic Regional Stranding Hotline (866-755-6622), and BSEE (protectedspecies@bsee.gov) as soon as feasible, but no later than 24 hours from the sighting. The report must include the following information: (A) Time, date, and location (latitude/longitude) of the first discovery (and updated location information if known and applicable); (B) Species identification (if known) or description of the animal(s) involved; (C) Condition of the animal(s) (including carcass condition if the animal is dead); (D) Observed behaviors of the animal(s), if alive; (E) If available, photographs or video footage of the animal(s); and (F) General circumstances under which the animal was discovered. Staff responding to the hotline call will provide any instructions for handling or disposing of any injured or dead animals, which may include coordination of transport to shore, particularly for injured sea turtles.

e. Ocean Wind must compile and submit weekly reports during pile driving that document the start and stop of all pile driving daily, the start and stop of associated observation periods by the PSOs, details on the deployment of PSOs, and a record of all observations of marine mammals and sea turtles. These weekly reports must be submitted to NMFS GARFO (nmfs.gar.incidental-take@noaa.gov), BOEM, and BSEE directly from the PSO providers and can consist of raw data. Weekly reports are due on Wednesday for the previous week (Sunday – Saturday).

f. Ocean Wind must compile and submit reports following any UXO detonation that provide details on the UXO that was detonated (e.g., charge size), location of the detonation, the start and stop of associated observation periods by the PSOs, details on the deployment of PSOs, and a record of all observations of marine mammals and sea turtles. This must include any observations of dead or injured fish or other marine life in the post detonation monitoring period. These reports must be submitted to NMFS GARFO (nmfs.gar.incidental-take@noaa.gov) and BOEM directly from the PSO providers and can consist of raw data. Reports must be submitted within one week of the detonation, with reports of dead or injured ESA listed species required to be submitted immediately, but no later than 24 hours following the observation.

g. Ocean Wind must compile and submit monthly reports that include a summary of all project activities carried out in the previous month, including trawl surveys, vessel transits (number, type of vessel, and route), and piles installed, and all observations of ESA listed whales, sea turtles, and sturgeon. These reports must be submitted to NMFS GARFO (nmfs.gar.incidental-take@Noaa.gov) and are due on the 15th of the month for the previous month.

7. To implement the requirements of RPM 4 and to facilitate monitoring of the incidental take exemption for sea turtles, BOEM, BSEE, USACE, and NMFS must meet twice annually to review sea turtle observation records. These meetings/conference calls will be held in September (to review observations through August of that year) and December (to review observations from September to November) and will 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.

8. To implement RPM 5, within 10 business days of BSEE issuing a no objection to the complete Facility Design Report (FDR)/Fabrication and Installation Report (FIR) (but at least 30 calendar days prior to the initiation of pile driving) or the soonest time the relevant information is available, BOEM and/or BSEE must provide NMFS GARFO with the following information: number and size of foundations to be installed to support wind turbine generators and offshore substations, installation method for each of the seven planned cofferdams (i.e., gravity cell or sheet pile), the proposed construction schedule (i.e., months when pile driving is planned), and information that has become available on the ports identified for foundation fabrication and load out, WTG pre-assembly and load out, and cable staging. If at that time the amount or extent of incidental take is likely to exceed the maximum amount for each source and type of take considered in this ITS, consultation may need to be reinitiated. NMFS and BOEM will each endeavor to notify the other of the need to reinitiate consultation within 30 calendar days of BOEM's submission to NMFS, and NMFS' receipt, of the requested information.

9. To implement RPM 5, BOEM, BSEE and/or Ocean Wind must submit the PSO Training Plan for Trawl Surveys as soon as possible after issuance of this Opinion but no later than 7 calendar days prior to the start of trawl surveys. BOEM, BSEE, and Ocean Wind must obtain NMFS GARFO's concurrence with this plan prior to the start of any trawl surveys. As described in Table 3.1.1, at least one of the survey staff onboard the trawl survey

vessels must have completed NMFS Northeast Fisheries Observer Program training within the last 5 years or other training in protected species identification and safe handling (inclusive of taking genetic samples from Atlantic sturgeon). If Ocean Wind will deploy non-NEFOP trained observers, BOEM, BSEE, and/or Ocean Wind must submit a plan to NMFS describing the training that will be provided to the survey observers.

10. To implement RPM 5, the plans identified below must be submitted to NMFS GARFO by BOEM, BSEE and/or Ocean Wind at nmfs.gar.incidental-take@noaa.gov. For each plan, within 45 calendar days of receipt of the plan, NMFS GARFO will provide comments to BOEM, BSEE, and Ocean Wind, including a determination as to whether the plan is consistent with the requirements outlined in this ITS and/or in Table 3.3.1 of this Opinion. If the plan is determined to be inconsistent with these requirements, BOEM, BSEE and/or Ocean Wind must resubmit a modified plan that addresses the identified issues at least 15 calendar days before the start of the associated activity; at that time, BOEM, BSEE and NMFS will discuss a timeline for review and approval of the modified plan. BOEM, BSEE and Ocean Wind must receive NMFS GARFO's concurrence with these plans before the identified activity is carried out:

    a. Passive Acoustic Monitoring Plan. BOEM, BSEE and/or Ocean Wind must submit this Plan to NMFS GARFO at least 180 calendar days before impact pile driving is planned. BOEM, BSEE, and Ocean Wind must obtain NMFS GARFO's concurrence with this plan prior to the start of any pile driving. The Plan must include a description of all proposed PAM equipment, address how the proposed passive acoustic monitoring will follow standardized measurement, processing methods, reporting metrics, and metadata standards for offshore wind (Van Parijs *et al.,* 2021). The plan must describe all proposed PAM equipment, procedures, and protocols including information to support that it will be able to detect vocalizing right whales within the clearance and shutdown zones. The plan must also incorporate the following requirements: If a North Atlantic right whale (NARW) is detected via real-time PAM, data shall be submitted by BOEM, BSEE and/or Ocean Wind to nmfs.pacmdata@noaa.gov using the NMFS Passive Acoustic Reporting System Metadata and Detection data spreadsheets (https://www.fisheries.noaa.gov/resource/document/passive-acoustic-reporting-system-templates as soon as feasible but no longer than 24 hours after the detection. BOEM, BSEE, and/or Ocean Wind must submit the completed data templates to nmfs.pacmdata@noaa.gov; the full acoustic species Detection data, Metadata and GPS data records, from real-time data, must be submitted within 90 calendar days via the ISO standard metadata forms available on the NMFS Passive Acoustic Reporting System website (https://www.fisheries.noaa.gov/resource/document/passive-acoustic-reporting-system-templates). BOEM, BSEE, and/or Ocean Wind must submit the completed data templates to nmfs.pacmdata@noaa.gov; the full acoustic recordings from real-time systems must be sent to NCEI for archiving within 90 calendar days after pile-driving has ended and instruments have been pulled from the water.

    b. Marine Mammal and Sea Turtle Monitoring Plan – Pile Driving and UXO Detonation. BOEM, BSEE, and/or Ocean Wind must submit this Plan to NMFS

GARFO at least 90 calendar days before impact or vibratory pile driving or UXO detonation is planned. BOEM, BSEE, and/or Ocean Wind must obtain NMFS GARFO's concurrence with this plan prior to the start of any pile driving or carrying out any UXO detonation. The plan must include a description of all monitoring equipment and PSO protocols (including number and location of PSOs) for all pile driving and UXO detonations. The plan must detail all plans and procedures for sound attenuation as well as for monitoring ESA-listed whales and sea turtles during all impact and vibratory pile driving and UXO detonation. The plan would also describe how BOEM, BSEE, and Ocean Wind would determine the number of whales exposed to noise above the Level B harassment threshold during pile driving with the vibratory hammer to install cofferdams.

c. Cofferdam Installation and Removal Monitoring Plan. BOEM, BSEE, and/or Ocean Wind must submit this Plan to NMFS GARFO at least 90 calendar days before vibratory pile driving is planned to begin. BOEM, BSEE, and Ocean Wind must obtain NMFS GARFO's concurrence with this plan prior to the start of any pile driving or the start of any cofferdam installation or removal with a vibratory hammer. This plan must include a description of how BOEM, BSEE, and Ocean Wind would determine the number of whales exposed to noise above the Level B harassment threshold during pile installation and removal with the vibratory hammer. This plan may be stand-alone or a component of the Pile Driving and Marine Mammal and Sea Turtle Monitoring Plan.

d. Alternative Monitoring Plan/Night Time Pile Driving Monitoring Plan. BOEM, BSEE, and/or Ocean Wind must submit this Plan to NMFS GARFO at least 90 calendar days before impact pile driving is planned to begin. BOEM, BSEE, and Ocean Wind must obtain NMFS GARFO's concurrence with this plan prior to the start of pile driving. This plan must contain a thorough description of how Ocean Wind plans to monitor pile driving activities at night including proof of the efficacy of their night vision devices (*e.g.,* mounted thermal/IR camera systems, hand-held or wearable night vision devices (NVDs), infrared (IR) spotlights) in detecting ESA listed marine mammals and sea turtles over the full extent of the required clearance and shutdown zones, including demonstration that the full extent of the minimum visibility zones (1,650 m May-November, 2,500 m December) can be effectively and reliably monitored. The Plan must identify the efficacy of the technology at detecting marine mammals and sea turtles in the clearance and shutdowns under all the various conditions anticipated during construction, including varying weather conditions, sea states, and in consideration of the use of artificial lighting. If the plan does not include a full description of the proposed technology, monitoring methodology, and data demonstrating to NMFS GARFO's satisfaction that marine mammals and sea turtles can reliably and effectively be detected within the clearance and shutdown zones for monopiles and pin piles before and during impact pile driving, nighttime pile driving (unless a pile was initiated 1.5 hours prior to civil sunset) may not occur.

e. Sound Field Verification Plan. BOEM, BSEE, and/or Ocean Wind must submit to NMFS GARFO at least 180 calendar days before impact pile driving or UXO detonation is planned to begin. BOEM, BSEE, and Ocean Wind must obtain NMFS GARFO's concurrence with this plan prior to the start of pile driving or UXO detonation activities. The plan must describe how Ocean Wind would ensure that the first three monopile and pin pile installation sites and each UXO/MEC detonation site selected for SFV are representative of the rest of the monopile and pin pile installation and UXO/MEC sites. In the case that these sites are not determined to be representative of all other monopile and pin pile installation sites and UXO/MEC detonation locations, Ocean Wind must include information on how additional sites would be selected for SFV. The plan must also include methodology for collecting, analyzing, and preparing SFV data for submission to NMFS GARFO. The plan must describe how the effectiveness of the sound attenuation methodology would be evaluated based on the results. Ocean Wind must also provide, as soon as they are available but no later than 48 hours after each installation, the initial results of the SFV measurements to NMFS GARFO in an interim report after each monopile for the first 3 piles and pin pile installation for the first full jacket foundation (16 pin piles).

f. North Atlantic Right Whale Vessel Strike Avoidance Plan. BOEM, BSEE, and/or Ocean Wind must submit to NMFS GARFO at least 90 calendar days prior to commencement of vessel use, with the exception of vessels deployed for the fisheries surveys. The plan must provide details on the vessel-based observer protocols on transiting vessels. If Ocean Wind plans to implement the Alternative Plan for vessel strike avoidance (i.e., implement PAM in the Atlantic City to lease area transit lane to allow vessel transit above 10 knots from May 1 – October 31) the plan must describe how PAM, in combination with visual observations, will be conducted to ensure the transit corridor is clear of North Atlantic right whales. Consistent with the requirements of the proposed MMPA ITA, unless and until the Plan is approved by NMFS (OPR and GARFO), all vessels transiting between the O&M facility and the lease area, year round, must comply with the 10-knot speed restriction.

11. To implement the requirements of RPM 6, BOEM and BSEE must exercise their authorities to assess the implementation of measures to minimize and monitor incidental take of ESA-listed species during activities described in this Opinion. If any term and condition(s) is/are not being complied with, BOEM and/or BSEE, as appropriate, must immediately take effective action to ensure prompt implementation.

12. To implement the requirements of RPM 6, Ocean Wind must consent to on-site observation and inspections by Federal agency personnel (including NOAA personnel) during activities described in the Biological Opinion, for the purposes of evaluating the effectiveness and implementation of measures designed to minimize or monitor incidental take.

As explained above, reasonable and prudent measures are measures to minimize the amount or extent of incidental take (50 C.F.R. §402.02) that must be implemented in order for the incidental take exemption to be effective. The reasonable and prudent measures and terms and conditions are specified as required by 50 CFR 402.14 (i)(1)(ii), (iii) and (iv) to document the incidental take by the proposed action, minimize the impact of that take on ESA-listed species and, in the case of marine mammals, specify those measures that are necessary to comply with section 101(a)(5) of the Marine Mammal Protection Act of 1972 and applicable regulations with regard to such taking. We document our consideration of these requirements for reasonable and prudent measures and terms and conditions here. We have determined that all of these RPMs and associated terms and conditions are reasonable and necessary or appropriate, to minimize or document take and that they all comply with the minor change rule. That is, none of these RPMs or their implementing terms and conditions alter the basic design, location, scope, duration, or timing of the action, and all involve only minor changes.

RPM 1 and 2/Term and Condition 1
The proposed ITA includes a number of general conditions and specific mitigation measures that are considered part of the proposed action. The final ITA issued under the MMPA may have modified or additional measures that clarify or enhance the measures identified in the proposed ITA. Compliance with those measures is necessary and appropriate to minimize and document incidental take of North Atlantic right, sperm, sei, and fin whales. As such, the terms and conditions that require BOEM, BSEE, USACE, and NMFS OPR to ensure compliance with the conditions and mitigation measures of the final ITA are necessary and appropriate to minimize the extent of take of these species and to ensure that take is documented.

RPM 2/Term and Condition 2
The proposed action incorporates a clearance zone for sea turtles that is the same size as the greatest distance from the detonation that is expected to have noise above the PTS threshold (472 m). The measure included in Term and Condition 2a would expand the size of the clearance zone to 750 m. The expansion of the clearance zone minimizes the risk that a sea turtle just outside the clearance zone would enter the area where noise would be above the PTS threshold before the detonation occurred. Given the extensive PSO coverage, including aerial coverage, that will be required during UXO detonations, we expect that this larger area will be able to be effectively monitored. Implementation of this measure will serve to minimize take. Term and Condition 2b requires NMFS to be notified 48-hours in advance of any planned detonation. This notification will allow us to alert NMFS sea turtle and marine mammal stranding network partners, consistent with best practices, who can then be on alert for any reports of injured or distressed animals, which will assist in monitoring the effects of the detonations. This measure includes a clause for reduced notification period if a 48-hour delay would result in imminent risk of human life or safety.

RPM 3 /Term and Conditions 3 and 4
As explained above, take that may occur of Atlantic and shortnose sturgeon as a result of vessel strike is expected to occur from Ocean Wind 1 vessels transiting in the Delaware River/Bay as they move to/from the New Jersey Wind Port or the Paulsboro Marine Terminal. In this Opinion, we have identified the portion of the take identified in those Biological Opinions that will be attributable to Ocean Wind 1 vessels. That take is exempted through the Incidental Take Statements issued with NMFS' Biological Opinions for those port projects. Here, we identify the relevant RPMs and Terms and Conditions from those ITSs that must be complied with in order for the relevant take exemption to apply.

RPM 4/Term and Conditions 5-7

Documenting take that occurs is essential to ensure that reinitiation of consultation occurs if the amount or extent of take identified in the ITS is exceeded. Some measures for documenting and reporting take are included in the proposed action. The requirements of Term and Conditions 5 - 7 enhance or clarify those requirements. Documentation and timely reporting of observations of whales, sea turtles, and Atlantic sturgeon is important to monitoring the amount or extent of actual take compared to the amount or extent of take exempted. The reporting requirements included here will allow us to track the progress of the action and associated take. Proper identification and handling of any sturgeon and sea turtles that are captured in the survey gear is essential for documenting take and to minimize the extent of that take (i.e., reducing the potential for further stress, injury, or mortality). The measures identified here are consistent with established best practices for proper handling and documentation of these species. Identifying existing tags helps to monitor take by identifying individual animals. Requiring genetic samples (fin clips) from all Atlantic sturgeon and that those samples be analyzed to determine the DPS of origin is essential for monitoring actual take as genetic analysis is the only way to identify the DPS of origin for subadult and adult Atlantic sturgeon captured in the ocean. Taking fin clips is not expected to increase stress or result in any injury of Atlantic sturgeon.

RPM 4/Term and Condition 7
We recognize that documenting sea turtles that were struck by project vessels may be difficult given their small size and the factors that contribute to cryptic mortality addressed in the *Effects of the Action* section of this Opinion. Therefore, we are requiring that BOEM, BSEE, and Ocean Wind document any and all observations of dead or injured sea turtles over the course of the project and that we meet twice annually to review that data and determine which, if any, of those sea turtles have a cause of death that is attributable to project operations. We expect that we will consider the factors reported with the particular turtle (i.e., did the lookout suspect the vessel struck the turtle), the state of decomposition, any observable injuries, and the extent to which project vessel traffic contributed to overall traffic in the area at the time of detection.

RPM 5/Term and Condition 8-10
A number of plans are proposed for development and submission by Ocean Wind and/or required for submission by BOEM, BSEE, or NMFS OPR. Term and Condition 8 identifies all of the plans that must be submitted to NMFS GARFO, identifies timeline for submission, and clarifies any relevant requirements. This will minimize confusion over submission of plans and facilitate efficient review of the plans. Implementation of these plans will minimize or monitor take, dependent on the plan.

RPM 6/Term and Condition 11-12
RPM 6 and its associated terms and conditions are reasonable and necessary or appropriate to minimize and monitor incidental take. Measures to minimize and monitor incidental take, whether part of the proposed action or this ITS, first must be implemented in order to achieve the beneficial results anticipated in this Opinion for ESA listed species. Likewise, such measures once implemented must be effective at minimizing and monitoring incidental take consistent with the analysis. While the measures described as part of the proposed action and in the ITS are consistent with best practices in other industries, and are anticipated to be practicable and functional, gathering information in situ through observation, inspection, and assessment may confirm expectations or reveal room for improvement in a measure's design or performance, or

in Ocean Wind's implementation and compliance. While the ITS states that action agencies must adopt the RPMs and terms and conditions as enforceable conditions in their own actions, and while each agency is responsible for oversight regarding its own actions taken, specifying that Ocean Wind must consent to NOAA personnel's attendance during offshore wind activities clarifies its role as well. Given the nascence of the U.S. offshore wind industry information gathering on the implementation and effectiveness of these measures will help ensure that effects to listed species and their habitat are minimized and monitored.

12.0 CONSERVATION RECOMMENDATIONS

In addition to Section 7(a)(2), which requires agencies to ensure that all projects will not jeopardize the continued existence of listed species, Section 7(a)(1) of the ESA places a responsibility on all federal agencies to "utilize their authorities in furtherance of the purposes of this Act by carrying out programs for the conservation of endangered species." Conservation Recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information in furtherance of these identified purposes. As such, NMFS recommends that the BOEM, BSEE, USACE, and the other action agencies consider implementing the following Conservation Recommendations consistent with their authorities:

1. While recognizing that we have determined that interactions are extremely unlikely to occur, ensure that all dredges are operated in a manner that will further reduce the risk of interactions with listed species and monitor and document any such unlikely interactions.
    a. NMFS should be contacted prior to the commencement of dredging and again upon completion of the dredging activity.
    b. If sea turtles are present or material transport, vessels transiting the area should post a bridge watch, avoid intentional approaches closer than 100 yards when in transit, and reduce speeds to below 4 knots if bridge watch identifies a listed species in the immediate vicinity of the dredge as determined by the line of sight from the vessel bridge.
    c. Use a trained lookout to monitor for captured sea turtles or Atlantic sturgeon in the dredge bucket and to monitor the scow/hopper for sturgeon. Any interactions with sturgeon should be reported to NMFS GARFO (nmfs.gar.incidental-take@noaa.gov with a copy of the *NMFS Take Report Form* (download at: https://media.fisheries.noaa.gov/2021-07/Take%20Report%20Form%2007162021.pdf?null). Any sea turtles or Atlantic sturgeon observed in the dredge scow/hopper during mechanical dredging operations should be removed with a net and, if alive, returned to the water away from the dredge site.
2. Information on underwater noise generated during vibratory pile driving for installation and removal of sheet piles in the action area is limited. Additionally, information on operational noise of direct drive wind turbine generators is also limited.
    a. Sound field verification should be carried out during installation and removal of at least one cofferdam.
    b. A study to document operational noise during a variety of wind and weather conditions should be carried out.

3. Support research and development to aid in minimization of risk of vessel strikes on marine mammals, sea turtles, and Atlantic sturgeon.
4. Support development of regional monitoring of cumulative impacts of this and future projects through the Regional Wildlife Science Entity (RWSE).
5. Work with the NEFSC to support robust monitoring and study design with adequate sample sizes, appropriate spatial and temporal coverage, and proper design allowing the detection of potential impacts of offshore wind projects on a wide range of environmental conditions including protected species distribution, prey distribution, and habitat usage.
6. Support research into understanding and modeling effects of offshore wind on regional oceanic and atmospheric conditions and potential impacts on protected species, their habitats, and distribution of zooplankton and other prey.
7. Support the continuation of aerial surveys for post-construction monitoring of listed species in the lease area and surrounding waters; contribute all sightings of North Atlantic right whales to the NMFS Sighting Advisory System.
8. Support research on construction and operational impacts to protected species distribution, particularly the North Atlantic right whale and other listed whales. Conduct monitoring pre/during/post construction, including long-term monitoring during the operational phase, including sound sources associated with turbine maintenance (e.g., service vessels), to understand any changes in protected species distribution and habitat use in RI/MA and MA WEAs/southern New England.
9. Develop an acoustic telemetry array in the WDA and support research for the tracking of sturgeon and deployment of acoustic tags on sea turtles as well as other acoustically tagged species.
10. Conduct research regarding the abundance and distribution of Atlantic sturgeon in the wind lease area and surrounding region in order to understand the distribution and habitat use and aid in density modeling efforts, including the use of acoustic telemetry networks to monitor for tagged fish.
11. Submit all acoustic telemetry data to the Mid-Atlantic Acoustic Telemetry Observation System (MATOS) database for coordinated tracking of marine species over broader spatial scales in US Animal Tracking Network and Ocean Tracking Network.
12. Conduct long-term ecological monitoring to document the changes to the ecological communities on, around, and between wind turbine generator foundations and other benthic areas disturbed by the proposed Project.
13. Develop a PAM array in the WDA to monitor use of the area by baleen whales during the life of the Project, including construction, and to detect small-scale changes at the scale of the WDA. Bottom mounted recorders should be deployed at a maximum of 20 km distance from each other throughout the given study area in order to ensure near to complete coverage of the area over which North Atlantic right whales and other baleen whales can be heard. See NOAA/BOEM PAM Recommendations for specific details. Resulting data products should be provided according to the NOAA/BOEM PAM recommendations.

14. Support the development of a regional PAM network across lease areas to monitor long-term changes in baleen whale distribution and habitat use. A regional PAM network should consider adequate array/hydrophone design, equipment, and data evaluation to understand changes over the spatial scales that are relevant to these species for the duration of these projects, as well as the storage and dissemination of these data.
15. Monitor changes in commercial fishing activity to detect changes in bycatch or entanglement rates of protected species, particularly the North Atlantic right whale, and support the adaptation of ropeless fishing practices where necessary.
16. Provide support to groups that participate in regional stranding networks.

13.0 REINITIATION NOTICE

This concludes formal consultation for the proposed authorizations associated listed herein for the Ocean Wind 1 offshore energy project. As 50 C.F.R. §402.16 states, reinitiation of formal consultation is required and shall be requested by the Federal agency or by the Service, where discretionary Federal involvement or control over the action has been retained or is authorized by law and:

(1) If the amount or extent of taking specified in the incidental take statement is exceeded;

(2) If new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered;

(3) If the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the biological opinion or written concurrence; or,

(4) If a new species is listed or critical habitat designated that may be affected by the identified action.

14. LITERATURE CITED

To Be Provided