NOAA's 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 Revolution Wind Offshore Energy Project (Lease OCS-A 0486)
GARFO-2022-03532

CONDUCTED BY: National Marine Fisheries Service
Greater Atlantic Regional Fisheries Office

DATE ISSUED: July 21, 2023

APPROVED BY: Michael Pentony
Regional Administrator

https://doi.org/10.25923/cc4z-hx25

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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 its approval with conditions of the Construction and Operation Plan (COP) authorizing the construction, operation, maintenance, and decommissioning of the Revolution Wind Offshore Wind Project under the Outer Continental Shelf Lands Act (OCSLA). The applicant, Revolution Wind, is proposing to construct, operate, and eventually decommission a commercial-scale offshore wind energy facility within Lease Area OCS-A 0486 that would consist of up to 79 wind turbine generators, two offshore substations, and associated inter-array cabling as well as export cabling to bring electricity to land.

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]each of whom is taking action under their respective statutory and regulatory authorities related to approval of the COP and its conditions and therefore have corresponding ESA Section 7 consultation responsibilities. This Opinion considers effects of the proposed federal actions (collectively referred to in this opinion) as the proposed action) on ESA-listed whales, sea turtles, fish, and designated critical habitat that occur in the action area (as defined in Section 3.0 of this Opinion). 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. This 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 and amended in 2023. These regulations prescribe BOEM's responsibility for determining whether to approve, approve with modifications, or disapprove Revolution Wind's Construction and Operations Plan (COP). Revolution Wind filed their COP with BOEM on October 30, 2020, with subsequent updates in April 2021, December 2021, and July 21, 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 April 30, 2021, to assess the potential biological and physical

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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] The July 2022 COP and appendices are available online at: https://www.boem.gov/renewable-energy/state-activities/revolution-wind-farm-construction-and-operations-plan
Last accessed April 30, 2023.

environmental impacts of the Proposed Action and Alternatives (86 FR 22972) on the human environment. A draft EIS (DEIS) was published on August 29, 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. BSEE's approvals and activities are included as elements of the proposed action in this opinion.

USACE issued a Public Notice (NAE-2020-00707[4]) describing its consideration of Revolution 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 September 2, 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, involves the construction, operations and maintenance, and eventual decommissioning of the Revolution Wind Farm (RWF) and associated Revolution Wind Export Cable (RWEC). The RWF would include the installation of up to 100 wind turbine generators (WTGs or turbines) connected by a network of inter-array cables, up to two offshore substations (OSSs) connected by one offshore substation link cable (OSS-link cable), and one onshore logistics or O&M facility. The RWEC would include up to two alternating current (AC) electric cables (export cables) generally co-located within a single corridor; one onshore substation (OnSS); and one interconnection facility (ICF) that would connect the RWF to the existing onshore regional electric transmission grid at The Narragansett Electric Company d/b/a National Grid (TNEC) Davisville Substation in North Kingstown, Rhode Island. As explained further below, the scope of the project has been reduced since the publication of this notice (i.e., from a maximum of 100 WTGs to a maximum of 79 WTGs). USACE's permit is included as an element of the proposed action in this opinion.

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. USCG's proposal to permit installation of additional aids to navigation are included as elements of the proposed action in this opinion.

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

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[3] The DEIS is available online at: https://www.boem.gov/renewable-energy/state-activities/revolution-wind
Last accessed April 30, 2023.

[4] Public Notice is online at https://www.nae.usace.army.mil/Portals/74/docs/regulatory/PublicNotices/2022/NAE-2020-00707-20220901-Public-Notice.pdf
Last accessed April 30, 2023.

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 Revolution Wind, LLC, a 50/50 joint venture between Ørsted North America, Inc. and Eversource Investment, LLC, for the incidental take of small numbers of marine mammals during the construction of the Revolution Wind 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), detonation of unexploded ordnances or munitions and explosives of concern, and high-resolution geophysical (HRG) site characterization surveys conducted by Revolution Wind in Federal and State waters off of Rhode Island. A final ITR would allow for the issuance of a LOA to Revolution Wind for a 5-year period. NMFS OPR's issuance of an ITR and LOA is included as an element of the proposed action in this opinion.

Revolution Wind may choose to obtain a Letter of Acknowledgment from NMFS for certain fisheries survey activities. A Letter of Acknowledgement 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

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[5] Application, Notice of Receipt of Application, Proposed Rule, and Supporting Materials are available online at: https://www.fisheries.noaa.gov/action/incidental-take-authorization-revolution-wind-llc-construction-revolution-wind-energy; Last accessed April 30, 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.

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 related Letter of Acknowledgment 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 and the issuance of LOA's, should they be requested, is not considered an element of the proposed action in this opinion.. However, as BOEM's action we are consulting on includes some surveys that may be carried out with a Magnuson-Stevens Act Letter of Acknowledgement, and these surveys' effects would not occur but for the Revolution Wind project, it is appropriate to consider them in this Opinion as consequences of BOEM's proposed action and, to the extent the surveys may cause effects to listed species at a level resulting in the incidental take of ESA-listed species , address such 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 this section 7 consultation. BOEM submitted a draft Biological Assessment (BA) on April 25, 2022. BOEM submitted a revised BA and request for consultation on August 26, 2022, as the lead federal agency for the ESA consultation and on behalf of BSEE, USACE, EPA, and the USCG. We requested additional information from BOEM in correspondence dated October 1, 2022. On November 1, 2022, we received a draft *Notice of Proposed Incidental Take Regulations for the Taking of Marine Mammals Incidental to the Revolution Wind Offshore Wind Project*, from our Office of Protected Resources and an accompanying request for ESA section 7 consultation. On November 1, 2022, we also received a revised BA from BOEM. On November 17, 2022, we submitted a letter to BOEM responding to the November 1, 2022 BA. As noted in that letter, Orsted had communicated to us and to BOEM that the results of surveys carried out in summer 2022 indicate that 21 of the 100 identified positions for installing wind turbine generator foundations are not feasible. Orsted has indicated that installing foundations at those 21 locations would require foundation types and/or clearance/installation methods that are outside the scope of their current COP and their Project Design Envelope. Our letter explained the additional information that was necessary to continue a consultation on 100 turbine foundations. Also in November 2022, Orsted submitted a request to NMFS OPR to modify their MMPA permit application to reflect a maximum of 79 foundations due to constructability constraints.

On January 31, 2023, we received a revised BA from BOEM that reflected the 79-foundation scenario. We submitted a memo to BOEM on February 16, 2023, that identified information that was missing from the BA that was necessary to initiate consultation. BOEM submitted an Addendum on March 23, 2023 and additional supplementary information on March 31, 2023. Formal consultation was initiated on March 31, 2023.

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 offshore wind program that allocates 150 days for consultation and production of a biological opinion for each proposed offshore wind project, unless extended (with a March 31 initiation date, the 150-day deadline would have been August 28, 2023). In this case, BOEM requested that we expedite consultation and shorten the consultation timeline from the regulatory timeline of 135 days (August 13, 2023); the agreed to deadline for the Opinion is July 21, 2023.

Consideration of Activities Addressed in Other ESA Section 7 Consultations

As described in Section 3 below, some Revolution Wind project vessels will utilize the Paulsboro Marine Terminal in Paulsboro, NJ. NMFS GARFO has completed ESA section 7 consultation with the USACE for the construction and operation of the Paulsboro Marine Terminal. The Biological Opinion prepared by NMFS for the Paulsboro Marine Terminal (July 19, 2022, "2022 Paulsboro Opinion") considered effects of all vessels transiting to/from the port on shortnose sturgeon, Atlantic sturgeon, and critical habitat designated for the New York Bight distinct population segment (DPS) of Atlantic sturgeon. On June 7, 2023, NMFS notified the USACE that we have received new information that reveals effects of the action that may affect listed species in a manner or to an extent not previously considered and that the consultation must be reinitiated.

The Paulsboro Opinion analyzed an overall amount of vessel transits, of which Revolution Wind would contribute a small part. The effects analyzed in the completed Paulsboro Opinion 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 Revolution Wind's vessel use of the Paulsboro Marine Terminal will be discussed in the *Effects of the Action* section by referencing the analysis in the port Opinion and determining whether the effects of Revolution Wind's vessels transiting to and from the port are consistent with the analysis in the Paulsboro Opinion or anticipated to cause additional or different effects. In the *Integration and Synthesis* section, if we determine any additional or different effects of Revolution Wind's vessels will be caused by the proposed action, we will evaluate them in addition to the effects included in the *Environmental Baseline*, which already includes the effects of vessel transits analyzed in the Paulsboro Biological Opinion. By using this methodology, this Opinion ensures that all of the effects of Revolution Wind's vessel transits to and from the Paulsboro facility 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 Revolution Wind's vessel transits to and from the port–once in the *Environmental Baseline* and then again in the *Effects of the Action* section. Any incidental take anticipated by Revolution Wind's vessel transits, even if already specified and exempted in the Paulsboro Opinion's Incidental Take Statement, 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 Paulsboro Opinion. This approach is being taken because BOEM was not a party to the Paulsboro Opinion, yet Revolution Wind's vessel transits to/from the Paulsboro Marine Terminal 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 and Revolution Wind.

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 this biological opinion and its 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. The Wind Development Area (WDA) is the area consisting of the location of the wind turbine generators, offshore substations, inter-array cables (IAC), and the cable corridors between the offshore substations (OSS) and the landfall sites in Rhode Island. The Wind Farm Area (WFA) is that portion of Revolution Wind's lease (OCS-A 0486) where the wind turbine generators and OSSs will be installed and operated (i.e., the offshore portion of the WDA minus the cable routes to shore); in this case, the WFA and the lease area are co-extensive and we may use these terms interchangeably in this Opinion. The project area is the area consisting of the location of the wind turbine generators, offshore substations, inter-array cables, and the cable corridors to shore, as well as all vessel transit routes to ports in Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Maryland, and Virginia (i.e., the WDA plus these transit routes). The action area is defined in Section 3.8 below and includes the project area, WDA, and WFA as well as the portion of the U.S. EEZ used by project vessels transiting from ports in the Gulf of Mexico, Asia, and Europe.

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. The Proposed Project consists of the Revolution Wind Farm (RWF) and the Revolution Wind Export Cable (RWEC). As described in Section 2 of this Opinion, BOEM requested consultation on its proposal to approve[7] a COP to authorize the construction, operation and maintenance, and eventual decommissioning of the Revolution Wind Offshore Wind Farm and Revolution Wind Export Cable Project BSEE will work with BOEM to enforce safety, environmental, and conservation compliance with any associated legal and regulatory requirements during project construction and operations; oversee

[7] 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."

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

BOEM's August 29, 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; 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 November 1, 2022. 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 (NPDES) Vessel General Permit standards.

The information presented here reflects the proposed action described by BOEM in their January 31, 2023, Biological Assessment, the Addendums received on March 23, 2023, and March 31, 2023, and the proposed Marine Mammal Protection Act Incidental Take Authorization (88 *Federal Register* 3375; December 23, 2022). Here, for simplicity, we may refer to BOEM's proposed action when that proposed action may also include other federal actions (e.g., construction of the wind turbines requires authorizations from BOEM, USACE, EPA, USCG, and NMFS OPR).

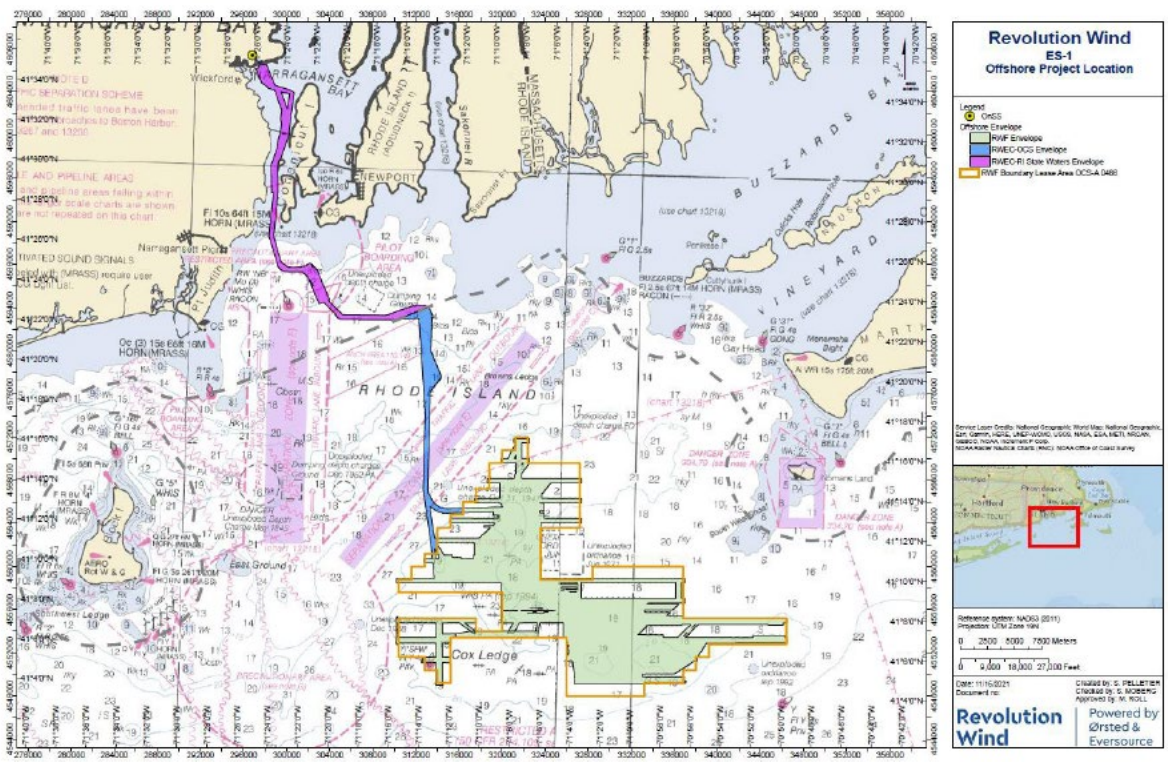
The project design envelope described in the COP includes up to 100 WTGs and 2 OSSs; however, as describe in the Consultation History section above, the scope of the project was reduced prior to the initiation of ESA consultation. The proposed action described in the BA and analyzed in this Opinion consists of up to 79 WTGs with a nameplate capacity of 8 MW to 12 MW per turbine, two OSSs, and a submarine transmission cable network connecting the WTGs to the OSSs, all of which will be located in BOEM Renewable Energy Lease Area OCS-A 0486, located within the RI/MA Wind Energy Area (WEA). As described in more detail below, the 79 WTGs will be installed on39-foot (12-m) diameter monopiles and the two OSSs will be installed on 49-foot (15-m) diameter monopiles.

The Lease Area is located in federal waters of the OCS, with the closest edge of the Lease Area approximately 15 miles (24.1 kilometers [km]) southeast of mainland Rhode Island. The proposed location of the RWF and the RWEC installation corridor are shown in Figure 3.1.

The RWEC consists of two HVAC electric cables that will connect to the electric grid in North Kingstown, Rhode Island. The RWEC includes both offshore and onshore segments. The Onshore Substation (OnSS), Interconnection Facility (ICF), and associated interconnection circuits will be located adjacent and connecting to the existing Davisville Substation in North Kingstown, Rhode Island. Offshore, the RWEC is located in federal waters (RWEC – OCS) and Rhode Island State territorial waters (RWEC – RI); it will be buried to a target depth of 4 to 6 feet below the seafloor. The two RWEC circuits will total approximately 84 miles in length (23 and 19 miles for each RWEC-OCS and RWEC-RI segment per circuit, respectively).

The project also includes a number of survey components including high-resolution geophysical surveys (HRG), and a Fisheries Research and Monitoring Plan that includes biological monitoring surveys, acoustic telemetry, and benthic monitoring. These survey activities will occur during the pre-construction, construction, and operation and maintenance phases of the project.

Figure 3.1 RWF and RWEC Location.



(Source: Figure 3.1 in BOEM’s BA)

3.2 Construction

Prior to installation of WTG and OSS foundations, site preparation activities will take place. These include clearance of unexploded ordnance/munitions and explosives of concern (UXO/MEC or generally, UXO) and seafloor preparation. The total number of construction and installation days for each project component would depend on several factors, including environmental conditions, planning, construction, and installation logistics. The general construction schedule, assuming a late 2023 start, is described in the figure and table below.

Figure 3.2. Revolution Wind's General Proposed Construction Schedule.

Table 3.1. Anticipated Installation Schedule for Revolution Wind Farm and Revolution Wind Export Cable.

Proposed Action Element	Construction and Installation Milestone	Activity Duration	Anticipated Timeframe
RWF	Monopile foundation installation	5 months	2024
RWF	Inter-array and OSS-link cable installation	8 months	2024
RWF	WTG installation	8 months	2024
RWF	OSS installation	6 months	2024
RWF and RWEC	HRG Surveys	12 months	2023-2024
RWEC	Onshore interconnection facility	18 months	2023-2024
RWEC	Sea-to-shore transition	4 months	2023-2024
RWEC	Offshore cable installation	5 months	2024
RWEC	Onshore cable installation	12 months	2023-2024

Source: BOEM's BA and BOEM staff updates

3.2.1 UXO/MEC Clearance/Detonation and Sea Floor Preparations

BOEM and Revolution Wind have determined that UXO/MEC may be present in the lease area and RWEC corridor. Revolution Wind will adhere to the as low as reasonably practicable (ALARP) standard process with avoidance of UXOs as the preferred mitigation methodology. As described in the BA, the exact number, size, and location of UXOs present in the Lease Area and RWEC corridor are not currently known. Where avoidance is not possible, in-situ disposal will be done with low-order (deflagration), high-order (detonation) methods, cutting the MEC/UXO to extract the explosive components, or through relocation ("lift and shift"). The "lift and shift" operations would relocate MEC/UXO to an adjacent location or previously designated disposal areas for either wet storage or disposal through low- or high-order methods.

As described in the BA, Revolution Wind has estimated that up to 13 1,000-pound (454 kg) devices may be encountered during project construction that require detonation in place. BOEM considers that due to the substantial pre-construction surveys that have been and will continue to be undertaken to locate and remedy confirmed MEC/UXO, the likelihood of an unanticipated MEC/UXO encounter is very low. In-situ detonation activities would take place between May 1 and November 30 and would be limited to one detonation per day. Implementation of sound attenuation technologies capable of achieving a 10-dB reduction in source sound intensity would be required by BOEM for all detonations.

Prior to placement of the monopile foundations and scour protection, sea floor preparation would be conducted to identify and remove anthropogenic debris and clear large boulders using a boulder grab or boulder plow to ensure the foundation site is suitable for installation. Sea floor preparation anticipated around each WTG and OSS foundation is expected to affect approximately 31.1 acres around each monopile, for an amount of seafloor disturbance up to 2,519.1 acres. Boulder grabs and boulder plows may be used to relocate/remove surface or partially embedded boulders and debris. For the boulder grab, a grab is lowered to the sea floor, over the targeted boulder and once "grabbed," the boulder is relocated a short distance away. For the boulder plow, boulder clearance is completed by a high-bollard pull vessel, with a towed plow generally forming an extended V-shaped configuration, splaying from the rear of the main chassis. The V-shaped configuration displaces any boulders to the extremities of the plow, thus establishing a clear corridor; multiple passes may be necessary.

3.2.2 Foundation Installation – WTGs and OSSs

Foundations would be installed following completion of the seafloor preparation. Foundations would be driven to target embedment depths using impact pile driving. For 39-foot (12-m) diameter WTG monopiles, the maximum impact hammer energies would be 4,000 kJ and target embedment depths would be 40 m. A single foundation installation sequence would require up to approximately nine hours (one-hour pre-start clearance, up to four hours of pile driving, and four hours to move to the next location). For the purposes of acoustic modeling, it was assumed that installation of a single WTG monopile would require 10,740 hammer strikes over 220 minutes (3.7 hours). Up to three monopile foundations would be installed in a 24-hour period, with up to 21 monopiles installed every 7 days using one installation vessel. Installation of the WTG monopiles is expected to be completed in a single 5-month campaign between May 1 and December 31. No pile driving for foundation installation will occur between January 1 and April 30. The OSS foundation installation is expected to occur within a 1- to-2-week period also between May 1 and December 31. Installation of each of the two OSS monopile foundations is expected to require approximately 11,564 hammer strikes over 380 minutes (6.3 hours). The maximum impact hammer energies for the 15-m diameter OSS foundations would be 4,000 kJ and target embedment depths would be 50 m. No concurrent impact pile driving (*i.e.*, installing multiple piles at the same time) is planned for this project and therefore no concurrent pile driving is considered in this Opinion. The typical monopile foundation and WTG installation sequence is summarized in Table 3.2.

During the installation of monopile foundations, Revolution Wind is proposing a 24-hour work window. Pile installation will occur during daylight hours and could, if Revolution Wind meets NMFS OPR's and BOEM's proposed requirements, 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. After dark initiation of pile driving would only be allowed if Revolution 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 allow for consistent and effective monitoring of the identified clearance and shutdown zones for marine mammals and sea turtles (see Table 3.12, below).

Table 3.2. Summary of Monopile Foundation and WTG Installation.

Activity/Action	Installation Details
Foundation Delivery	Monopiles may be transported directly to the Lease Area for installation or to the construction staging port. Monopiles [and Transition Pieces (TPs) if used] are transported to site by an installation vessel or a feeder barge.
Foundation Setup	At the foundation location, the main installation vessel upends the monopile in a vertical position in the pile gripper mounted on the side of the vessel. The hydraulic hammer is lifted on top of the pile to commence pile driving.
Pile Driving	Piles are driven until the target embedment depth is met, then the pile hammer is removed and the monopile is released from the pile gripper.
TP Installation (if used) or Secondary Structures Installation	Once the monopile is installed to the target depth, the TP or separate secondary structures would be lifted over the pile by the installation vessel. If used, the TP would be bolted to the monopile.
Foundation Completion	Once installation of the monopile and TP is complete, the vessel moves to the next installation location.
Tower and Nacelle Installation	The jack-up construction vessel is loaded with WTG towers, nacelles, and blades on a customized gantry. The jack-up construction vessel moves into position next to the foundation and lifts the tower into place on the foundation using an onboard crane. Once the tower is secured to the foundation, the WTG nacelle is lifted into place and

Activity/Action	Installation Details
	bolted to the top of the tower. This activity requires precision crane work and can only be conducted under no or low wind conditions. The schedule is therefore weather dependent.
WTG blade installation	Each WTG blade is lifted from the jack-up vessel gantry into position with its mounting point on the nacelle. The blade is centered and aligned with mounting points on the nacelle and secured by bolting it to the nacelle housing. This activity requires precision crane work and can only be conducted under no or low wind conditions. The schedule is therefore weather dependent.

Source: Revolution Wind COP March 2023

Scour protection would be installed around each foundation to prevent sea floor erosion and scour from natural hydrodynamic processes. Scour protection may be installed before or after the foundations are installed and would consist of placement of a filter layer, rock placement (most common), mattress protection, sandbags, and/or rock bags. Rock placement typically includes a rock armor layer placed over a filter layer with the filter layer installed before or after the foundation. Scour protection would cover approximately 0.7 acre centered on each WTG and OSS monopile (total 56.7 acres), ranging from 2.3 to 4.6 feet (0.7 to 1.4 m) in height above the sea floor. The quantity of scour protection required would vary based on site conditions and would be determined based on detailed design of the foundation, consideration of geotechnical data, metocean data, water depth, maintenance strategy, agency coordination, stakeholder concerns, and cost.

Up to two OSSs would be installed, each with a maximum nominal capacity of 440 MW. Each OSS would have a platform containing the electrical components necessary to collect the power generated by the WTGs (via the IAC), transform it to a higher voltage for transmission, and transport to the Project's onshore electricity infrastructure (via the export cables). Though the OSSs would be unmanned, they may include installed facilities to accommodate maintenance crews such as break rooms, bathrooms, locker facilities, and general storage rooms for equipment. There would not be any running water facilities on the platform and wastewater would be collected in holding tanks and removed from the OSS by transfer to a crew transfer vessel or services O&M vessel. Solid waste would also be removed by such vessels and brought to shore for proper disposal.

Each OSS would require various oils, fuels, and lubricants to support O&M. Sulfur hexafluoride (SF_6) would be used for insulation purposes. Table 3.3 provides a summary of the maximum quantities of these materials anticipated at each OSS. As described in the BA and COP, the spill containment strategy for each OSS consists of preventive, detective, and containment measures. The OSSs will be designed with a minimum of 110 percent of secondary containment of all identified oils, grease, and lubricants. Additionally, OSS devices containing SF_6 will be equipped with integral low-pressure detectors to detect SF_6 gas leakages should they occur.

Table 3.3. Summary of the Maximum Potential Quantities of Oils, Fuels, Lubricants, and SF_6 per OSS.

OSS Equipment	Material	Maximum Quantity per OSS
Transformers and Reactors	Transformer Oil	79,252 gallons (300,000 liters)
Generators	Diesel Fuel	52,834 gallons (20,000 liters)
Medium and High-Voltage Gas-insulated Switchgears	SF_6*	3,783 pounds (1,716 kg)
Crane	Hydraulic Oil	317 gallons (1,200 liters)

* SF_6 (sulfur hexafluoride) gas would be used for electrical insulation in some switchgear components
Source: Revolution Wind COP (March 2023)

The anticipated construction and installation sequence for the OSS is summarized in Table 3.4. It is anticipated that OSS installation and commissioning may require up to 6 months, not including cable pull-in.

Table 3.4. Summary of OSS Construction and Installation Sequence.

Activity/Action	Construction and Installation Summary
Foundation Delivery and Installation	Each OSS would be supported by 15-m monopile foundations. Delivery and installation would be similar to the monopile foundation described in Table 3.2, above.
Topside Installation	The topside platform, including the transformer module and switchgear, would be assembled as a single unit prior to being transported to the Lease Area via a heavy transport vessel or barge. This expedites the lift of the module onto the foundation. The lift would commence using a suitable installation vessel and the topside platform would be lowered onto the preinstalled foundation. The topside is then secured into position by use of grouted, bolted, or welded connection. This step would occur following installation of the OSS foundation.
Commissioning	Once the OSS topside is secured to the foundation, the RWEC, OSS-link cable, and IAC would be connected. Communication systems would be set-up with the shore, as well as lighting, firefighting system, etc. Once all systems are enabled, the electrical systems would be commissioned using back-feed (i.e., electricity is fed to the OSS from the onshore grid via the export cables). When completed, the OSS is operational.

3.2.3 Cable Installation

The proposed project includes three cable networks: the IAC, which would carry electrical current, produced by the WTGs to the OSSs; an OSS-link cable, that would transfer electrical current between the two OSSs; and the RWEC that would carry electrical current from each OSS to the Onshore Substation. Installation of the three cable networks will require hydraulic plow (i.e., jet-plow and mechanical plow) or similar technology for displacing sediments to allow for cable burial.

Sea floor preparation associated with cable installation would occur within a 131-foot (40-m)-wide corridor along submarine cable routes and within a 656-foot (200-m)-radius around WTG and OSS foundation locations. A pre-lay grapnel run (PLGR) will also be completed to clear cable routes of possible obstructions (e.g., derelict fishing nets, lobster pots, cables, rope, or other debris) prior to installation. Once complete, the sea floor would be prepared for cable installation by removing boulders. Boulder removal would be completed with a boulder grab or boulder plow as described above.

The IAC would include multiple segments that extend up to 155 miles, connecting WTGs to one of the two OSSs. The IAC segments would be installed within a 131-foot (40-m) wide corridor between the WTGs. Burial of the IAC would typically target a depth of 4 to 6 feet (1.2 m to 1.8 m) below sea floor with depth based on an assessment of sea floor conditions, mobility, and risk of interaction with external hazards such as fishing gear and vessel anchors, as well as the Cable Burial Risk Assessment (COP Appendix F). The IAC, as well as the OSS-link cable and RWEC, would consist of three bundled copper or aluminum conductor cores surrounded by layers of cross-linked polyethylene insulation and various protective armoring and sheathing to protect the cable from external damage and keep it watertight. A fiber optic cable would also be included in the interstitial space between the three conductors and would be used to transmit data from each of the WTGs to the Supervisory Control and Data Acquisition system for continuous monitoring of the IAC. Installation of the IAC would generally follow similar sequence as described for the RWEC, below, with the following two exceptions:

- After pre-lay cable surveys and sea floor preparation activities are completed, a cable-laying vessel would be pre-loaded with 66-kilovolt (kV) transmission cable for the IAC. Prior to the first end-pull, the cable would be fitted with a Cable Protection System (CPS) and the cable would be pulled into the WTG or OSS. The vessel would then move towards the second WTG (or OSS). Cable laying and burial would either occur simultaneously using a jet plow or similar lay and bury tool, or the cable would be laid on the sea floor and then trenched post-lay. Alternatively, a trench may be pre-cut prior to cable installation. The pull and lay operation, inclusive of fitting the cable with a CPS, is then repeated for the remaining IAC lengths, connecting the WTGs and OSSs together.
- The IAC would typically not require in-field joints; thus, "Joint Construction," as described for the RWEC, would generally not be required. However, joints may be used if a cable segment is damaged during installation and requires repair.

The two OSSs would be connected by a 9-mile (15-km)-long 275kV HVAC OSS-link cable. The OSS-link cable allows electricity transmission to be balanced between RWEC circuits. OSS-link cable installation methods would be similar to those described below for the RWEC.
The RWEC would transfer electricity from the OSSs to the Onshore Transmission Cable at the Transition Joint Bays (TJBs). The TJBs would be the transition from the RWEC to the Onshore Transmission Cable. Two TJBs would be required. The RWEC corridor would be located in both federal and Rhode Island State waters (see Figure 3.1).

The sequence of events required for RWEC construction and installation would include pre-lay cable surveys, sea floor preparation, cable installation, joint construction, cable installation surveys, cable protection, and connection to the OSSs. Construction of the RWEC would require approximately 5 months. Table 3.5 below summarizes the RWEC construction phases.

Table 3.5. Summary of RWEC Construction and Installation Sequence.

Activity	Construction and Installation Summary
Pre-Lay Cable Surveys	Prior to installation, geophysical surveys would be performed to check for debris and obstructions that may affect cable installation
Seabed Preparation	Seabed preparation would include boulder clearance and removal of debris and any subsea utilities (e.g. Out of Service Cables). Boulder clearance trials may be performed prior to wide-scale seabed preparation activities to evaluate efficacy of boulder clearing techniques. Proposed boulder clearance methods comprise an ROV guided boulder grab, WROV boulder skid, and a boulder plow. Boulder plow use would be limited to two 6.2 mile (10 km) RWEC segments.
Pre-Lay Grapnel Run (PLGR)	PLGR runs would be undertaken to remove any seabed debris along the export cable route. A specialized vessel would tow a grapnel rig along the centerline of each cable to recover any debris to the deck for disposal at a permitted onshore location.
Cable Installation	The offshore cable-laying vessel would move along the pre-determined route within the established corridor towards the OSSs. Cable laying and burial may occur simultaneously using a lay and bury tool, or the cable may be laid on the seabed and then trenched post-lay. Alternatively, a trench may be pre-cut prior to cable installation. Cable lay and burial trials within the 131-ft (40-m) wide disturbance corridor may be performed prior to main cable installation activities to test equipment. A jet plow or mechanical plow may be used for cable installation.
Joint Construction	Installation of the RWEC would require offshore subsea joints due to the length of the RWEC (up to two per cable). The joints would be located within the 131-ft (40-m) wide disturbance corridor. The subsea joint would be protected by marinized housing approximately four times the cross-sectional diameter of the cable. The joint housing would be protected using similar methods to those described below for Cable Protection. In case of repair due to damage, additional joints may be required during construction and installation.
Cable Installation Surveys	Cable installation surveys would be required, including pre- and post-installation surveys, to determine the actual cable burial depth. Depending on the instruments selected, type of survey,

Activity	Construction and Installation Summary
	length of cable, etc. the survey would be completed by equipment mounted to a vessel and/or remote operated vehicle.
Cable Protection	Cable protection in the form of rock berms, rock bags, and/or mattresses would be installed as determined necessary by the Cable Burial Risk Assessment, and where the cable crosses existing submarine assets. Cable protection would be installed from an anchored or dynamic positioning support vessel that would place the protection material over the designated area(s).
Connection to OSS and WTGs	Export cable ends would be pulled into each WTG and OSS foundation via a J-tube connected to the monopile foundation and secured. Cable protection systems would be installed on top of foundation scour protection. A portion of the cable protection system would extend beyond the scour protection footprint, resulting in 0.04 acre of additional seabed impacts at each foundation.

Source: BOEM's BA and BOEM staff updates

The RWEC would consist of two 275-kV HVAC submarine cables, each originating at a respective OSS. Both are routed along parallel tracks within a single approximately 1,312-foot (400-m) wide right-of-way corridor extending from the northwest side of the RWF northward to landfall in North Kingstown, Rhode Island. Within this right-of-way corridor, the seafloor will be disturbed within an approximately 131-foot (40-m)-wide corridor, inclusive of any boulder clearance. Prior to any sea floor preparation or disturbance required for cable installation, MEC/UXO will be addressed, as described above.

Because of its length, the RWEC will require installation of two offshore submarine joints. Joint construction may include an inline or omega joint depending on the joint location and sea floor conditions. Omega joints would result in an expanded 673-foot (205-m)-wide disturbance corridor at the joint locations. Up to four omega joints (two per RWEC cable) are anticipated.
Burial of the RWEC would be approximately 4-6 feet deep (1-2 m) below sea floor. Burial depth may be deeper in some areas based on an assessment of sea floor conditions, sea floor mobility, risk of interaction with external hazards such as fishing gear and vessel anchors, and a Cable Burial Risk Assessment. Where burial cannot occur, or depth not achieved, or where cable crosses other cables/pipelines, additional cable protection methods may be used (e.g., rock berms/bags, concrete mattresses). Revolution Wind anticipates up to 10 percent of the route (10% in federal waters and up to 5% in state waters are anticipated to require secondary cable protection) for each cable comprising the RWEC will require additional protection measures. One or more of the following cable protection solutions may be used for secondary cable protection:

- Rock Berm – involves dumping or placing rock overtop and/or surrounding the cable.
- Concrete Mattresses – composed of cast concrete blocks interlinked to form a flexible, articulated mat, which can be placed on the sea floor over a cable.

- Fronded Mattresses – concrete mattress with “fronds” that are designed to slow down current and naturally allow sediment to deposit and blanket the mattress.
- Rock Bags – rock-filled mesh bags placed over the cable.

3.2.3.1 Sea-to-Shore Connection
The RWEC would transition from offshore to onshore using Horizontal Directional Drilling (HDD). HDD would involve drilling underneath the sea floor using a drilling rig positioned onshore in the landfall envelope; the maximum design envelope for the HDD methodology includes excavation of two exit pits (one per cable), each measuring 182 feet x 113 feet x 14 feet (55 m x 34 m x 4 m).

Multiple methods are being proposed for sea-to-shore construction, one of which will be selected for implementation; these are described below and include a casing pipe, cofferdam, and a no containment method.

Casing Pipe Installation and Removal
Casing pipes would be installed using a combination of vibratory and impact pile driving. The HDD would drill into the end of the casing pipe, completely enclosing the exit point within the pipe. This method would require no cofferdam containment or dredging. Casing pipe installation would occur from the construction barge using a pneumatic pipe ramming tool (Gundoram Taurus or similar) with a hammer energy of up to 18 kJ. The casing pipes would each require up to 3 hours per day of pneumatic impact hammering to install, over a period of two days for each pipe (6 hours total over 4 days for both), depending on the number of pauses required to weld additional sections onto the casing pipe. Removal of the casing pipe would also involve the use of a pneumatic pipe-ramming tool, but the pipe would be pulled out of the seabed while hammering was occurring instead of being pushed into it. A total of 4 days of pneumatic hammering (6 hours total) would be required for removal of both pipes.

Up to six goal posts would be installed to support each casing pipe (12 goal posts total); these would be located between a barge and the penetration point on the seabed. Each goal post would be composed of two vertical sheet piles installed using a vibratory hammer. A horizontal crossbeam connecting the two sheet piles would then be installed to provide support to the casing pipe. Up to 10 additional sheet piles may be installed per casing pipe to help anchor the barge and support the construction activities. This results in up to 22 sheet piles per casing pipe, for 44 total sheet piles to support both casing pipes. Sheet piles used for the goal posts and supports would be up to 30 m (100 ft.) long, 0.6 m (2 ft.) wide, and 1 inch thick. For each casing pipe, installation of six goal posts would require up to three days total of vibratory pile driving, or up to 6 days total for both casing pipes. Removal of the goal posts would also involve the use of a vibratory hammer and is expected to require approximately the same amount of time as installation (6 days total for both casing pipes). Thus, use of a vibratory pile driver to install and remove the 12 goal posts may occur on up to 12 days at the landfall location. Casing pipe and sheet pile installations would not occur simultaneously, and would be limited to daylight hours.

Cofferdam Installation and Removal
As an alternative to the casing pipe/goal post scenario, two sheet pile or gravity cell cofferdams would be erected around each exit pit to allow construction and installation to occur in the dry.

Each cofferdam would be approximately 164 feet x 33 feet x 10 feet to align with HDD exit dimensions. If a gravity cell cofferdam were installed, the structure would be fabricated onshore, transported to the site on a barge, and then lifted off the barge and placed on the seafloor using a crane. This process would not involve pile driving.

If cofferdams are installed using sheet piles, a vibratory hammer such as an APE model 200T (or similar) would be used to drive sheet piles of up to 30 m (100 ft.) long, 0.6 m (2 ft.) wide, and 1 inch thick. The sidewalls and endwall would be driven to a depth of up to 30 ft. (9.1 m); sections of the shore-side endwall would be driven to a depth of up to 6 ft. (1.8 m) to facilitate the borehole entering underneath the endwall. Installation of each sheet pile cofferdam may take up to 14 days, as would removal, for a total of 28 days per cofferdam or 56 days of vibratory hammer use (installation and removal) for both cofferdams.

After the sheet piles are installed, each exit pit would be excavated to approximately 10 ft. (3 m) by mechanical dredge to expose the HDD exit point allowing for landfall connection. All dredge spoils would be contained on a barge and used to backfill the excavated areas inside each cofferdam. Once HDD operations are complete and the cables installed, the cofferdams would be removed, using vibratory hammering, over the course of up to 14 days per cofferdam. Separate cofferdams would be installed and removed for each of the two export cable bundles, amounting to up to 56 days of vibratory hammering at the landfall location.

No Containment Method
A no containment method is also being proposed, which would have the HDD conduit terminate in a dredged HDD exit pit lined with rock bags to maintain the sidewall slope. The exit pit dimensions for the no containment method would be similar to those proposed for the cofferdam method.

3.2.4 Vessels and Aircraft
Various types of vessels will be used during construction and installation, O&M, and decommissioning. The construction and decommissioning phases would involve the most intensive activity over a short-term period, whereas O&M-related vessel traffic would occur intermittently over the life of the project.

3.2.4.1 Construction Phase
Revolution Wind has identified various vessels and helicopters that would be used to construct the Project. Each vessel would have operational Automatic Identification Systems (AIS), which would be used to monitor the number of vessels and traffic patterns for analysis and compliance with vessel speed requirements. Construction and installation will involve approximately 60 vessels of various classes ranging from small inflatables to construction and installation vessels and barges up to 300 feet in length and helicopters. Construction and installation vessels will operate over a period of approximately 2 years. In the BA and supplemental information, BOEM identifies the potential for up to 26 transits of a heavy transport vessel carrying project components from ports in Canada, Europe, or Asia, directly to the WDA or to New London, CT or Quonset, RI. These trips will occur at some time during the 2-year construction phase. The ports that these vessels will originate from in Canada, Europe, and Asia and the vessel routes from those port facilities to the project site are unknown and will be variable and depend, on a

trip-by-trip basis, on weather and sea-state conditions, other vessel traffic, and any maritime hazards. Table 3.6 summarizes the various vessels associated with project-related offshore construction and installation.

Table 3.6. Vessel classes proposed for project construction, number of vessels, anticipated number of vessel trips by port, indicative specifications, and anticipated transit and operational speeds by vessel class.

Vessel Type	Number of Vessels	Vessel Trips	Anticipated Ports*	Construction Element						Representative Specifications by Class						
				Foundations	OSS	RWEC	IAC	OSS-Link Cable	WTGs	Tonnage[†]	Length ft. (m)	Beam ft. (m)	Draft ft. (m)	Transit Speed (knots)	Average Speed When Moving in Lease Area or RWEC (knots)	% Time Moving in Lease Area or RWEC
Anchor Handling Tug	2	50	QST	●	--	●	--	●	--	345 GT	98 (30)	49 (15)	23 (7)	14	7	44%
Boulder Clearance Vessel	2	13	PRV, QST, DVS, NBD	●	●	●	●	●	--	3,285 LT	312 (70)	66 (20)	23 (7)	23	8	38%
Bubble Curtain Vessel	1	20	PRV	●	--	--	--	--	--	4,900 T	295 (90)	66 (20)	23 (7)	23	7	26%
Cable Burial Vessel	1	6	PRV, QST, DVS, NBD	--	--	--	●	●		12,200 Te	328 (100)	98 (30)	16 (5)	15	<4	39%

Cable Burial Vessel - Remedial	1	1	PRV, QST, DVS, NBD	--	--	●	--	--	--	12,200 Te	328 (100)	98 (30)	16 (5)	15	<4	39%
Cable Lay & Burial Vessel (Export)	1	5	PRV, QST, DVS, NBD	--	--	●	--	--	--	10,800 Te	427 (130)	98 (30)	16 (5)	15	<4	39%
Cable Lay Vessel (Barge)	1	3	PRV, QST, DVS, NBD, QNC	--	--	●	--	--	--	10,000 Te	400 (122)	110 (33.5)	25 (7.6)	14	<4	39%
Cable Laying Vessel	1	6	PRV, QST, DVS, NBD	--	--	--	●	●	--	10,000 Te	459 (140)	95 (30)	16 (5)	15	<4	39%
Crew Transfer Vessel (CTV)	6	870	JFF, PRV, QST, DVS, NBD, NLD,	●	●	●	●	●	●	235 GT	98 (30)	36 (11)	10 (3)	23	17	42%
DP2 Construction Vessel	2	7	PRV	--	--	●	●	●	--	60,825 GT	758 (231)	160 (49)	33 (10)	11	8	34%
Fall Pipe Vessel	1	6	PRV	●	--	--	--	--	--	28,734 T	531 (162)	125 (38)	21 (6.4)	13	9	39%
Fuel Bunkering Vessel	1	8	To be determine d	--	--	--	--	--	●	3,500 T	295 (90)	62 (19)	17 (5.2)	10	7	26%
Guard Vessel/Scout Vessel	6	8	PRV, QST, DVS, NBD, New York	●	●	●	●	●	--	700 T	90 (27)	33 (10)	16 (5)	17	17	42%

			or Gulf of Mexico													
Heavy Lift Installation Vessel	1	1	NLD, QST, PLB, SPP, NFK	●	--	--	--	--	--	61,000 T	787 (240)	164 (50)	44 (13.5)	10	8	34%
Heavy Lift Installation Vessel (Secondary Steel)	1	1	NLD, QST, PLB, SPP, NFK	●	--	--	--	--	--	61,000 T	787 (240)	164 (50)	44 (13.5)	10	8	34%
Heavy Transport Vessel	5	26	NLD, QST, PLB, SPP, NFK, Canada, Europe, or Asia	●	●	--	--	--	--	50,000 Te	715 (218)	141 (43)	33 (10)	13.5	8	38%
Helicopter	1 or 2	76	QST	●	●	--	--	--	●	n/a	n/a	n/a	n/a	120	120	100%
Jack-Up Installation Vessel	1	20	NLD, QST	--	--	--	--	--	●	8,000 T	459 (140)	131 ft. (40)	23 (7)	10	8	34%
Lift Boat – Jack-Up Accommodati on Vessel	1	1	JFF, QST	●	●	●	●	●	●	61,000 T	787 (240)	164 (50)	23 (7)	10	8	39%
Platform Supply Vessel	3	85	PRV	●	--	--	--	--	--	6,200 T	300 (92)	69 (21)	21 (6.5)	11.5	8	38%

Pre-lay Grapnel Run Vessel	2	6	PRV, QST, DVS, NBD, New York or Gulf of Mexico	--	--	●	●	●	--	2,400 GT	262 (80)	66 (20)	23 (7)	23	7	26%
PSO Noise Monitoring Vessel	4	80	PRV	●	--	--	--	--	--	4,900 T	295 (90)	66 (20)	23 (7)	23	7	26%
Safety Vessel	2	100	JFF, QST	●	●	●	●	●	●	700 T	90 (27)	33 (10)	16 (5)	12	12	42%
Service Operations Vessel (SOV)	2	7	JFF, QST	●	●	●	●	●	●	4,100 T	268 (82)	59 (18)	24 (7.5)	23	7	26%
Supply Barge	1	4	PRV, QST, DVS, NBD, New York or Gulf of Mexico	●	--	●	●	●	--	5,480 T	300 (91)	44 (13.4)	17 (5)	7	7	44%
Supply Vessel	1	30	PRV	●	●	●	●	●	●	6,000 GT	348 (106)	72 (22)	31 (9.4)	12	8	38%
Survey Vessel	1	11	PRV, QST, DVS, NBD, New York or Gulf of Mexico	--	--	●	●	●	--	235 GT	164 (50)	39 (12)	23 (7)	18	<4	42%
Tow Tug	5	29	QST	●	--	--	--	--	●	450 GT	148 (45)	49 (15)	23 (7)	7	7	44%

Source: BOEM supplemental BA March 2023 and additional information provided by BOEM staff

Port abbreviations used in Table 3.6 are as follows:

- New York = Port of Montauk (MON), Port Jefferson (JFF), Port of Brooklyn (BRK)
- Rhode Island: Port of Providence (PRV), Port of Davisville, and Quonset Point (DVS, QST)
- Connecticut: Port of New London (NLD)
- Virginia: Port of Norfolk (NFK)
- Massachusetts: New Bedford Marine Commerce Terminal (NBD), Cashman Shipyard (Quincy, MA; QNC)
- Maryland: Sparrow's Point (SPP)
- New Jersey: Paulsboro Marine Terminal (PLB).

3.3 Operations and Maintenance (O&M)

Maintenance activities would be planned for periods of low wind and good weather (typically during spring and summer seasons), mostly during daylight hours. The WTGs would remain operational when not shut down for maintenance or when wind speeds are above or below operational cutoff thresholds.

3.3.1 O&M Activities

A summary of the WTG maintenance activities and the maximum frequency at which they are anticipated to occur is provided in Table 3.7, below.

Table 3.7. Summary of WTG Maintenance Activities.

Maintenance/Survey Activity	Indicative Frequency
Routine Service & Safety Surveys/Checks	Annual
Oil and HV Maintenance	Annual
Visual Blade Inspections (Internal and External)	Annual
Fault Rectification	As needed
Major Replacements	As needed
End of Warranty Inspections	At end of warranty period

Source: Revolution Wind COP March 2023

A summary of the WTG and OSS foundation maintenance activities and the anticipated frequency at which they are expected to occur is provided in Table 3.8.

Table 3.8. Foundation Maintenance Activities.

Maintenance/Survey Activity	Indicative Frequency
Above Water Inspection & Maintenance	Annual
Sea Floor Survey	At 1 year after commissioning, 2-3 years after commissioning and 5-8 years after commissioning. Frequency thereafter would depend on the findings of the initial surveys.
Subsea Inspection (to detect, measure record deterioration that could affect structural integrity)	3-5 years or defined based on risk
Major Maintenance	Every 8 years
Corrective Maintenance	As needed
End of Warranty Inspections	At end of warranty period

Source: Revolution Wind COP March 2023 (

Each WTG would require various oils, fuels, and lubricants to support O&M. Sulfur hexafluoride (SF_6) would also be used for insulation purposes. Table 3.9 provides a summary of the maximum quantities of these materials potentially required for each WTG. The spill containment strategy for each WTG comprises similar preventive, detective, and containment measures to those described for the OSSs. These measures include 100 percent leakage-free joints to prevent leaks at the connectors; high pressure and oil level sensors that can detect both water and oil leakage; and integrated retention reservoirs capable of containing 110 percent of the volume of potential leakages at each WTG. Additionally, WTG switchgear containing SF_6 will be equipped with integral low-pressure detectors to detect SF_6 gas leakages should they occur.

Table 3.9. Summary of the Maximum Potential Quantities of Oils, Fuels, Lubricants per WTG.

WTG System/Component	Material	Maximum Quantity per WTG
WTG Bearings, Yaw, and Pitch Pinyons	Grease	119 gallons (470 liters)
Hydraulic Pumping Unit, Hydraulic Pitch Actuators, Hydraulic Pitch Accumulators	Hydraulic Oil	142 gallons (540 liters)
Drive Train Gearbox (if applicable), Yaw/Pitch Drives Gearbox	Gear Oil	63 gallons (2(240 liters)
Blades and Generator Accumulators	Nitrogen	9,510 gallons (36,000 liters)
High-Voltage Transformer	Transformer Silicon/Ester Oil	1,611 gallons (6,100 liters)
Emergency Generator	Diesel Fuel	793 gallons (3,000 liters)*
Tower Damper and Cooling System	Glycol/Oil/Coolants	476 gallons (1,800 liters)

Source: Revolution Wind COP March 2023 (vhb 2023)
* Emergency generator is not housed on the WTG but would be brought to the WTG during commissioning or in an emergency power outage in which battery backup, power from other WTGs, or shore power was not available.

Table 3.10 describes routine OSS and cable maintenance activities. Revolution Wind will employ a proprietary state-of-the-art asset management system to inspect offshore transmission assets including the OSS (electrical components), RWEC, IAC, and OSS-Link Cable. This system provides a data-driven assessment of the asset condition and allows for prediction and assessment of whether inspections and/or maintenance activities should be accelerated or postponed. Revolution Wind indicates that the RWEC, IAC, and OSS-Link Cable typically have no maintenance requirements unless a fault or failure occurs. As described in section 3.5 below, Revolution Wind will carry out periodic bathymetry surveys along the cable routes. Should the periodic bathymetry surveys indicate that the cables no longer meet an acceptable burial depth (as determined by the Cable Burial Risk Assessment), remedial burial or secondary protection may be carried out. Submarine cables may need to be repaired or replaced due to fault or failure. In the COP, Revolution Wind estimates that a maximum of 10 percent of the cable protection placed during installation may require replacement/remediation over the lifetime of the Project.

Table 3.10. OSS and Cable Maintenance Activities.

Maintenance/Survey Activity	Indicative Frequency
Routine Service of Electrical Components	20 per year
Electrical Inspections	2 per year

Scheduled Maintenance of OSS Components	Annual
Sea Floor Survey (i.e., bathymetry, cable burial depth, cable protection)	Immediately following installation, then 1 year after commissioning, 2-3 years after commissioning and 5-8 years after commissioning.
Minor Corrective and Preventative Maintenance of OSS Equipment	5 per year
Major Corrective and Preventative Maintenance of OSS Equipment	2 per lifetime

Source: Revolution Wind COP March 2023

3.3.2 Vessel Operations - O&M Phase

As described in the BA, Revolution Wind has estimated that Project O&M would involve up to four crew transfer vessel and two services operations vessel trips per month for wind farm O&M, for approximately 2,730 vessel trips over the life of the Project. These trips would originate from an O&M facility located in either Montauk, New York, Port Jefferson, New York, or Davisville, Rhode Island. One or more CTVs ranging from 62 to 95 feet in length would service the RWF over the life of the Project. SOVs are larger mobile work platforms, approximately 215 to 305 feet long and 60 feet in beam, equipped with dynamic positioning systems used for more extensive, multi-day maintenance activities. Larger vessels like those used for construction and installation could be required for unplanned maintenance, such as repairing scour protection or replacing damaged WTGs. Those activities would occur on an as-needed basis. Helicopters may also be used for aerial inspections.

Table 3.11. Vessels and Anticipated Trips per Year for Offshore O&M by Project Component.

Activity Type	Vessel Type	Anticipated Trips per Year	Foundations	OSS	RWEC	IAC	OSS-Link Cable	WTGs
Routine (e.g., annual maintenance, troubleshooting, inspections)	SOV	26	X	X	X	X	X	X
	Daughter Craft	10	X	X	X	X	X	X
	CTV	52	X	X	X	X	X	X
	Shared CTV	13	X	X	X	X	X	X
Non-Routine (e.g., major components exchange)	Jack-up Vessel	As needed		X				X
	Cable-lay/Cable Burial Vessel	As needed			X	X	X	
	Support Barge	As needed		X	X	X	X	X

Source: COP March 2023

3.4 Decommissioning

The RWF and RWEC would be decommissioned and removed at the end of their operating period. The Lease (OCS A-0486) has a 25-year operating period, but could be extended to 30 or 35 years; BOEM has identified the operational period as 35 years in the BA. Consistent with the requirements of 30 CFR 585 and their lease, Revolution Wind would be required to remove or decommission all components of proposed action and clear the sea floor of all obstructions created by the proposed Project. All facilities would need to be removed 15 feet (4.6 m) below mudline (BML) (30 CFR 285.910(a). Absent permission from BSEE, Revolution Wind would have to achieve complete decommissioning within 2 years of termination of the lease and reuse, recycle, or responsibly dispose of all materials removed. Revolution Wind has submitted a conceptual decommissioning plan as part of the COP and will submit a decommissioning application prior to any decommissioning activities.

For both WTGs and OSSs, decommissioning would be a "reverse installation" process, with turbine components or the OSS topside structure removed prior to foundation removal. WTG components and the OSSs will be disconnected and will be removed using a jack-up lift vessel or a derrick barge. Cables will be removed, in accordance with BSEE regulations (30 CFR 285, Subpart I). A material barge would transport components to a recycling yard where the components would be disassembled and prepared for reuse and/or recycling for scrap metal and other materials.

The foundations will be cut by an internal abrasive water jet-cutting tool at 15 feet BML and returned to shore for recycling in the same manner described for the WTG components and the OSSs. Revolution Wind will be required to completely remove all transmission cables from the sediment to the extent practicable and remove all associated cable protection from the sea floor. Any cable segments that cannot be fully extracted would be cut off using a cable saw and buried at least 4 to 6 feet BML. All remaining components would be completely removed from the environment and collected for recycling of valuable metals and other materials. Revolution Wind will clear the area after all components have been decommissioned to ensure that no unauthorized debris remains on the sea floor. Onshore decommissioning requirements will be subject to state/local authorizations and permits.

The number and type of vessels required for project decommissioning would be similar to those used during project construction, with the exception that impact pile driving would not be required. As such, while the same class of vessel used for foundation installation may be used for decommissioning, that vessel would not be equipped with an impact hammer.

3.5 Surveys and Monitoring

Revolution Wind is proposing to carry out or BOEM is proposing to require that Revolution Wind carry out as conditions of COP approval, high-resolution geophysical (HRG) surveys and a number of ecological surveys/monitoring activities. These activities are described in the BA and are part of the proposed action that BOEM has requested consultation.

3.5.1 High-Resolution Geophysical Surveys

Intermittent geophysical surveys would be conducted prior to and during construction, operations, and decommissioning to identify any sea floor debris, MEC/UXO, and cultural and historical resources, and to survey for as-built requirements, O&M, and site clearance purposes.

HRG surveys would be conducted prior to construction and installation to finalize design and support micrositing of project features such as WTG and OSS foundations and cables. HRG surveys use a combination of sonar-based methods to map shallow geophysical features. The survey equipment is typically towed behind a moving survey vessel attached by an umbilical cable. HRG survey vessels move slowly, with typical operational speeds of less than approximately 4 knots.

These surveys are expected to utilize active acoustic equipment including multibeam echosounders, side scan sonars, shallow penetration sub-bottom profilers (SBPs) (*e.g.*, Compressed High-Intensity Radiated Pulses (CHIRPs) non-parametric SBP), medium penetration sub-bottom profilers (e.g., sparkers and boomers), ultra-short baseline positioning equipment, and marine magnetometers. Surveys would occur annually, with durations dependent on the activities occurring in that year (i.e., construction year versus a non-construction year). The purpose of surveying during non-construction years is to monitor seabed levels and scour protection, identify any risks to inter-array and export cable integrity, and conduct seabed clearance surveys prior to maintenance/repair.

BOEM has completed a programmatic ESA consultation with NMFS for HRG surveys and other types of survey and monitoring activities supporting offshore wind energy development (NMFS 2021a; Appendix C to this Opinion). As described in the Revolution Wind BA, BOEM will require Revolution Wind to comply with all relevant programmatic survey and monitoring PDCs and BMPs included in the 2021 programmatic ESA consultation; these measures are detailed in Appendix B of the programmatic consultation). HRG surveys related to the approval of the Revolution Wind COP are considered part of the proposed action evaluated in this Opinion and the applicable survey and monitoring PDCs and BMPs included in the 2021 programmatic ESA consultation are incorporated by reference. They are thus also considered components of the proposed action evaluated in this Opinion.

HRG surveys would utilize up to a maximum of four vessels working concurrently in different sections of the lease area and RWEC corridor. During the first year of construction, Revolution Wind estimates that 9,669 km would be surveyed over 136.6 days in the lease area, and 5,748 km would be surveyed along the RWEC corridor over 82.1 days, in water depths ranging from 2 m (6.5 ft.) to 50 m (164 ft.). During the next 4-years, Revolution Wind estimates 2,117 km would be surveyed in the lease area over 30.2 days and 1,642 km would be surveyed over 23.5 days along the RWEC corridor each year. Revolution Wind anticipates that each vessel would survey an average of 70 km (44 miles) per day, assuming a 4 km/hour (2.16 knots) vessel speed and 24-hour operations. Over the course of 5 years, HRG surveys would be conducted at any time of year for a total of 30,343 km (18,854 miles) over 433.5 vessel days. Each day that a survey vessel covers 70 km (44 miles) of survey trackline is considered a vessel day. In this schedule, Revolution Wind accounted for periods of downtime due to inclement weather or technical malfunctions.

3.5.2 Fisheries and Benthic Monitoring

Revolution Wind is proposing to implement their Fisheries Research and Monitoring Plan (FRMP; Revolution Wind and Inspire Environmental 2023); in the BA, BOEM identified this as part of the Proposed Action for this ESA consultation. A revised FRMP was provided to NMFS in May 2023, post-dating initiation of this consultation; the May 2023 FRMP has been incorporated into this Opinion. We note that the FRMP includes a description of a ventless trap survey along the cable route in Rhode Island state waters; however, BOEM has described that the state waters ventless trap survey is conducted by the Rhode Island Department of Environmental Management (RIDEM) as an extension of their existing lobster survey program. The survey will occur regardless of the Revolution Wind project; therefore, while Revolution Wind may support this effort and use data from the survey to inform the findings of the FRMP, the survey is not part of the proposed action here and will not be considered further.

Ventless Trap Surveys
Ventless trap surveys will be used to evaluate changes in the distribution and abundance of lobsters and crabs in the WDA and adjacent reference areas. Following submission of the BA, Revolution Wind and BOEM informed us that they are proposing to carry out the ventless trap survey with "ropeless" methodology, which will eliminate all vertical lines and buoys. All groundlines will be constructed of sinking line.

Ventless traps will be set at two locations within the RWF and two reference locations adjacent to the RWF to the east and west (see Figure 10 in the FRMP). Sites within each location will be randomly selected using the spatially balanced sampling approach employed in the Southern New England Cooperative Ventless Trap Survey (SNECVTS) (Collie and King 2016). Twelve surveys per month will occur from May through November; surveys will begin in 2023 and continue during construction and for two years following completion of Project construction and installation for a total of up to five years of planned surveys. Between monthly sampling sessions, all gear will be removed from the water and stored on land. The standard soak time will be five nights, which is consistent with local fishing practices. Traps will be baited with locally available bait (likely skate), and the bait type will be recorded for each trawl. Each trawl will be configured with 10 traps. The BACI survey will employ a combination of six ventless traps, and four standard vented traps on each trawl. The BAG survey will employ 10 ventless traps. There will be four ventless traps and two vented traps on each ground line, spanning over 400 feet of ground line, with traps separated from each other by approximately 80 feet. Traps will consist of a single parlor trap that is 16 inches high, 40 inches long, and 21 inches wide with 5-inch entrance hoops and constructed with 1-inch square rubber-coated 12-gauge wire that is consistent with traps used in the ASMFC and SNECVTS ventless trap surveys. The trap is constructed with a disabling door that closes off the entrance during periods when the trap is on the bottom but not sampling.

Otter Trawl Surveys
Otter trawl surveys will be carried out to assess abundance and distribution of target fish and invertebrate species. Three randomly selected trawl sites will be identified, one in the northern half of the lease area where substrate conditions are suitable for benthic trawling and two reference survey areas located to the west of the impact survey area (adjacent to the lease area). Trawl surveys will be carried out four times per year in winter (December, January, and February), spring (March, April, and May), summer (June, July and August), and fall (September, October, November). A sample size of 15 trawl tows per area will be targeted per season in each year; this will result in 180 trawl tows per year. Surveys are expected to begin in late summer of fall 2023 and will continue during construction and for two years following

completion of project construction and installation for a total of up to four complete survey years (e.g., Fall 2023-Summer 2027). Each survey will consist of 15 20-minute tows. The net planned for use is a 400 x 12-centimeter (cm) three-bridle four-seam bottom trawl, and the net is paired with Thyboron, Type IV 168 cm (66 inch [in]) trawl doors. A 2.5-cm (1-inch) knotless codend liner will be used to sample marine taxa across a broad range of size and age classes. The trawl survey will use sampling gear and protocols consistent with the Virginia Institute of Marine Science's (VIMS) Northeast Area Monitoring and Assessment Program (NEAMAP) trawl survey.

Acoustic Telemetry – Highly Migratory Species
To complement existing studies, Revolution Wind will maintain an additional 15 VEMCO model VR2-AR receivers within the Revolution Wind lease area and surrounding waters. Receivers are deployed on the bottom, consistent with manufacturer recommendations. In the spring and fall of each year, acoustic receivers will be summoned, downloaded, cleaned, and re-deployed. Receiver deployment and maintenance will be done primarily in collaboration with a local commercial fishing vessel. Acoustic receivers will monitor for the presence of fish and sharks tagged with existing VEMCO compatible tags while also monitoring and recording water temperature and ambient noise. Revolution Wind also proposes to capture and tag 150 tuna and sharks (50 annually from 2023-2025) using rod and reel from a charter or commercial fishing vessel operating in or near the WDA.

Benthic Monitoring
Revolution Wind will monitor impacts and changes to hard-bottom and soft-bottom habitat in response to construction disturbance and habitat modification. Hard bottom monitoring will focus on measuring changes in percent cover, species composition, and volume of macrofaunal attached communities using a combination of acoustic survey and remotely operated vehicle imaging techniques. Targeted high-resolution acoustic surveys (side-scan sonar [SSS] and multibeam echosounder [MBES]) will be conducted over the selected IAC corridors prior to boulder relocation and again after all construction is complete to map boulder locations within the survey areas. Survey areas will include existing undisturbed boulder distributions in selected areas adjacent to the IAC corridor to facilitate comparison between disturbed and undisturbed sites. Post-construction surveys will be compared to existing MBES and SSS data to identify the survey areas. Soft-bottom monitoring will employ sediment profile imaging and plan view (SPI/PV) survey techniques. Surveys will occur at 1-, 2-, 3-, and 5-years post-construction.

3.5.3 Passive Acoustic and Other Environmental Monitoring
Revolution Wind will deploy passive acoustic monitoring (PAM) buoys or autonomous PAM devices to record ambient noise, vocalizing marine mammals, and cod vocalizations in the Lease Area before, during, and after construction for at least three years to monitor construction and operational noise. BOEM will require the archival recorders to have a minimum capability of detecting and storing acoustic data on anthropogenic noise sources, vocalizing marine mammals, and cod vocalizations in the Lease Area. The deployment of six receivers is anticipated. Monitoring will be conducted using the data collection, processing methods, and visualization metrics developed by the Atlantic Deepwater Ecosystem Observatory Network (ADEON) for the U.S. Mid- and South Atlantic OCS (see https://adeon.unh.edu/). Additional meteorological buoys to provide real-time weather data and other data collection buoys may be temporarily

deployed in the Project area during construction and operations. All buoy deployments will comply with the project design criteria and best management practices included in NMFS 2021 informal programmatic consultation on site assessment activities (see Appendix B to the programmatic consultation).

3.6 Minimization and Monitoring Measures that are part of the Proposed Action

There are a number of measures that Revolution 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 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. Additionally, NMFS OPR includes a number of measures to avoid, minimize, or monitor effects in the proposed MMPA ITA (see below); these measures are also considered as part of the proposed action for this consultation. The ITA only proposes mitigation and monitoring measures for marine mammals including the threatened and endangered whales considered in this Opinion. Although some measures for marine mammals 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, and thus mandatory for implementation, are described in Table 3.18 and 3.19 in BOEM's BA and for ease of reference, are copied into Appendix A of this Opinion. These are in addition to the conditions of the proposed ITA, which are also part of the proposed action. We note that the final MMPA ITA may contain measures that include requirements that may differ from the proposed rule; as explained in this Opinion's ITS, compliance with the conditions of the final MMPA ITA is necessary for the ESA take exemption to apply.

BOEM and NMFS OPR are proposing to require monitoring of clearance and shutdown zones before and during pile driving as well as clearance zones prior to UXO relocation or detonation. More information is provided in the *Effects of the Action* section of this Opinion. These zones are summarized in table 3.3.3. In addition to the clearance and shutdown zones, the MMPA ITA identifies minimum visibility zones for pile driving of WTG and OSS foundations. These are the distances from the pile that the visual observers must be able to effectively monitor for marine mammals; that is, lighting, weather (e.g., rain, fog, etc.), and sea state must be sufficient for the observer to be able to detect a marine mammal within that distance from the pile. The clearance zone is the area around the pile or UXO that must be declared "clear" of marine mammals and sea turtles prior to the activity commencing. The size of the zone is measured as the radius with the impact activity (i.e., pile or UXO) at the center. For sea turtles, the area is "cleared" by visual observers determining that there have been no sightings of sea turtles in the identified area for a prescribed amount of time. For marine mammals, both visual observers and passive acoustic monitoring (PAM, which detects the sound of vocalizing marine mammals) will be used; the area is determined to be "cleared" when visual observers have determined there have been no sightings of marine mammals in the identified area for a prescribed amount of time and, for North Atlantic right whales in particular, if no right whales have been visually observed in any area beyond the minimum clearance zone that the visual observers can see. Further, the PAM operator will declare an area "clear" if they do not detect the sound of vocalizing right whales within the identified PAM clearance zone for the identified amount of time. Pile driving or UXO detonation cannot commence until all of these clearances are made.

Once pile driving begins, the shutdown zone applies. There is no shutdown zone for UXO detonation as once a detonation begins it cannot be stopped; additionally, the duration of the detonation is extremely short (one second). If a marine mammal or sea turtle is observed by a visual PSO entering or within the respective shutdown zones after pile driving has commenced, an immediate shutdown of pile driving will be implemented unless Revolution 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. For right whales, shutdown is also triggered by: the visual PSO observing a right whale at any distance (i.e., even if it is outside the shutdown zone identified for other whale species), and a detection by the PAM operator of a vocalizing right whale at a distance determined to be within the identified PAM shutdown zone. If shutdown is called for but Revolution 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 when the lead engineer determines it is practicable. As described in Revolution 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, Revolution 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, Revolution 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. Revolution Wind 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, Revolution 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, Revolution

Wind 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 3.12. Proposed clearance and exclusion zones.
Note that these are in addition to a minimum visibility zone of 2,300m May-November (4,400m in December) for WTG foundations and 1,600m May-November (2,700m December) for OSS foundations. Zone sizes identified here are those described in the proposed MMPA ITA and BOEM's BA.

Species	Clearance Zone (m)	Shutdown Zone (m)
Impact pile driving[a]		
North Atlantic right whale – visual PSO	Minimum visibility zone plus any additional distance observable by the visual PSOs	Minimum visibility zone plus any additional distance observable by the visual PSOs
North Atlantic right whale – PAM WTG	3,900 (4,300)	3,900 (4,300)
North Atlantic right whale – PAM OSS	4,100 (4,700)	4,100 (4,700)
Blue, fin, sei, and sperm whale – WTG foundation	2,300 (4,400)	2,300 (4,400)
Blue, fin, sei, and sperm whale – OSS foundation	1,600 (2,700)	1,600 (2,700)
Sea Turtles	500	500
Cofferdam Installation		
NARW, blue, fin, sei, and sperm whale	100	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.

3.7 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 Revolution Wind an ITA for the take of small numbers of marine mammals incidental to construction of the project with a proposed duration of five years, it is anticipated that the proposed regulation would be effective from October 5, 2023 to October 4, 2028. More information on the proposed Incidental Take Regulation (ITR) and associated Letter of Authorization (LOA), including Revolution Wind's application is available online (*https://www.fisheries.noaa.gov/action/incidental-take-authorization-revolution-wind-llc-construction-revolution-wind-energy*). As described in the Notice of Proposed Rule (87 FR 79072; December 23, 2022), take of marine mammals may occur incidental to the construction of the project due to in-water noise exposure resulting from Project activities likely to result in incidental take include pile driving (impact and vibratory), detonation of unexploded ordnance (UXO/MEC), and vessel-based site assessment surveys using high-resolution geophysical (HRG) equipment.

3.7.1 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 Level B harassment as the only type of take of ESA listed species 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.

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) the number of days of activities. NMFS OPR is proposing to authorize MMPA take of ESA listed marine mammals resulting from noise exposure from impact pile driving for foundation installation, UXO detonations, and HRG surveys (see Table 3.13). We note that while the proposed rule included a proposed authorization for level B take of two sperm whales due to exposure to noise during vibratory installation of cofferdams, NMFS OPR has since determined that this take will not be included in the final rule. This is because, similar to the conclusions made for mysticetes, no sperm whales are expected to occur in the area where noise will be above the Level A or Level B thresholds during vibratory installation or removal of the cofferdam structures. Similarly, no Level A or Level B harassment is expected for any ESA listed whales due to noise exposure from casing pipe or goal post installation or removal.

Table 3.13. Take of ESA Listed Species by Level A Harassment and Level B Harassment Proposed for Authorization through the MMPA ITA, inclusive of HRG Surveys*

Species	Total	
	Level A	Level B
Blue Whale	0	7
Fin Whale	0	48
North Atlantic Right Whale	0	56
Sei Whale	0	26
Sperm Whale	0	13**

*As described in the Effects of the Action section, no incidental take, as defined by the ESA, is expected to occur as a result of HRG surveys
source: Information in 87 FR 79072
**The two takes of sperm whales associated with installation/removal of cofferdams included in the proposed ITA have been removed from this table.

Installation of Monopiles 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 3.14 show the proposed Level A and Level B take to be authorized resulting from impact pile driving (79 monopiles for WTG foundations and 2 monopiles for OSS foundations) assuming 10 dB attenuation (as required by conditions of the proposed ITA).

Table 3.14. Take of ESA Listed Species by Level A and B Harassment Proposed for Authorization through the MMPA ITA Resulting from Impact Pile Driving of 81 Monopiles

Species		
	Level A Harassment	Level B Harassment
Blue whale	0	1
Fin whale	0	16
North Atlantic right whale	0	22
Sei whale	0	8
Sperm whale	0	3

Source: Information in 87 FR 79072

Potential UXO/MEC Detonations
As described in the Notice of Proposed ITA, for potential UXO detonations, acoustic modeling was conducted to determine distances to thresholds for behavioral disturbance, temporary threshold shift (TTS), permanent threshold shift (PTS), and non-auditory injury. Table 3.15 shows the amount of Level A and Level B harassment that NMFS OPR is proposing to authorize resulting from the detonation of 13 UXOs, assuming 10 dB of sound attenuation.

Table 3.15. Take of ESA Listed Species by Level a Harassment and B Harassment Proposed for Authorization through the MMPA ITA from the Detonation of up to 13 UXOs, Assuming 10 dB of Sound Attenuation

Species	Level A Harassment	Level B Harassment (TTS)
Blue whale	0	1
Fin whale	0	17
North Atlantic right whale	0	12
Sei whale	0	8
Sperm whale	0	2

Source: Information in 87 FR 79072

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. The amount of Level A and Level B harassment take proposed for authorization by NMFS OPR is illustrated in Table 3.16.

Table 3.16. Take of ESA Listed Species by Level B Harassment Proposed for Authorization through the MMPA ITA Resulting from High-Resolution Geophysical Surveys Over 5-years.

Marine Mammal Species	Construction Phase (Year 1)	Post-Construction (Years 2 to 5)
	Level B Harassment	Level B Harassment
Blue whale	1	4
Fin whale	7	8
North Atlantic right whale	10	12
Sei whale	2	8
Sperm whale	2	8

Source: Information in 87 FR 79072

3.7.2 Mitigation Measures Included in the Proposed ITA
The proposed ITA includes a number of minimization and monitoring methods that are designed to ensure that the proposed project has the least practicable adverse impact upon the affected species or stocks and their habitat and would be required to be implemented by Revolution Wind. The proposed ITA, inclusive of the proposed mitigation requirements, has been published in the FR (87 FR 79072). The proposed mitigation measures 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 (Appendix A as referenced above). The mitigation measures included in the December 2022 Proposed ITA are listed in Appendix B.

3.8 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." 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."

The action area includes the WDA where construction, operations and maintenance, and decommissioning activities will occur and the surrounding areas ensonified by noise from project activities; the cable corridors; and the areas where HRG and biological resource surveys will take place. Additionally, the action area includes the US EEZ along the Atlantic and Gulf coasts; this includes the vessel transit routes between the WDA and ports in Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Maryland, and Virginia; and the routes used by vessels transporting manufactured components from ports along the U.S. South Coast in the Gulf of Mexico to the project site. As explained below, it does not include a portion of the vessel transit routes between the WDA and ports in Canada, Europe, or Asia outside the US EEZ as we have determined that the effects of vessel transit from those ports are not effects of the proposed action as defined in 50 CFR 402.17.

In the BA, BOEM identifies the potential for up to 26 vessel transits associated with the proposed project to originate from ports in Canada, Europe, or Asia. These trips will occur at some time during the 2-year construction phase. The ports that these vessels will originate from in Canada, Europe, and Asia and the vessel routes from those port facilities to the project site are unknown and will be variable and depend, on a trip-by-trip basis, on weather and sea-state conditions, other vessel traffic, and any maritime hazards. These vessels are expected to enter the US EEZ along the Atlantic Coast and then travel along established traffic lanes and fairways until they approach the lease area. Because the ports of origin and vessel transit routes are unknown, we are not able to identify what areas outside the US EEZ will be affected directly or indirectly by the Federal action; that is, while we recognize that there will be vessel trips outside of the US EEZ that would not occur but for the approval of Revolution Wind's COP, we cannot identify what areas vessel transits will occur as a result of BOEM's proposed approval of Revolution Wind's COP. Though these vessel transits may be caused by the proposed action, without specific information including vessel types and size, the ports of origin, and, the location, timing and routes of vessel transit, we cannot predict that specific consequences of these activities on listed species[8] are reasonably certain to occur, and they are therefore not considered effects of the proposed action. 50 CFR 402.17(a)-(b). Therefore, the action area is limited to the US EEZ off the Gulf and Atlantic coasts of the United States.

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[8] In an abundance of caution, we have considered the risk that these vessel trips may pose to ESA listed species that may occur outside the US EEZ. We have determined that these species fall into two categories: (1) species that are not known to be vulnerable to vessel strike and therefore, we would not expect a project vessel to strike an individual regardless of the location of the vessel; or (2) species that may generally be vulnerable to vessel strike but outside the US EEZ, co-occurrence of project vessels and individuals of those ESA listed species are expected to be extremely unlikely due to the seasonal distribution and dispersed nature of individuals in the open ocean, and intermittent presence of project vessels. These factors make it extremely unlikely that there would be any effects to ESA listed species from the operation of project vessels outside the EEZ.

4.0 SPECIES AND CRITICAL HABITAT NOT CONSIDERED FURTHER IN THIS OPINION

In the BA, BOEM addresses a number of species and designated critical habitat that may occur in the action area but either will not be affected by the proposed action (i.e., the proposed action will have no effect on the species) or for which all effects will be insignificant or discountable (i.e., the proposed action may affect but is not likely to adversely affect the species). Here, we address those species and designated critical habitat identified in BOEM's BA and present our own analysis of potential effects.

4.1 ESA Listed Species

ESA Listed Corals – Threatened and Endangered

There are six species of corals protected under the ESA that occur in the action area: Elkhorn coral (*Acropora palmata*); Staghorn coral (*Acropora cervicornis*); Boulder star coral (*Orbicella franksi*); Mountainous star coral (*Orbicella faveolata*); Lobed star coral (*Orbicella annularis*); Rough cactus coral (*Mycetophyllia ferox*); and Pillar coral (*Dendrogyra cylindrus*) (79 FR 53851). The only activity that overlaps with the distribution of these species are vessel transits to/from ports in the Gulf of Mexico, including transits along the U.S. South Atlantic coast. Transit routes for project vessels may co-occur with coral habitats, however, no impacts to corals are anticipated along vessel transit routes as water depths exclude the potential for vessel hulls and propellers to interact with the sessile species, and no anchoring will occur in areas where corals could be present. No effects to any of these coral species are anticipated.

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 WDA or where surveys will occur. While in the U.S. EEZ, vessels transiting to/from Canada could overlap with the marine distribution of Atlantic salmon. However, even if migrating salmon occurred along the routes of these vessels, 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 Canada. The proposed action will have no effect on the Gulf of Maine DPS of Atlantic salmon.

Gulf Sturgeon (Acipenser oxyrinchus desotoi) – Threatened

The Gulf sturgeon is a sub-species of the Atlantic sturgeon that can be found from Lake Pontchartrain and the Pearl River system in Louisiana and Mississippi to the Suwannee River in Florida (USFWS and NMFS 2009). Historically the species ranged from the Mississippi River east to Tampa Bay. Gulf sturgeon spawn in rivers in the spring and fall and spend the summer months between the upstream spawning areas and the estuary. In the winter, adults will move into marine waters but younger fish remain in the estuarine and freshwater habitats for their first few years.

The only portion of the action area that could potentially overlap with the range of Gulf sturgeon are the vessel transit routes to and from Gulf of Mexico ports. The few vessels trips to/from the Gulf of Mexico (up to 21 over two-years) are anticipated to occur from ports west of the Mississippi River associated with oil and gas operations, where Gulf sturgeon do not occur. The distribution of Gulf sturgeon within the Gulf of Mexico is limited to the northeastern areas of the Gulf. Vessels transiting from western Gulf of Mexico ports are not expected to be in these areas. As such, we do not expect any effects on Gulf sturgeon caused by project vessels. The proposed action will have no effect on Gulf sturgeon.

Nassau Grouper (Epinephelus striatus) – Threatened
Nassau grouper are reef fish found in tropical and subtropical waters of the western North Atlantic. This includes Bermuda, Florida, Bahamas, the Yucatan Peninsula, and throughout the Caribbean to southern Brazil. There has been one verified report of Nassau grouper in the Gulf of Mexico at Flower Gardens Bank. They generally live among shallow reefs, but can be found in depths to 426 ft (NMFS 2013). The range of Nassau grouper is described as including the southeastern portion of the Gulf of Mexico between the Florida coast and the Yucatan Peninsula (NMFS 2013). As described in NMFS 2013, the Nassau grouper is considered a reef fish, but it transitions through a series of ontogenetic shifts of both habitat and diet. As larvae, they are planktonic; as juveniles, they are found in nearshore shallow waters in macroalgal and seagrass habitats. They shift progressively deeper with increasing size and maturation into predominantly reef habitat (e.g., forereef and reef crest). Adult Nassau grouper tend to be relatively sedentary and are found most abundantly on high relief coral reefs or rocky substrate in clear waters (Sadovy and Eklund 1999 in NMFS 2013), although they can be found from the shoreline to about 100-130 m. Larger adults tend to occupy deeper, more rugose, reef areas (Semmens et al. 2007a in NMFS 2013).

Overlap with the range of Nassau grouper and the action area is limited to the portion of the action area where vessels transiting to or from ports in the Gulf of Mexico would move through the southeastern portion of the Gulf of Mexico into the Atlantic Ocean. Given the primary distribution of Nassau grouper over reef habitats, which will be avoided by the transiting vessels, there is a low potential for occurrence of Nassau grouper in the areas where vessels will transit. Further, the near-bottom distribution of Nassau grouper in the water column makes it extremely unlikely that there would be any interactions with any project vessels. Vessel strikes are not identified as a threat in the biological report that supported the listing determination (NMFS 2013), listing determination (81 FR 42268), or the recovery outline (NMFS 2018). We have no information to suggest that vessels in the ocean have any effects on Nassau grouper. Therefore, we do not expect any effects to this species even if individuals co-occur with project vessels. The proposed action will have no effect on Nassau grouper.

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 action area does not overlap with the distribution of the Northeast Atlantic DPS of loggerheads. The proposed action will have no effect on the Northeast Atlantic DPS of loggerheads.

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, or 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 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 WDA and the area 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 of the U.S. EEZ that may be transited by vessels traveling to/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. The proposed action will have no effect on the oceanic whitetip shark.

Smalltooth Sawfish (Pristis pectinate) – Endangered

Smalltooth sawfish live in shallow, coastal waters of tropical seas and estuaries of the Atlantic Ocean and sometimes enter the lower reaches of tropical freshwater river systems. The historical range for smalltooth sawfish in the western Atlantic extended from Brazil to the Gulf of Mexico and eastern seaboard of the U.S. (Carlson et al. 2013 in NMFS 2018). However, the species has been wholly or nearly extirpated from large areas of its historical range, and in U.S. waters smalltooth sawfish are now found only off the coast of Florida (NMFS 2018). Small, juvenile smalltooth sawfish are generally restricted to mangroves and estuaries around the Florida peninsula, where project vessels will not travel. Larger adults have a broader distribution and could be found in the southeastern Gulf of Mexico in nearshore waters along the Florida shoreline. Given the distribution of the species in nearshore waters, the occurrence of smalltooth sawfish along the deepwater areas that will be used by project vessels to transit to or from Gulf of Mexico ports is extremely unlikely. Vessel strikes are not identified as a threat in the listing determination (68 FR 15674), the most-recent 5-year review (NMFS 2018), or the recovery plan (NMFS 2009). We have no information to suggest that vessels in the ocean have any effects on smalltooth sawfish. Therefore, we do not expect any effects to this species even if individuals unexpectedly occurred along the vessel transit routes to be traveled by project vessels. The proposed action will have no effect on smalltooth sawfish.

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. 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 ft (200 to 400 m) (NMFS 2019a); the only portion of the action area with these depths is along the vessel transit routes south and east of the WDA. Based on the documented distribution of the species, Giant manta rays are not anticipated to occur in the WDA or in areas where surveys will occur. 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, Chesapeake Bay, and the Gulf of Mexico) and east of the lease area (i.e., within the U.S. EEZ where vessels travel across the continental shelf edge south of 40°N).

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 area where these vessels will operate, and the small number of potential vessel trips through the range of Giant manta rays (i.e., up to 21 trips to/from the Gulf of Mexico and up to 28 trips to/from ports in NJ, MD, and VA) make any effects of the proposed action extremely unlikely to occur. Since there will be no effects from potential exposure to vessel noise, and all other effects will be discountable, no take is anticipated and 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).

Given their rarity in waters north of Florida, hawksbill sea turtles are not expected to occur in the WDA. The presence of hawksbill sea turtles in the action area is limited to the portion of the action area in the Gulf of Mexico and off the Florida coast that may be transited by project vessels. As noted in Section 3.0, use of this area is expected to be limited to up to 21 vessel trips during the two-year construction period. Given the low numbers and dispersed nature of hawksbills in the areas where vessels will transit and the small number of vessel trips, it is extremely unlikely that any hawksbill sea turtles will co-occur with project vessels. As such, effects to hawksbill sea turtles from vessel operations are also extremely unlikely to occur. No take is anticipated. As all effects will be discountable, the proposed action is not likely to adversely affect the hawksbill sea turtle.

Rice's whale (Balaenoptera ricei) – Endangered
On August 23, 2021, NMFS issued a direct final rule to revise the common and scientific name of the Gulf of Mexico Bryde's whale to Rice's whale, *Balaneoptera ricei*, and classification to species to reflect the scientifically accepted taxonomy and nomenclature of the whales (86 FR 47022). The distribution of Rice's whale is limited to the northeastern Gulf of Mexico, along the continental shelf break between 100 m and 400 m depths (Rosel et al. 2016). The only project-related activity that has the potential to overlap with the species distribution is a portion of the vessel activity. We have considered whether vessels transiting to and from the project area from ports in the Gulf of Mexico could potentially encounter Rice's whales. BOEM estimates up to 21 trips between Gulf of Mexico ports and the WDA, with any ports of origin in the Gulf of Mexico likely located west of the mouth of the Mississippi River. These vessel routes are not anticipated to overlap with the distribution of Rice's whales. Based on the vessel transit routes, which are anticipated to be south and west of the distribution of Rice's whales, it is extremely unlikely that any Rice's whales will co-occur with project vessels. As such, effects to Rice's whales are extremely unlikely to occur. No take is anticipated. As all effects will be discountable, the proposed action is not likely to adversely affect the Rice's whale.

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). Some vessels traveling from ports in Canada may transit through

portions of Unit 1 while within the U.S. EEZ. Additionally, vessels transiting to/from ports in the Gulf of Mexico or other South Atlantic ports may transit through Unit 2. 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 Canada, 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 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 Revolution Wind project would extend to Unit 1. The Revolution 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 Revolution Wind project is not anticipated to cause changes to the physical or biological features of critical habitat by worsening climate change. 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 m, 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 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 WDA. The only project activities that may overlap with Northwest Atlantic loggerhead DPS critical habitat are vessels transiting to or from the project site from ports outside the Northeast U.S. As explained below, the proposed action will have no effect on this critical habitat.

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 occasional 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 occasional 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 occasional 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.

Critical Habitat Designated for the New York Bight DPS of 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. 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 river kilometer 139). 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.

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 (RM 132.5), downstream to where the main stem river discharges into Delaware Bay at approximately RKM 78 (RM 48.5).

The Biological Opinions prepared by NMFS for the Paulsboro Marine Terminal considered effects of construction of the 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. Based on the available information, we expect that Revolution Wind vessels are similar to the vessels considered in the Paulsboro 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. We have determined that because the number of trips and vessel types are consistent with the activities described in the Paulsboro 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 Revolution Wind project. We have not identified any effects of the Revolution Wind project on critical habitat designated for the New York Bight DPS of Atlantic sturgeon that are beyond what was considered in the Paulsboro consultation; therefore, Revolution Wind vessels are not likely to adversely affect that that critical habitat.

5.0 STATUS OF THE SPECIES

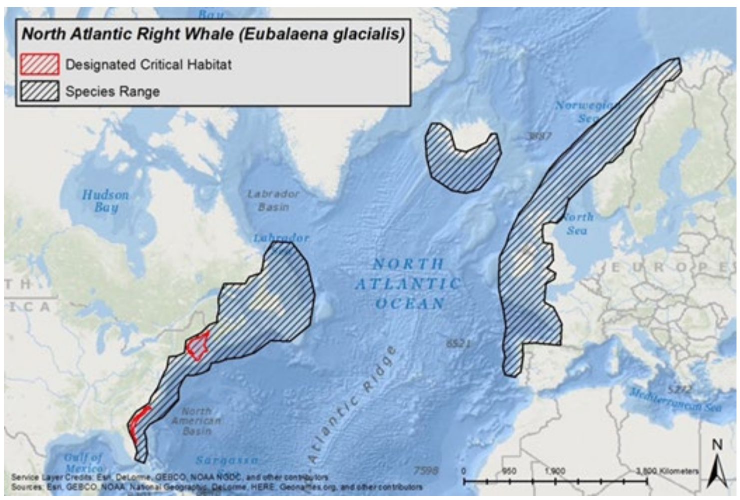
5.1 Marine Mammals

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*[9]), 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

[9] 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.

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. 2017a). From 1983 to 2005, annual 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. 2017b; 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.[10] 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 July 3, 2023, there are 36 confirmed mortalities for the UME, 33 serious injuries, and 29 sublethal injuries or illness (for more information on UMEs, see https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-unusual-

[10] 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).

mortality-events). Mortalities are recorded as vessel strike (12), entanglement (9), perinatal (2), unknown/undetermined (3), or not examined (10).[11]

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, 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[12].

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

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[11] https://www.fisheries.noaa.gov/national/marine-life-distress/2017-2023-north-atlantic-right-whale-unusual-mortality-event; last accessed July 3, 2023

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

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 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.

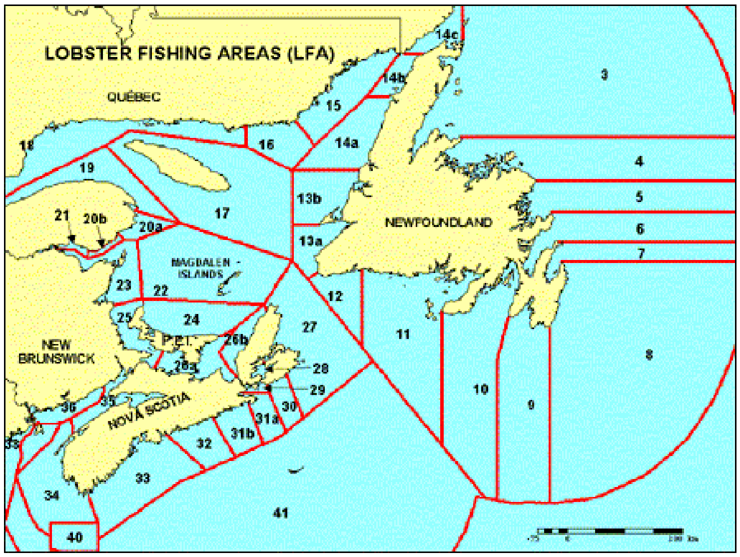
Fishery Interactions in Canadian Waters
There are numerous fisheries operating in Canadian waters. Rock and toad crab fisheries, as well as fixed gear fisheries for cod, Atlantic halibut, Greenland halibut, winter flounder, and herring have historically had few interactions. While these fisheries deploy 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.[13] 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

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

(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.

Figure 5.1.2. Lobster fishing areas in Atlantic Canada.



Source: 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[14]. 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

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

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 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 m 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.

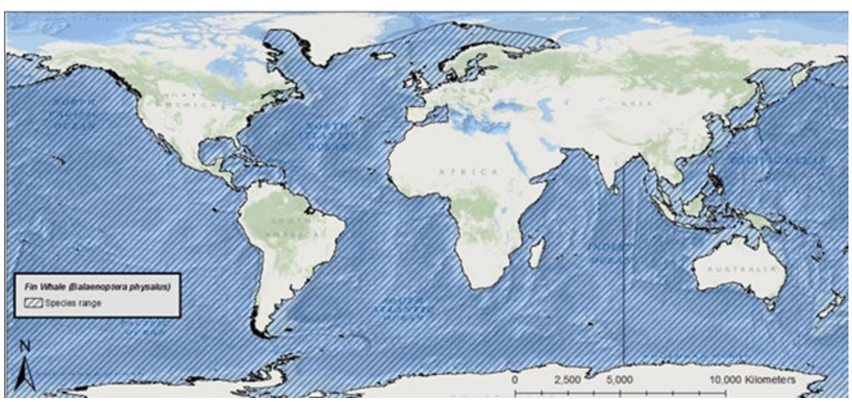
Specific criteria for delisting North Atlantic right whales are not included in the recovery plan; as described in the recovery plan, conditions related to delisting are too distant and hypothetical to realistically develop specific criteria. The current abundance of North Atlantic right whales is currently 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. 2019), 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. 2019, 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).[15] 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.

[15] 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).

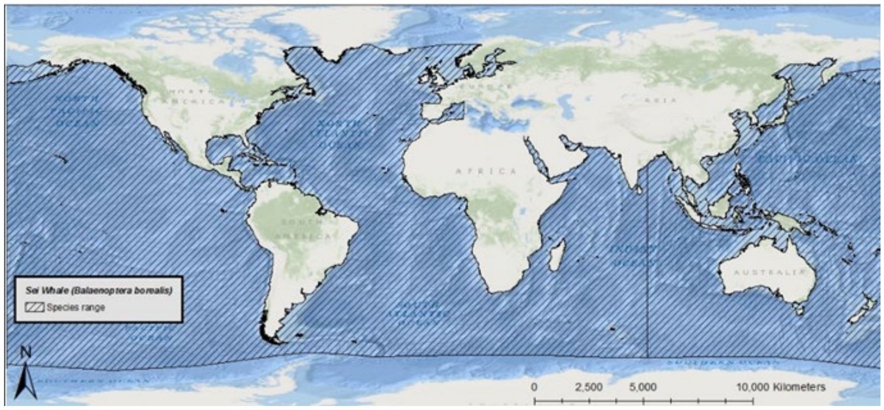
Recovery Goals
The goal of the 2010 Recovery Plan for the fin whale (NMFS 2010a) is to promote the recovery of fin whales to the point at which they can be downlisted from endangered to threatened status, and ultimately to remove them from the list of Endangered and Threatened Wildlife and Plants, under 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:

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 180°), 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

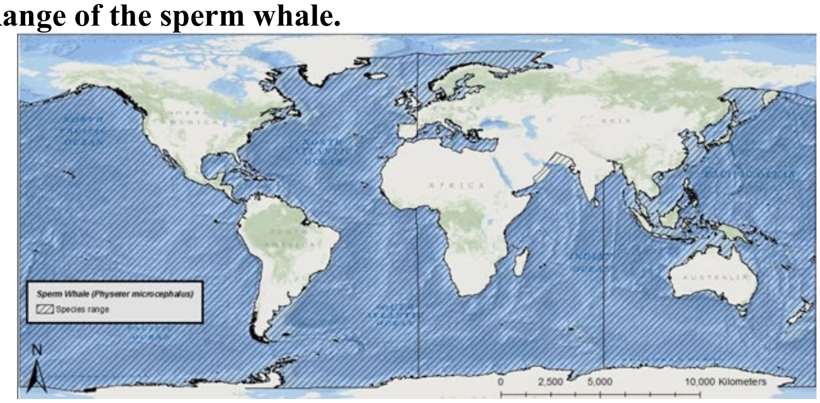
Endangered and Threatened Wildlife and Plants, under the provisions of the ESA. The intermediate goal is to reclassify the species from endangered to threatened. The recovery plan incorporates an adaptive management strategy that divides recovery actions into three tiers. Tier I involves: 1) continued 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. 2019), 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. 2019, 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[16], 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 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 2010b).

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.*

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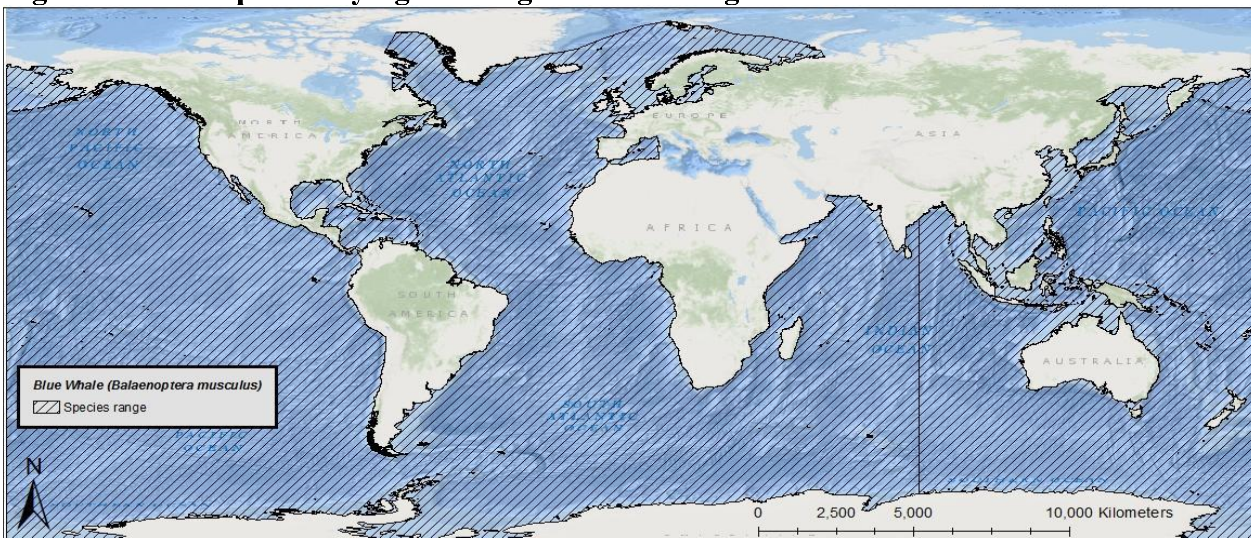
[16] Allee effects are broadly characterized as a decline in individual fitness in populations with a small size or density.

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. 2019), 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 m.

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

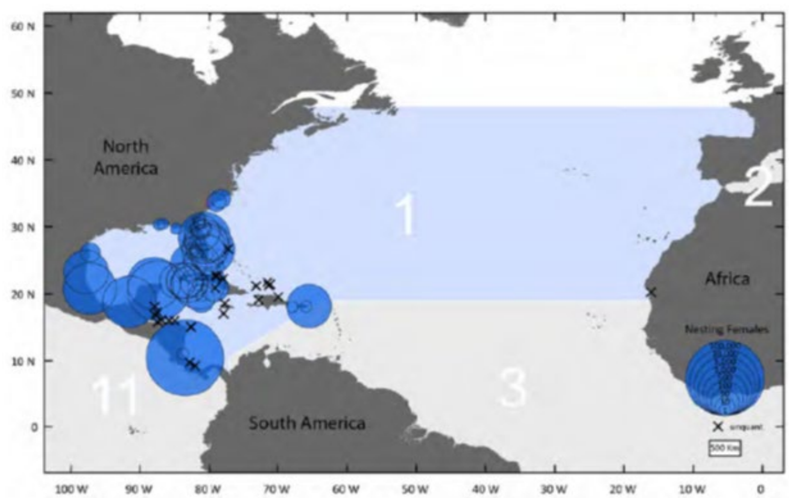
Kemp's ridley and leatherback sea turtles are currently listed under the ESA at the species level; green and loggerhead sea turtles are listed at the DPS level. Therefore, we include information on the range-wide status of Kemp's ridley and leatherback sea turtles to provide the overall status of each 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.

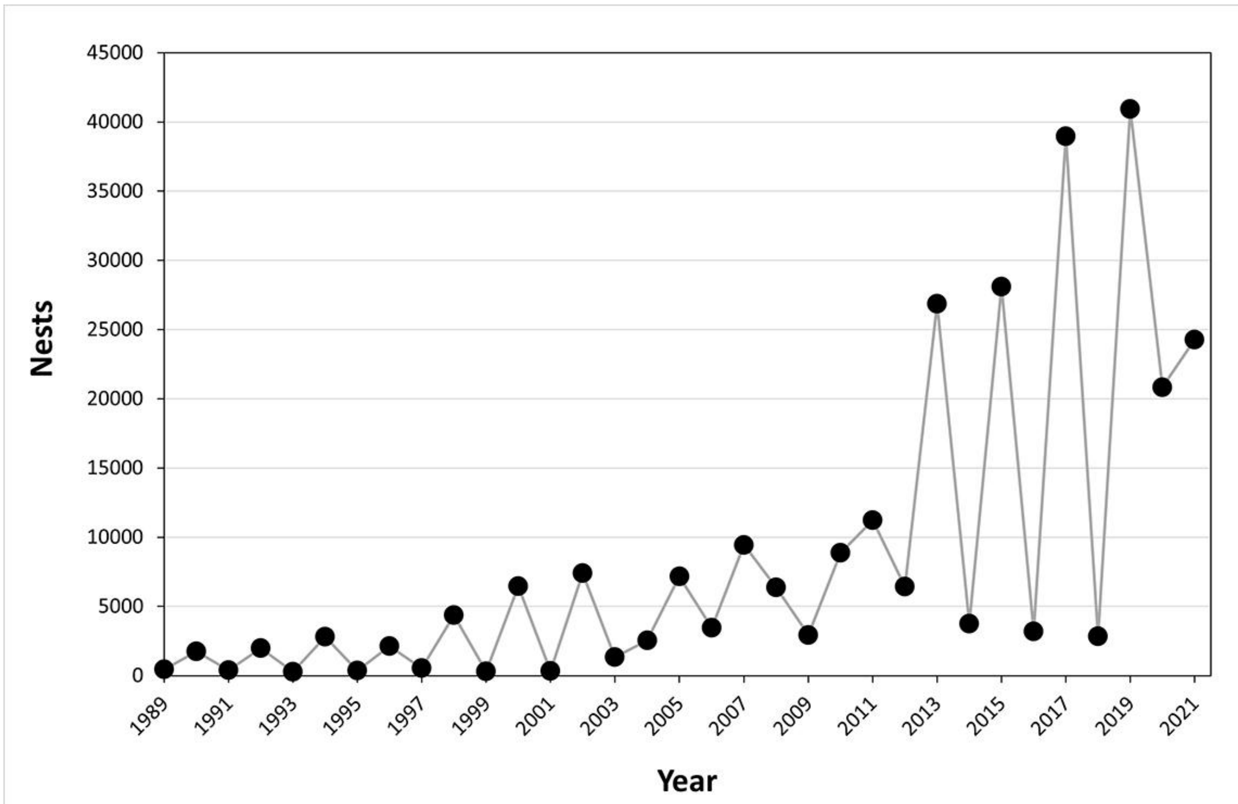
There are no reliable estimates of population growth rate for the DPS as a whole, but estimates have been developed at a localized level. The status review for green sea turtles assessed population trends for seven nesting sites with more than10 years of data collection in the North Atlantic DPS. The 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.



Source: 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:

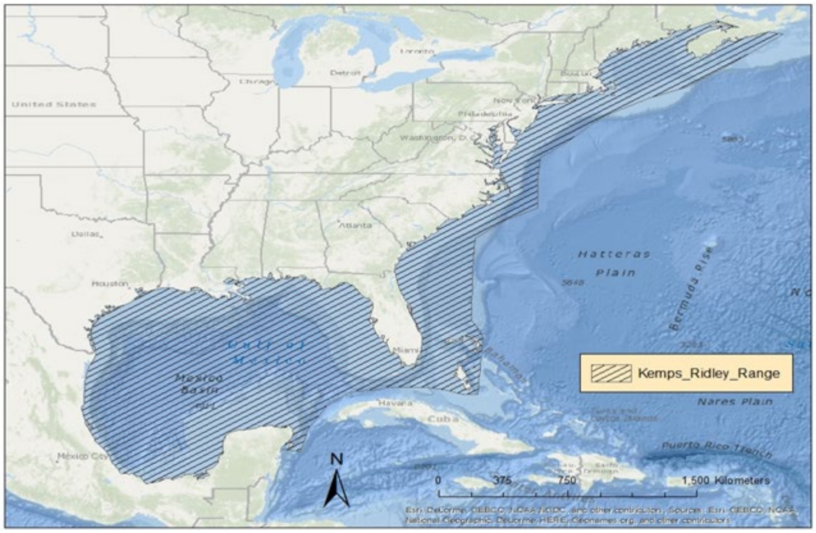
1. Providing long-term protection to important nesting beaches.
2. Ensuring at least a 60% hatch rate success on major nesting beaches.
3. Implementing effective lighting ordinances/plans on nesting beaches.
4. Determining distribution and seasonal movements of all life stages in the marine environment.
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 ft (37 m) 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

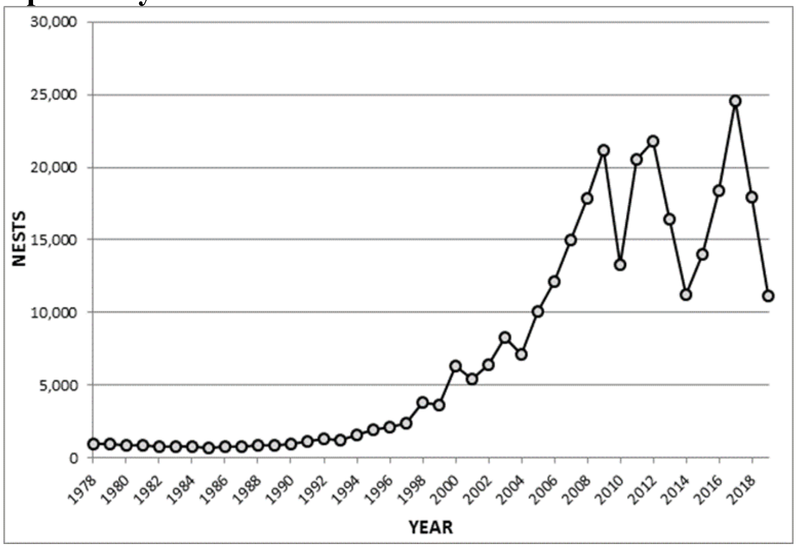
Of the sea turtles species in the world, the Kemp's ridley has declined to the lowest population level. Nesting aggregations at a single location (Rancho Nuevo, Mexico) were estimated at 40,000 females in 1947. By the mid-1980s, the population had declined to an estimated 300 nesting females. From 1980 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.



Source: Gladys Porter Zoo nesting database 2019

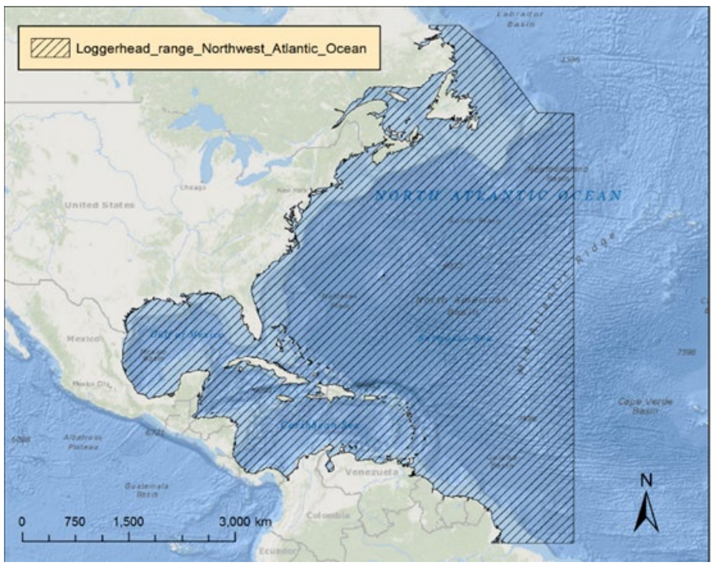
Critical Habitat
Critical habitat has not been designated for Kemp's ridley sea turtles.

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).

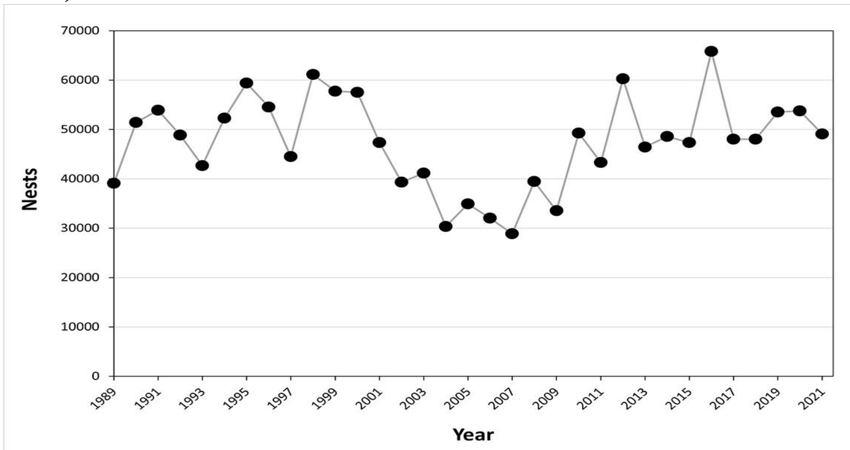
Population Dynamics

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).

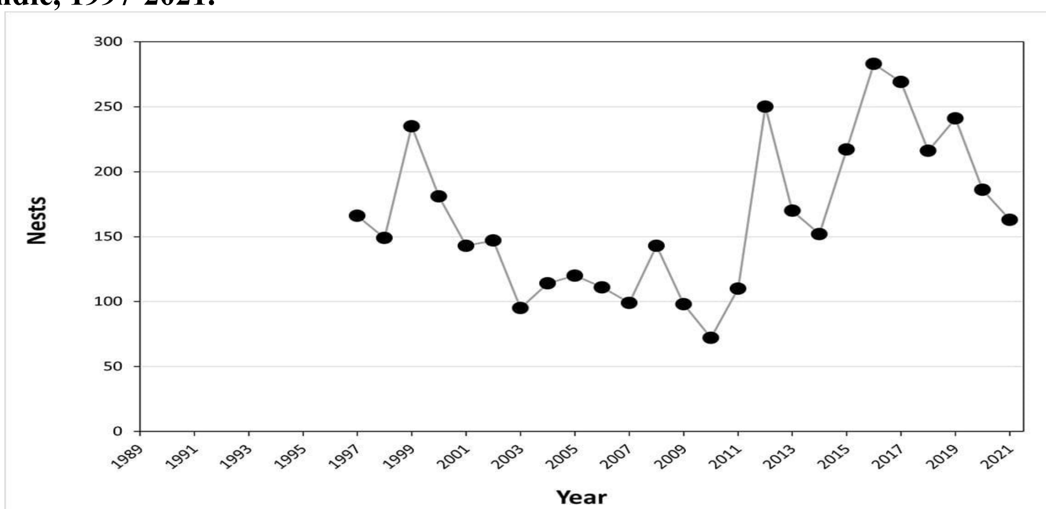
About 80% of loggerhead nesting in the southeast United States occurs in six Florida counties (NMFS and USFWS 2008). The Peninsula Florida Recovery Unit and the Northern Recovery Unit represent approximately 87% and 10%, respectively of all nesting effort in the Northwest Atlantic DPS (Ceriani and Meylan 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.



Source: 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.



Source: 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.

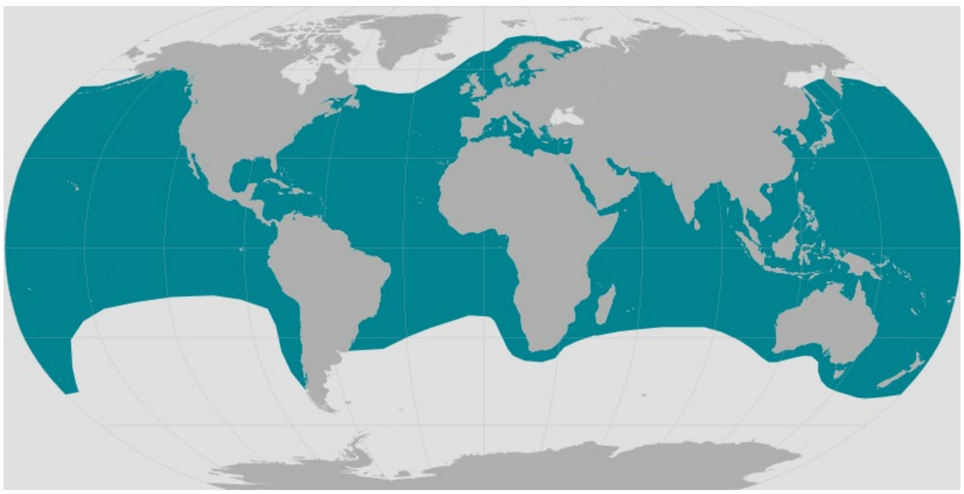
12. Minimize marine debris ingestion and entanglement.

13. Minimize vessel strike mortality.

5.2.4 Leatherback Sea Turtle (Deromchelys coriacea)

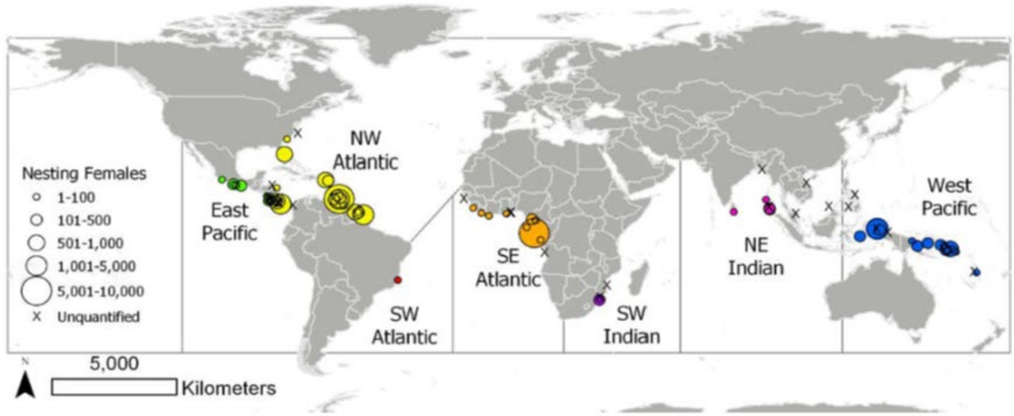
The leatherback sea turtle is unique among sea turtles for its large size, wide distribution (due to thermoregulatory systems and behavior), and lack of a hard, bony carapace. It ranges from tropical to subpolar latitudes, worldwide (Figure 5.2.8).

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).

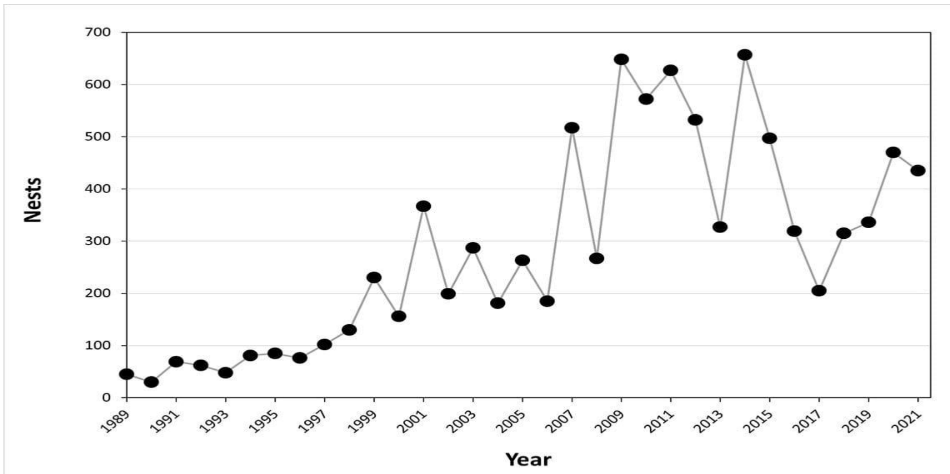
Previous assessments of leatherbacks concluded that the Northwest Atlantic population was stable or increasing (TEWG 2007, Tiwari et al. 2013b). However, based on more recent analyses, leatherback nesting in the Northwest Atlantic is showing an overall negative trend, with the most notable decrease occurring 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.



Source: 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.

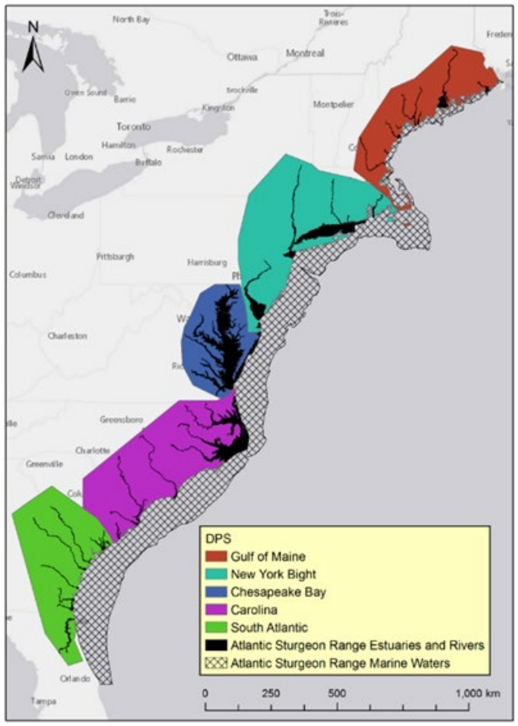
The 2013 Five-Year Review (NMFS and USFWS 2013) concluded that the leatherback turtle should not be delisted or reclassified and notes that the 1991 and 1998 recovery plans are dated and do not address the major, emerging threat of climate change.

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.

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.

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



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; as explained in Section 4.0, all effects to the Delaware River unit of critical habitat will be insignificant and discountable.

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.[17] 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). Size and age that individuals leave their natal river for the marine environment is variable at the individual and geographic level; age and size of maturity is similarly variable. 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). Note that the size and duration information presented in the table below should be considered a generalization and there is individual and geographic variation.

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[17] 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).

Table 5.3.1. Descriptions of Atlantic sturgeon life history stages.

Age Class	Typical Size	General 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.[18] 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.

[18] 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.)

Recovery Goals

A Recovery Plan has not been completed for any DPS of Atlantic sturgeon. In 2018, NMFS published a Recovery Outline[19] 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 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

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

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 5.3.3. 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[20]. The other two groups (Connecticut/Housatonic and the Hudson River) function as independent 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.

[20] 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.

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.

<u>Gulf of Maine Metapopulation</u>
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)).

<u>Delaware River-Chesapeake Bay Metapopulation</u>
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." Consistent with that definition, future offshore wind projects, as well as activities caused by aspects of their development and operation, that are not the subjects of a completed section 7 consultation are not in the Environmental Baseline for the Revolution Wind 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 WDA (i.e., the WFA and the cable routes to shore), project-related vessel routes in the identified portion of the U.S. EEZ along the Atlantic and Gulf coasts, and the geographic extent of effects caused by project-related activities in those areas. The Revolution Wind WDA 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 WDA is located within the Southern New England 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 action area also overlaps with the Mid-Atlantic Bight, which is bounded by Cape Cod, MA to the north and Cape Hatteras, NC to the south. 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). Due to these factors, the Northeast U.S. shelf area experiences one of the largest summer to winter temperature changes of any part of the ocean around the world. The result is a unique ocean feature called the Cold Pool, a band of cold bottom water that extends the length of the Mid-Atlantic Bight from spring through early fall. This temperature- salinity water mass occupies nearshore and offshore regions, including over Nantucket Shoals (east and southeast of Nantucket Island), creating a persistent frontal zone in the area (Kaplan 2011). Additionally, the region has seasonal upwelling and downwelling regimes, influenced by the edge of the continental shelf, which creates a shelf-break front. Marine vertebrates often use these oceanographic fronts for foraging and migration as they can aggregate prey (Scales et al. 2014). Offshore from Martha's Vineyard and Nantucket, shelf currents flow predominantly toward the southwest, beginning as water from the Gulf of Maine heading south veers around and over Nantucket Shoals. As the water transitions through Nantucket Sound, tidal water masses from nearshore mix with the shelf current, generally following depth contours offshore (Ullman and Cornellion 1999, BOEM 2020).

Water depths range from 24-50m in the WDA (BOEM 2023); sea surface temperatures vary seasonally from approximately 37 °F (3 °C) in winter to 87 °F (30 °C) in summer (VHB 2023). Site-specific benthic surveys identified three distinct habitat types in the WDA: large-grained complex habitat (i.e., large boulders and bedrock), complex habitat (i.e., SAV, shell substrate, and sediments with >5 percent gravel of any size), and soft-bottom habitat with fine unconsolidated substrates (i.e., mud and sand) (BOEM 2023).With the exception of bedrock and large boulders, these sediments are mobile, propelled by bottom currents that form ripples on the seafloor, which influence sediment resuspension, deposition, and sorting. This type of motion creates a dynamic habitat supporting mobile plants and animals that are accustomed to a certain degree of natural disturbance and are generally resilient to change. Conversely, the mobile sediment habitat is less conducive to species that live on, or are attached to, the seafloor making their occurrence in the action area uncommon.

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 extending to the waters of Greenland and Iceland (Hayes et al. 2022; 81 FR 4837). The few published sightings of right whales in the Gulf of Mexico (Moore and Clark 1963, Schmidly and Melcher 1974, Ward Geiger et al. 2011) represent either geographic anomalies or a more extensive historic range beyond the sole known calving and wintering ground in the waters of the southeastern U.S. (Waring et al. 2009; 81 FR 4837). The Gulf of Mexico is not considered part of the species range (NMFS 2015; 81 FR 4837) and no right whales are expected to occur in the Gulf of Mexico portion of the action area.

In the late fall, 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. 2022); however, calving outside of the southeastern U.S. is considered to be extremely rare. 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 locations previously thought to be used only seasonally by individuals migrating along the coast (e.g., waters 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. 2022, Leiter et al. 2017, Morano et al. 2012, Whitt et al. 2013). Surveys have demonstrated several areas where North Atlantic right whales congregate seasonally, including the coastal waters of the southeastern U.S.; the Great South Channel; Jordan Basin; Georges Basin along the northeastern edge of Georges Bank; Cape Cod; Massachusetts Bay; and the continental shelf south of New England (Brown et al. 2002, Cole et al. 2013, Hayes et al. 2020, Leiter et al. 2017). 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), and changing migration patterns (Gowan et al. 2019), as well as changing numbers in existing known high-use areas (Davis et al. 2017, 2020).

North Atlantic right whales feed on extremely dense patches of certain copepod species, primarily the late juvenile developmental stage of *C. finmarchicus*. These dense patches can be found throughout the water column depending on time of day and season. They are known to undergo daily vertical migration where they are found within the surface waters at night and at depth during daytime to avoid visual predators. North Atlantic right whales' diving behavior is strongly correlated to the vertical distribution of *C. finmarchicus*. Baumgartner et al. (2017) investigated North Atlantic right whale foraging ecology by tagging 55 whales in six regions of the Gulf of Maine and southwestern Scotian Shelf in late winter to late fall from 2000 to 2010. Results indicated that on average North Atlantic right whales spent 72 percent of their time in the upper 33 feet (10 meters) of water and 15 of 55 whales (27 percent) dove to within 16.5 feet (5 meters) of the seafloor, spending as much as 45 percent of the total tagged time at this depth.

The distribution of right whales is linked to the distribution of their principal zooplankton prey, calanoid copepods (Baumgartner and Mate 2005, NMFS 2005, Waring et al. 2012, Winn et al. 1986). New England waters are important feeding habitats for right whales (Hayes et al. 2020). Right whale calls have been detected by autonomous passive acoustic sensors deployed between 2005 and 2010 at three sites (Massachusetts Bay, Stellwagen Bank, and Jeffreys Ledge) in the southern Gulf of Maine (Morano et al. 2012, Mussoline et al. 2012). Comparisons between detections from passive acoustic recorders and observations from aerial surveys in Cape Cod Bay between 2001 and 2005 demonstrated that aerial surveys found whales on approximately two-thirds of the days during which acoustic monitoring detected whales (Clark et al. 2010).

Recent changes in right whale distribution (Kraus et al. 2016) are driven by warming of deep waters in the Gulf of Maine (Record et al. 2019). Prior to 2010, right whale movements followed the seasonal occurrence of the late stage, lipid-rich copepod *C. finmarchicus* from the western Gulf of Maine in winter and spring to the eastern Gulf of Maine and Scotian Shelf in the summer and autumn (Beardsley et al. 1996, Mayo and Marx 1990, Murison and Gaskin 1989, Pendleton et al. 2009, Pendleton et al. 2012). Recent surveys (2012 to 2015) have detected fewer individuals in the Great South Channel and the Bay of Fundy, and additional sighting records indicate that at least some right whales are shifting to other habitats, suggesting that existing habitat use patterns may be changing (Weinrich et al. 2000; Cole et al. 2007, 2013; Whitt et al. 2013; Khan et al. 2014). Warming in the Gulf of Maine has resulted in changes in the seasonal abundance of late-stage *C. finmarchicus*, with record high abundances in the western Gulf of Maine in spring and significantly lower abundances in the eastern Gulf of Maine in late summer and fall (Record et al. 2019). Baumgartner et al. (2017) discuss that ongoing and future environmental and ecosystem changes may displace *C. finmarchicus* from the Gulf of Maine and Scotian Shelf. The authors also suggest that North Atlantic right whales are dependent on the high lipid content of calanoid copepods from the Calanidae family (i.e., *C. finmarchicus, C. glacialis, C. hyperboreus*), and would not likely survive year-round only on the ingestion of small, less nutritious copepods in the area (i.e., *Pseudocalanus* spp., *Centropages* spp., *Acartia* spp., *Metridia* spp.). It is also possible that even if *C. finmarchicus* remained in the Gulf of Maine, changes to the water column structure from climate change may disrupt the mechanism that causes the very dense vertically compressed patches that North Atlantic right whales depend on (Baumgartner et al. 2017). One of the consequences of these environmental changes has been a shift of right whales out of habitats such as the Great South Channel and the Bay of Fundy, and into areas such as the Gulf of St. Lawrence in the summer and waters of southern New England primarily in the winter and spring, however, right whales have been observed there in all seasons. (NMFS NEFSC, unpublished data, Kraus et al. 2016b, Leiter et al. 2017, Stone et al. 2017, Quintana-Rizzo et al. 2021, Estabrook et al. 2022, O'Brien et al. 2022), with observations of foraging in both areas.

North Atlantic right whale Presence in the Revolution Wind WDA and Surrounding Waters

Right whale presence in the WDA is predominately seasonal; however, year-round occurrence in southern New England waters is documented, most notably around Nantucket Shoals (Leiter et al., 2017; O'Brien et al., 2022, Stone et al., 2017; Oleson et al., 2020, Quintana-Rizzo et al., 2021). Based on detections from aerial surveys and PAM deployments within the RI/MA WEA, right whales are expected in the WDA in higher numbers in winter and spring followed by decreasing abundance into summer and early fall. The WDA both spatially and temporally overlaps a portion of the migratory Biologically Important Area (BIA), which describes the area within which right whales migrate south to calving grounds generally in November and December, followed by a northward migration into feeding areas east and north of the WDA in March and April (LaBrecque et al., 2015; Van Parijs et al., 2015).

Since 2017, right whales have been sighted in the southern New England area nearly every month, with peak sighting rates between late winter and spring. Model outputs suggest that 23% of the right whale population is present from December through May, and the mean residence time has increased to an average of 13 days during these months (Quintana-Rizzo et al., 2021). A hotspot analysis analyzing sighting data in southern New England from 2011-2019 indicated that right whale occurrence in the MA and MA/RI WEA was highest in the spring (March through May), and that few right whales were sighted in the area during that time frame in summer or winter (Quintana-Rizzo et al., 2021), a time when right whales distribution shifted to the east and south into other portions of the study area. In this analysis, "hotspots" were defined as season−period combinations with greater than 10 right whale sightings and clusters within a 90% confidence level). Density data from Roberts et al. (2023) confirm that the highest average density of right whales in the WDA (both the lease area and RWEC corridor) occurs from January to April, with the highest density in March (0.0060 whales/100km^2), which aligns with available sighting and acoustic data.

Quintana-Rizzo et al. (2021) examined aerial survey data collected between 2011−2015 and 2017−2019 to quantify right whale distribution, residency, demography, and movements in the RI/MA and MA WEAs, including the Revolution Wind WFA. Considering the study area as a whole, the authors conclude that right whale occurrence increased during the study period with whales sighted in the area nearly every month since 2017; peak sighting rates were between December and May with mean residence time at 13 days. Age and sex ratios of the individuals present in the area are similar to those of the species as a whole, with adult males the most common demographic group. Reported behaviors include animals feeding and socializing. Areas of higher use within the study area varied between years and seasons, likely due to variable distribution of prey. The authors conclude that the mixture of movement patterns within the population and the geographical location of the study area suggests that the area could be a feeding location for whales that stay in the mid-Atlantic and north during the winter−spring months and a stopover site for whales migrating to and from the calving grounds. Estabrook et al. (2022) reviewed acoustic data from 2011-2015 focused on theRI/MA and MA WEA, which includes the Revolution Wind Farm WFA; they found seasonal variations that were elevated from January to March and lowest during the summer months of July to September. Despite the seasonal variation in detections of right whale upcalls, detections occurred year-round.

The Right Whale Sighting Advisory System (RWSAS) alerts mariners to the presence of right whales, and collects sighting reports from a variety of sources including aerial surveys, shipboard surveys, whale watch vessels, and opportunistic sources (Coast Guard, commercial ships, fishing vessels, and the public). In 2016, North Atlantic right whales were observed in the shelf waters south of Martha's Vineyard and Nantucket during January, February, and May. In 2017, North Atlantic right whales were observed in the shelf waters south of Martha's Vineyard and Nantucket in every month except January, August, and December. In 2018 and 2019, North Atlantic right whales were observed in the shelf waters south of Martha's Vineyard and Nantucket (i.e., the area between the islands and the Nantucket to Ambrose traffic lane) in every month except October; in 2020, right whales were detected in this area from January to March and July to December. No right whales were detected during aerial surveys of this area in June 2020, but right whales were observed in July, August, September, October, November, and December. Sightings data is not available for April and May 2020 as aerial survey operations were affected by pandemic restrictions (see https://whalemap.org/WhaleMap). In 2021, North Atlantic right whales were observed in the shelf waters south of Martha's Vineyard and Nantucket in every month except for June. For 2022, North Atlantic right whales were observed in the shelf waters south of Martha's Vineyard and Nantucket in every month except May and June with detections in every month for the first half of 2023 (see https://whalemap.org/WhaleMap).

During aerial surveys conducted from 2011-2015 in the MA/RI WEA, including the WDA, the highest number of right whale sightings occurred in March (n=21), with sightings also occurring in December (n=4), January (n=7), February (n=14), and April (n=14), and no sightings in any other months (Kraus et al., 2016). There was not significant variability in sighting rate among years, indicating consistent annual seasonal use of the area by right whales. North Atlantic right whales were acoustically detected in 30 out of the 36 recorded months (Kraus et al., 2016). However, right whales exhibited strong seasonality in acoustic presence, with mean monthly acoustic presence highest in January (mean = 74%), February (mean = 86%), and March (mean = 97%), and the lowest in July (mean = 16%), August (mean = 2%), and September (mean = 12%). Aerial survey results indicate that North Atlantic right whales begin to arrive in the WDA in December and remain in the area through April. However, acoustic detections occurred during all months, with peak number of detections between December and late May (Kraus et al. 2016b; Leiter et al. 2017).

Kraus et al. (2016) observed that NARWs were most commonly present in and near the RI/MA WEA in the winter and spring and absent in the summer and fall. Quintana-Rizzo et al. (2018) observed similar occurrence patterns in the winter and spring but an increase in observations in the summer and fall. The change in seasonal occurrence between the 2011-2015 aerial surveys (Kraus et al. 2016) and the 2017 and 2018 (Quintana-Rizzo et al. 2018) aerial surveys is consistent with an increase trend in acoustic detections on the Mid-Atlantic OCS in the summer and autumn (Davis et al. 2017).[21] These data suggest an increasing likelihood of species presence from September through June. NARW SPUE in and near the RI/MA WEA by season in 2017 and 2018 is summarized in Figure 4 of the BA. Seasons are defined as winter = December, January, and February; Spring = March, April, and May; Summer = June, July, and August; and Autumn = September, October, and November. As described in the Notice of Proposed IHA, the best available information regarding marine mammal densities in the action area is provided by habitat-based density models produced by the Duke University Marine Geospatial Ecology Laboratory (Roberts *et al*., 2016, 2017, 2018, 2020). T updated models incorporate additional sighting data, including sightings from the NOAA Atlantic Marine Assessment Program for Protected Species (AMAPPS) surveys from 2010-2016 which included some aerial surveys over the RI/MA & MA WEAs (NEFSC & SEFSC, 2011a, 2011b, 2012, 2014a, 2014b, 2015, 2016). Roberts et al. (2020) further updated model results for North Atlantic right whales by incorporating additional sighting data and implementing three major changes: Increasing spatial resolution, generating monthly estimates on three time periods of survey data, and dividing the study area into five discrete regions.

As described in the BA and in the Notice of Proposed ITA, the best available information regarding marine mammal densities in the portion of the action area encompassing the WDA is provided by habitat-based density models produced by the Duke University Marine Geospatial Ecology Laboratory (Roberts et al., 2016, 2017, 2018, 2021a, 2021b, 2022)(see Tables 6.1 and 6.2 below). 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

[21] Based on frequency of acoustic detections of NARW in Davis et al. (2017) designated monitoring region 7: Southern New England and New York Bight. This monitoring region encompasses the lease area.

partially or fully within the analysis polygon (LGL and Jasco, 2022[22]). In the area within 10 km of the WDA and along the cable route, density is highest in March and lowest in June-August.

Table 6.1. Average Monthly Density Estimates for North Atlantic right whales within 10 km of the Lease Area Perimeter.

Species	Monthly Densities (animals per 1 km^2)											
	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec
North Atlantic right whale	0.0045	0.0059	0.0060	0.0052	0.0022	0.0004	0.0002	0.0002	0.0003	0.0005	0.0008	0.0026

Table 6.2. Average Monthly Density Estimates for North Atlantic right whales along the Export Cable Route.

Species	Monthly Densities (animals per 1 km^2)											
	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec
North Atlantic right whale	0.0021	0.0027	0.0029	0.0022	0.0008	0.0002	0.0001	0.0001	0.0001	0.0002	0.0004	0.0013

In summary, we anticipate individual right whales to occur year round in the action area in both coastal, shallower waters as well as offshore, deeper waters. We expect these individuals to be moving throughout the action area, making seasonal migrations, foraging in northern parts of the action area when copepod patches of sufficient density are present, and calving during the winter months in southern waters of the action area. As noted above, right whales are generally not expected to occur in the Gulf of Mexico with any presence being rare and limited to occasional, sporadic out of range individuals.

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 along the Atlantic coast. 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

[22] https://media.fisheries.noaa.gov/2022-09/Revolution%20Wind%20Updated%20Densities%20Memo_508_OPR1.pdf

Maine, Georges Bank, and south of New England (Halpin et al. 2009, Hayes et al. 2017, Hayes et al. 2020). The breeding and calving areas used by this species are unknown (Hayes et al. 2021).Sei whales are very rare in the Gulf of Mexico with recent sightings limited to stranded individuals in the northern Gulf of Mexico (NMFS 2011). Sei whales are not documented as inhabitants of the Gulf of Mexico in NMFS' stock assessment reports (Waring 2016) and it is extremely unlikely that they would occur along the routes used by project vessels moving to or from ports in the Gulf of Mexico.

Sei whales occurring in the North Atlantic belong to the Nova Scotia stock (Hayes et al. 2020). They 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). Documented sei whale sightings along the U.S. Atlantic Coast south of Cape Cod are relatively uncommon compared to other baleen whales (CETAP 1982; Kagueux et al. 2010; Hayes et al. 2020). Sei whale sightings in U.S. Atlantic waters are typically centered on mid-shelf and the shelf edge and slope (Olsen et al. 2009). Spring is the period of greatest sei whale abundance in New England waters, with sightings concentrated along the eastern margin of Georges Bank, into the Northeast Channel area, south of Nantucket, and along the southwestern edge of Georges Bank in the area of Hydrographer Canyon (Hayes et al. 2022).

Sei whales often occur along the shelf edge to feed, but also use shallower shelf waters, particularly during certain years when oceanographic conditions force planktonic prey to shelf and inshore waters (Payne et al. 1990, Schilling et al. 1992, Waring et al. 2004). 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. LaBrecque et al. (2015) defined a May to November feeding BIA 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, including the northern shelf break area of Georges Bank, the Great South Channel, and the southern shelf break area of Georges Bank from 328 to 6,562 feet (100–2,000 m). This feeding BIA does not overlap with the Revolution Wind WDA.

Sei whales may be present in and around the WDA year-round but are most commonly present in the spring and early summer (Davis et al. 2020).[23] Sightings data from 1981 to 2018, indicate that sei whales may occur in the area in relatively moderate numbers during the spring and in low numbers in the summer (North Atlantic Right Whale Consortium 2018). Kraus et al. (2016) and Quintana-Rizzo et al. (2018) report observed sei whales in and near the RI/MA WEA from March through June from 2011 through 2015 and in 2017, respectively, with the timing of peak occurrence varying by year. Sei whales were absent from the area from August through February. In the RI/MA WEA in 2017, sightings were generally concentrated to the south and east of the Revolution Wind WDA. This distribution suggests that sei whales are likely to occur in and near the lease area between March and June if recent patterns of habitat use continue. However, no sei whales were observed in the same study area in 2018 (Quintana-Rizzo et al.

[23] Based on frequency of acoustic detections of sei whales in Davis et al. (2020) designated monitoring region 7: Southern New England and New York Bight. This monitoring region encompasses the lease area. The sei whale detection range of the sensor network extends up to 12.5 miles (20 km).

2018). During 2020-2021 aerial surveys of the Massachusetts WEA, one sei whale was observed during the spring of 2021 in an area to the southeast of the Revolution Wind lease area (O'Brien et al. 2021). Kraus et al. (2016) observed an unusually large number of sei whales during aerial and acoustic surveys of the RI/MA WEA and vicinity that were conducted from 2011 through 2015. Several individuals were observed in the study area from March through June, with peaks in May and June, at a mean abundance ranging from zero to 26 animals (Stone et al. 2017). Quintana-Rizzo et al. (2019) observed a large concentration of sei whales in the area in April, May, and July of 2017 peaking at 29 individuals in May, but none were observed in 2018. O'Brien et al. (2020, 2021a, 2021b) observed several sei whales 40 miles or more to the southeast of the WDA in 2019 but none were observed in the study area in 2020.

As part of the application for an MMPA ITA for the Revolution Wind project, LGL and Jasco (2022) used data from Roberts et al. (2022) to calculate mean monthly density estimates within 10 km of the Revolution Wind lease area and along the export cable route. In the lease area, monthly density of sei whales ranges from 0.0001-0.0013 sei whales/km^2, with the lowest densities from July to August and the highest in May. Along the export cable route, monthly density of sei whales ranges from 0 – 0.0007 sei whales/km^2, with the lowest density (predicted absence) in July and August and highest density in April.

In summary, we anticipate individual sei whales to occur in the action area year round, with presence in the nearer shore portions of the action area, including the lease and cable corridors, primarily in the spring and fall. The presence of sei whales along vessel transit routes south of the WDA is expected to be rare given the species offshore and more northerly distribution. We expect individuals in the action area to be making seasonal migrations, and to be foraging when krill are present. Foraging adult sei whales are most likely to occur in the WDA but the observation of three adult sei whales with calves in the MA and MA/RI WEA during spring and summer months (Kraus et al. 2016) indicates adult/calf pairs could occasionally be seasonally present in the WDA.

Sperm whale (Physeter macrocephalus)
In the action area, sperm whales may be present along the oceanic portions of all potential vessel transit routes, in the Gulf of Mexico, and occasionally in the more offshore portion of the WDA. Sperm whales in the Gulf of Mexico belong to the Northern Gulf of Mexico stock while sperm whales in the other portions of the action area belong to the North Atlantic stock. 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.

<u>Northern Gulf of Mexico Stock</u>
In the northern Gulf of Mexico (i.e., U.S. Gulf of Mexico), systematic aerial and ship surveys indicate that sperm whales inhabit continental slope and oceanic waters where they are widely

distributed and present year round (Hayes et al. 2021). The best abundance estimate (Nest) for the northern Gulf of Mexico sperm whale is 1,180 (CV=0.22). This estimate is from summer 2017 and summer/fall 2018 oceanic surveys covering waters from the 200-m isobath to the seaward extent of the U.S. EEZ (Garrison et al. 2020). An Unusual Mortality Event (UME) was declared for cetaceans in the northern Gulf of Mexico beginning 1 March 2010 and ending 31 July 2014 (Litz et al. 2014; https://www.fisheries.noaa.gov/national/marine- life-distress/2010-2014-cetacean-unusual-mortality-event-northern-gulf-mexico). It included cetaceans that stranded prior to the Deepwater Horizon (DWH) oil spill, during the spill, and after. Exposure to the DWH oil spill was determined to be the primary underlying cause of the elevated stranding numbers in the northern Gulf of Mexico after the spill (e.g., Schwacke et al. 2014; Venn-Watson et al. 2015; Colegrove et al. 2016; DWH NRDAT 2016 in Hayes et al. 2021). Sperm whales in the Gulf of Mexico experienced increased mortality related to oil exposure resulting from the DWH incident (Hayes et al. 2021).

North Atlantic Stock

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 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.

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). 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 2015; 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).

Historical sightings data from 1979 to 2018 indicate that sperm whales may occur in and near the RI/MA WEA in the summer and autumn in relatively low to moderate numbers (North Atlantic Right Whale Consortium 2018). Kraus et al. (2016) recorded four sperm whale sightings in and near the RI/MA WEA between 2011 and 2015. Three of the four sightings occurred in August and September 2012, and one occurred in June 2015. Because of the limited sample size, Kraus et al. (2016) were not able to calculate SPUE or estimate abundance in the action area, and specific sighting locations were not provided. Sperm whale sightings in the region during AMAPPS aerial surveys conducted from 2010 to 2013 are shown in Figure 6 of the BA (BOEM 2021a) and do not indicate any observations within the lease area. No adults were observed foraging or with calves during the 2011-2015 aerial surveys (Kraus et al. 2016).

As part of the application for an MMPA ITA for the Revolution Wind project, LGL and Jasco (2022) used data from Roberts et al. (2022) to calculate mean monthly density estimates within 10 km of the Revolution Wind lease area and along the export cable route. In the lease area, monthly density of sperm whales ranges from 0.0001-0.0004 sperm whales/km2, with the lowest density in December to May, July, and October, and with the highest presence in August. Along the export cable route, monthly density of sperm whales ranges from 0-0.0001 sperm whales/km2 with the lowest density (predicted absence) in January to April and September to October and highest densities in May to August and November to December.

In summary, individual adult sperm whales are anticipated to occur infrequently in deeper, offshore waters of the North Atlantic 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 through the MA/RI WEA 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 2015) well beyond that of the lease area, foraging is not expected to occur in WDA. Additionally, sperm whales may occur along the vessel transit routes south of the WDA, with presence most likely in more offshore waters. Sperm whales are also present in the Gulf of Mexico 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 do not occur in the Gulf of Mexico.

Fin whales occurring in the North Atlantic belong to the western North Atlantic stock (Hayes et al. 2019). 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). 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 2010a). 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). However, neonate strandings along the U.S. Mid-Atlantic coast from October through January indicate a possible offshore calving area (Hain et al. 1992). 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). 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).

Aerial survey observations collected by Kraus et al. (2016) from 2011 through 2015 and Quintana-Rizzo et al. (2018) in 2017 and 2018 indicate peak fin whale occurrence in the RI/MA WEA from May to August; however, the species may be present at varying densities during any month of the year. During seasonal aerial and acoustic surveys conducted from 2011-2015 in the MA/RI WEA, fin whales were observed every year, and sightings occurred in every season with the greatest numbers during the spring (n = 35) and summer (n = 49) months (Kraus et al., 2016). Observed behavior included feeding and migrating. Despite much lower sighting rates during the winter, a hydrophone array confirmed fin whales presence throughout the year (Kraus et al. 2016). LaBrecque et al. (2015) delineated a BIA for fin whale feeding in an area extending from Montauk Point, New York, to the open ocean south of Martha's Vineyard between the 49-foot (15-m) and 164-foot (50-m) depth contours. This BIA encompasses the Revolution Wind WFA, and is used extensively by feeding fin whales from March to October.

As part of the application for an MMPA ITA for the Revolution Wind project, LGL and Jasco (2022) used data from Roberts et al. (2022) to calculate mean monthly density estimates within 10 km of the Revolution Wind lease area and along the export cable route. In the lease area, monthly density of fin whales ranges from 0.0003- 0.0029 fin whales/km^2, with the lowest density in October and highest density in July. Along the export cable route, monthly density of fin whales were 0.0000 fin whales/km2 (predicted absence) across all months. Fin whale sightings per unit effort (SPUE) in the RI/MA WEA and larger action area in 2017 and 2018 are displayed by season in Figure 4.6 of the BA (from Kraus et al. 2016). This is consistent with regional occurrence timing derived from regional PAM data, which indicate that this species is present and vocalizing in the region throughout the year, (Davis et al. 2020). However, while Davis et al. (2020) found the lowest likelihood of occurrence in May and June, Kraus et al. (2016) observed fewer individuals from September through March. As shown, fin whales are likely to be present in the WDA year round with seasonal variations, and fin whales are likely to have reduced density during the fall.

In summary, we anticipate individual fin whales to occur in the WDA year-round, with the highest numbers in the spring through early fall. 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. No fin whales are anticipated in the Gulf of Mexico portion of the action area.

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).

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). Davis et al. (2020) assessed PAM data on the Atlantic Coast between 2004-2010 and 2011-2014. Using PAM system deployed during 2011-2014, they detected blue whale calls off the coast of Massachusetts and Rhode Island, with seasonal variations. Blue whale vocalizations were detected in the winter months of November to February. There is some evidence of shifts in blue whale distribution, with a decrease in abundance on the Scotian shelf and southern New England mirroring shifts in prey distribution (Davis et al. 2020).

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. Based on the available information summarized above, 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. As part of the application for an MMPA ITA for the Revolution Wind project, LGL and Jasco (2022) used data from Roberts et al. (2022) to calculate density estimates for blue whales within 10 km of the Revolution Wind lease area and along the export cable route. Density estimates for blue whales within 10 km of the WDA were 0.000 animal/km^2 (LGL and Jasco 2022). Based on the rarity of detections in nearshore waters, it is reasonable to expect that the presence of blue whales along vessel transit routes to and from ports in New York, New Jersey, and Norfolk is rare.

In summary, individual blue whales are anticipated to occur infrequently in deeper, offshore waters of the action area, with a small number of individuals occurring in the furthest offshore portions of the WDA. These individuals are expected to be moving near the WDA as they make seasonal migrations, and to be foraging along the shelf break. The presence of blue whales along the vessel transit routes to and from ports in the Mid-Atlantic is expected to be rare. No blue whales are expected in the Gulf of Mexico.

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 along the U.S. Atlantic Coast, including into southern New England waters that include the WDA. All four species also occur in the Gulf of Mexico where vessels may transit from Gulf of Mexico ports to the WDA.

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 2011a, 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 (79 FR 39855). 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 and in the Gulf of Mexico year round.

Regional historical sightings, strandings, and bycatch data indicate that loggerhead and leatherback turtles are relatively common in waters of southern New England, while Kemp's ridley turtles and green turtles are less common (Kenney and Vigness-Raposa 2010). Aerial surveys conducted seasonally, from 2011-2015, in the MA WEA recorded the highest abundance of endangered sea turtles during the summer and fall, with no significant inter-annual variability. For most species of sea turtles, relative density was even throughout the WEA. Sea turtles in the

WDA are adults or juveniles; due to the distance from any nesting beaches, no hatchlings occur in the WDA. Similarly, no reproductive behavior is known or suspected to 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; 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 2013 routinely documented leatherbacks in the MA/RI WEA and surrounding areas during summer months (NEFSC and SEFSC 2018, 2022: Palka 2021).

Satellite tagging studies have been used to understand leatherback sea turtle behavior and movement in portions of the action area (Dodge et al. 2014, Dodge et al. 2015, Eckert et al. 2006, James et al. 2005a, James et al. 2005b, James et al. 2006a). These studies show that leatherback sea turtles move throughout most of the North Atlantic from the equator to high latitudes. Key foraging destinations include, among others, the eastern coast of United States (Eckert et al. 2006). 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 to/from the South Atlantic.

Telemetry studies provide information on the use of the water column by leatherback sea turtles. Based on telemetry data for leatherbacks (n=15) off Cape Cod, Massachusetts, leatherback turtles spent over 60% of their time in the top 33 ft. (10 m) of the water column and over 70% in the top 49 ft. (15 m) (Dodge et al. 2014). Leatherbacks on the foraging grounds moved with slow, sinuous area-restricted search behaviors. Shorter, shallower dives were taken in productive, shallow waters with strong sea surface temperature gradients. They were highly aggregated in shelf and slope waters in the summer, early fall, and late spring. During the late fall, winter, and early spring, they were more widely dispersed in more southern waters and neritic habitats (Dodge et al. 2014). Leatherbacks (n=24) tagged in Canadian waters primarily used the upper 98 ft. (30 m) of the water column and had shallow dives (Wallace et al. 2015).

Leatherbacks tagged off Massachusetts showed a strong affinity to the northeast United States continental shelf before dispersing widely throughout the northwest Atlantic (Dodge et al. 2014). The tagged leatherbacks ranged widely between 39°W and 83°W, and between 9°N and 47°N, over six oceanographically distinct ecoregions defined by Longhurst: the Northwest Atlantic Shelves (n=20), the Gulf Stream (n=16), the North Atlantic Subtropical Gyral West (hereafter referred to as the Subtropical Atlantic, n=15), the North Atlantic Tropical Gyral (the Tropical Atlantic, n=15), the Caribbean (n=6) and the Guianas Coastal (n=7) (Dodge et al. 2014). This data indicates that leatherbacks are present throughout the action area considered here and may be present along the vessel transit routes from Canada, Europe, and the Gulf of Mexico. From the tagged turtles in this study, there was a strong seasonal component to habitat selection, with most leatherbacks remaining in temperate latitudes in the summer and early autumn and moving into subtropical and tropical habitat in the late autumn, winter, and spring. Leatherback turtles might initiate migration when the abundance of their prey declines (Sherrill-Mix et al. 2008).

Dodge et al. (2018) used an autonomous underwater vehicle (AUV) to remotely monitor fine-scale movements and behaviors of nine leatherbacks off Cape Cod, Massachusetts. The "TurtleCam" collected video of tagged leatherback sea turtles and simultaneously sampled the habitat (e.g., chlorophyll, temperature, salinity). Representative data from one turtle was reported in Dodge et al. (2018). During the 5.5 hours of tracking, the turtle dove continuously from the surface to the seafloor (0-66 ft. (0-20 m)). Over a two-hour period, the turtle spent 68% of its time diving, 16% swimming just above the seafloor, 15% at the surface, and 17% just below the surface. The animal frequently surfaced (>100 times in ~2 hours). The turtle used the entire water column, feeding on jellyfish from the seafloor to the surface. The turtle silhouetted prey 36% of the time, diving to near/at bottom and looking up to locate prey. The authors note that silhouetting prey may increase entanglement in fixed gear if a buoy of float is mistaken for jellyfish (Dodge et al. 2018).

Leatherbacks were the most frequently sighted sea turtle species in monthly aerial surveys of the RI/MA WEA from October 2011 through June 2015 (Kraus et al. 2016). However, leatherback sea turtles showed an apparent preference for the northeastern corner of the WEA, which is consistent with results from a tagging study on leatherbacks in the area (Kraus et al. 2016, Dodge et al., 2014). These results suggest an important seasonal habitat for leatherbacks in southern

New England (Kraus et al. 2016, Dodge et al. 2014) that overlaps with a portion of the action area but is outside the WDA. Kraus et al. (2016) recorded 153 observations (161 animals) in monthly aerial surveys, all between May and November, with a strong peak in the fall (see Table 4.7 in the BA). Data from Kraus et al. (2016) indicates that in some parts of the year, leatherbacks would be the most abundant sea turtle species in the WDA, which is consistent with the other information on sea turtle occurrence in the vicinity presented here. Leatherback sightings per unit effort (SPUE) in the RI/MA WEA and vicinity from 2011 to 2015 are displayed by season in Figure 4.13 of the BA. As shown, the majority of observations were clustered to the east of the WDA and south of Nantucket; however, several summer observations were recorded in immediate proximity to the WFA. Aerial surveys conducted over the Massachusetts WEA in 2020-2021, observed leatherback sea turtles in the eastern portions of the WEA with highest numbers in the fall months of October-December, with one observation in July (O'Brien 2021, 2022).

There are limited density estimates for sea turtles in the WDA. As part of the acoustic impact analysis for this project, Kussel et al. (2023) reviewed the available data and presented density estimates for the Revolution Wind WDA plus a 10 km buffer. More information on the data sources is presented in Section 7.1 of this Opinion. For leatherbacks, seasonal density ranges from 0.020 animal/100km^2 in the winter and spring to 0.873 animals/100km^2 in the fall.

Sasso et al. (2021) presents information on the use of the Gulf of Mexico by leatherbacks. Individuals are present year round with highest abundance during the summer and early autumn as post-nesting turtles enter the Gulf from Caribbean nesting beaches during the summer and move to the Caribbean in the late fall. The summer and early fall period coincides with the period of greatest abundance of the leatherback's preferred jellyfish prey. The northeastern Gulf of Mexico off the Florida Panhandle and the southeastern Gulf of Mexico in the Bay of Campeche off the state of Tabasco, Mexico have been identified as primary foraging areas.

Based on the information presented here, we anticipate leatherback sea turtles to occur in the WDA during the warmer months, typically between June and November. Leatherbacks are also expected along the vessel transit routes to ports to the south of the WDA, with seasonal presence dependent on latitude, as well as in the Gulf of Mexico (year round).

Northwest Atlantic DPS of Loggerhead sea turtles

The loggerhead 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 Gulf of Mexico.

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 action area (Winton et al. 2018). In southern New England, 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). Loggerheads are absent from southern New England during winter months (Kenney and Vigness-Raposa 2010; Shoop and Kenney 1992). Aerial surveys conducted over the Massachusetts WEA in 2020-2021, observed loggerhead sea turtles in the eastern portions of the WEA and Nantucket Shoals concentrated in the fall (O'Brien 2021, 2022).

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). 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 (NEFSC and SEFSC 2011a). 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 2013 AMAPPS aerial surveys of the Atlantic continental shelf. Large concentrations were regularly observed in proximity to the RI/MA WEA (NEFSC and SEFSC 2018). Kraus et al. (2016) observed loggerhead sea turtles within the RI/MA WEA in the spring, summer, and autumn, with the greatest density of observations in August and September.

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).

There are limited density estimates for sea turtles in the WDA. As part of the acoustic impact analysis for this project, Kussel et al. (2023) reviewed the available data and presented density estimates for the Revolution Wind WDA plus a 10 km buffer. More information on the data sources is presented in Section 7.1 of this Opinion. For loggerheads, seasonal density ranges from 0.131 animal/100km^2 in the winter and spring to 0.633 animals/100km^2 in the fall.

Based on the information presented here, we anticipate loggerheads from the Northwest Atlantic DPS to occur in the WDA (i.e., the WFA and cable corridors) during the warmer months, typically between June and November. Loggerheads are also expected along the vessel transit routes to southern ports, with seasonal presence dependent on latitude, as well as in the Gulf of Mexico (year round).

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. Adult Kemp's ridleys primarily occupy nearshore coastal (neritic) habitats. Many adult Kemp's ridleys 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.

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 United States Atlantic coast from southern Florida to the Mid-Atlantic and New England. In addition, the NEFSC caught a juvenile Kemp's ridley during a recent research project in deep water south of Georges Bank (NEFSC unpublished data, as cited in NMFS [2020a]). In the fall, most Kemp's ridleys migrate to deeper or more southern, warmer waters and remain there through the winter (Schmid 1998). Adult habitat largely consists of sandy and muddy areas in shallow, nearshore waters less than 120 feet (37 m) deep (Seney and Landry 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). 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. However, Kraus et al. (2016) recorded six observations in the RI/MA WEA over 4 years, all in August and September 2012. The sighting data were insufficient for calculating SPUE for this species (Kraus et al. 2016). Other aerial surveys efforts conducted in the region between 1998 and 2017 have observational records of species occurrence in the waters surrounding the RI/ME WEA during the autumn (September to November) at densities ranging from 10 to 40 individuals per 1,000 km (North Atlantic Right Whale Consortium 2018; NEFSC and SEFSC 2018). Juvenile Kemp's ridley sea turtles represented 66% of 293 cold-stunned turtle stranding records collected in inshore waters of Long Island Sound from 1981 to 1997 (Gerle et al. 1998) and represent the greatest number of sea turtle strandings in most years.

There are limited density estimates for sea turtles in the WDA. As part of the acoustic impact analysis for this project, Kussel et al. (2023) reviewed the available data and presented density estimates for the Revolution Wind WDA plus a 10 km buffer. More information on the data sources is presented in Section 7.1 of this Opinion. For Kemp's ridleys, seasonal density ranges were 0.001 animal/100km^2 year round, with no Kemp's ridleys expected in the winter.

Based on the information presented here, we anticipate Kemp's ridley sea turtles to occur in the WDA during the warmer months, typically between June and November. Kemp's ridleys are also expected along the vessel transit routes to southern ports, with seasonal presence dependent on latitude, as well as in the Gulf of Mexico (year round).

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 in 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. Green sea turtles are present year round in the Gulf of Mexico and nesting occurs at some Gulf of Mexico beaches (NMFS and USFWS 2007).

In addition to being seasonally present in the WDA, green sea turtles are likely to occur in portions of the vessel traffic component of the action area.

This species is typically observed in U.S. waters in the Gulf of Mexico or coastal waters south of Virginia (USFWS 2021). Juveniles and subadults are occasionally observed in Atlantic coastal waters as far north as Massachusetts (NMFS and USFWS 1991), including the waters of Long Island Sound and Cape Cod Bay (CETAP 1982). Kenney and Vigness-Raposa (2010) recorded one confirmed sighting within the RI/MA WEA in 2005. The Sea Turtle Stranding and Salvage Network (STSSN) reported one offshore and 20 inshore green sea turtle strandings between 2017 and 2019, and green sea turtles are found each year stranded on Cape Cod beaches (NMFS STSSN 2021; WBWS 2018). Five green turtle sightings were recorded off the Long Island shoreline 10 to 30 miles southwest of the RI/MA WEA in aerial surveys conducted from 2010-2013 (NEFSC and SEFSC 2018). However, given the relative abundance of observations farther to the south, adult green sea turtles are likely an infrequent visitor to the area. This conclusion is supported by the lack of green sea turtle observations recorded in an intensive aerial survey of the RI/MA WEA from October 2011 to June 2015 (Kraus et al. 2016). However, the aerial survey methods used in the region to date are unable to reliably detect juvenile turtles, sight several unidentified turtles, and do not cover the shallow nearshore habitats most commonly used by this species.

Juvenile green sea turtles represented 6% of 293 cold-stunned turtle stranding records collected in inshore waters of Long Island Sound from 1981 to 1997 (Gerle et al. 1998) and represent the lowest number of overall stranding between 1979 and 2016. These and other sources of information indicate that juvenile green turtles occur periodically in shallow nearshore waters of Long Island Sound and the coastal bays of New England (Morreale et al. 1992; Massachusetts Audubon 2012), but their presence offshore in the Lease Area is also possible.

There are limited density estimates for sea turtles in the WDA. As part of the acoustic impact analysis for this project, Kussel et al. (2023) reviewed the available data and presented density estimates for the Revolution Wind WDA plus a 10 km buffer. More information on the data sources is presented in Section 7.1 of this Opinion. Green sea turtles are rare in this area and there are no density data available for this species, so the Kemp's ridley sea turtle density is used as a surrogate; this is reasonable based on the known distribution of Green sea turtles in New England waters. As such, seasonal density ranges for green sea turtles are expected to be less than 0.001 animal/100km^2 year-round, with no green sea turtles expected in the winter.

Based on the information presented here, we anticipate green sea turtles to occur in the WDA during the warmer months, typically between June and November. Green sea turtles are also expected along the vessel transit routes to southern ports, with seasonal presence dependent on latitude, as well as in the Gulf of Mexico (year round).

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

Atlantic sturgeon (Acipenser oxyrinchus oxyrinchus)

Adult and subadult (not sexually mature, but have left their natal rivers; typically less than 150cm in total length,) 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 traveling to/from distant ports. In addition to at least occasional presence in the WDA, Atlantic sturgeon may also occur along the transit routes to the Paulsboro Marine Terminal (transiting Delaware Bay and the lower Delaware River), Brooklyn (NY), the Port of Baltimore (MD), Sparrows Point (MD), and Norfolk International Terminal (VA) (transiting channels within the 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). 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, including an area off Sandy Hook, New Jersey, and off Rockaway, New York. 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). 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). 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. South of Cape Cod, the nearest rivers to the WDA that is known to regularly support Atlantic sturgeon spawning is the Hudson River. Atlantic sturgeon may also at least occasionally spawn in the Connecticut River.

The offshore portion of the action area has not been systematically surveyed for Atlantic sturgeon; however, a number of surveys occur regularly in the action area 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. Atlantic sturgeon are regularly captured in this survey; however, there are few instances of collection in the action area. The area is also sampled in the NEFSC bottom trawl surveys; few Atlantic sturgeon are collected in this area.

Between March 2009 and February 2012, 173 Atlantic sturgeon were documented as bycatch in Federal fisheries by the Northeast Observer Program. Observers operated on fishing vessels from the Gulf of Maine to Cape Hatteras. Observer Program coverage across this entire area for this period was 8% of all trips with the exception that Observer coverage for the New England ground fish fisheries, extending from Maine to Rhode Island, was an additional 18% (26% coverage in total). Despite the highest observer coverage in the ground fish fisheries that overlap with the action area and the regular occurrence of commercial fishing activity in the area, only 2 of the 173 Atlantic sturgeon observed by the observer program in this period were collected in the MA/RI portion of the action area.

Dunton et al. (2015) documented sturgeon bycatch in waters less than 50 feet deep during the New York summer flounder fishery; 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 off the coast of New York 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.

None of the scientific literature that has examined the distribution of Atlantic sturgeon in the marine environment has identified the WDA 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 WDA. Based on the location of spawning rivers both north and south of the WDA and the general distribution of Atlantic sturgeon in the marine environment, individual Atlantic sturgeon are expected to be moving through the WDA during the warmer months of the area and may be foraging opportunistically in areas where benthic invertebrates are present; however, the area is not known to be a preferred foraging area. Individual Atlantic sturgeon may be present in the WDA year-round. In the lease area and along the cable corridor (i.e., the WDA), the majority of individuals will be from the Gulf of Maine and 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 a 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 Gulf of Mexico and 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.

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 will travel. The July 19, 2022 Paulsboro 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
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, 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 Revolution Wind Farm project.

Fishing Activity in the Action Area
Commercial and recreational fishing occurs throughout the action area. The Revolution Wind WDA is a small portion (<1%) of NMFS statistical area 537 and 539. Transit routes to southern ports, including those in the Gulf of Mexico 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 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 capture and 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, 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. 2022, 2021, and 2020 and 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). For the Gulf of Mexico, Hayes et al. (2021) reports the estimated mean annual fishery-related mortality and serious injury for sperm whales during 2014–2018 was 0.2 sperm whales (CV=1.00) due to interactions with the large pelagic longline fishery. 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. 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[24]. Of the 114 right whales in the UME, 9 mortalities are attributed to entanglement as well as 30 serious injuries and 36 sublethal injuries. None of the whales recorded as part of the UME were first documented in the WDA[25]. We reviewed information on serious injury and mortalities reported in Henry et al. 2022. Six live right whales were first documented as entangled in waters off the coast of southern Massachusetts; right whale 3139 was documented showing entanglement related injuries (without gear currently present) on July 4, 2017 approximately 1.5 nm south of Nantucket, MA, right whale 4091 was documented as free-swimming with a line trailing from it on May 12, 2018 approximately 53.7 nm east of Chatham, MA. North Atlantic right whale 3208 was observed injured without gear present on December 1, 2018, 30.8 nm south of Nantucket, MA. On December 20, 20218, right whale 2310 was observed swimming with gear through the mouth 238.5 nm southeast of Nantucket, MA, and on December 27, 2018, right whale 3950 was observed with new, healed injuries without gear present and was located 16.3 nm south of Nantucket, MA. North Atlantic right whale 3466 was seen swimming 20.03 nm south of Nantucket, MA on December 21, 2019. It was free-swimming, but multiple lines were seen around the mouth and trailed behind the whale for approximately 1 body length, and subsequent sightings indicated the gear was shed successfully with evidence of healing injuries. It is unknown where these entanglements actually occurred. Henry et al. 2022 includes no records of entangled fin, sei, blue, or sperm whales first reported in waters between Long Island, NY to Nantucket Shoals. Henry et al. 2022 presented three documented human-caused mortality events for North Atlantic right whales in the coastal area between Long Island, NY and Martha's Vineyard, MA since 2016. The first was the right whale 4681 located near Morris Island, MA (southeast of Cape Cod) on May 3, 2016 due to sharp trauma. The following two were unknown whales on August 6, 2017 and August 25, 2018 and both where near Martha's Vineyard, MA. The whale found on August 6, 2017 had no gear present, but showed signs of constriction

[24] 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 July 17, 2023
[25] https://noaa.maps.arcgis.com/apps/webappviewer/index.html?id=e502f7daf4af43ffa9776c17c2aff3ea; last accessed July 17, 2023

associated with gear and evidence of subsequent hemorrhaging, and similarly the whale found on August 25, 2018 had no gear present, but showed evidence of acute entanglement surrounding the pectoral area as well as hemorrhaging.

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 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 (2018-2022) were queried for the number of reports of Atlantic sturgeon bycatch in the statistical areas that overlap with the lease area and cable routes (537 and 539[23]). 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 (2018-2022), a total of 60 Atlantic sturgeon were reported as bycatch in bottom otter trawls and gillnets in these two statistical areas, this represents approximately 8.6% of the total observed 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. Note that the WDA occupies only a portion of area 537 and 539. 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 commercial otter trawls and 70% in commercial gillnets), bycatch is expected to be a primary source of mortality of Atlantic sturgeon in the action area. Atlantic sturgeon do not occur in the Gulf of Mexico.

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, there were a total of 15 incidents of observed sea turtle bycatch in gillnet, trap/pot, and bottom otter trawl fisheries in areas 537 and 539 (1 green, 2 Kemp's ridley, 2 leatherback, 8 loggerhead and 2 unknown). Leatherback sea turtles are particularly vulnerable to entanglement in vertical lines. Since 2005, over 230 leatherbacks have been reported entangled in vertical lines in Massachusetts alone. 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 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.

Vessel Traffic between the Lease Area and Ports to the South
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.

The Gulf of Mexico is known for a high level of commercial shipping activity and many large ports, especially those with transiting bulk carriers (Wiggins et al. 2016). AIS data for the Gulf of Mexico shows a variety of vessel traffic for the region ranging from cargo, fishing, passenger, pleasure, tankers, and tug-tows. Ports located within the Gulf of Mexico support large amounts of shipping traffic (e.g., the ports of Houston, TX and Corpus Christi, TX have annual tonnage of

240,933,408 and 85,674,968 respectively).[26] Gulf of Mexico vessel traffic is routed with shipping fairways, traffic separations schemes, and traffic lanes.

Vessel Traffic in the Lease Area and Surrounding Waters
In the COP, Revolution Wind reports on vessel traffic in the WDA based on AIS data. Based on this data, the most common type of vessels transiting in the WDA are commercial fishing and recreational vessels. The data show that traffic is most dense through Rhode Island Sound and along the traffic separation zones.

The marine component of the action area supports considerable vessel traffic, ranging from thousands of large and small vessel trips per year near coastal areas and in and around major shipping lanes to dozens of vessel trips in some low-traffic areas in the Revolution Wind WFA (DNV GL 2020). DNV GL (2020) summarized vessel traffic in the vicinity of the proposed action based on AIS data from July 1, 2018, through June 30, 2019. The data include eight vessel classes: cargo/carrier, fishing, other and unidentified, passenger, pleasure, tanker, tanker – oil, and tug and service. Vessel lengths ranged from 17 m to 186 m, vessel beams ranged from 5 m to 31 m and vessel deadweight tonnage ranged from less than 137 metric tons to 47,573 metric tons (DNV GL 2020). Most vessels sail between 8 and 12 knots. AIS data suggest that primarily fishing, other and unidentified, and pleasure vessels currently transit within the Revolution WDA. No military vessels operated in the Lease Area during this period. Between July 1, 2018, and June 30, 2019, there were 113,697 vessel crossings of a measurement line at the entrance of Narragansett Bay via East Passage. Approximately 75 percent of these crossings were pleasure vessels (58%) and Tug/Service vessels (21%). Fishing and other/unidentified vessels account for approximately 70 percent of the vessels that went into the WDA. The levels of vessel traffic observed by DNV GL (2020) for 2018 to 2019 is broadly consistent with the findings of the U.S. Coast Guard (USCG 2020) analysis of vessel traffic patterns in the same area for the period from 2015 through 2018. However, as described below, the levels of vessel traffic in the general vicinity increased significantly from 2015 to 2018 (USCG 2020).

In the vicinity of the lease area, cargo vessels showed greatest traffic density following the Traffic Separation Scheme into Narragansett Bay, with some traffic traversing the area proposed for WTGs. The RWEC will cross the southeastern edge of the Narragansett Bay Traffic Separation Scheme and the vessel traffic paths leading to Narragansett Bay (DNV GL 2020). The majority of the vessel traffic that transits the RWEC through the north-south Narragansett Bay traffic Separation Zone will largely be pleasure craft (followed by fishing, tug/service, undefined, and passenger in descending order) (DNV GL 2020). Deep draft commercial craft typically travel south-north/north-south through the Narragansett Bay Traffic lanes to the west of the WDA as well as east-west/west-east from Buzzards Bay to Block Island Sound. This second course travels to the north and northwest of the WDA. Transit information available for commercial fishing traffic shows greatest density near the coastline to the north and west of the lease area; however, fishing vessel transit information is not fully available due to some vessels not being outfitted with AIS (automatic identification system) and the practice of fishermen temporarily disabling their AIS to preserve proprietary fishing information (DNV GL 2020). Pleasure craft in the area are concentrated around the coastline, to the north of the WDA and

[26] marinecadastre.gov (last accessed July 17 2023).

outside the majority of the Narragansett Bay Traffic lanes (DNV GL 2020). See Appendix R of the COP for a detailed description of vessel traffic patterns and statistics.

General vessel traffic in the area surrounding the lease area varies, ranging from thousands of large and small vessel trips in and around major shipping lanes to dozens of vessel trips in the low-traffic areas in the WFA (DNV GL 2020). DNV GL (2020) analyzed vessel traffic patterns in the WDA to assess navigation safety risks using a two-step analysis. The first step relied on quantification of vessel transits through designated cross sections in proximity to the action area using AIS data for all vessel classes. The second step relied on Vessel Monitoring System (VMS) data for fishing vessels. The VMS system provides location data used by NMFS to monitor fishing activity while maintaining confidentiality.

Figure 6.1 below (from BOEM's BA) displays AIS vessel tracks and the 21 analysis cross sections in proximity to the proposed project footprint, regional traffic corridors, and port entrances. Vessel transits through each cross section during the study period are displayed in Figure 6.2. Vessel classes represented by these results include deep-draft commercial vessels (e.g., cargo/carriers and tankers), tugs/barges, service, fishing, passenger, and recreational vessels, and other or unspecified vessel types.

Figure 6.1. AIS Vessel Traffic Tracks for July 1, 2018 to June 30, 2019 and Analysis Cross Sections Used for Traffic Pattern Analysis (DNV GL 2020).

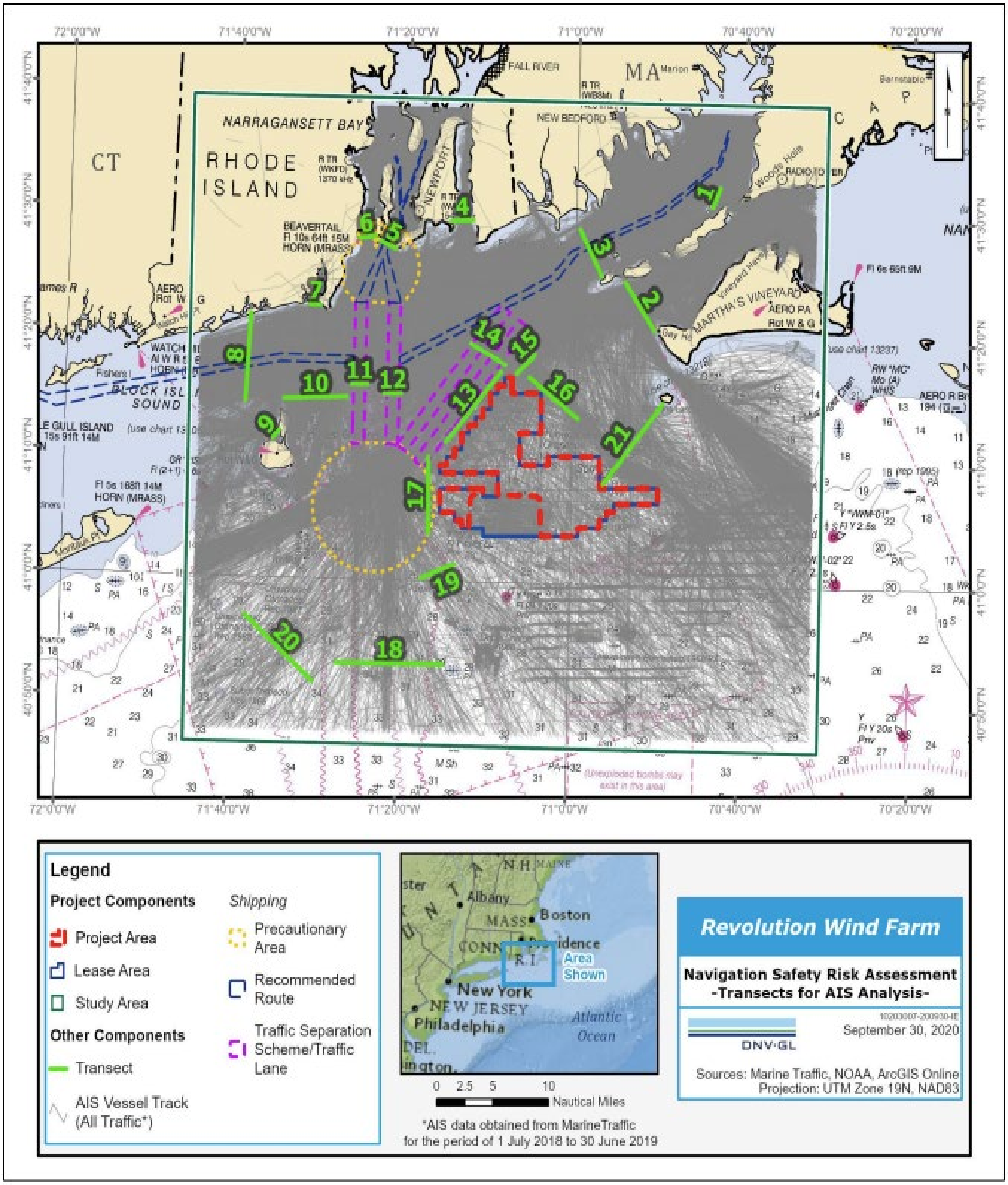
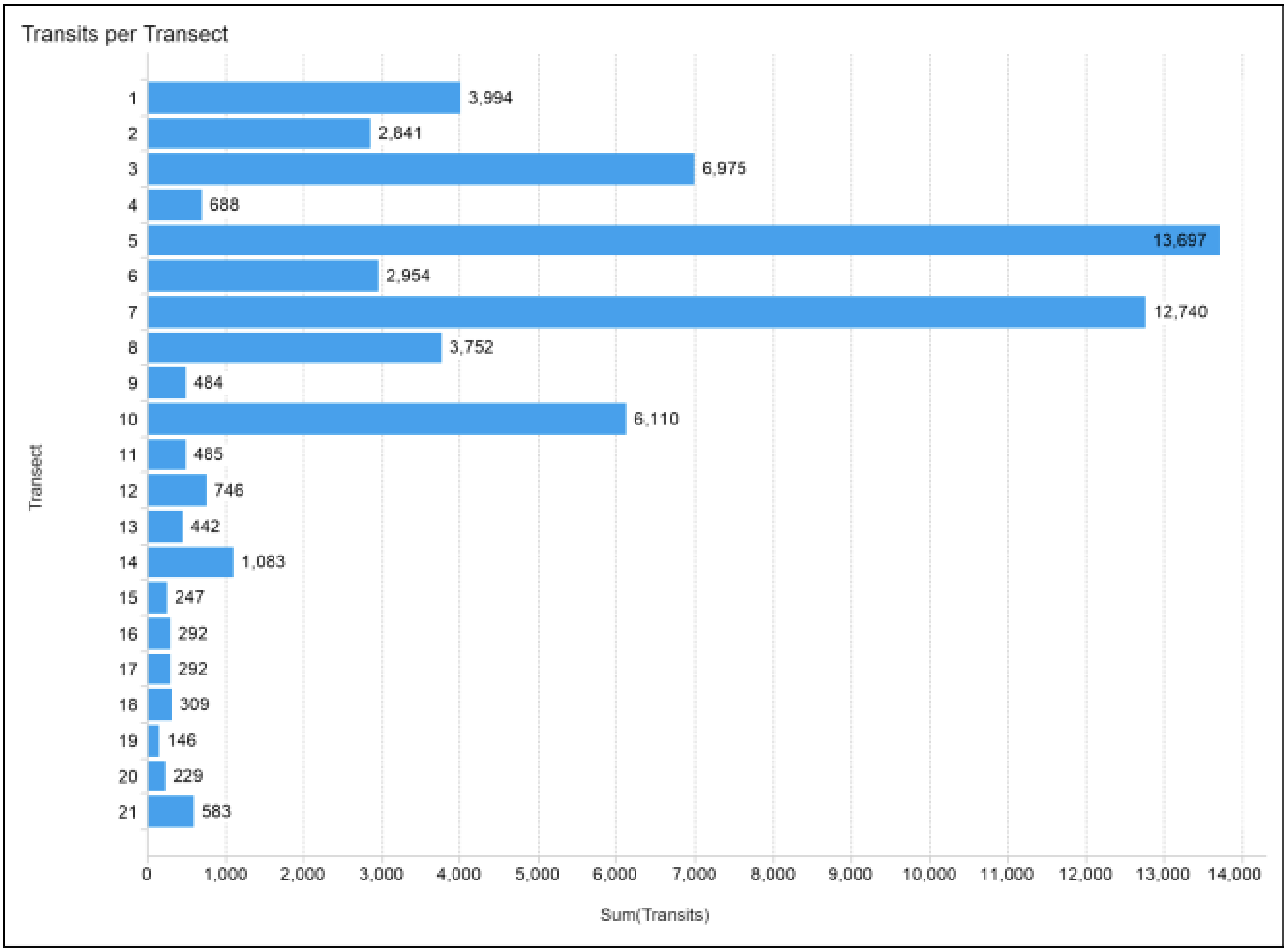


Figure 6.2. Vessel Transits from July 1, 2018, to June 30, 2019, by Analysis Cross Section, All Vessel Classes (DNV GL 2020).



As shown, the cross sections surrounding the Lease Area (13, 16, and 17) have relatively low annual traffic counts with less than 10 transits per day. The approach to Narragansett Bay (cross section 5) has a high level of vessel traffic consistent with the presence of several commercial and recreational port facilities and a major naval and coast guard facility. DNV GL (2020) analyzed the proportional distribution of vessel types crossing each cross section. Approximately half of the vessel traffic transiting cross sections 13 and 16 is from fishing vessels, with “other/unidentified” vessels being the next largest contributor. Cross section 17, which captures vessels merging in and out of regional traffic separation zones, shows 30 percent of the tracks captured are from deep draft vessels (cargo/carrier and tankers). Approximately 69 percent of transits through cross section 19 are in cargo/carrier or tanker-oil products vessel categories. The USCG (2020) vessel traffic analysis also summarized vessel traffic by class in the RI/MA WEA and surroundings but did not use the transect based approach 84 applied by DNV GL (2020). USCG data indicate a substantial increase in vessel traffic in the defined study

area[27] from 2015 through 2018
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). The Block Island SMA, overlaps with the portion of the action area where the project will be constructed. All vessels 65 feet or longer that transit the SMA 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

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[27] The MARIPARS study area is bounded by a rectangular area defined by the following corner coordinates: (1) 41°20′ N, 070°00′ W; (2) 40°35′ N, 070°00′ W; (3) 40°35′ N, 071°15′ W; (4) 41°20′ N, 071°15′ W.

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, and 0.2 for sei whales. No vessel strikes for blue or sperm whales have been documented (Hayes et al. 2020). Hayes et al. (2021) reports no vessel strikes have been documented in recent years (2014–2018) for sperm whales in the Gulf of Mexico. Historically, one possible sperm whale mortality due to a vessel strike was documented for the Gulf of Mexico. The incident occurred in 1990 near Grande Isle, Louisiana. Deep cuts on the dorsal surface of the whale indicated the vessel strike was probably pre-mortem (Jensen and Silber 2004). 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 no records of fin or right whales and one record of right whales presumed to have been killed by vessel strike that were first detected in the WDA. The nearest record is a right whale first observed near Morris Island, MA (off the southeast coast of Cape Cod). 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. Additionally, a 2012 Florida stranding mortality was classified as a vessel strike mortality. 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 Rhode Island and Massachusetts, south and east of Cape Cod to overlap with the area where the majority of project vessel traffic will occur. Out of the 59 recovered stranded sea turtles in the southern New England region during the most recent three year period (2020-2022) for which data was available, there were 33 recorded sea turtle vessel strikes, primarily between the months of August and November.

The majority of strikes were of leatherbacks with a smaller number of loggerhead and green; there was one record of Kemp's ridleys struck in the area for which data was obtained. 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. Due to the greater abundance of sea turtles in southern portions of the action area, particularly along the Florida coast and in the Gulf of Mexico, vessel strike occurs more frequently in this portion of the action area. Foley et al. (2019) reports that based on stranding numbers, being struck by a vessel causes up to about 30% of the mortality of loggerheads, green turtles, and leatherbacks; and up to about 25% of the mortality of Kemp's ridleys in the nearshore areas of Florida. The authors estimate that overall, strikes by motorized watercraft killed a mean of 1,326–4,334 sea turtles each year in Florida during 2000–2014.

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, with all records within rivers and estuaries. 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 geographies that increase the likelihood of co-occurrence between Atlantic sturgeon and 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 influence the environmental baseline for this action. 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 Revolution Wind project, BOEM estimates up to 28 trips to the Paulsboro Marine Terminal (see also Table 3.6 in this Opinion). This is approximately 3% of the total trips considered in the Paulsboro Biological Opinion. Based on the available information, we expect that Revolution 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. Consistent with the analysis in the Paulsboro Marine Terminal, we consider that all vessels using the port are equally likely to strike an Atlantic sturgeon. As such, we would expect that 3% of the total vessel strikes of Atlantic sturgeon could result from Revolution Wind vessels. Calculating 3% of 7 Atlantic sturgeon results in an estimate of 0.22 vessel struck sturgeon. As such, we anticipate that vessels using the Paulsboro Marine Terminal as part of the Revolution Wind project will result in the strike of no more than one Atlantic sturgeon. Based on the proportional assignment of take in the July 2022 Paulsboro Opinion, we expect that this would be no more than one Atlantic sturgeon belonging to the New York Bight DPS. Calculating 3% of 1 shortnose sturgeon results in an estimate of 0.03 vessel struck sturgeon. It is not possible to determine which of the 880 trips to Paulsboro over the 10 year period considered in the Opinion would result in a vessel strike, as such, consistent with the analysis in the Paulsboro Opinion, we consider it equally likely that one of the 28 Revolution Wind vessel trips will strike and kill a shortnose sturgeon as any of the other vessels transiting to/from the port. As such, we anticipate that vessels using the Paulsboro Marine Terminal as part of the Revolution Wind project will result in the strike of no more than one shortnose sturgeon. The effects of these vessel trips on shortnose and Atlantic sturgeon are included in the Environmental Baseline for the Revolution Wind 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 include 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) as well as ongoing effects of construction of the South Fork and Vineyard Wind 1 projects. To date, we have completed section 7 consultation to consider the effects of construction, operation, and decommissioning of multiple commercial scale offshore wind project in the action area (Vineyard Wind 1, South Fork Wind, Ocean Wind 1), and to date, construction has only started for South Fork Wind and Vineyard Wind 1. We have also completed ESA section 7 consultation on two smaller scale offshore wind projects that occur in the action area, the Block Island project, and Dominion's Coastal Virginia Offshore Wind Demonstration Project; these projects 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. NMFS GARFO completed a programmatic informal consultation with BOEM in June 2021 that considered the effects of geotechnical and geophysical surveys and buoy deployments (NMFS GAR 2021). The consultation includes a number of best management practices and project design criteria designed to minimize the potential effects of these activities on ESA listed species. In the consultation, we concluded that these activities are not likely to adversely affect any ESA listed species. 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 action area to support

OSW development; surveys for the Vineyard Wind 1 and South Fork projects were considered in the Biological Opinions issued for those projects. 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. To date, we have records of ten Atlantic sturgeon captured in gillnet surveys (for the South Fork project) in the action area; six of the sturgeon were released alive with minor injuries while the remaining four were killed. South Fork does not anticipate further gillnet survey efforts at this time. A number of Atlantic sturgeon have also been captured in trawl surveys; however, all animals have been released alive with no serious injuries observed.

Consideration of Construction, Operation, and Decommissioning of Other OSW Projects
We have completed ESA consultation for five OSW projects to date. Complete information on the assessment of effects of these three projects is found in their respective Biological Opinions (Ocean Wind 1 - NMFS 2023, South Fork Wind - NMFS 2021a, Vineyard Wind 1 - NMFS 2021b, CVOW - NMFS 2016, and Block Island - NMFS 2014). The Block Island and CVOW projects have been constructed and turbines are operational. Construction of the Vineyard Wind 1 and South Fork projects is expected to be complete prior to the beginning of construction of the Revolution Wind project. In the Biological Opinions prepared for the South Fork, Vineyard Wind 1, and Ocean Wind 1 projects, we anticipated short term behavioral disturbance of ESA listed sea turtles and whales exposed to pile driving noise. In these Opinions, we concluded that effects of operational noise would be insignificant. With the exception of the gillnet interactions noted above, the only mortality anticipated is a small number of sea turtles and Atlantic sturgeon expected to be struck and injured or killed by vessels associated with the Vineyard Wind 1, Ocean Wind 1, and South Fork projects.

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.

Kraus et al. (2016) surveyed the ambient underwater noise environment in the RI/MA WEA as part of a broader study of large whale and sea turtle use of marine habitats in this wind energy development area. The Revolution 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 WEA, also contributed ambient sound.

Acoustic monitoring sensor locations in and around the RI/MA WEA are depicted in Figure 11 of Kraus et al. (2016). As shown, sensors RI-1, RI-2, and RI-3 effectively surround the SFWF, whereas the remaining sensor locations are in the more seaward portion of the WEA. 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 on the western side of the SFWF 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) are the dominant sources of underwater noise in the action area.

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. Outside of the Gulf of Mexico, 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; noise associated with construction and operations of other offshore wind projects is addressed above.

Factors Relevant only for the Gulf of Mexico portion of the Action Area
In addition to fishing activities and vessel operations, oil and gas exploration and extraction activities occur in the Gulf of Mexico as do a number of military activities. The air space over the Gulf of Mexico is used extensively by the Department of Defense for conducting various air-to-air and air-to-surface operations. Nine military warning areas and five water test areas are located within the Gulf of Mexico. The western Gulf of Mexico has four warning areas that are used for military operations. In addition, six blocks in the western Gulf of Mexico are used by the Navy for mine warfare testing and training. The central Gulf of Mexico has five designated military warning areas that are used for military operations. Oil and gas operations on the Gulf of Mexico OCS that have been ongoing for more than 50 years involve a variety of activities that may adversely affect ESA-listed species in the action area. These activities and resulting impacts include vessels making supply deliveries, drilling operations, seismic surveys, fluid spills, oil spills and response, and oil platform removals.

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.

Marine ecosystems are described using the Coastal and Marine Ecological Classification Standard (CMECS), a classification system based on biogeographic setting for the area of interest (FGDC 2012). CMECS provides a comprehensive framework for characterizing ocean and coastal environments and living systems using categorical descriptors for physical, biological, and chemical parameters relevant to each specific environment type (FGDC 2012). The CMECS biogeographic setting for the WDA is the Temperate Northern Atlantic Realm, Cold Temperate Northwest Atlantic Province, Virginian Ecoregion. The biotic component of

CMECS classifies living organisms of the sea floor and water column based on physical habitat associations across a range of spatial scales. This component is organized into a five-level branched hierarchy: biotic setting, biotic class, biotic subclass, biotic group, and biotic community. The biotic subclass is a useful classification category for characterizing the aquatic ecosystem. Biotic component classifications in the WDA are defined by the dominance of life forms, taxa, or other classifiers observed in surveys of the site. In the case of photos, dominance is assigned to the taxa with the greatest percent cover in the photo (FGDC 2012).

The cable corridor is located in coastal marine waters where available water quality data are also limited. The EPA classified coastal water quality conditions nationally for the 2010 National Coastal Condition Assessment (EPA 2016). The 2010 National Coastal Condition Assessment used physical and chemical indicators to rate water quality, including phosphorus, nitrogen, dissolved oxygen, salinity, water clarity, pH, and chlorophyll *a*. The most recent National Coastal Condition Report rated coastal water quality from Maine to North Carolina as "good" to "fair" (EPA 2012). This survey included four sampling locations near the WDA, all of which were within Block Island Sound. EPA (2016) rated all National Coastal Condition Report parameters in the fair to good categories at all four of these locations.

The WDA is located in temperate waters and, therefore, subjected to highly seasonal variation in temperature, stratification, and productivity. Overall, pelagic habitat quality within the WFA and offshore components of the cable corridor is considered fair to good (USEPA 2015). Baseline conditions for water quality are further described below. Section 4.2.4 of the COP details oceanographic conditions in the WFA and surrounding area. Circulation patterns in the Lease Area and vicinity are influenced by water moving in from Block Island Sound and the colder water coming in from the Gulf of Maine with a net transport of water from Rhode Island Sound towards the southwest and west. While the net surface transport is to the southwest and west, bottom water may flow toward the north, particularly during the winter (Rhode Island Coastal Resources Management Council [RI CRMC] 2010).

Narragansett Bay is heavily developed with historical inputs of pollution from industrial, commercial, and residential development. Water quality conditions in the Bay declined over the 10 years between 2008 and 2018 (Moss et al. 2019), including increasing water temperature and salinity and decreasing pH over this 10-year period. Steps to improve water quality in the Bay have been implemented and are ongoing, including improving wastewater treatment plants and reducing polluted runoff from development and roadways.

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 (EPA 2012). 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).

TSS in Rhode Island Sound from five studies cited in EPA and USACE (2004) ranged from 0.1 to 7.4 milligrams/liter (mg/L) TSS. Bottom currents may re-suspend silt and fine-grained sands, causing higher suspended particle levels in benthic waters. Storm events, particularly frequent intense wintertime storms, may also cause a short-term increase in suspended sediment loads (BOEM 2013). Vinhateiro et al. (2018) assumed that ambient TSS levels in the marine component of the action area were generally low, less than 10 mg/L.

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 Revolution 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 Revolution Wind 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 England. All of the electricity generated will support existing uses. Even if we assume the Revolution Wind 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 Revolution Wind project specifically. Because the electricity generated by Revolution Wind will be pooled with that of other sources in the power grid, we are unable to trace any particular new use of electricity to Revolution Wind's contribution to the grid and, therefore, we cannot identify any impacts, positive or negative, that would occur because of the Revolution 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 Revolution 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

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[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.

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 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 WDA, also contribute ambient sound; these sources are described in the *Environmental Baseline*.

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. 2023; Appendix P3 and P4, dated November 2021), Revolution Wind's Application for an ITA and Revised Density and Take Estimate Memo[29], the Proposed Rule prepared for the ITA (87 FR 79072; December 23, 2022), and BOEM's BA.

Impact Pile Driving for WTG and OSS Foundations

As described in section 3, up to 79 12-m diameter and two 15-m diameter monopiles will be installed to support the 79 WTGs and 2 OSSs, resulting in about 328 hours total of active pile driving over a 5-month period. 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.

The impact pile driving installation scenario that was modeled considered:

- 79 tapered 7/12-m diameter WTG monopile foundations: 10,740 hammer strikes per pile modeled over 220 minutes (3.7 hours); and,
- 2 tapered 7/15-m diameter OSS foundations: 11,564 hammer strikes per pile modeled over 380 minutes (6.3 hours).

[29] Available at: https://www.fisheries.noaa.gov/action/incidental-take-authorization-revolution-wind-llc-construction-revolution-wind-energy; last accessed June 5, 2023.

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. Representative Impact Hammer Energy Schedules for WTG and OSS Monopiles Used for Modeling.

Monopile foundations (7/12m diameter)			OSS Foundations (7/15m diameter)		
Hammer: IHC S-4000			Hammer: IHC S-4000		
Energy Level (kJ)	Strike Count	Pile Penetration Depth (m)	Energy Level (kJ)	Strike Count	Pile Penetration Depth (m)
1,000	1,705	0-6	1,000	954	0-5
2,000	3,590	6-24	2,000	2,944	5-17
3,000	2,384	24-36	3,000	4,899	17-36
4,000	3,061	36-50	4,000	2,766	36-50
Total:	10,740	50	Total:	11,563	50

(Source: Table 12 in the Proposed ITA)

As described in the proposed ITA, the model assumes vertical installation to a penetration depth of 50 m. While pile penetration depth among the foundation positions might vary slightly, this value was chosen as a reasonable penetration depth for the purposes of acoustic modeling based on Revolution Wind's engineering designs. All modeling was performed assuming that only one pile is driven at a time (as Revolution Wind would not conduct concurrent monopile installations), up to three WTG foundations would be installed per day, and no more than one OSS foundation would be installed per day.

Additional modeling parameters based on Revolution Wind's engineering designs for monopile installation were as follows:

- Both WTG and OSS
  - Impact pile driver: IHC S-4000 (4000 kilojoules (kJ) rated energy; 1977 kilonewtons (kN) ram weight)
  - Helmet weight: 3234 kN
- WTG only
  - Tapered 7/12-m steel cylindrical piling with 16-cm thick wall
  - Pile length: 110 m
- OSS only
  - Tapered 7/15-m cylindrical piling with 20-cm thick wall
  - Pile length: 120 m.

Revolution Wind is proposing to use noise abatement systems, also known as noise mitigation systems (NMS) or noise attenuation systems, during all impact pile driving for WTG and OSS foundations 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. Revolution 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. The exact system to be used is not specified at this time but the system ultimately selected must be capable of minimizing sound from pile installation by 10dB. As noted below, this requirement is also in the proposed MMPA ITA; NMFS OPR is proposing that Revolution 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. Revolution 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 Revolution 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 Revolution 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 of the writing of this Opinion, we have received interim sound field verification reports from the first few piles installed for the South Fork and Vineyard Wind 1 projects; these results indicate that the required sound attenuation systems are capable of reducing noise levels by at least 10 dB.

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 ensuring adequate visibility for monitoring. 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 time of day 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 Revolution Wind can demonstrate through a nighttime/low visibility monitoring plan that their planned set up of night vision devices (e.g., mounted thermal/IR camera systems, hand-held or wearable night vision devices (NVDs), infrared (IR) spotlights) are able to reliably detect sea turtles and marine mammals to the full extent of the established clearance and shutdown zones. NMFS OPR includes a similar condition in the proposed ITA. 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 monitoring plan 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 monitoring plan 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 (May to November: 2,300 for WTG foundations and 1,600 for OSS; December: 4,400 for WTG foundations and 2,700 for OSS). As explained below, these “minimum visibility zone” sizes exceed the anticipated distances to the cumulative Level A harassment threshold for ESA listed whales.

Pile Driving at the Sea to Shore Transition
As described in section 3.0 of this Opinion, impact and vibratory pile driving may be required at the sea to shore cable transition, dependent on the construction methodology used. As part of the MMPA ITA application, modeling was carried out to estimate distances to Level A and Level B thresholds for installation of casing pipes and sheet piles (Küsel et al., 2022). Revolution Wind determined the geographic area that would be ensonfied above the Level A and Level B thresholds during casing pipe and sheet pile installation and removal is solely within Narragansett Bay. The best available information indicates that ESA listed whales are unlikely to occur in the immediate vicinity of the sea to shore transition or within Narragansett Bay generally (Raposa, 2009). Therefore, Revolution Wind did not request and NMFS OPR is not proposing to authorize any MMPA take of these species. We have reviewed the analysis and agree that the best available science supports the conclusion that exposure of any ESA listed whale to noise above the Level A or Level B thresholds during casing pipe or sheet pile installation or removal is extremely unlikely to occur. As such, effects of noise from casing pipe or sheet pile installation and removal on ESA listed marine mammals are discountable will not be evaluated further.

UXO Detonations
As described in section 3.0, the proposed action includes the detonation in place of up to 13 UXOs with up to 454-kg (1,000 pounds) charges, which is the largest charge that is reasonably expected to be present. As described by BOEM, Revolution Wind, and NMFS OPR, while the specific charges of all 13 UXOs are unknown, it is reasonable to expect that all 10 could consist of this 454 kg charge. Any detonations would occur on up to 13 different days (*i.e.*, only one detonation would occur per day) during daylight hours between May 1 and October 31.

Revolution 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). As described in the proposed ITA, the locations were deemed to be representative of both the export cable route and the lease area.

Revolution Wind is committing to use of a dual noise-mitigation system during all detonations. Based on the available literature, 10 dB minimum of attenuation is possible with the use of a noise mitigation system (review provided in Hannay and Zykov 2022), and Revolution 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 Revolution 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 Revolution Wind project (8-12 MW direct drive turbines) 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 Revolution 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 Revolution Wind 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 Revolution Wind 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 Revolution Wind turbines. We acknowledge that as the Revolution 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 Revolution 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, which is 1.5 to three times the average annual wind speed in the Revolution Wind WFA (COP section 4.2.4.1), which is summarized in Table 7.1.2 below. 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)
* 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. As summarized in the COP, average wind speeds in the lease area are between 17.5 and 35 km/h and exceed 54 km/h less than 5% of the time. As indicated by data from the nearby Buzzards Bay Buoy maintained by NOAA's National Data Buoy Center (BUZM3; November 2008 – April 2023), average wind speed is 27 km/h with average gusts of 30 km/h; 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 6% of the time across a year[30].

[30] https://www.windfinder.com/windstatistics/ambrose_buoy. and https://www.ndbc.noaa.gov/station_page.php?station=44065; last accessed March 30, 2023

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
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
As part of the proposed action for consultation in this opinion described in Section 3, Revolution Wind plans to conduct HRG surveys in the WDA, including along the export cable routes to landfall locations in Rhode Island 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. During the first year of construction, Revolution Wind estimates that 9,669 km would be surveyed over 136.6 days in the WDA, and 5,748 km would be surveyed along the RWEC corridor over 82.1 days, in water depths ranging from 2 m (6.5 ft.) to 50 m (164 ft.). During the next 4-years, Revolution Wind estimates 2,117 km would be surveyed in the WDA over 30.2 days and 1,642 km would be surveyed over 23.5 days along the RWEC corridor each year. 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, HRG surveys are anticipated over the life of the project.

As noted in Section 3.5, BOEM has completed a programmatic ESA consultation with NMFS for HRG surveys and other types of survey and monitoring activities supporting offshore wind energy development (NMFS 2021a; Appendix C to this Opinion). 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 3.0 and Appendix A and B). As described in the Revolution Wind BA, BOEM will require Revolution Wind to comply with all relevant programmatic survey and monitoring PDCs and BMPs included in the 2021 programmatic ESA consultation; these measures are detailed in Appendix B of the programmatic consultation). HRG surveys related to the approval of the Revolution Wind COP are considered part of the proposed action evaluated in this

Opinion and the applicable survey and monitoring PDCs and BMPs included in the 2021 programmatic ESA consultation are incorporated by reference. They are thus also considered components of the proposed action evaluated in this Opinion.

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. The information on these noise sources is consistent with the information and effects analysis contained in the above referenced programmatic consultation.

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. This is consistent with the conclusions made in the above referenced programmatic consultation.

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 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
Side-scan sonar (>200 kHz) (mobile, non-impulsive, intermittent)	184 dB SEL 220 dB RMS 226 PEAK	NA	NA	NA	NA

[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 distances to disturbance thresholds by equipment type – Fish and Sea Turtles.

HRG SOURCE		DISTURBANCE DISTANCE (m)	
	Highest Source Level (dB re 1uPa)	Sea Turtles (175 dB re 1uPa rms)	Fish (150 dB re 1uPa rms)
Boomers, Bubble Guns	176 dB LE,24h 207 dB Lrms 216 Lpk	40	708
Sparkers	188 dB LE,24h 214 dB Lrms 225 Lpk	90	1,996[a]
Chirp Sub-Bottom Profilers	193 dB LE,24h 209 dB RMS 214 Lpk	2	32
Multi-beam Echosounder (100 kHz)	185 dB LE,24h 224 dB Lrms 228 Lpk	NA	NA
Multi-beam Echosounder (>200 kHz)	182 dB LE,24h 218 dB Lrms 223 Lpk	NA	NA
Side-scan Sonar (>200 kHz)	184 dB LE,24h 220 dB Lrms 226 Lpk	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). The modeling is consistent with BOEM's characterization of these noise sources presented in the BA.

Table 7.1.6. Distance to 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	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})
CHIRPs	<1	<1	48
Boomer/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 79072; December 23, 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). We consider the NMFS technical guidance the best scientific information available for assessing the effects of anthropogenic noise on marine mammals.

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[31] See www.nmfs.noaa.gov/pr/acoustics/guidelines.htm for more information.

Table 7.1.7. 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 – blue, fin, right, sei)	7 Hz to 35 kHz	Lpk,flat: 219 dB LE,LF,24h: 183 dB	Lpk,flat: 213 dB LE,LF,24h: 168 dB
Mid-Frequency Cetaceans (MF: sperm whales)	150 Hz to 160 kHz	Lpk,flat: 230 dB LE,MF,24h: 185 dB	Lpk,flat: 224 dB LE,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 considers exposure to impulsive noise greater than 160 dB re 1uPa rms to result in MMPA Level

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[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] Lpk,flat: unweighted ($_{flat}$) peak sound pressure level (L_{pk}) with a reference value of 1 µPa; LE,$_{XF,24h}$: 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 ($_{24h}$)

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.

7.1.3.1 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 Revolution Wind project. As explained in section 3, NMFS OPR is proposing to authorize Level B take by harassment of a number of blue, fin, sei, sperm, and right whales as a result of exposure to noise from pile driving, UXO detonation, and HRG surveys. Revolution Wind did not apply for an ITA to authorize take 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

[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.

to any project noise sources and none is proposed to be authorized through the MMPA ITA. As described below, NMFS GARFO has carried out our own independent analysis of these noise sources and has determined that the only noise sources expected to result in ESA take by harassment of ESA-listed whales are impact pile driving and UXO detonation.

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.

Pile Driving

In their ITA application and in a Revised Density and Take Estimate Memo[35], Revolution Wind estimated exposure of marine mammals (including ESA listed blue, fin, right, 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 marine mammals 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 independently evaluated and adopted OPR's analysis of the number of blue, fin, right, sei, and sperm 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 is consistent with the analysis and exposure estimates presented in the Notice of Proposed ITA. Below we describe Revolution Wind and NMFS OPR's exposure analyses for these species.

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. 2023; COP Appendix P3 and P4). That information is summarized here. 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 the Notice of Proposed ITA, two WTG and three OSS locations within the WFA were selected for acoustic modeling to provide representative propagation conditions and sound fields (see Figure 2 in Küsel *et al.*, 2023). The two WTG locations were selected to represent the relatively shallow (36.8 m) northwest section of the WFA to the somewhat deeper (41.3 m) southeast section. The three potential OSS locations (of which only two would be used to install the two OSS foundations)

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[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 June 26, 2023.

selected occupy similar water depths (33.7, 34.2, and 34.4 m). The acoustic propagation fields applied to exposure modeling (described below) were based on the WTG (1 of 2) and OSS (1 of 3) locations resulting in the largest fields. In addition to bathymetric and seabed geoacoustic data specific to the specific locations within the WFA, acoustic propagation modeling was conducted separately for "summer" (April through November) and "winter" (December through March) using representative sound velocity profiles for those timeframes (based on in situ measurements of temperature, salinity, and pressure within the water column) to account for variations in the acoustic propagation conditions between summer and winter. Note that pile driving for WTG and OSS foundations is only proposed from May 1 through December 31.

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 7.1.7). 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 in order 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, Revolution Wind modeled both acoustic ranges and exposure ranges. Acoustic ranges represent the distance to a harassment threshold based on sound propagation through the environment (*i.e.*, independent of any receiver) while exposure range represents the distance at which an animal can accumulate enough energy to exceed a Level A harassment threshold in consideration of how it moves through the environment (*i.e.*, using movement modeling). In both cases, the sound level estimates are calculated from three-dimensional sound fields and then, at each horizontal sampling range, the maximum received level that occurs within the water column is used as the received level at that range. These maximum-over-depth (R_{max}) values are then compared to predetermined threshold levels to determine exposure and acoustic ranges to Level A harassment and Level B harassment isopleths. However, the ranges to a threshold typically differ among radii from a source, and might not be continuous along a radii because sound levels may drop below threshold at some ranges and then exceed threshold at farther ranges. To minimize the influence of these inconsistencies, 5 percent of the farthest such footprints were excluded from the model data. The resulting range, $R_{95\%}$, was chosen to identify the area over which marine mammals may be exposed above a given threshold, because, regardless of the shape of the maximum-over-depth footprint, the predicted range encompasses at least 95 percent of the horizontal area that would be exposed to sound at or above the specified threshold. For purposes of calculating estimated take by Level A harassment and Level B harassment, Revolution Wind applied $R_{95\%}$ exposure ranges (described below), not acoustic ranges, to estimate exposure and determine mitigation distances for the reasons described below. Applying animal movement and behavior within the modeled noise fields provides the exposure range, which allows for a more realistic indication of the distances at which PTS acoustic thresholds are reached that considers the accumulation of sound over different durations (note that in all cases the distance to the peak threshold is less than the SEL-based threshold). 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 $ER_{95\%}$). Notably, the $ER_{95\%}$ 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. More detail on the modeling approach is provided in the Notice of Proposed ITA.

Tables 7.1.7 describes the $ER_{95\%}$ exposure ranges (for SEL_{cum} and SPL_{rms}) for monopile foundations, demonstrating the ranges using the summer and winter sound speed profiles. For both seasons, a single WTG monopile per day, three WTG monopiles per day, and one OSS monopile per day are shown. Exposure modeling for the blue whale was not conducted because blue whale density was considered too low to be carried into exposure estimation. Instead, Revolution Wind requested take of blue whales based on group size. NMFS OPR is proposing to authorize take of blue whales based on group size (1 individual). Blue whales are expected to be rare in the action 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.

Revolution Wind also modeled the distance to the Level A peak harassment threshold (Tables J-6 to J-15 in their MMPA application); for all ESA listed species, the ER95% was 0 for all WTG and OSS monopile scenarios in summer and winter with 10 dB attenuation. As such, no noise above the Level A peak thresholds is anticipated.

To estimate the number of fin, right, sei, and sperm whales exposed to noise above the Level A cumulative and Level B harassment thresholds, the three WTG monopile foundation per day scenario was used. As noted in the Notice of Proposed ITA, while it is unlikely that this installation rate would be consistently possible throughout construction, Revolution Wind considers it feasible to install three piles per day, a scenario considered to have the greatest potential impact on marine mammals: so this feasible lessee-proposed scenario that is consistent with the proposed action described by BOEM in the BA was evaluated. Exposure ranges ($ER_{95\%}$) to the Level A SEL_{cum} thresholds and Level B SPL_{rms} threshold resulting from animal exposure modeling for installation of one (for comparative purposes) or three (assumed for exposure modeling) WTG foundations and one OSS foundation per day (assumed for exposure modeling), assuming 10-dB of attenuation, for the summer (when Revolution Wind intends to install the majority of monopile foundations) and winter are shown in Tables 14 and 15. Any activities conducted in the winter (December) would utilize monitoring and mitigation measures based on the exposure ranges ($ER_{95\%}$) calculated using winter sound speed profiles. Revolution Wind does not plan to install two OSS foundations in a single day, therefore, modeling results are provided for installation of a single OSS foundation per day. Exposure ranges were also modeled assuming installation of two WTG foundations per day (not shown here); see Appendix

A of Revolution Wind's ITA application for those results. Meaningful differences (greater than 500 m) between species within the same hearing group occurred for low-frequency cetaceans, so exposure ranges are shown separately for those species (Tables 14 and 15).

Table 7.1.8. Exposure Ranges[1] ($ER_{95\%}$) to Level A (SEL_{cum}) Thresholds for Installation of One and Three 7/12-m WTG Monopiles (10,740 Strikes) or One 7/15-m OSS Monopile (11,564 Strikes) During Summer and Winter with 10-dB Attenuation, 4,000 kJ hammer.

Range (km)							
Hearing Group	SELcum Threshold (dB re 1 $\mu Pa^2 \cdot s$)	WTG Monopile 1 pile/day		WTG Monopile 3 piles/day		OSS Monopile 1 pile/day	
		Summer	Winter	Summer	Winter	Summer	Winter
Low-frequency:	183						
Fin Whale		2.15	3.53	2.23	4.38	1.57	2.68
North Atlantic Right Whale		1.85	3.42	1.93	3.97	1.25	2.66
Sei Whale		1.42	2.82	1.81	3.67	1.22	2.05
Mid-frequency: Sperm Whale	185	0	0.01	0.02	0.02	0	0

Source: Table 14 in the Proposed ITA

Table 7.1.9. Exposure Ranges[1] ($ER_{95\%}$) to the Level B (SPL_{rms}) Isopleth for Installation Of One and Three 7/12-m WTG Monopiles or One 7/15-m OSS Monopile During Summer and Winter with 10-dB Attenuation.

Range (km)						
Species	WTG Monopile 1 pile/day		WTG Monopile 3 piles/day		OSS Monopile 1 pile/day	
	Summer	Winter	Summer	Winter	Summer	Winter
Fin Whale	3.72	4.05	3.76	4.09	3.62	3.88
North Atlantic Right Whale	3.70	4.06	3.67	3.95	3.51	3.75
Sei Whale	3.66	4.11	3.67	4.02	3.58	3.92
Sperm Whale	3.69	4.07	3.67	4.03	3.63	3.81

Source: Table 15 in the Proposed ITA

JASCO's Animal Simulation Model Including Noise Exposure (JASMINE) animal movement model, which we have reviewed and consider the best available science, was used to predict the number of marine mammals exposed to impact pile driving sound above the Level A and Level B 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 Revolution 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 79 WTG monopiles and 2 OSS monopiles 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 7.1.11) at a rate of 3 WTG monopiles per day for 26 days, 1 WTG monopile for 1 day, and 1 OSS monopile for each of two days. 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 7.1.10. Construction Schedule Incorporated into Modeling for WTG and OSS Foundations.

Foundation Type	Schedule	Days of Impact Pile Driving
		1st Highest Density Month
WTG	Monopile foundation, 3 piles per day	26
	Monopile foundation, 1 pile per day	1
OSS	Monopile foundation, 2 pile per day	2

Table 7.1.11. Monthly Marine Mammal Densities (Animals per Km^2 within and around the lease area out to 10km) Used for the Modeling of Revolution 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
North Atlantic right whale	0.0026 (December)
Fin whale	0.0029 (July)
Sei whale	0.0013 (May)
Sperm whale	0.0004 (August)

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 with 10dB attenuation are shown in Tables 7.1.12. For fin whales, observational data from PSOs aboard HRG and geotechnical survey vessels indicate that the density-based exposure estimates for Level B harassment may be insufficient to account for the number of individuals of a species that may be encountered during the planned activities. PSO data from these surveys conducted in the area surrounding the Revolution Wind lease area and RWEC route from October 2018 through February 2021 (AIS-Inc., 2019; Bennett, 2021; Stevens *et al.,* 2021; Stevens and Mills, 2021, all as cited in the Notice of Proposed ITA) were analyzed to determine the average number of individuals of each species observed per vessel day. The total number of individuals observed (including the "proportion of unidentified individuals") was divided by the number of vessel days during which observations were conducted in 2018-2021 HRG surveys (470 vessel days) to calculate the number of individuals observed per vessel day. As explained above, mean group size was used to estimate exposure of blue whales to noise above the level B harassment threshold.

Table 7.1.12. Estimated Take by Level A and Level B Harassment (with 10 dB Sound Attenuation) for 79 WTG and 2 OSS monopile foundations.

Species	Exposure Modeling Take Estimates		PSO Data Take Estimate	Mean Group Size	Maximum Level B Take Estimate
	Level A (SPL_{cum})	Level B (SPL_{rms})			
Blue Whale	N/A	N/A	-	1.0	1
Fin Whale	6.4	14.9	15.8	1.8	16
North Atlantic Right Whale	17.5	21.6	1.4	2.4	22
Sei Whale	2.5	7.8	0.4	1.6	8
Sperm Whale	0.0	2.8	-	1.5	3

Based on the exposure estimates for impact pile driving activities related to WTGs and OSS installation, the take as proposed to be authorized by NMFS OPR, are found below in Table 7.1.13. The Level B exposure estimates shown are based on the exposure ranges resulting from sound exposure modeling using the unweighted 160 dB SPL_{rms} criterion. The calculated exposures were rounded to the next whole number. As explained above, NMFS OPR is proposing to authorize the Level B harassment of one blue whale 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 6.4 fin whales, 17.5 North Atlantic right whales, and 2.5 sei whales would be exposed to noise above the cumulative Level A harassment threshold; Revolution Wind did not request any Level A take for these species. NMFS OPR determined that with the implementation of the mitigation measures required by the proposed MMPA ITA, no Level A takes are expected. As described in section 3, these measures are considered part of the proposed action we are consulting on.

Total Take Estimates for All Pile Driving

Table 7.1.14 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 all proposed pile driving. Below we present information to support the determination that no ESA listed whales are expected to be exposed to noise above the Level A harassment threshold.

Table 7.1.13. Take by Level A and Level B Harassment (assuming 10 dB Sound Attenuation) for 79 WTG and 2 OSS monopile foundations proposed for authorization through the MMPA ITA.

Species	Level A Harassment (SEL_{cum})	Level B Harassment (160 dB rms)
Blue whale	0	1
Fin whale	0	16
North Atlantic right whale	0	22
Sei whale	0	8
Sperm whale	0	3

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 Revolution Wind in the COP, by BOEM as described in the BA regarding potential COP approval conditions, or by NMFS OPR as requirements of the proposed 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, Revolution 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
As described in Section 3, Revolution Wind proposed as part of the COP and BOEM and NMFS OPR are proposing to require monitoring of clearance and shutdown zones before and during impact pile driving. In addition to the clearance and shutdown zones, the MMPA ITA identifies minimum visibility zones for pile driving of WTG and OSS foundations. These are the distances from the pile that the visual observers must be able to effectively monitor for marine mammals; that is, lighting, weather (e.g., rain, fog, etc.), and sea state must be sufficient for the observer to be able to detect a marine mammal within that distance from the pile. For WTG foundations, these visibility distances are 2,300 m from May – November and 4,400 m in December. For OSS foundations, these visibility distances are 1,600 m from May – November and 2,700 m in December. The clearance zone is the area around the pile that must be declared "clear" of marine mammals and sea turtles prior to the activity commencing. The size of the zone is measured as the radius with the impact activity (i.e., pile) at the center. For marine mammals, both visual observers and passive acoustic monitoring (PAM, which detects the sound of vocalizing marine mammals) will be used; the area is determined to be "cleared" when visual observers have determined there have been no sightings of marine mammals in the identified area for a prescribed amount of time and, for North Atlantic right whales in particular, if no right whales have been visually observed in any area beyond the minimum clearance zone that the visual observers can see. Further, the PAM operator will declare an area "clear" if they do not detect the sound of vocalizing right whales within the identified PAM clearance zone for the identified amount of time. Pile driving cannot commence until all of these clearances are made.

Once pile driving begins, the shutdown zone applies. If a marine mammal is observed by a visual PSO entering or within the respective shutdown zones after pile driving has commenced, an immediate shutdown of pile driving will be implemented unless Revolution 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 (see section 3.0 for more information). For right whales, shutdown is also triggered by: the visual PSO observing a right whale at any distance (i.e., even if it is outside the shutdown zone identified for other whale species), and a detection by the PAM operator of a vocalizing right whale at a distance determined to be within the identified PAM shutdown zone.

Additionally, Revolution Wind proposed as part of the COP and in their application for an MMPA ITA to implement clearance and shutdown zones for vibratory pile driving. Vibratory pile driving is only proposed for sheet pile installation and removal at the sea to shore cable transition.

Table 7.1.14. Proposed Clearance and Shutdown Zones. (Note that these are in addition to a minimum visibility zone of 2,300m (4,400m in December) for WTG foundations and 1,600m (2,700m in December) for OSS foudnations. Zone sizes identified here are those described in the proposed MMPA ITA and BOEM's BA.)

Species	Clearance Zone (m)	Shutdown Zone (m)
Impact pile driving[a]		
North Atlantic right whale – visual PSO	Minimum visibility zone plus any additional distance observable by the visual PSOs	Minimum visibility zone plus any additional distance observable by the visual PSOs
North Atlantic right whale – PAM WTG	3,900 (4,300)	3,900 (4,300)
North Atlantic right whale – PAM OSS	4,100 (4,700)	4,100 (4,700)
Blue, fin, sei, and sperm whale – WTG foundation	2,300 (4,400)	2,300 (4,400)
Blue, fin, sei, and sperm whale – OSS foundation	1,600 (2,700)	1,600 (2,700)
Sea Turtles	500	500
Cofferdam Installation		
NARW, blue, fin, sei, and sperm whale	100	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.

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 located 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 a distance determined to provide optimal coverage of the clearance and shutdown zones. These PSOs would be required to maintain watch at all times when impact pile driving of monopiles 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, the PSO must confirm that the relevant clearance zones have been free of marine mammals for at least the 30 minutes immediately prior to starting a soft-start of pile driving. For blue, fin, sei, and sperm whales, this means that the PSOs have not seen any individuals within the 3,900 m clearance zone (4,300 m in December) for WTG foundations or the 1,600 m clearance zone (2,700 m in December) for OSS foundations. For right whales, this means that the PSO has not seen any right whales in those areas plus any additional distance that they can see beyond those areas. Similarly, the PAM operator must confirm that there have been no detections of vocalizing right whales in the PAM clearance zone for the preceding 60 minutes. If a visual PSO observes a marine mammal entering or within the relevant clearance zone, or the PAM operator detects a right whale within the PAM 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 lighting, weather (e.g., rain, fog, etc.), and sea state have been sufficient for the observer to be able to detect a marine mammal within the identified minimum visibility distances for at least 30 minutes (i.e., clearance zone is fully visible for at least 30 minutes). 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.

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 zones for WTG and OSS foundations and requirement that PSOs be working from two platforms (two near the pile driving platform, two on a vessel at a distance from the pile), makes it reasonable to expect that 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 PAM clearance zone (see Table 7.1.14 above), 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 79072).

If an ESA listed whale is observed entering or within the identified shutdown zone (see Table 7.1.14) 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 Revolution 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 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

As explained above, noise above the Level A peak harassment threshold is not anticipated to occur during pile driving for the WTG or OSS foundations. Considering WTG and OSS foundations, to be exposed to noise above the Level A cumulative threshold, a blue, fin, right, or sei whale would need to remain within the clearance zone for the entire duration of day's pile driving. That is, a whale would need to stay within 2.3 km of a WTG foundation (4.4 km in December) for the entire 4 hour pile driving duration or stay within 1.6 km of an OSS foundation (2.7 km in December) for the entire 6.3 hour pile driving duration. For a sperm whale, the distance is even smaller; a sperm whale would need to remain within 20 m of the pile being driven (which would likely be within the bubble curtain). The visual clearance zones proposed by BOEM and NMFS OPR, and part of the proposed action, are larger than the distance to the Level A cumulative harassment threshold for all ESA listed whale species (with the exception that the clearance zone is approximately 80 m smaller than the Level A cumulative threshold distance for fin whales if 3 monopiles were installed in a single day in December, which is a low probability event). Pile driving cannot begin if a whale is detected by the visual PSOs within the clearance zone. Considering placement of visual PSOs at the pile driving platform and on a vessel 3km from the pile being driven and with a visual range of another at least 1.5km, we expect that an area of at least 4.5 km from the pile will be able to be effectively monitored for ESA listed whales by the visual PSOs; the minimum visibility requirements mean that the area able to be monitored is likely to be even larger. As such, while the modeling carried out for the MMPA ITA application and in the BA predicts the exposure of up to 6.4 fin whales, 17.5 right whales, and 2.5 sei whales to noise above the cumulative Level A harassment threshold, we agree with the determination made in the Proposed ITA that this exposure is extremely unlikely to occur. This is because it is extremely unlikely that any individual of any of these species could remain undetected in the area close enough to the pile for the entire duration of a day's pile driving events, which is what would need to occur for exposure to noise above the Level A cumulative threshold to occur. 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 whale within the clearance zone. Even considering that there may be a brief delay between a PSO detecting a whale within the shutdown zone and shutdown occurring, we do not expect any instances where a whale is close enough to the pile for the entire duration of pile driving during a 24-hour period such that it would actually be exposed to noise above the cumulative Level A threshold. As such, we do not expect any ESA listed whales to be exposed to noise above the Level A thresholds; therefore, no PTS is anticipated to occur.

The risk of exposure to noise that could result in PTS, which we determined is extremely unlikely to occur, is even lower for right whales. 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. 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. The visual and PAM clearance zones proposed by BOEM and NMFS OPR, and part of the proposed action, are larger than the distance to the Level A cumulative harassment threshold . The PAM clearance zone is 3,900 from May – November for WTG foundations (4,100 for OSS) and 4,300 m in December (4,700 m for OSS). 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, with the minimum visibility requirement covering the distance to the cumulative Level A threshold. Considering placement of visual PSOs at the pile driving platform and on a vessel 3km from the pile being driven and with a visual range of another at least 1.5km, we expect that an area of at least 4.5 km from the pile will be able to be effectively monitored for right whales by the visual PSOs; the minimum visibility requirements mean that the area able to be monitored is likely to be even larger. The area that we expect can be effectively monitored by the visual PSOs is larger than the area where noise will be above the Level A cumulative noise threshold (for WTG monopiles: 1.85 km May – November, 3.42 km in December; for OSS foundations: 1.25 km May – November, 2.66 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 3,900 from May – November for WTG foundations (4,100 for OSS) and 4,100 m in December (4,700 m for OSS). 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 any distance from the pile being driven. 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, as stated above, it is extremely unlikely that any right whales will experience permanent threshold shift or any other injury.

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; however, they 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, 1 blue, 16 fin, 22 right, 8 sei, and 3 sperm whales may be exposed to noise above the Level B threshold during the installation of monopiles.

Soft Start

As described in the Notice of Proposed ITA, 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. Revolution 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, which we consider part of the proposed action, 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 risk of whales being 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, Revolution Wind will conduct sound field verification for at least the first three monopiles. 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, Revolution Wind is required to conduct sound field verification of any additional monopiles 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, Revolution 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 next 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, Revolution 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 noise attenuation measures and/or adjustments to pile driving cannot reduce the distances to less than those modeled, this may be considered new information that reveals effects of the action that may affect listed species in a manner or to an extent not previously considered and reinitiation of this consultation may be necessary.

7.1.3.2 Effects to ESA-Listed Whales from Exposure to Pile Driving Noise

As explained above, we anticipate that up to 1 blue, 16 fin, 22 right, 8 sei, and 3 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) and masking.

An extensive discussion of TTS is presented in the proposed MMPA ITA 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 pile driving generates sounds in the lower frequency ranges (with most of the energy below 1-2 kHz but with a small amount energy ranging up to 20 kHz); therefore, in general and all else being equal, we would anticipate the potential for TTS 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 Revolution 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 WTG foundations last for four hours at a time (6.3 hours for the 2 OSS foundations), 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, consistent with the literature cited above, the effects of TTS and any behavioral response resulting from this TTS will be limited to no more than 24 hours from the time of exposure. Effects of TTS resulting from exposure to Revolution 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 to disturbing levels of noise would be limited to less than a day (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 for the 79 WTG foundations or 6.3 hours for the 2 OSS foundations), 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, this infrequent, time-limited exposure of individuals to pile driving noise is unlikely to impact the fitness of any individual; that is, the anticipated disturbance is 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 up to 22 North Atlantic right whales may experience TTS or behavioral disturbance from exposure to pile driving noise. We expect that this will be up to 22 different individuals each experiencing a single exposure to pile driving noise above the Level B harassment threshold. We do not expect repeat exposures (i.e., the same individual exposed to multiple pile driving events) due to the short duration and intermittent natures of the pile driving noise and the limited residence time of right whales in the area. When in the portion of the action area where exposure to pile driving noise would occur, right whales are migrating, foraging, resting, and socializing (Quintana-Rizzo et al. 2021). If a North Atlantic right whale 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. Animals displaced from a particular portion of the area due to exposure to pile driving noise would either return to the area after the noise stopped or would continue their normal behaviors from the location they moved to. As noted previously, responses to pile driving noise are anticipated to be short-term (no more than about 4 to 6 hours depending on the pile type).

Quintana-Rizzo et al. (2021) reported on observations of right whales in the MA/RI and MA Wind Energy Areas. Feeding was recorded on more occasions (n = 190 occasions) than socializing (n = 59 occasions). Feeding was observed in all seasons and years, whereas social behaviors were observed mainly in the winter and spring and were not observed in 2011 and 2017. No impact pile driving for WTG or OSS foundations will occur in the majority of months defined in that paper as winter (December – February) and spring (March – May); given that social behavior is limited in the time of year that pile driving is proposed (May-December), the potential for effects to social behavior is very low. However, even if a whale was engaged in social behavior when pile driving commenced, any disruption is limited to no more than the four to six hours it would take to complete driving the pile. As explained above, social behavior is not necessarily indicative of mating and there is currently no evidence of mating behavior in the lease area. However, even if mating does occur in the lease area we would expect it to occur in the winter months when pile driving will not occur. Therefore, disruption of mating is extremely unlikely to occur.

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 approximately 4 km for WTG foundations and up to 4.7 km for OSS foundations. 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 3.8 -4.7 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 25-32 minutes, but at the median speed observed in Hatin et al. (1.3 kph, 2013), it would take the animal approximately 2.9 – 3.6 hours to move out of the noisy area. However, given the requirements for visual and PAM clearance, it is unlikely that any right whale would be closer than the minimum visibility distance (2.3 or 4.4 km for a WTG foundation and 1.6 or 2.7 km for an OSS foundation depending on the season). 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 WTG monopile and 6.3 hours for an OSS monopile).

Based on 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 exposed animals will be able to return to normal behavioral patterns (i.e., socializing, foraging, resting, migrating) 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). The up to 22 right whales exposed to pile driving noise may experience one-time, temporary, disruptions to foraging activity; this would be the case if a right whale was foraging while pile driving started and it stopped foraging to move away from the noise or if it was actively avoiding the noisy area and did not forage during that period. As explained above, given that the duration of pile driving is short (4 to 6 hours), and we expect an individual to only be exposed to noise from a single pile driving event, we expect the potential for disruption of foraging to occur for a short period of time on a single day.

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. There is no indication this is the case, particularly since unconsumed prey would likely still be available in the environment following the cessation of acoustic exposure (i.e., the pile driving is not expected to disrupt copepod prey). There would likely be an energetic cost associated with any temporary displacement to find alternative locations for foraging, 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 (Southall et al. 2007a). Disruption of resting and socializing may also result in short term stress. Efforts have been made to try to quantify the potential consequences of responses to behavioral disturbance, 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 Revolution Wind project.

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 22 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 3.8 to 4.7 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.

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 likely last between less than 30 minutes but could last 4 to 6 hours. 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 overall energy budget, health, or fitness.

Stress responses are also anticipated in the 22 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 the minutes to up to 6 hours the individual right whales are expected to be exposed to disturbing levels of noise during impact pile driving. 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 22 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.

As noted above, 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 22 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 is expected to resolve within a day and in all cases would 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 the 22 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 potentially for up to 6.3 hours) and none will be repeated. 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 Revolution 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.

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 Revolution 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. 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). As such, TTS and masking are not expected to increase the risk that a right whale will be hit by a vessel or become entangled in fishing gear.

While we do expect pile driving noise to cause avoidance and temporary localized displacement as discussed above, 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. Information on patterns and distribution of vessel traffic and fishing activity, including fishing gear that may result in the entanglement or capture of sea turtles, is illustrated in the Navigational Safety Risk Assessment prepared for the Revolution Wind Project (DNV GL 2021 (Revolution Wind NSRA, COP Appendix M)). Based on the available information, we do not expect avoidance of pile driving noise resulting in an increased risk of vessel strike or entanglement in fishing gear. This determination is based on the relatively small size of the area with noise that a right whale is expected to avoid (no more than 4 km from the pile being installed), the short term nature of any disturbance, and the lack of any significant differences in vessel traffic or fishing activity in that 4 km area that would put a right whale at greater risk of vessel strike or entanglement/capture.

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[37] 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,

[37] Available at: https://www.fisheries.noaa.gov/national/laws-and-policies/protected-resources-policy-directives

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 22 individuals expected to be exposed to noise above the Level B harassment threshold meet the definition of harassment. We have established that up to 22 individual right whales will be exposed to disturbing levels of noise (step 1). For an individual, the nature of this exposure is expected to be limited to a one-time exposure to pile driving noise and will last for as long as it takes the individual to swim away from the disturbing noise or, at maximum, the duration of the pile event (up to 4 to 6 hours); this disruption will occur in areas where individuals may be migrating, foraging, resting, or socializing (step 2). Animals that are exposed to this noise are expected to abandon their activity and move far enough away from the pile being driven to be outside the area where noise is above the Level B harassment threshold (traveling up to 3.8-4.7km). As explained above, these individuals are expected to experience TTS (temporary hearing impairment), masking, stress, disruptions to foraging, and energetic consequences of moving away from the pile driving noise and potentially needing to seek out alternative patches of copepod prey (step 3). Together, these effects will significantly disrupt a right whale's normal behavior for that day; that is, the nature and duration/intensity of these responses are a significant disruption of normal behavioral patterns that creates the likelihood of injury (step 4). Therefore, based on this four-step analysis, we find that the 22 right whales exposed to pile driving noise louder than 160 dB re 1uPa rms threshold are likely to be adversely affected and that effect amounts to harassment. As such, we expect the harassment of 22 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 normal behaviors of individual right whales on the day that the whale is exposed to the pile driving noise creating the likelihood of injury, it will not actually kill or injure any right whales by significantly impairing any essential behavioral patterns. This is because the effects will be limited to that single day and are expected to be fully recoverable, there will not be an effect on the animal's overall energy budget in a way that would compromise its ability to successfully obtain enough food to maintain its health, or impact the ability of any individual to make seasonal migrations or participate successfully in nursing, breeding, or calving. TTS will resolve within no more than 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. We also expect that stress responses will be limited to the single day that exposure to pile driving noise occurs and there will not be such an increase in stress that there would be physiological consequences to the individual that could affect its health or ability to socialize, migrate, forage, breed, calve, or raise its young. Thus, as no injury or mortality will actually occur, the response of right whales to pile driving noise does not meet the definition of "harm."

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 normal or essential behavioral 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 for a WTG foundation or 6.3 hours for the OSS foundations); 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; actual time spent swimming away from the noise is likely to be significantly less. However, given the requirements for ensuring an area extending 2.3 km from a WTG foundation pile, or 1.6 km from an OSS foundation pile is clear of fin, sei, and sperm whales before pile driving begins (with larger distances required if pile driving occurs in December), 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.

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. In our judgment it is reasonable to assume here that it is likely 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 expect that any effects of TTS and/or masking on communication or nursing by blue, fin, or sei whale mother-calf pairs will be extremely unlikely to occur or will be so small that they cannot be meaningfully measured, evaluated, or detected; therefore, all effects of TTS and/or masking on mother-calf fitness will be insignificant or discountable.

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 Revolution 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. Information on patterns and distribution of vessel traffic and fishing activity, including fishing gear that may result in the entanglement or capture of sea turtles, is illustrated in the Navigational Safety Risk Assessment prepared for the Revolution Wind Project (DNV GL 2021 (Revolution Wind NSRA, COP Appendix M)). Based on the available information, we do not expect avoidance of pile driving noise resulting in an increased risk of vessel strike or entanglement in fishing gear. This determination is based on the relatively small size of the area with noise that a right whale is expected to avoid (no more than 4 km from the pile being installed), the short term nature of any disturbance, and the lack of any significant differences in vessel traffic or fishing activity in that 4 km area that would put an individual whale at greater risk of vessel strike or entanglement/capture.

We set forth the NMFS interim guidance definition of ESA take by harassment above and the four-step analysis to evaluate whether harassment is likely to occur. Here, we carry out that four-step assessment to determine if the effects to the 1 blue, 16 fin, 8 sei, and 3 sperm whales expected to be exposed to noise above the Level B harassment threshold meet the definition of harassment. We have established that up to 1 blue, 16 fin, 8 sei, and 3 sperm whales will be exposed to disturbing levels of noise (step 1). For an individual, the nature of this exposure is expected to be limited to a one-time exposure to pile driving noise and will last for as long as it takes the individual to swim away from the disturbing noise or, at maximum, the duration of the pile event (up to 4 to 6 hours); this disruption will occur in areas where individuals may be migrating, foraging, resting, or socializing (step 2). Animals that are exposed to this noise are expected to abandon their activity and move far enough away from the pile being driven to be outside the area where noise is above the Level B harassment threshold (traveling up to 3.8-4.7km). As explained above, these individuals are expected to experience TTS (temporary hearing impairment that may impair their ability to communicate), masking, stress, disruptions to foraging, and energetic consequences of moving away from the pile driving noise and potentially needing to seek out alternative locations to forage (step 3). Together, these effects will significantly disrupt an individual blue, fin, sei, or sperm whale's normal behavior for that day; that is, the nature and duration/intensity of these responses are a significant disruption of normal behavioral patterns that creates the likelihood of injury (step 4). Therefore, based on this four-step analysis, we find that the 1 blue, 16 fin, 8 sei, and 3 sperm whales exposed to pile driving noise louder than 160 dB re 1uPa rms threshold are likely to be adversely affected and that effect amounts to harassment. As such, we expect the harassment of 1 blue, 16 fin, 8 sei, and 3 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." No blue, fin, sei, or sperm whales will be injured or killed due to exposure to pile driving noise. Further, while exposure to pile driving noise will significantly disrupt normal behaviors of individual whales on the day that the whale is exposed to the pile driving noise creating the likelihood of injury, it will not actually kill or injure any individuals by significantly impairing any essential behavioral patterns. This is because the effects will be limited to that single day and are expected to be fully recoverable, there will not be an effect on the animal's overall energy budget in a way that would compromise its ability to successfully obtain enough food to maintain its health, or impact the ability of any individual to make seasonal migrations or participate successfully in nursing, breeding, or calving. TTS will resolve within no more than 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. We also expect that stress responses will be limited to the single day that exposure to pile driving noise occurs and there will not be such an increase in stress that there would be physiological consequences to the individual that could affect its health or ability to socialize, migrate, forage, breed, calve, or raise its young. Thus, as no injury or mortality will actually occur, the response of blue, fin, sei, or sperm whales to pile driving noise does not meet the definition of "harm."

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 13 UXOs. NMFS OPR has also considered the detonation of up to 13 UXOs in the notice of proposed ITA. As described above, modeling was carried out to support the assessment of effects of UXO detonation. UXO detonation may occur along the cable corridor and within the WFA (i.e., the lease area); due to different environmental conditions that affect sound propagation (e.g., water depth) and the differences in marine mammal density in the nearshore and further offshore areas, separate modeling was done for the two areas. Because Revolution 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 7.1.15.

Table 7.1.15 Maximum Distances to Non-Auditory Injury and Mortality Thresholds for Marine Mammals (10 dB mitigation) considering all modeled sites.

Threshold Type	Marine Mammal Species	Maximum Distance (m) to Thresholds	
		Adult	Calf
Mortality	Baleen whale/sperm whale	34	109
Lung Injury	Baleen whale/sperm whale	80	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)
[a] Based on 1% of animals exposed (mortality/Lung injury).
m = meters; UXO = unexploded ordnance

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 7.1.16 and 7.1.17.

Table 7.1.16. SEL-based $R_{95\%}$ PTS-onset Areas for the E12 Charge Weight (454 kg) with 10 dB Attenuation.

Marine Mammal Hearing Group	Threshold (dB *re 1 $\mu Pa^2 s$*)	Distance (m) to PTS threshold (R95%)		Maximum ensonified zone (km^2)	
		RWEC	Lease Area	RWEC	Lease Area
Low-frequency cetaceans	183	3,780	3,610	44.9	40.9
Mid-frequency cetaceans	185	461	412	0.67	0.53

Table 7.1.17. SEL-based $R_{95\%}$ TTS-onset Areas for the E12 Charge Weight (454 kg) with 10 dB Reduction.

Marine Mammal Hearing Group	Threshold (dB *re 1 μPa²s*)	Distance (m) to TTS threshold (R95%)		Maximum ensonified zone (km²)	
		RWEC	Lease Area	RWEC	Lease Area
Low-frequency cetaceans	183	11,900	11,800	445	437
Mid-frequency cetaceans	185	2,550	2,480	20.43	19.3

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 – November) for the area of interest were used as described in the Notice of Proposed ITA. The densities used are presented in Table 7.1.18.

Table 7.1.18. Highest Monthly Marine Mammal Densities (Animals per Km²) Used for the Modeling of Revolution Wind's UXO/MEC detonations (considering the May – November window).

Marine Mammal Species	Highest Density Month	Estimated Density	
		RWEC	Lease Area
Blue whale	Annual Density	0.0000	0.0000
Fin whale	July	0.0015	0.0029
North Atlantic right whale	May	0.0009	0.0019
Sei whale	May	0.0007	0.0012
Sperm whale	August	0.0002	0.0004

Source: Table 22 in Proposed ITA

The estimated maximum PTS and TTS exposures are presented in Table 7.1.19. 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 7.1.19. Estimated Potential Maximum Level A and B Harassment Exposures of Marine Mammals Resulting from the Possible Detonation of up to 13 UXOs with 10 dB of Sound Attenuation.

Species	Including 10 dB of Sound Attenuation	
	Level A Harassment (PTS SEL)	Level B Harassment (TTS SEL)
Blue whale	0	0.1
Fin whale	1.2	11.4
North Atlantic right whale	0.8	11.2
Sei whale	0.5	7.1
Sperm whale	0	0.1

Source: Table 23 in Proposed ITA

Through conditions of the ITA, NMFS OPR proposes to require Revolution Wind to clear a zone extending 10 km for low-frequency cetaceans (fin, sei, right, blue whales) and 2 km for mid-frequency cetaceans (sperm whales). These zones are based on (but not equal to) the greatest TTS threshold distances from 454 kg charge at any site modeled and are at least twice the size of the greatest PTS threshold distances. 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 a number of visual PSOs and one PAM operator on at least two dedicated PSO vessels. Additionally, due to the size of the 10 km clearance zone, 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 have independently evaluated

NMFS OPR and BOEM's analyses and 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 7.1.20 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. The estimated exposure of sperm whales was rounded up to mean group size.

Table 7.1.20. Anticipated Number of Individuals exposed to noise above the Level A Harassment and B Harassment thresholds Resulting From The Detonation Of Up To 13 UXOs, with 10 dB of Sound Attenuation.

Species	Level A Harassment	Level B Harassment (TTS)
Blue whale	0	1
Fin whale	0	17
North Atlantic right whale	0	12
Sei whale	0	8
Sperm whale	0	2

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, while TTS is expected to increase the risk of injury by significantly disturbing normal behavioral patterns it is not likely to result in significant impairment of essential behavioral patterns that actually kill or injure any individuals.

Therefore, we expect the 12 right, 17 fin, 8 sei, 1 blue, and 2 sperm whales that experience TTS as a result of exposure to UXO detonation noise to meet the definition of ESA take by harassment but not harm applying the definitions and processes for evaluation described above. Therefore, we expect the 13 detonations to result in the harassment of no more than 12 right, 17 fin, 8 sei, 1 blue, and 2 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 Section 3 (inclusive of Appendix A and B) 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 or essential 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 Revolution Wind 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 Revolution 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 WDA. 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. 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). 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. 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.

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 most intense condition likely to occur, 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 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 (Eliot et al. 2019). As noted above, based on wind speed records within the WDA (Revolution Wind COP) and the nearby Buzzards Bay Buoy, average wind speeds in the WDA are between 17.5 and 35 km/h and exceed 54 km/h less than 5% of the time.

Given the conditions necessary to result in noise above 120 dB re 1uPa only occur less than 5% 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 Revolution Wind. 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 Revolution Wind WDA, 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 and are elements of the proposed action under consultation in this opinion. A number of minimization measures for HRG surveys are also 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, Revolution Wind requested Level B harassment take associated with HRG surveys during the 5-year effective period of the ITA. During this period, HRG surveys are anticipated to operate at any time of year for a maximum of 247.8 active sound source days in year 1 and approximately 24.5 days of survey activity in years 2-5. Revolution Wind has requested the take of 5 blue, 15 fin, 10 sei, 22 North Atlantic right whales, and 10 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 MMPA 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 (i.e. not adverse effects rising to the level of ESA take by harm, harassment or otherwise). 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) which we consider the best available science and information on these effects. 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 7.1.14). Based on these considerations, it is extremely unlikely that any ESA-listed whale will be exposed to noise that could result in PTS. Therefore, auditory injury is extremely unlikely to occur. No other types of 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 substantial 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 extremely unlikely 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." For similar reasons it is extremely unlikely that any individual would experience ESA take by harm.

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.

Based on the limited information about acoustically induced stress responses in sea turtles, it is reasonable to assume that 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, in part, 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 would likely 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 take by 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 7.1.21). The cumulative metric accumulates all sound exposure within a 24-hour period and is therefore different from a peak, or single exposure, metric.

Table 7.1.21. 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·s SEL_{cum} 232 dB re: 1 µPa SPL (0-pk)	189 dB re: 1 µPa^2·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 7.1.22 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 7.1.22 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 Revolution Wind project in the context of the noise thresholds presented above.

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. 2023); these are summarized below for the WTG and OSS monopile foundations, assuming 10 dB broadband attenuation and a summer acoustic propagation environment. Exposure ranges vary between species due to differences in their behavior (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 the period when sea turtle exposure to pile driving noise is expected to occur.

Table 7.1.23. WTG monopile foundation (12 m diameter, summer): Exposure ranges ($ER_{95\%}$) in m to sea turtle threshold criteria with 10 dB attenuation.

	One pile per day			**Two piles per day**			**Three piles per day**		
	PTS		Behavior	PTS		Behavior	PTS		Behavior
Species	*LE, 24h*	*Lpk*	*Lpk*	*LE, 24h*	*Lpk*	*Lpk*	*LE, 24h*	*Lpk*	*Lpk*
Kemp's ridley	40	0	900	50	0	840	120	0	880
Leatherback	<10	0	610	30	0	630	120	0	620
Loggerhead	20	0	570	10	0	500	30	0	580
Green	200	0	940	200	0	870	210	0	890

Table 7.1.24. OSS monopile foundation (15 diameter, summer): Exposure ranges ($ER_{95\%}$) in m to sea turtle threshold criteria with 10 dB attenuation.

	One pile per day		
	PTS		**Behavior**
Species	***LE, 24h***	***Lpk***	***Lpk***
Kemp's ridley	50	0	970
Leatherback	0	0	720
Loggerhead	40	0	760
Green	250	0	820

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. (2023), there are limited density estimates for sea turtles in the WDA. For the modeling, sea turtle densities were obtained from the US Navy Operating Area Density Estimate (NODE) database on the Strategic Environmental Research and Development Program Spatial Decision Support System (SERDP-SDSS) portal (DoN, 2012, 2017) and from the Northeast Large Pelagic Survey Collaborative Aerial and Acoustic Surveys for Large Whales and Sea Turtles (Kraus et al. 2016). These data are summarized seasonally (winter, spring, summer, and fall).

Sea turtles were most commonly observed in summer and fall, absent in winter, and nearly absent in spring during the Kraus et al. (2016) surveys of the MA WEA and RI/MA WEAs; this is consistent with expected seasonal distribution of sea turtles in New England waters. Because of this, the winter and spring densities from SERDP-SDSS were used for all species. SERDP-SDSS densities are provided as a range, where the maximum density will always exceed zero, even though turtles are unlikely to be present in winter. As a result, winter and spring sea turtle densities in the WDA, while low, are likely still overestimated.

For summer and fall, the more recent leatherback and loggerhead densities extracted from Kraus et al. (2016) were used. These species were the most commonly observed sea turtle species during aerial surveys by Kraus et al. (2016) in the MA/RI and MA WEAs. However, Kraus et al. (2016) reported seasonal densities for leatherback sea turtles only, so the loggerhead densities were calculated for summer and fall by scaling the averaged leatherback densities from Kraus et al. (2016) by the ratio of the seasonal sighting rates of the two species during the surveys. The Kraus et al. (2016) estimates of loggerhead sea turtle density for summer and fall are slightly higher than the SERDP-SDSS densities. Kraus et al. (2016) reported only six total Kemp's ridley sea turtle sightings, so the estimates from SERDP-SDSS were used for all seasons. Green sea turtles are rare in this area and there are no density data available for this species, so the Kemp's ridley sea turtle density is used as a surrogate; this is reasonable based on the known distribution of Green sea turtles in New England waters.

Table 7.1.25. Sea turtle density estimates for the Revolution Wind WDA plus a 10 km buffer.

Species	Density (animals/100km^2)			
	Spring	*Summer*	*Fall*	*Winter*
Kemp's ridley sea turtle	<0.001	<0.001	<0.001	<0.001
Leatherback sea turtle	0.020	0.630[a]	0.873[a]	0.020
Loggerhead sea turtle	0.131	0.206[b]	0.633[b]	0.131
Green sea turtle [c]	<0.001	<0.001	<0.001	<0.001

Source: Küsel et al. 2023 (table 14)

Density estimates are extracted from SERDP-SDSS NODE database within a 10 km perimeter range of the lease area, unless otherwise noted.

[a] Densities calculated as averaged seasonal densities from 2011 to 2015 (Kraus et al. 2016).

[b] Densities calculated as the averaged seasonal leatherback sea turtle densities scaled by the relative, seasonal sighting rates of loggerhead and leatherback sea turtles (Kraus et al. 2016).

[c] Kraus et al. (2016) did not observe any green sea turtles in the RI/MA WEA. Densities of Kemp's ridley sea turtles are used as a proxy.

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 WDA 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 density or exposure estimates. 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.

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 7.1.26. Modeled Number of Sea Turtles Predicted to Receive Sound Levels Above Cumulative and Peak Injury and Behavioral Criteria from Impact Pile Driving all 79 WTG and Two OSS Proposed Piles, with 10-dB Attenuation.

Sea Turtle Species	Individuals Exposed to Noise above the Injury (PTS) threshold		Individuals Exposed to Noise above the 175 dB threshold (TTS and/or Behavioral Effects)
	Peak	Cumulative (24 hour)	
Kemp’s ridley	0	0.45	6.91
Leatherback	0	0.5	5.95
Loggerhead	0	0.59	14.02

Green	0	1.07	7.51

Source: Table 5.4 in BOEM's January 2023 BA.

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 they are proposed by Revolution Wind or BOEM and are 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
Revolution Wind will implement sound attenuation measures 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, Revolution 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 zone is 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 2,300 m (May – November; 4,400 m in December) must be fully visible before pile driving can begin. If a sea turtle is observed entering or within the 500 m 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 an area approximately 2,000 m from the pile. Given that PSOs at an elevated position are expected to reasonably be able to detect sea turtles at a distance of 500 m from their station, we expect that the PSOs from the pile driving platform will be able to effectively monitor the clearance zone and that the PSOs on the PSO vessel will provide additional information on sea turtles detected outside 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; 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 the duration of pile driving to experience injury from exposure to pile driving noise (less than 210 m considering 3 piles/day, smaller for 1 or 2 piles per day), 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 WTG and OSS monopiles). Based on information in Küsel et al. 2022, at these hammer energies, underwater noise does not exceed the peak threshold for considering PTS 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, Revolution 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. If noise levels are higher than predicted by the modeling described here (i.e., measured distances exceed the distances to the peak and/or cumulative injury and/or behavioral disturbance thresholds identified in tables 7.1.32 and 7.1.33), additional noise attenuation measures will be implemented to reduce distances to the injury and behavioral disturbance thresholds. In the event that noise attenuation measures and/or adjustments to pile driving cannot reduce the distances to less than those modeled, this may be considered new information that reveals effects of the action that may affect listed species in a manner or to an extent not previously considered and 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, modeling indicates the peak PTS threshold is not exceeded in any pile driving scenario. The cumulative PTS threshold is only exceeded within a distance of 210 m or less. The exposure analysis conducted by Küsel et al. (2023) predicts exposure of less than 1 Kemp's ridley, 1 leatherback, and 1 loggerhead, and approximately 1 green sea turtle to noise above the cumulative PTS threshold. In order for noise exposure above the cumulative PTS threshold to occur, a sea turtle would need to remain within 210 m of a single monopile being installed for the entire 4-hour duration of the pile driving event (250 m for the 6-hour duration of the OSS installation). 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 anticipated.

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 7 Kemp's ridleys, 6 leatherbacks, 14 loggerheads, and 8 green sea turtle will be exposed to noise above the behavioral impacts threshold. Neither Revolution 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 600 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 temporarily 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) and displacement from a particular areas would last, at the longest, the duration of pile driving (four hours for a WTG foundation, 6 hours for an OSS foundation). 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, up to four or six 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 WDA used by foraging sea turtles. We have no information to indicate that any particular portion of the WDA 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 WDA 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 Revolution 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 29 to 81 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 overall health, survivability, or reproduction of any individual sea turtle.

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. Information on patterns and distribution of vessel traffic and fishing activity, including fishing gear that may result in the entanglement or capture of sea turtles, is illustrated in the Navigational Safety Risk Assessment prepared for the Revolution Wind Project (DNV GL 2021 (Revolution Wind NSRA, COP Appendix M)). Based on the available information, we do not expect avoidance of pile driving noise resulting in an increased risk of vessel strike or entanglement in fishing gear. This determination is based on the relatively small size of the area with noise that a sea turtle is expected to avoid (approximately 1 km from the pile being installed), the short term nature of any disturbance, the limited number of sea turtles impacted, and the lack of any significant differences in vessel traffic or fishing activity in that 1 km area that would put a sea turtle at greater risk of vessel strike or entanglement/capture.

We evaluate the potential for noise produced by the proposed action to cause ESA take by harassment. 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 that four-step assessment to determine if the effects to the 7 Kemp's ridley, 8 green, 6 leatherback and 14 loggerhead sea turtles expected to be exposed to noise above the 175 dB threshold meet the definition of harassment. We have established that up to 7 Kemp's ridley, 8 green, 6 leatherback and 14 loggerhead sea turtles will be exposed to disturbing levels of noise (step 1). For an individual, the nature of this exposure is expected to be limited to a one-time exposure to pile driving noise and will last for as long as it takes the individual to swim away from the disturbing noise or, at maximum, the duration of the pile event (up to 4 to 6 hours); this disruption will occur in areas where individuals may be migrating, foraging, or resting (step 2). Animals that are exposed to this noise are expected to abandon their activity and move far enough away from the pile being driven to be outside the area where noise is above the 175 dB threshold (traveling up to 1 km). As explained above, these individuals are expected to experience TTS (temporary hearing impairment), masking (which, together with TTS would affect their ability to detect certain environmental cues), stress, disruptions to foraging, and energetic consequences of moving away from the pile driving noise and potentially needing to seek out alternative prey resources (step 3). Together, these effects will significantly disrupt a sea turtle's normal behavior for that day; that is, the nature and duration/intensity of these responses are a significant disruption of normal behavioral patterns that creates the likelihood of injury (step 4). Therefore, based on this four-step analysis, we find that the 7 Kemp's ridley, 8 green, 6 leatherback and 14 loggerhead sea turtles exposed to pile driving noise louder than 175 dB re 1uPa rms are likely to be adversely affected and that effect amounts to harassment. As such, we expect the harassment of 7 Kemp's ridley, 8 green, 6 leatherback, and 14 loggerhead sea turtles as a result of pile driving.

NMFS defines "harm" in the definition of ESA "take" as "an act which actually kills or injures fish or wildlife (50 CFR 222.102). 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 normal behaviors of individual sea turtles on the day that the turtle is exposed to the pile driving noise creating the likelihood of injury, it will not actually kill or injure any sea turtles by significantly impairing any essential behavioral patterns. This is because the effects will be limited to that single day and are expected to be fully recoverable, there will not be an effect on the animal's overall energy budget in a way that would compromise its ability to successfully obtain enough food to maintain its health, or impact the ability of any individual to make seasonal migrations or participate successfully in breeding or nesting. TTS will resolve within no more than a week of exposure and is not expected to affect the health of any turtle or its ability to migrate, forage, breed, or nest. We also expect that stress responses will be limited to the single day that exposure to pile driving noise occurs and there will not be such an increase in stress that there would be physiological consequences to the individual that could affect its health or ability to migrate, forage, breed, or nest. Thus, as no injury or mortality will actually occur, the response of individual sea turtles to pile driving noise does not meet the definition of "harm."

UXO Detonation

As explained above, no more than 13 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 for sea turtles proposed by Revolution Wind and BOEM is dependent on the estimated charge weight of the UXO and ranges from 50 to 480 m (see below).

Revolution Wind conducted modeling of acoustic fields for UXO detonations (Hannay and Zykov 2022, LGL 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 combined with density estimates to determine the number of individuals potentially exposed to noise above these thresholds. Table 7.1.29 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.

Table 7.1.27 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 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).

Table 7.1.28 Maximum Ranges to PTS and TTS-onset thresholds in the RWEC and Lease area for the largest charge sizes with 10 dB mitigation.

Threshold (dB re 1uPa)		$R_{95\%}$ distance (km)		Maximum Area (km2)	
		RWEC	Lease Area	RWEC	Lease Area
PTS	204	0.472	0.369	0.7	0.4
TTS	189	2.25	2.13	15.9	14.3

The number of potential sea turtle exposures to noise above the PTS and TTS thresholds were calculated by multiplying the expected densities of sea turtles in the WDA (considering the area along the RWEC and in the Lease Area where UXO may be detonated) (table 7.3.31) by the area of water likely to be ensonified above the defined threshold levels. The result is then multiplied by 13 (number of detonations considered). Table 7.1.31 (Table 7 in LGL 2022) outlines the number of ESA-listed turtles potentially exposed to sound sources above PTS and TTS associated with UXO detonations. 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. As Revolution 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 7.1.29 Expected Densities of Sea Turtles in the WDA (considering the area along the RWEC and in the Lease Area where UXO may be detonated).

Species	Maximum Monthly Density (individuals/km^2)
Kemp's ridley	0.0001
Leatherback	0.0087
Loggerhead	0.0076
Green	0.0001

Table 7.1.30 Total Number of ESA-Listed Sea Turtles Estimated to be Exposed to Sound Levels above PTS and TTS thresholds for the Detonation of 13 UXOs – Mitigated (10 dB).

	Modeled	
Species	PTS	TTS
Kemp's ridley	0	0
Leatherback	0.1	0.8
Loggerhead	0.1	0.7
Green turtle	0	0

Source: Distances to thresholds taken from Hannay and Zykov (2022).

Modeling predicts that no sea turtles would be exposed to noise that could result in mortality. Given the small distances to the non-auditory mortality and injury thresholds (429 m) and the proposed measures to ensure the area within 480 m of the detonation is clear of sea turtles prior to detonation, no sea turtles are expected to be exposed to noise above those thresholds. The clearance zone for sea turtles will extend 480 m from the site of the planned detonation. Given that a sea turtle would need to be within 429 meters of the detonation to be exposed to noise/pressure that could result in non-auditory injury or 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 non-auditory injury or mortality.

As reflected in the table, the model predicts that no Kemp's ridley or green sea turtles would be exposed to noise that could result in PTS or TTS. The model predicts that 0.1 leatherback and 0.1 loggerhead and 0.8 leatherback and 0.7 loggerhead sea turtles could be exposed to noise that could result in PTS and TTS, respectively. However, the modeling does not take the pre-clearance zone into account. 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 PTS 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 (which extends to 480 m), it is extremely unlikely that a sea turtle would be close enough to the blast to experience PTS. The distance to the TTS threshold (2.13 – 2.25 km) exceeds the clearance zone and is larger than the distance we would reasonably expect observers would be able to detect sea turtles. As such, based on the modeling, we expect that no more than 1 loggerhead and no more than 1 leatherback could experience TTS as a result of exposure to noise from a UXO detonation.

Modeling was not carried out to estimate the number of sea turtles exposed to noise above the 175 dB behavioral threshold. 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 sea turtles exposed to noise above the behavioral threshold but below the TTS threshold would be so small that they cannot be meaningfully measured, evaluated, or detected. As such, effects are insignificant.

Sea to Shore Transition – Casing Pipe and Temporary Cofferdam Installation and Removal
Modeling was carried out to estimate the distances to thresholds of interest for casing pipe and cofferdam installation and removal. The distance to the peak injury threshold is not expected to be exceeded. The distance to the cumulative injury threshold and the 175 dB re 1uPa RMS behavioral disturbance threshold are estimated at 31 and 53 m, respectively. Given the very small areas impacted and the rarity of sea turtles in the nearshore waters of Narragansett Bay where these activities will take place, no sea turtles are expected to be exposed to noise above the injury or behavioral disturbance thresholds during the sea to shore transition activities.

Prior to the start of pile driving to support the sea to shore transition, a clearance zone with a 300 m radius around the piles to be driven will be monitored by a PSO for at least 30 minutes (COP Apendix Z2). Any visual detection of sea turtles within the 300-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 300 m or less, sea turtles at the surface are expected to be able to be sighted by the PSO. While submerged sea turtles may not be detected by the PSO, the length of the clearance period increases the potential for detection as individuals surface to breath. The clearance procedures further reduce the already very low likelihood of exposure of sea turtles to these noise sources. No take of sea turtles is anticipated as a result of noise caused by casing pipe or cofferdam installation or removal.

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 Revolution Wind 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 Revolution 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 within the WDA (Revolution Wind COP) and the nearby Buzzards Bay Buoy, average wind speeds in the WDA are between 17.5 and 35 km/h and exceed 54 km/h less than 5% of the time. Elliot et al. (2019) conclude that based on monitoring of underwater noise at the Block Island site, under maximum potential impact scenarios, 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. No take of sea turtles from exposure to operational noise is expected.

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 fish in a variety of ways, and in certain circumstances, can 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). Fish 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 (Lokkeborg 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): $L_{p,\text{0-pk,flat}}$: 229 dB
- onset of physical injury (received level): $L_{p,\text{0-pk,flat}}$: 206 dB; $L_{\text{E},p,,\text{12h}}$: 187 dB (fish 2 grams or greater); $L_{\text{E},p,,\text{12h}}$: 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

Acoustic propagation modeling of impact pile driving of monopiles and UXO detonations was undertaken by JASCO Applied Sciences to determine distances to injury and behavioral disturbance thresholds for fish (Hannay and Zykov 2021; Küsel et al. 2021). The distances from the pile where noise will be elevated above the identified thresholds are presented in table 7.1.31 and 7.32 below.

Table 7.1.31. Ranges ($R_{95\%}$ in meters) to acoustic thresholds for Atlantic sturgeon for 1, 2, and 3 WTG monopiles per day. 12 m diameter monopiles with 10 dB attenuation, 4,000 kJ hammer, 50 m penetration depth.

Threshold		1 Pile/day	Piles/Day	3 Piles/Day
		m May-November (December)		
Physiological Effects	peak (206)	115 (122)	115 (122)	115 (122)
	Cumulative (12 hr) 187	6,048 (10,144)	7,294 (12,794)	8,022 (14,821)
Behavior	150 dB rms	6,301 (10,664)	6,301 (10,664)	6,301 (10,664)

Source: Tables 24, 26, and in Küsel et al. 2023; the greatest distance modeled at the two representative locations is presented here.

Table 7.1.32. Ranges ($R_{95\%}$ in meters) to thresholds used to evaluate responses of sturgeon to impact pile driving noise resulting for one 15m OSS monopile in 24 hours with 10 dB attenuation, IHC S-4000 hammer, 50 m penetration depth.

Threshold		(m)	
		May-November	December
Physiological Effects	206 peak	93	99
	187 SELcum	6,524	10,564
Behavior	150 dB rms	6,921	10,888

Source: Table 31 in Küsel et al. 2021 the greatest distance modeled at the two representative locations is presented here.

As described above, impact and vibratory pile driving may be used for the installation and removal of the casing pipe and sheet piles respectively to support the sea to shore cable transition, depending on methodology selected. As described in the BA (Table 5.2), noise will not exceed the injury thresholds. Noise may exceed the 150 dB re: 1 µPa RMS behavioral threshold at a distance of up to 775 m (dependent on the installation methodology).

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. For UXO detonations, modeling was conducted as described above to estimate the distances to thresholds used to evaluate onset of injury (Table 7.1.33).

Table 7.1.33 Maximum range to thresholds used to evaluate onset of injury for Atlantic sturgeon exposed to underwater explosives.

Onset of Mortality	Maximum (m)				
	E4 (2.3 kg)	E6 (9.1 kg)	E8 (45.5 kg)	E10 (227 kg)	E12 (454 kg)
Lp, 0-pk, flat: 229 dB	49	80	135	230	290

Source: Table 39 in Hannay and Zykov 2022.
Note: Water depth 50 m

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 Revolution 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 December 1 and April 30. 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 Revolution 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, Revolution 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., 400 to 800 kJ for monopiles), for a minimum of 20 minutes. During installation of the WTG and OSS monopiles, at 1,000 kJ hammer intensity, a sturgeon would need to be within 55m and 47 m of the pile, respectively, to be exposed to be exposed to noise above the 206 dB re 1uPa threshold (see Table 24 and 31 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 4.3km from the WTG monopile being driven (approximately 5 km for the OSS monopile) (see tables 24 and 31 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, Revolution 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. If noise levels are higher than predicted by the modeling described here, additional noise attenuation measures will be implemented to reduce distances to the injury and behavioral disturbance thresholds. In the event that noise attenuation measures and/or adjustments to pile driving cannot reduce the distances to less than those modeled, this may be considered new information that reveals effects of the action that may affect listed species in a manner or to an extent not previously considered and 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 WTG monopile is estimated to require approximately 4 hours of impact pile driving for each of 79 foundations for a total of 316 hours. Installation of each of the two OSS monopile foundations is expected to require approximately 6.3 hours of impact pile driving. Over the course of the potential pile-installation window of May 1 – December 31, pile driving will occur approximately 5.6% of the time (329 hours of pile driving/5,856 total hours). Considering the narrowest window within which pile driving could occur (29 days, with 3 WTG monopiles per day and 1 OSS monopile per day), pile driving would occur for approximately 47% of the time (584 hours of pile driving/696 total hours).

In order to be exposed to pile driving noise that could result in injury, an Atlantic sturgeon would need to be within 122 m of a WTG monopile, or 99 m of an OSS monopile, for a single strike (based on the 206 dB peak threshold). Given the dispersed distribution of Atlantic sturgeon in and near the WDA, the potential for co-occurrence in time and space is extremely unlikely given the small area where exposure to peak noise could occur (extending less than 122 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 a WTG monopile and 6.3 hours for an OSS monopile). 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 approximately 50 meters of the pile being driven to be exposed to peak noise that could result in physiological effects. Given these considerations, we do not anticipate any Atlantic sturgeon to be exposed to noise above the peak injury threshold during monopile installation.

Considering the 187 dB SELcum threshold, an Atlantic sturgeon would need to remain within 6,048 m (10,144 in December) of a single monopile for the duration of the pile driving event (i.e., 4 hours) or stay within 8,022 m (14,820 m in December) of all three WTG monopiles being installed in a 24-hour period. For the OSS monopile, an Atlantic sturgeon would need to remain within 6,524 m (10,569 in December) of the pile for the entire 6.3-hour duration of pile driving. 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 WDA. 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 WTG monopile is 21.6 km, in the 6 hours it would take to drive an OSS monopile, a sturgeon could swim at least 32.4 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 and consideration of the peak and cumulative noise thresholds for injury, 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.

Sea to Shore Transition Pile Driving
As indicated above, the installation and removal of the goal posts and/or cofferdam with a vibratory or impact hammer does not have the potential to exceed the injury thresholds. As such, there is no potential for injury to result from exposure to this 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 13 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 a UXO detonations (approximately one second), 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 as a result of exposure to UXO detonations.

Pile Driving for the Sea to Shore Transition

As noted above the distance to the 150 dB re 1uPa RMS threshold was modeled. During the period 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 775 m from the cofferdam. Given the very small area impacted, the intermittent noise, and the rarity of Atlantic sturgeon in Narragansett Bay, effects to Atlantic sturgeon are extremely unlikely to occur. Take is not anticipated to occur as a result of exposure to noise associated with the sea to shore transition.

Impact Pile Driving for Monopile and OSS Installation

During the 4 hour periods where impact pile driving occurs for 79 WTG foundations and 6.3 hour period for each of the two OSS foundations, the area that will have underwater noise above the 150 dB re 1uPa RMS threshold will extend approximately 6.3 km from May – November and nearly 11 km in December, from the pile being installed. We expect that Atlantic sturgeon exposed to noise above 150 dB re 1uPa RMS would exhibit a behavioral response and may temporarily 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 habitat 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; avoidance of any area ensonified during impact pile driving for the WTG or OSS foundations would not block or delay movement to spawning, foraging, or other important habitats.

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 29 to 81 days (depending on how many piles are installed per day), with pile driving occurring for no more than 4-12 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.

As explained above, NMFS 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." Here, we consider whether the effects to Atlantic sturgeon resulting from exposure to pile driving noise meet the ESA definition of harassment. We have established that some Atlantic sturgeon are likely to be exposed to the stressor or disturbance (in this case, pile driving noise above 150 dB re 1uPa rms). This disturbance is expected to be intermittent and limited in time and space as it will only occur when active pile driving is occurring and only in the geographic area where noise is above the behavioral disturbance threshold. As explained above, the expected response of any Atlantic sturgeon exposed to disturbing levels of noise, are expected to be alterations to their movements and swimming away from the source of the noise. This means they will need to alter their migration route; foraging would also be disrupted during this period. This will result in minor, temporary energetic costs that are expected to be fully recoverable. The nature, duration, and intensity of the response will not be a significant disruption of any behavior patterns. This is because any alterations of the movements of an individual sturgeon to avoid pile driving noise will be a minor disruption of migration, potentially taking it off of its normal migratory path for a few hours but not disrupting its overall migration (e.g., it will not result in delays or other impacts that would have a consequence to the individual). Similarly, any disruption of foraging will be temporary and limited to the few hours that the sturgeon is moving away from the noise. As the area where these impacts will occur is an area where only occasional, opportunistic foraging will occur, this will not be a significant disruption to foraging behavior. Based on this analysis, the nature and duration of the response to exposure to pile driving noise above the behavioral disturbance threshold is not a significant disruption of behavior patterns; therefore, no take by harassment is anticipated. Based on this analysis we have similarly determined that it is extremely unlikely that any Atlantic sturgeon will be exposed to noise which actually kills or injures any individual; thus no take by harm is anticipated.

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 km (11 km in December) 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 2-15 and 2016 DNV GL 2020 (Revolution 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 as a result of exposure to noise from driving of WTG or OSS foundations.

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. Based on this analysis we have similarly determined that it is extremely unlikely that any Atlantic sturgeon will experience significant impairment of essential behavioral patterns. Thus, no take by harm is anticipated. 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 Revolution Wind 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 Revolution 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 within the WDA (Revolution Wind COP) and the nearby Buzzards Bay Buoy, average wind speeds in the WDA are between 17.5 and 35 km/h and exceed 54 km/h less than 5% of the time. 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 7.1.15). 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

The ESA listed species in 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 290 m of the detonation to be seriously injured or killed (see Table 39 in Hannay and Zykov 2022), and that no more than 13 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 Revolution 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 13 UXO detonations and that losses will be limited due to the small number of detonations (13) 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 Revolution Wind 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 Revolution 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 within the WDA (Revolution Wind COP) and the nearby Buzzards Bay Buoy, average wind speeds in the WDA are between 17.5 and 35 km/h and exceed 54 km/h less than 5% of the time. 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. As effects to prey from operational noise on prey are extremely unlikely, effects to ESA listed species resulting from impacts to prey are also extremely unlikely and therefore, discountable.

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. as 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 listed whales, sea turtles, 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 project noise, including vessels, were considered in Section 7.1, and are not repeated here. Project vessels will operate in distinct areas within the action area over the life of the project: in and around the WDA and transiting to/from relatively nearby ports in New England (Cashman Shipyard, New Bedford Marine Commerce Terminal, Port of Providence, Port of Davisville, Quonset Point, Port of New London) and New York (Port of Montauk, Port Jefferson, Port of Brooklyn); between the WDA and more distant ports along the U.S. east coast (Paulsboro Marine Terminal, Sparrow's Point, Port of Norfolk) and the Gulf of Mexico; and, within the U.S. EEZ on routes between the WDA and foreign ports in eastern Canada, Europe, and/or Asia (Figure 7.2.1). Transits during the operation and maintenance phase will only be between the WDA and the O&M facility in either Montauk, New York, Port Jefferson, New York, or Davisville, Rhode Island, with the exception of a limited number of vessel transits of fisheries and benthic survey vessels from other local ports. We note that if there is an unexpected, non-routine maintenance event, a vessel may travel to the project site from an additional location; however, it is not possible to predict when or where such unanticipated trips may occur and therefore, neither the trips or their effects are reasonably certain to occur and therefore do not meet the definition of "effects of the action" and are not considered here, 50 CFR 402.02; 402.17.

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 WDA and between the WDA and the ports used to support Revolution Wind construction, operations and maintenance, and decommissioning; these ports were identified in BOEM's BA. Approximately 60 vessels of various classes will be used during the construction phase with a total of 1,404 vessel trips between various ports and the Revolution Wind WDA. Not all vessels will utilize all ports under consideration, the number of possible vessels and trips for each port under consideration is shown in Table 7.2.1 and usage during construction is shown in Table 7.2.2.

As explained in Section 3, up to 26 transits of heavy transport vessels may occur between ports in eastern Canada, Europe, and/or Asia and the WDA, New London, or Quonset; here, we consider the effects of the portion of those vessel transits that are within the U.S. Atlantic EEZ (see explanation in Section 3 of this Opinion). We also consider the effects of the up to 21 trips that may occur between the WDA and the Gulf of Mexico.

Table 7.2.1. Potential Ports and Estimated Total Number of Vessels and Trips to Support Construction Activities. Trips are Between the Identified Port and the Revolution Wind WDA.

Ports	Number of Vessels	Maximum Vessel Trips
Cashman Shipyard, Quincy, Massachusetts	1	3
New Bedford Marine Commerce Terminal, Massachusetts*	23	933
Port of Providence, Rhode Island*	35	1,161
Port of Davisville, Rhode Island*	23	933
Quonset Point Port, Rhode Island*	43	1,168
Port of New London, Connecticut*	14	918
Port Jefferson, New York	21	1,007
Port of Montauk, New York	10	29
Port of Brooklyn, New York	10	29
Paulsboro Marine Terminal, New Jersey	7	28
Sparrows Point, Maryland	7	28
Port of Norfolk, Virginia	7	28
Gulf of Mexico	4	21
Asia, Europe, eastern Canada	5	26

Source: BOEM (Bureau of Ocean Energy Management). 2023. *Revolution Wind Farm and Revolution Wind Export Cable – Development and Operation. Biological Assessment—Supplement to the March 23,*

2023 Addendum. Prepared for BOEM, Washington, D.C.. Seattle, Washington: Confluence Environmental Company.
This is the potential maximum number of vessels and vessel trips for each port being considered, however, the maximum number of vessels and trips for all ports listed will not occur and is not additive among ports. That is, the total anticipated trips is 1,404 and will occur from a combination of the ports listed here.
* Includes CTV trips during construction

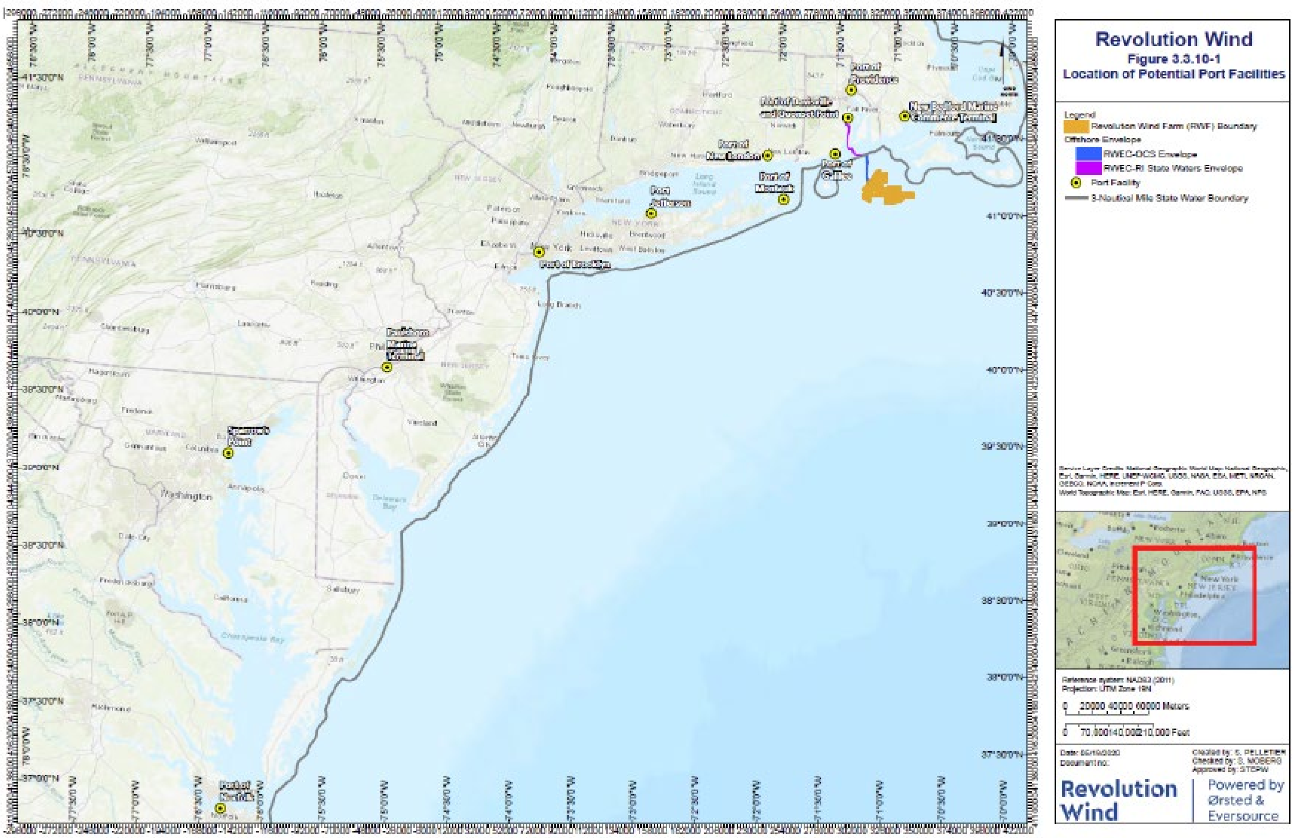
Table 7.2.2. Potential U.S. Atlantic Ports and Usage During Revolution Wind Construction.

Port	Usage
Port of Montauk, New York; Port of Brooklyn, New York; Port of Davisville, Rhode Island; Quonset Point Port, Rhode Island; Cashman Shipyard, Massachusetts	General construction
Port Jefferson, New York	Construction crew mobilization; Surveys and monitoring
Port of Providence, Rhode Island	Construction crew mobilization; Surveys and monitoring; WTG component staging; Foundation staging, and advanced component fabrication
Port of New London, Connecticut; New Bedford Marine Commerce Terminal, Massachusetts	Construction crew mobilization and surveys and monitoring; and WTG component staging
Port of Norfolk, Virginia	WTG component staging
Sparrows Point, Maryland; Paulsboro Marine Terminal, New Jersey	Foundation staging and advanced component fabrication

Source: BOEM (Bureau of Ocean Energy Management). 2023. *Revolution Wind Farm and Revolution Wind Export Cable – Development and Operation. Biological Assessment—Addendum*. Prepared for BOEM, Washington, D.C.. Seattle, Washington: Confluence Environmental Company

As described in Section 3 (Table 3.6), during the construction phase a variety of vessels will be used including installation and transport vessels that may transit between 7-23 knots (when not subject to a speed restriction), range from 45 to 240 meters in length, from 15 to 50 meters in beam, and draft from 5 to 13.5 meters, as well as smaller (approximately 30 meters in length) and faster moving support vessels (maximum speeds up to 23 knots). The larger installation vessels, such as the floating/jack-up crane and cable-laying vessel, will generally travel to and from the construction area in the WDA at the beginning and end of the wind turbine and cable construction/installation and will not make transits to port on a regular basis. 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 Revolution Wind WDA more frequently. However, we note that construction crews responsible for assembling the WTGs may hotel onboard installation vessels at sea thus limiting the number of crew vessel transits expected during wind farm installation. Within the Revolution Wind WDA, many vessels will be stationary or moving 8 knots or less. Construction of the offshore export cables will utilize various vessel types including a cable-laying vessel, tugs, barges, and work and transport vessels (see Table 3.6).

Figure 7.2.1. U.S. Port Facilities under Consideration for Project Construction and Installation and O&M Support (Cashman Shipyard in Quincy, MA and ports in the Gulf of Mexico may also be utilized).
Source: BOEM (Bureau of Ocean Energy Management). 2023. *Revolution Wind Farm and Revolution Wind Export Cable – Development and Operation. Biological Assessment.* Prepared for BOEM, Washington, D.C.. Seattle, Washington: Confluence Environmental Company.



During the operation and maintenance phase, Revolution Wind vessel traffic to the WDA will be limited to visits to carry out inspections and maintenance; there will be approximately 2,730 operation and maintenance transits during the approximate 35-year lifespan of the project primarily occurring from Davisville, Rhode Island, to the Revolution Wind WDA; however BOEM indicates that Montauk, New York or Port Jefferson, New York may be used as back up ports. During the operational phase, crew transport vessels (CTV) would make approximately 52 round trips to the Revolution Wind WDA each year. The service operations vessel (SOV) would make an estimated 26 trips per year to the Revolution Wind WDA on an as-needed basis. Shared CTVs, vessels servicing multiple offshore wind projects, and daughter craft may make an additional 13 and 10 trips to or within the Revolution Wind WDA each year, respectively.

Helicopters may also be used for aerial inspections. Jack-up vessels, cable-lay/cable burial vessels, and support barges may be required on an as-needed basis for major repairs. Typical draft and operational speeds for operation and maintenance vessel types are expected to be similar to those for equivalent vessels used during construction.

As described in the BA, the number and type of vessels required for project decommissioning would be similar to those used during project construction, with the exception that impact pile driving would not be required. As such, while the same class of vessel used for foundation installation may be used for decommissioning, that vessel would not be equipped with an impact hammer. At this time, no information is available on the ports that may be used for decommissioning; however, based on information presented for other wind projects we expect that trips will occur primarily between the WDA and the ports used for operation and maintenance or within the general vicinity of the operation and maintenance ports (i.e., MA, RI, CT, NY).

Total vessel trips during the construction period are 1,404 over the 2-year construction period (anticipated over 3 calendar years) plus an additional 50 or less vessel trips per year to support fisheries and benthic resource surveys for a total of approximately 1,550 trips ; these trips will be between the Revolution Wind WDA and the ports identified above. During the operation and maintenance phase, 2,730 vessel trips will occur over the 35-year period, all trips would occur to/from Davisville, RI, Montauk, NY or Port Jefferson, NY. An additional 50 or less vessel trips from local ports (likely NY or RI or MA) would occur for vessels carrying out fisheries and benthic resource surveys up to the first three years of project operations. During the decommissioning period, 1,404 trips are anticipated over a two-year period. As explained in the Section 6, the best available information indicates there are approximately 46,900 vessel transits annually in the general area that the majority of Revolution Wind vessel transits will overlap. Additional information on vessel traffic in the area is also presented in BOEM's BA. Table 7.2.3 below describes the calculated increase in traffic attributable to Revolution Wind project vessels during each project phase.

Table 7.2.3. Percent Increase above Baseline Vessel Traffic in the Project Area Due to Revolution Wind Project Vessels.

Phase	Annual Project-Related Vessel Transits	Phase Duration	% Increase in Annual Vessel Transits in the Project Area[d]
Construction	727[a]	2 years	1.6%
Operation	82[b]	35 years	0.17%
Decommissioning	752[c]	2 years	1.6%

[a] Source: BOEM March 2023 BA Addendum (1,404 total trips divided by 2 years of construction), plus 50 fisheries/benthic survey vessel transits per year.
[b] Source: BOEM January 2023 BA (2,730 total trips divided by 35 years of operations), plus 50 fisheries/benthic survey vessel transits for 3 of these years.
[c] Source: BOEM January 2023 BA, decommissioning vessel traffic is expected to be the same as construction.
[d] Source: Baseline vessel traffic in the Revolution Wind WDA is based on 46,900 transits (USCG 2020).

7.2.2 Minimization and Monitoring Measures for Vessel Operations

There are a number of measures that Revolution 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 when the ITA is active (5 years from when first valid) and will also be required by BOEM as conditions of COP approval over the life of the project. The complete list of required measures is provided in Appendices A and B of this Opinion. These measures can be grouped into two main categories: vessel speed reductions and increased vigilance/animal avoidance. These measures are all considered part of the proposed action or are otherwise required by regulation (62 FR 6729, February 13, 1997), (66 FR 58066, November 20, 2001), (73 FR 60173, October 10, 2008).

Specific measures related to vessel speed reduction that are part of the proposed action (inclusive of the requirements included in the proposed MMPA ITA, see Section 3 and Appendixes A and B) include:

- Between November 1 and April 30, vessels of all sizes will operate at 10 knots or less when transiting between the WDA and ports in Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Maryland, Delaware, or Virginia as well as when transiting between any of these ports. This speed restriction does not apply to vessels transiting in Narragansett Bay or Long Island Sound (as whales are unlikely to occur in these areas). Additionally, between November 1 and April 30, all project vessels of all sizes transiting from any other ports (i.e., Gulf of Mexico, or foreign ports) will operate at 10 knots or less when within any active SMA and within the Revolution Wind WDA.
- Year round, all vessels of all sizes will operate at 10 knots or less in any Slow Zone/DMA.
- Year round, all vessels of all sizes will reduce speed to 10 knots or less when a North Atlantic right whale is sighted, at any distance, by anyone on a Project vessel, or when any large whale, mother/calf pairs, or large assemblages of non-delphinid cetaceans are observed near (within 500 m) an underway Project vessel.
- From May 1 to October 31, all project vessels of all sizes transiting between the WDA and ports in Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Maryland, Delaware, or Virginia as well as when transiting between any of these ports will be required to transit at speeds of 10 knots or less unless they are operating in a "transit corridor" that is being monitored by real-time PAM. In that case, a vessel may travel over 10 knots if there have been no detections of a North Atlantic right whale via visual observation or PAM within or approaching the transit corridor for the previous 12 hours, with any subsequent detection triggering a 12-hour reset. The 10-knot slowdown requirement in the transit corridor would expire when there has been no further visual or acoustic detection of North Atlantic right whales in the transit corridor in the past 12 hours. Vessels traveling in any portion of the "transit corridor" that overlaps with a SMA

or Slow Zone/DMA would be restricted to 10 knots or less during the period when the SMA or Slow Zone/DMA is in effect. Note that we expect the "transit corridors" will be defined in the MMPA final ITA; however, based on the language in the proposed rule that refers to operation of CTVs in transit corridors, we expect that these "transit corridor" will include the area between the WDA and the ports used by CTVs (New Bedford, Providence, Davisville, Quonset, and New London).

- All underway vessels operating at any speed must have a dedicated visual observer on duty at all times to monitor for protected species. For vessels operating at speeds greater than 10 knots, that observer/lookout must have no other duties during the period the vessel is traveling at speeds greater than 10 knots.
- 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.

Monitoring measures 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 is required to 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 must 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.

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.

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). Considering the area where project vessels will operate, Atlantic sturgeon may be present in nearshore waters along the U.S. Atlantic coast (depths less than 50 m), including the WDA, and in some rivers and bays that may be transited by Project vessels (i.e., Delaware Bay and Delaware River (Paulsboro Marine Terminal), Chesapeake Bay (Port of Norfolk and Sparrow's Point), and New York Bay (Port of Brooklyn)). Atlantic sturgeon do not occur in the Gulf of Mexico.

Effects of Vessel Transits in the Marine Environment and to/from Identified Ports in MA, RI, CT, and Long Island, NY

While Atlantic sturgeon are known to be struck and killed by vessels in rivers and in estuaries adjacent to spawning rivers (e.g., Delaware Bay), we have no reports of vessel strikes in the marine environment. With the exception of the limited number of trips in the Delaware Bay and Delaware River (Paulsboro Marine Terminal), Chesapeake Bay (Port of Norfolk and Sparrow's Point), and New York Bay (Port of Brooklyn), Revolution Wind vessels will not be transiting estuarine or riverine areas where Atlantic sturgeon occur. 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 WDA and marine waters used by Revolution Wind vessels.

As established elsewhere in this Opinion, Atlantic sturgeon use of the WDA (described in Section 3.0) is intermittent and dispersed; there are no aggregation areas in the WDA, the cable corridor, or in the marine portions of the action area that vessels will travel to reach the identified ports in MA, RI, CT, and Long Island, NY. 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 in this portion of the action area 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 marine waters that will be transited by project vessels (with the exception of near shore areas where vessels will dock at the identified ports in MA, RI, CT, and Long Island, New York) 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 identified in this section 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 to swim deeper to avoid a vessel or to swim away from it which further reduces the potential for strike. The nearshore areas at the ports in MA, RI, CT, and Long Island, New York where vessels will enter shallower water and dock are not known to be used by Atlantic sturgeon; as such, co-occurrence between any Atlantic sturgeon and any project vessels in areas near these ports 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 Revolution Wind WDA or between these areas and the listed ports in this section will strike an Atlantic sturgeon during any phase of the proposed project. Therefore, effects to Atlantic sturgeon of project vessels operating in this portion of the action area are discountable.

Effects of Vessel Transits to Paulsboro, Norfolk, Sparrow's Point, and Port of Brooklyn

Paulsboro Marine Terminal
As explained in Section 2.0 and Section 6.0 of this Opinion, NMFS has completed ESA Section 7 consultation on the construction and use of the 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. In that Opinion, 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 Revolution Wind project, BOEM estimates up to 28 trips to the Paulsboro Marine Terminal (see also Table 3.6 in this Opinion). This is approximately 3% of the total trips considered in the Paulsboro Biological Opinion. Based on the available information, we expect that Revolution 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. Consistent with the analysis in the Paulsboro Marine Terminal, we consider that all vessels using the port are equally likely to strike an Atlantic sturgeon. As such, we would expect that 3% of the total vessel strikes of Atlantic sturgeon could result from Revolution Wind vessels. Calculating 3% of 7 Atlantic sturgeon results in an estimate of 0.22 vessel struck sturgeon. As such, we anticipate that vessels using the Paulsboro Marine Terminal as part of the Revolution Wind project will result in the strike of no more than one Atlantic sturgeon. Based on the proportional assignment of take in the July 2022 Paulsboro Opinion, we expect that this would be no more than one Atlantic sturgeon belonging to the New York Bight DPS. On June 7, 2023, NMFS notified the USACE that reinitiation of the 2022 Paulsboro Opinion was required due to new information (data from the New Jersey Division of Fish and Wildlife regarding vessel struck Atlantic sturgeon) that reveals effects of the action that may affect listed species in a manner or to an extent not previously considered. In the context of the *Environmental Baseline* for another Biological Opinion (for the Edgemoor Container Port[38], NMFS applied this additional information to update the predictions of vessel strikes from use of the Paulsboro Marine Terminal for a new estimate of 9 strikes of Atlantic sturgeon over the 10 year period. We note that even applying this new estimate, the predictions of the likelihood and extent of vessel strike attributable to the Revolution Wind vessels using Paulsboro does not meaningfully change (i.e., the estimate would change from 0.22 to 0.28) and we still predict no more than one New York Bight DPS Atlantic sturgeon will be struck by Revolution Wind vessels transiting to/from Paulsboro.

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 Revolution Wind project

[38] June 2, 2023 Opinion issued by NMFS GARFO to USACE Philadelphia District; available at: https://repository.library.noaa.gov/view/noaa/41694

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 of Norfolk received 1,908 vessel calls in 2021[39] while Norfolk Harbor had visits from over 5,000 commerce-carrying vessels. In the BA, BOEM estimates up to 28 vessel trips between the WDA and the Port of Norfolk. This represents approximately 1.5% of the annual vessel traffic to the port and less than 0.5% of the traffic in the Harbor. As the vessels will be using existing port facilities, these 28 vessel trips may not actually increase vessel traffic at the Port or in the Harbor and thus is unlikely to increase the risk of a vessel strike that would occur absent the Revolution Wind project. 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. The geography of this area is significantly different from the portions of the James River where vessel strikes have been documented (that is, there is not a narrow, restricted channel that would increase the potential for co-occurrence of vessels and Atlantic sturgeon). Given this information, vessel strikes of Atlantic sturgeon by Revolution Wind vessels transiting to and from the Port of Norfolk are extremely unlikely to occur. As such, effects to Atlantic sturgeon from project vessels operating in this portion of the action area are extremely unlikely to occur and are discountable.

Sparrows Point, MD

In the BA, BOEM indicates that up to 28 vessel transits may occur between Sparrows Point, MD and the WDA. Sparrows Point is located near the mouth of the Patapsco River at the Port of Baltimore. Vessels traveling to/from this port will travel within the Federal navigation channels within Chesapeake Bay. Subadult and adult Atlantic sturgeon are seasonally present in portions of the Chesapeake Bay as they migrate between riverine habitats and the Atlantic Ocean. Little information is available on the risk of vessel strike in the Bay. Atlantic sturgeon are not known to occur in the Patapsco River itself.

The Port of Baltimore typically has over 100 vessel arrivals and departures per day[40] and had over 4,300 inbound and 4,300 outbound commerce-carrying vessel trips in 2019 (ACOE 2020). The 28 Revolution Wind vessel trips represent approximately 0.5% of the annual commerce-carrying vessel traffic traveling through the Chesapeake Bay to the Port of Baltimore and an even smaller percentage of the total vessel traffic in the Bay and at the Port. As the vessels will be using existing port facilities, there may not be an increase in vessel traffic at the Port or in the Chesapeake Bay and thus project related vessels are unlikely to increase the risk of a vessel strike as a result of the proposed project. Given this, it is extremely unlikely that a Revolution Wind vessel transiting within Chesapeake Bay to/from Sparrows Point will result in an increase of risk of vessel 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. As such, effects to Atlantic sturgeon from project vessels operating in this portion of the action area are extremely unlikely to occur and are discountable.

Port of New York/Brooklyn

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[39] https://wp.portofvirginia.com/wp-content/uploads/2022/07/2021-Trade-Overview.pdf; last accessed February 14, 2023.

[40] https://www.marinetraffic.com/en/ais/details/ports/95?name=BALTIMORE&country=USA#Statistics; last accessed June 22, 2023.

In the BA, BOEM indicates that up to 29 vessel transits may occur between the Port of Brooklyn, NY and the lease site. The Port of Brooklyn is located along the lower reaches of the East River near the confluence with Upper New York Bay. Vessels traveling to/from this port will travel within the Federal navigation channels within New York Bay/New York Harbor. Subadult and adult Atlantic sturgeon are seasonally present in New York Bay/New York Harbor as they migrate in and out of the Hudson River. Transient Atlantic sturgeon have also been documented in the East River.

From 2013 to 2020, NYSDEC reported 13 Atlantic sturgeon carcasses in New York Bay that had some evidence of a possible vessel strike. These carcasses were not examined and we do not have an estimate of the total number of vessel strikes in this area annually. However, as explained below, given that the Revolution Wind vessel trips will not meaningfully increase vessel traffic in this area and represent an extremely small percentage of total traffic in this area, we do not expect any Atlantic sturgeon to be struck by Revolution Wind vessels traveling to or from the Port of Brooklyn.

Upper New York Bay is transited by over 8,000 commerce-carrying vessels annually (ACOE 2020), which represent only a portion of the total vessel traffic in the area. The 29 Revolution Wind vessel trips represent approximately 0.3% of the annual commerce-carrying vessel traffic traveling through Upper New York Bay and an even smaller percentage of the total vessel traffic in the area. As the vessels will be using existing port facilities, these trips may not increase the total amount of traffic in Upper New York Bay or at the Port of Brooklyn and thus are unlikely to increase the risk of a vessel strike that would occur absent the Revolution Wind project. . Given this analysis, it is extremely unlikely that a Revolution Wind vessel transiting to/from the Port of Brooklyn will result in the strike of an Atlantic sturgeon. As such, effects to Atlantic sturgeon from project vessels operating in this portion of the action area are extremely unlikely to occur and are discountable.

Summary of Effects of Vessel Operations on Atlantic Sturgeon
Considering all vessel traffic over the life of the project, we anticipate the mortality of no more than one Atlantic sturgeon from the New York Bight DPS. This take is expected to occur as a result of a vessel transiting within the Delaware River or Bay and has been evaluated in the above referenced Biological Opinion issued by NMFS to the USACE for the Port of Paulsboro.

7.2.3.2 Shortnose sturgeon
The only portion of the action area that overlaps with the distribution of shortnose sturgeon is the estuarine/riverine portions of the vessel transit routes used by vessels transiting Delaware Bay and Delaware River (Paulsboro Marine Terminal), Chesapeake Bay (Port of Norfolk and Sparrow's Point), and New York Bay (Port of Brooklyn). As we do not expect shortnose sturgeon to occur in the marine waters transited by project vessels, they will not be exposed to vessel traffic that portion of the action area.

Paulsboro
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). The 2022 Paulsboro Opinion considered effects of vessels transiting between the

mouth of Delaware Bay and Paulsboro on shortnose sturgeon. The 2022 Paulsboro Opinion analyzed an overall amount of vessel transits, of which Revolution Wind would contribute a small part. 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. As noted above, the Revolution wind project would result in up to 28 trips to the Paulsboro Marine Terminal. This is approximately 3% of the total trips considered in the Paulsboro Biological Opinion. Consistent with the analysis in the Paulsboro Marine Terminal, we consider that all vessels using the port are equally likely to strike a shortnose sturgeon. Calculating 3% of 1 shortnose sturgeon results in an estimate of 0.03 vessel struck sturgeon. It is not possible to determine which of the 880 trips to Paulsboro over the 10 year period considered in the Opinion would result in a vessel strike, as such, consistent with the analysis in the Paulsboro Opinion, we consider it equally likely that one of the 28 Revolution Wind vessel trips will strike and kill a shortnose sturgeon as any of the other vessels transiting to/from the port. As such, we anticipate that vessels using the Paulsboro Marine Terminal as part of the Revolution Wind project will result in the strike of no more than one shortnose sturgeon.

Norfolk
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. As such, effects to shortnose sturgeon from project vessels operating in this portion of the action area are extremely unlikely to occur and are discountable.

Sparrows Point
Transient individual shortnose sturgeon are at least occasionally present in upper Chesapeake Bay; the best available information indicates that these are individuals that travel to the Bay from the C&D Canal (which connects the upper Bay to the Delaware River). Shortnose sturgeon are rare, infrequent visitors to the lower Chesapeake Bay. Shortnose sturgeon are not known to occur in the Patapsco River or at the Port of Baltimore. We have no reports of vessel strikes of shortnose sturgeon in this portion of the action area.

As noted above, the 28 Revolution Wind vessel trips represent approximately 0.5% of the annual commerce-carrying vessel traffic traveling through the Chesapeake Bay to the Port of Baltimore and an even smaller percentage of the total vessel traffic in the Bay and at the Port. As the vessels will be using existing port facilities, there may not be an increase in the amount of traffic in this area and thus no increase in risk of vessel strike that would occur absent the proposed action. . Given the very small number of trips, and the rarity of shortnose sturgeon in the Chesapeake Bay, it is extremely unlikely that a Revolution Wind vessel transiting within Chesapeake Bay to/from Sparrows Point will strike a shortnose sturgeon. As such, effects to shortnose sturgeon from project vessels operating in this portion of the action area are extremely unlikely to occur and are discountable.

Brooklyn
Adult shortnose sturgeon have occasionally been captured in trawl surveys in Upper New York Bay. From 1998-2011, six shortnose sturgeon total were identified in the HDP Aquatic Biological Survey (ABS) program (USACE 2021); from 2003-2017, 19 shortnose sturgeon were collected in the Hudson River Utilities winter trawl survey (unpublished data). The best available information indicates that only rare transient adult shortnose sturgeon are likely to occur in the area transited by vessels traveling to/from the Port of Brooklyn. We have no evidence of any vessel strikes of shortnose sturgeon in this area. The 29 Revolution Wind vessel trips represent approximately 0.3% of the annual commerce-carrying vessel traffic traveling through Upper New York Bay and an even smaller percentage of the total vessel traffic in the area. As the vessels will be using existing port facilities, we do not expect there to be an increase in vessel traffic or an increase in the risk of vessel strike. Given this, and the lack of evidence of shortnose sturgeon being struck in this area, it is extremely unlikely that a Revolution Wind vessel transiting to/from the Port of Brooklyn will strike a shortnose sturgeon. As such, effects to shortnose sturgeon from project vessels operating in this portion of the action area are extremely unlikely to occur and are discountable.

Summary of Effects of Vessel Operations on Shortnose Sturgeon
In summary, considering all vessel traffic over the life of the project in the action area, we anticipate vessel traffic related to the Revolution Wind project to cause the mortality of no more than one shortnose sturgeon in the Delaware River. This take has been evaluated in the above referenced Biological Opinion issued by NMFS to the USACE for the Paulsboro Marine Terminal.

7.2.3.2 ESA Listed Whales

Background Information on the Risk of Vessel Strike to ESA Listed Whales
Vessel strikes from a variety of sizes of commercial, recreational, and military vessels have resulted in serious injury and fatalities to ESA listed whales (Laist et al. 2001, 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 severity 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). Large whales 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) by expanding the geographic area and the size of vessels subject to the speed restrictions. That regulation has not been finalized.

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 speed 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 Revolution Wind WFA overlaps with the Block Island SMA and the vessel transit routes to a number of ports overlap with a number of Mid-Atlantic SMAs. Project vessels transiting to ports in New York Harbor, Delaware River/Bay, and Norfolk may travel through or adjacent to SMAs near the mouth of New York, Delaware Bay, and Chesapeake Bay. These Mid-Atlantic SMAs are in effect from November 1 - April 30 each year. Vessels traveling from ports in the Gulf of Mexico may travel through or adjacent to Mid-Atlantic SMAs near Morehead City, NC and along the coast from Wilmington, NC to Charleston, SC and Southeast SMAs near the east coast of Georgia and Florida. The Southeast SMA is in effect from November 15 – April 15 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] Slow Zones/DMAs along the U.S. East Coast. Of these, 30 were triggered by right whale sightings and 47 were triggered by acoustic detections. Slow Zones/DMAs were declared in 11 locations in the Northeast/Mid-Atlantic U.S. (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 Revolution Wind vessels of any size travel at speeds of 10 knots or less in any SMA or Slow Zone/DMA in

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[41] https://www.fisheries.noaa.gov/s3/2023-01/2022_DMAs_and_Right_Whale_Slow_Zones_508.pdf; last accessed June 27, 2023.

all project phases; this requirement is also included in the proposed MMPA ITA for its 5-year operative period.

Exposure Analysis – ESA Listed Whales

Effects of Vessel Transits in the Revolution Wind WDA and to/from Ports in MA/RI/CT/NY (Long Island Sound)

To assess risk of vessel strike in the area where the majority of vessel traffic will occur (i.e., the WDA, the waters of Long Island Sound and off the southern Massachusetts, Rhode Island, and Connecticut coasts) 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 that geographic area (i.e., the area where the majority of vessel traffic will occur: the WDA, and the waters of Long Island Sound and off the southern Massachusetts, Rhode Island, and Connecticut coasts). Second, we used the best available information on baseline traffic (i.e., the annual number of vessel transits within that geographic area absent the proposed action) and the information provided by BOEM and Revolution Wind on the number of anticipated vessel transits in that area by Revolution Wind project vessels to determine to what extent vessel traffic would increase in this geographic area during each of the three phases of the Revolution Wind project. For example, if baseline traffic was 100 trips per year and the Revolution Wind 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 that 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 in the action area as this provides the most accurate representation of vessel traffic in the action area 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. Based on this foregoing reasoning, using vessel trips results in a more accurate assessment of the risk of adding the Revolution Wind vessels to the baseline than could have been carried out using vessel miles.

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 Revolution Wind WDA and identified ports in MA, RI, CT, and NY (Long Island Sound) (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 in Section 6. Vessel traffic between the WDA and ports in MA, RI, CT, and NY (Long Island Sound) accounts for up to 97% of the anticipated vessel traffic during the construction phase (dependent on the actual ports used) and 100% of the anticipated traffic during the operations and maintenance phase.

We reviewed the best available data for the period since the 2008 vessel strike rule was implemented (Henry et al. 2015 for 2009-2010 data, Henry et al. 2017 for 2011-2015 data, Henry et al. 2022 from 2016-2020 data); from the marine mammal stock assessment reports and serious injury and mortality reports produced by NMFS, for the period of 2011-2020 (most recent reports available), we did not identify any records of mortality of ESA listed whales consistent with vessel strike that were first detected in waters of southern New England (Connecticut, Rhode Island and, Massachusetts - south of Cape Cod), Long Island Sound, and eastern edge of Long Island, New York which is the best representation of the geographic area representing the Revolution Wind WDA, and the area where vessels will transit between these areas and the identified ports in Massachusetts, Rhode Island, Connecticut, and New York (Long Island Sound). In 2010, there was one fin whale (calf) first observed 24.3 nm E of Montauk with two healed propellor scars; given that these injuries were healed we do not consider this as a report of a vessel strike in the geographic area considered here (Henry et al. 2015). There were no other reports of fin, sei, sperm, blue, or right whales with vessel strike injuries in this area for the time period considered. As noted above, this accounts for nearly all of the vessel traffic associated with the Revolution Wind project. We also reviewed NMFS records post-dating 2020, including information from the right whale UME, and did not identify any records of vessel strikes in this area. However, we note that multiple vessel strikes of sei, fin and right whales have occurred in this period in waters outside the geographic area considered here (Hayes et al. 2022, Henry et al. 2017, Henry et al. 2022).[42] Additionally, we note that the location of where a vessel strike occurs is not always known and the location the animal is first documented may not be the location where the strike occurred.

Considering right and fin whales, absent any mitigation measures we would expect an increase in risk proportional to the increase in vessel traffic. As such, this would increase risk during the construction period by 1.6%, during the operational period by 0.17%, and 1.6% during the decommissioning period. As noted above, there are no records of right or fin whales with evidence of vessel strike where the first observation was in waters of southern New England (Connecticut, Rhode Island and, Massachusetts - southwest of Cape Cod), Long Island Sound, and eastern edge of Long Island, New York, which is where vessel transits between the WDA and the regional ports will occur. This suggests that baseline risk of vessel strike in this area is low compared to other areas along the Atlantic coast: this is likely given the nearshore

[42] https://www.fisheries.noaa.gov/national/marine-life-distress/2017-2021-north-atlantic-right-whale-unusual-mortality-event; last accessed 6/20/2003

environment where large whales typically are not common. Blue, sei, and sperm whales are typically found in deeper waters of the continental shelf, and are expected to be rare in the Revolution Wind WDA and even less likely to occur in the nearshore/inland portions of the action area where vessels will transit between coastal ports and the Revolution Wind WDA. Thus, any potential increase in risk of strike of blue, sei, and sperm whales is even smaller.

There are a number of factors that result in us determining that any potential increase in vessel strike is extremely unlikely to occur. As described above, 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 Revolution Wind, 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 above and in Appendices A and B of this Opinion, specific measures related to vessel speed reduction include that between November 1 and April 30 vessels of all sizes will operate at speeds of 10 knots or less while traveling between ports in Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Maryland, Delaware, and Virginia and while traveling between those ports and the WDA. Vessels transiting from other ports outside those described will operate at 10 knots or less when within any active SMA or within the Revolution Wind WDA. Year round all vessels of all sizes will operate at 10 knots or less in any DMA. Year round, all underway vessels will have a lookout to monitor for protected species, with that lookout having no other duties when the vessel is transiting at speeds greater than 10 knots. 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 to improve detectability of large whales when operating at night or in other low visibility conditions, and additional measures as outlined in Appendices A and B. 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 potential increase in vessel strike due to increases in vessel transit caused by the proposed action 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 potential for effective detection and avoidance.

<u>Vessel speed restrictions:</u>

Consistent with the vessel speed measures included in the proposed action, all vessels operating in the geographic area described above (i.e., within the WDA or between ports in MA, RI, CT, and NY [Long Island Sound]) will be limited to traveling at speeds of 10 knots or less, with the only exception being vessels operating from May 1 to October 31 in a “transit corridor” being monitored by real-time PAM, when no right whales have been detected in the previous 12 hours and when there is no overlap with an active SMA or Slow Zone/DMA. Year round, all underway vessels operating at >10 knots will have a dedicated visual observer to monitor for protected species and implement mitigation measures as necessary. The November - April period is the time of year when North Atlantic right whales are most likely to occur in the area transited by project vessels being considered here and covers the months when density is highest. Vessels would also be required to slow to 10 knots or less any time a large whale (of any species) is observed within 500 m of a vessel. All vessels, regardless of size, would immediately reduce speed to 10 knots or less when a North Atlantic right whale is sighted, at any distance, by an observer or anyone else on the vessel.

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.

<u>Exceptions to 10 knot speed restriction:</u>
In this geographic area (i.e., within the WDA or between ports in MA, RI, CT, and NY [Long Island Sound]), vessels may travel at speeds greater than 10 knots only under particular circumstances. Project vessels in this area may travel at speeds above 10 knots from May 1 – October 31 if the vessel is not transiting through a Slow Zone/DMA or a speed restriction has not been triggered by PAM detections and the transit is within a "transit corridor" being monitored by real-time PAM. The period of time and areas when vessels can travel at speeds greater than 10 knots are at times when North Atlantic 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 when no right whales have been detected in the previous 12 hours, which decreases the potential for a vessel traveling greater than 10 knots to co-occur with a right whale (as described in further detail below). In all instances, PSOs/lookouts will be monitoring a vessel strike zone, see below.

<u>PSOs/Lookouts and Increased right whale awareness:</u>
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. Year round, during any vessel transits within or to/from the Revolution Wind WDA, 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 protected species. During vessel transits over 10 knots, these lookouts will have no other duty than to monitor for listed species. If a whale is sighted, the lookout will 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 meters away from any right whale or unidentified large whale. If any whale is detected within 500 meters 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 (Slow Zones/DMAs 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.

Passive Acoustic Monitoring:
As noted above, outside of Slow Zones/DMAs, SMAs, and the November 1 through April 30 period, if a vessel is traveling at greater than 10 knots, in addition to the required dedicated visual observer, real-time PAM of transit corridors must be conducted 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 vessels must travel at 10 knots or less for the following 12 hours. Each subsequent detection will trigger a 12-hour reset. A slowdown in the transit corridor expires when there has been no further visual or acoustic detection of North Atlantic right whales in the transit corridor in the past 12 hours. This increases detectability beyond the area that an observer can see and enhances the effectiveness of required vessel avoidance measures.

Summary of Effects of Vessel Transits in MA/RI/CT/NY (Long Island)
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.

Given the more offshore distribution of sei, blue, and sperm whales and the low density of these species in this geographic area, we expect that the potential for co-occurrence of an individual of one of these species with a Revolution Wind vessel operating in this area is extremely unlikely. The required mitigation measures outlined above further reduce this risk. As such, effects to sei, blue, and sperm whales from the operation of Revolution Wind vessels in this area are discountable.

Given the location of the Revolution Wind WFA in the northwest corner of the MA/RI WEA and the area where vessel transits will occur to/from ports in MA, RI, CT, NY (Long Island Sound) and the WDA, vessels will be transiting in areas where right whale sightings and predicted density are low. Combined with the already very low increased risk of vessel strike anticipated due to increased project vessel traffic, we expect that the measures that are specifically designed to reduce risk of project vessels striking a right whale will further reduce that risk and make it extremely unlikely that a Project vessel will strike a right whale. Therefore, effects to right whales from the operation of Revolution Wind vessels in this area are discountable.

As described above, given the inshore coastal areas where Project vessels will be transiting, fin whale predicted density is low, thus there is not a high likelihood for co-occurence. Additionally, there are no reports of vessel strikes of fin whales in this geographic area between 2011-2020. Combined with the already very low increased risk of vessel strike anticipated due to increased project vessel traffic, we expect that the measures that are designed to reduce risk of project vessels striking fin whales will further reduce that risk and make it extremely unlikely that a Project vessel will strike a fin whale. Therefore, effects to fin whales from the operation of Revolution Wind vessels in this area are discountable.

Effects of Vessel Transits in the U.S. EEZ East and North of the Revolution Wind WDA
Due to project component and vessel availability, a small number of vessels will transit from ports in eastern Canada, Europe, and/or Asia to the Revolution Wind WDA; this section considers those vessel transits while in the U.S. EEZ. These vessels will be heavy transport vessels, during transit these vessels may travel up to 13.5 knots with speed of less than 10 knots more typical. BOEM has indicated that during the entire two-year construction period (over the course of three calendar years) there may be up to 26 vessel transits between the WDA and ports in eastern Canada, Europe, and/or Asia to transport project components. Project vessels will represent an extremely small portion of the vessel traffic traveling through the EEZ. 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 (26 transits over a two year period). When operating outside of an active SMA or Slow Zone/DMA, these vessels could operate at speeds over 10 knots; however, they will have a dedicated lookout monitoring for whales and will be required to slow down if any whales are sighted. Given the limited amount of vessel trips in this area (i.e., up to 26 trips over a two-year period), the dispersed nature of whales in this offshore area, and the therefore limited potential for co-occurrence of a whale and one of these vessels, it is extremely unlikely that any ESA listed whales will be struck by a project vessel during one of the no more than 26 transits within the U.S. EEZ on its way to or from ports in eastern Canada, Europe, and/or Asia. The requirements for lookouts and slow downs would further decrease this risk. Therefore, effects to right, fin, sei, blue, and sperm whales from vessel strike due to project vessels operating in this portion of the action area are discountable.

Effects of Vessel Transits to/from Ports in NY (Brooklyn), NJ, MD, VA and the Revolution Wind WDA
During the two-year construction phase (over the course of three calendar years), Revolution Wind anticipates up to 113 vessel trips between the WDA and ports south of Long Island, including the Port of Brooklyn, Paulsboro Marine Terminal, Sparrows Point, and the Port of Norfolk. These vessels would include heavy transport vessels, heavy installation vessels, guard/scout vessels, pre-lay grapnel run vessels, supply barges, and survey vessels. Some of these vessels are capable of transit speeds of up to 23 knots; however, for all transits between November 1 and April 30, transit speed will be limited to 10 knots or less. Between May 1 and October 31, these vessels will only transit over 10 knots if they are outside of an active SMA or Slow Zone/DMA and are operating within a "transit corridor" being monitored by real-time PAM that has had no detections of right whales in the previous 12 hours. Additionally, these vessels will have lookouts monitoring for whales. Vessels transiting between these ports and the

Revolution Wind WDA are expected to travel in shipping lanes when entering/leaving port and then transit offshore along typical commercial vessel transit routes.

As described in Section 6 of this Opinion, ESA listed whales occur in this area in varying distributions and abundances throughout the year. North Atlantic right whales occur in the area primarily in the fall and early spring, as some individuals in the population migrate through the Mid-Atlantic to the Southeast calving grounds. 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 typically in northern Mid-Atlantic waters, primarily during the fall, winter, and spring. Sperm whales along the Mid-Atlantic are found offshore along the shelf break year-round. Blue whales are typically 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.

Project vessels will represent an extremely small portion (up to 113 trips over the two-year construction period) of the vessel traffic traveling through Mid-Atlantic waters to/from the Revolution Wind WDA. Considering, an estimated 74,000 vessel transits a year occur in the Mid-Atlantic area, this is about an 0.07% increase in traffic in this area, assuming that all of these trips represent "new" trips for vessels that otherwise would not be operating in this area. Given that with few exceptions, these vessels will be traveling at speeds of 10 knots or less year-round and will be in compliance with vessel strike regulations, and have lookouts monitoring for whales, and in consideration of the extremely small increase in vessel traffic in this portion of the action area that these vessels will represent, it is extremely unlikely that any ESA listed whales will be struck by a project vessel operating in this portion of the action area. Therefore, effects to right, fin, sei, blue, and sperm whales from vessel strike due to project vessels operating in this portion of the action area are discountable.

Effects of Vessel Transits to/from Ports in the Gulf of Mexico and the Revolution Wind WDA
During the two-year construction phase (over the course of three calendar years), Revolution Wind anticipates up to 21 vessel trips between the WDA and four ports in the Gulf of Mexico. These vessels would include pre-lay grapnel run vessels, supply barges, and survey vessels and have transit speeds of up to 23 knots. Vessels transiting between these ports and the Revolution Wind WDA are expected to travel in shipping lanes when entering/leaving port and then transit offshore along typical commercial vessel routes around Florida and then along the U.S. East Coast. These vessels will travel at speeds of less than 10 knots in any SMAs or Slow Zones/DMAs that their transit routes overlap with. They will also have a lookout to monitor for whales and to communicate with the vessel captain and will be required to slow down if whales are sighted (as described above).

As described in Section 6, ESA listed whales occur in this area and along the U.S. South Atlantic in varying distribution and abundance throughout the year. North Atlantic right whales are not expected to occur in the Gulf of Mexico. They occur in coastal waters of the South Atlantic primarily in the fall and early spring; during this time, SMAs overlap with the anticipated vessel traffic routes (i.e., November 1 - April 30, multiple Mid-Atlantic SMAs, and November 15 - April 15, calving and nursery grounds SMA). Fin whales are not expected to occur in the Gulf of Mexico and are not common in the South Atlantic, they may be present in small numbers in offshore waters along the shelf break, further offshore than where the vessels will transit. Sei whales are not expected to occur in the Gulf of Mexico and are uncommon in the South Atlantic. Sperm whales may be found in deep offshore waters in the Gulf of Mexico and along the South Atlantic are found offshore along the shelf break year-round. Blue whales are not expected to occur in the Gulf of Mexico and are uncommon in the South Atlantic. 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.

Project vessels will represent an extremely small portion (up to 21 trips over two year construction period) of the vessel traffic traveling through the Gulf of Mexico and South Atlantic waters to/from the Revolution Wind. Given the number of major ports along the South Atlantic and Gulf of Mexico, baseline vessel traffic is expected to be similar to, or higher than, waters of the Mid-Atlantic (approximately 74,000 vessel transits a year). Considering, an estimated 74,000 vessel transits a year occur in the Mid-Atlantic area, this is about an 0.01% increase in traffic in this area, assuming that all of these trips represent "new" trips for vessels that otherwise would not be operating in this area. Given that these vessels will be in compliance with vessel strike regulations, including traveling at speeds of 10 knots or less in any SMA or Slow Zone/DMA that overlap their transit routes, and have lookouts monitoring for whales, and in consideration of the extremely small increase in vessel traffic in this portion of the action area that these vessels will represent, it is extremely unlikely that any ESA listed whales will be struck by a project vessel operating in this portion of the action area. Therefore, effects to right, fin, sei, blue, and sperm whales from vessel strike due to project vessels operating in this portion of the action area are discountable.

Summary of Effects of Vessel Traffic on ESA Listed Whales
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. Therefore, effects to right, fin, sei, blue, and sperm whales from vessel strike due to project vessels operating in the action area are discountable.

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 generally 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 Revolution Wind WFA and the transit routes to ports in southern New England and New York 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.

Effects of Vessel Transits in the Revolution Wind WDA and to/from Ports in MA/RI/CT/NY (Long Island Sound)

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 southern New England and Long Island Sound. 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 Long Island Sound, Long Island forks, Rhode Island coast, Massachusetts coast from Massachusetts/Rhode Island border to the eastern extent of Vineyard Sound, defined by a line from East Chop to Succonnesset Point (Territorial Sea line on NOAA Chart 13237), inclusive of Narragansett and Buzzards Bays, from 2013 to 2022. We selected this geographic area as it represents the waters that will be transited by the majority of project vessels traveling to/from the WDA and the ports identified in New England and Long Island Sound. 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 478 reported sea turtle stranding cases (excluding incidental captures and cold stuns) in the Long Island Sound and southern New England region during the 10-year time period (2013-2022) of data, there were 127 records of sea turtles recovered with definitive evidence from vessel strikes. In addition, there were 26 sea turtles with evidence of blunt force trauma, which indicates probable vessel collision. As anticipated based on the abundance of turtle species in the area, the majority of these records are of loggerhead and leatherback 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, we consider that 93% of the sea turtle strandings recorded as "definitive vessel" and "blunt force trauma" had a cause of death attributable to vessel strike. Therefore, 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 to get a total number of sea turtle strandings with indications of vessel strike, and then calculated 93% of the total (e.g., for loggerheads, we first added the "definitive vessel" (64) and "blunt force trauma" (17) then multiplied that value (81) by 0.93 (=75)). The result is the number of turtles in the "total presumed vessel mortalities" column in Table 7.2.4.

Table 7.2.4. Preliminary STSSN cases from 2013 to 2022 with Evidence of Propeller Strike or Probable Vessel Collision in the Long Island Sound and Southern New England Region and Estimated Presumed Vessel Mortalities.

Sea Turtles	Total Records	Definitive Vessel	Blunt Force Trauma	Total Presumed Vessel Mortalities*
Loggerhead	232	64	17	75
Green	21	3	2	4.65
Leatherback	178	56	6	58
Kemp's ridley	47	4	1	4.65

Source: STSSN (June 2023)
* 93% of the total of "definitive vessel" plus "blunt force trauma"

The data in Table 7.2.4 reflect 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 percent. The resulting, adjusted number of vessel strike mortalities of each species in the Long Island Sound and southern New England region are presented in the "annual total presumed vessel mortalities" column in Table 7.2.5. 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%) 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.

Table 7.2.5. Estimated Annual Vessel Strike Mortalities Corrected for Unobserved Vessel Strike Mortalities in the Long Island Sound and Southern New England Region.

Sea Turtles	Presumed Vessel Mortalities* Over 10 years	Total Over 10 Years (17% Detection Rate)	Annual Total Presumed Vessel Mortalities
Loggerhead	75	441	44.1
Green	5	29	2.9
Leatherback	58	341	34.1
Kemp's ridley	5	29	2.9

* 93% of the total of "definitive vessel" plus "blunt force trauma"

Finally, assuming a proportional relationship between vessel strikes and vessel traffic, we considered the phase-specific increase in vessel traffic and calculated the expected increase in vessel strikes proportional to the increase in project vessel traffic. As explained above, during the construction, operations, and decommissioning phases of the Revolution Wind project the vast majority of vessel traffic will occur between the Revolution Wind WDA and ports in MA, RI, CT, and NY ports in Long Island Sound. The formula used to generate the estimate of project vessel strikes over the construction, operations, and decommissioning phases is: (annual baseline strikes)*(% increase in traffic)*(years of project phase).

Construction = 1.6% increase in traffic for 2 years

Loggerhead sea turtles: (44.1)(0.016)(2) = 1.41 loggerhead sea turtles

Green sea turtles: (2.9)(0.016)(2) = 0.093 green sea turtles

Leatherback sea turtles: (34.1)(0.016)(2) = 1.09 leatherback sea turtles

Kemp's Ridley sea turtles: (2.9)(0.016)(2) = 0.093 Kemp's Ridley sea turtles

Operation = 0.17% increase in traffic for 35 years

Loggerhead sea turtles: (44.1)(0.0017)(35) = 2.62 loggerhead sea turtles

Green sea turtles: (2.9)(0.0017)(35) = 0.17 green sea turtles

Leatherback sea turtles: (34.1)(0.0017)(35) = 2.03 leatherback sea turtles

Kemp's Ridley sea turtles: (2.9)(0.0017)(35) = 0.17 Kemp's Ridley sea turtles

Decommissioning = same as Construction

As explained above in Section 7.2.2, Revolution Wind 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 trained 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 up to the number identified in Table 7.2.6 below:

Table 7.2.6. Estimate of Sea Turtle Vessel Strikes as a Result of the Proposed Action.

Species	Maximum Vessel Strike Anticipated
NWA DPS Loggerhead sea turtle	6
NA DPS Green sea turtle	1
Leatherback sea turtle	5
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, given the likelihood of vessel strike to cause serious injury or mortality, it is reasonable to assume that all strikes will result in serious injury or mortality.

Effects of Vessel Transits in the U.S. EEZ East and North of the Revolution Wind WDA
Due to project component and vessel availability, vessels will transit from ports in eastern Canada to the Revolution Wind WDA; this section considers vessel transits through the U.S. EEZ. These vessels will be heavy transport vessels, during transit these vessels may travel up to 13.5 knots when not subject to vessel speed restrictions that would limit speed to 10 knots. BOEM has indicated that during the entire two-year construction period (over the course of three calendar years) there may be up to 26 vessel transits between the WDA and ports in eastern Canada to transport project components to the project site. Project vessels will represent an extremely small portion of the vessel traffic traveling through the EEZ during this period of time. 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 and limited seasonal occurrence 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. Therefore, effects of vessel transits on sea turtles by vessel strike in this portion of the action area are discountable.

Effects of Vessel Transits to/from Ports in NY (Brooklyn), NJ, MD, VA and the Revolution Wind WDA
During the two-year construction phase (over the course of three calendar years), Revolution Wind anticipates up to 113 vessel trips between the Port of Brooklyn, Paulsboro Marine Terminal, Sparrows Point, and the Port of Norfolk. These vessels would include heavy transport vessels, heavy installation vessels, guard/scout vessels, pre-lay grapnel run vessels, supply barges, and survey vessels and may transit up to 23 knots except when subject to vessel speed restrictions that would limit speeds to up to 10 knots. Vessels transiting between these ports and the Revolution Wind WDA are expected to travel in shipping lanes when entering/leaving port and then transit offshore along the same routes as commercial vessels.

As described in Section 6, ESA listed sea turtles occur in this area in varying distribution and abundance throughout the year, with a notable seasonal pattern. All listed sea turtle species have a seasonal migration where they move into more northerly waters (i.e. northern Mid-Atlantic, southern New England, parts of the Gulf of Maine) during the summer and then migrate back through the Mid-Atlantic to more southern areas through the fall and occur there throughout the spring. During Project vessel transits to ports in the Mid-Atlantic, in the deeper offshore waters of the action area, the species and age classes most likely to be impacted are hatchlings and pre-recruitment juveniles of all sea turtle species, all age classes of leatherback sea turtles, and occasionally adult loggerheads. Hatchlings and pre-recruitment juveniles of all sea turtle species may also occur in open-ocean habitats, where they reside among Sargassum mats. 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. In general, ESA listed sea turtles are expected to be highly dispersed in offshore waters on the continental shelf and, given the large area over which Project vessels could potentially transit, the likelihood of co-occurrence is low. Project vessels have the greatest chance to co-occur with sea turtles in the nearshore waters as vessels enter New York Harbor (to transit to Brooklyn), Delaware Bay (to transit to Paulsboro) and Chesapeake Bay (to transit to Sparrows Point and Norfolk); however, in these areas vessels are expected to be traveling slowly which decreases the risk of vessel strike.

Project vessels will represent an extremely small portion (up to 113 trips over two year construction period) of the vessel traffic traveling through Mid-Atlantic waters to/from the Revolution Wind WDA. Considering, an estimated 74,000 vessel transits a year occur in the Mid-Atlantic area, this is about an 0.07% increase in traffic in this area, assuming that all of these trips represent "new" trips for vessels that otherwise would not be operating in this area. Given this extremely small increase in vessel traffic, any increased risk of vessel strike of sea turtles is also extremely small. As such, we expect that Revolution Wind vessels operating in this portion of the action area are extremely unlikely to strike any sea turtles; therefore, effects of vessel traffic on sea turtles by vessel strike in this portion of the action area are discountable.

Effects of Vessel Transits to/from Ports in the Gulf of Mexico and the Revolution Wind WDA
During the two-year construction phase (over the course of three calendar years), Revolution Wind anticipates up to 21 vessel trips between four ports in the Gulf of Mexico. These vessels would include pre-lay grapnel run vessels, supply barges, and survey vessels and may transit up to 23 knots when not subject to vessel speed restrictions. Vessels transiting between these ports and the Revolution Wind WDA are expected to travel in shipping lanes when entering/leaving port and then transit offshore along the same routes as commercial vessels around Florida and then along the U.S. East Coast.

In general, ESA listed sea turtles are expected to be highly dispersed in offshore waters on the continental shelf and, given the large area over which Project vessels could potentially transit, the likelihood of co-occurrence is low. As described in Section 6, ESA listed sea turtles are most common in the Gulf of Mexico and the U.S. South Atlantic, however, there is variability in their distribution and abundance throughout the year. Project vessels have the greatest chance to co-occur with sea turtles in the nearshore waters as the vessel comes into or leaves ports in the Gulf of Mexico; however, in these areas vessels are expected to be moving slowly which decreases the risk of vessel strike.

Project vessels will represent an extremely small portion (up to 21 trips over two year construction period) of the vessel traffic traveling through the Gulf of Mexico and South Atlantic waters to/from the Revolution Wind. Given the number of major ports along the South Atlantic and Gulf of Mexico, vessel traffic is expected to be similar or higher to the Mid-Atlantic (approximately 74,000 vessel transits a year). Considering, an estimated 74,000 vessel transits a year occur in the Mid-Atlantic area, this is about an 0.01% increase in traffic in this area, assuming that all of these trips represent "new" trips for vessels that otherwise would not be operating in this area. Given this extremely small increase in vessel traffic, any increased risk of vessel strike of sea turtles is also extremely small. As such, we expect that Revolution Wind vessels operating in this portion of the action area are extremely unlikely to strike any sea turtles; therefore, effects of vessel traffic on sea turtles by vessel strike in this portion of the action area are discountable.

Summary of Effects of Vessel Traffic on ESA Listed Sea Turtles
In summary, we expect that the operation of project vessels over the life of the proposed action (i.e., 39 years) will result in the strike and mortality of up to 6 loggerhead, 1 green, 5 leatherback, and 1 Kemp's ridley sea turtles.

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 Safety Risk Assessment ("NSRA;" see COP Appendix R), 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 OSSs 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.

Currently, vessel traffic in the Revolution Wind WDA is primarily recreational vessels and fishing vessels which transit the area in non-uniform patters. Larger vessels such as cargo, tug, or cruise vessels transit the Revolution Wind WDA infrequently as these larger vessels primarily transit the Nantucket to Ambrose TSS and TSS routes into New Bedford and Buzzards Bay which are south and west of the Revolution Wind WDA, respectively. Depending on final layout, existing vessel traffic may transit within the turbines in the Revolution Wind WDA, or operators may avoid the Revolution Wind WDA and transit around it. However, this potential shift in traffic does not increase the risk of interaction with listed species as densities of listed species are not incrementally higher outside the Revolution Wind WDA such that risk of ship strike would increase. As such, even if there is a shift in vessel traffic outside of the WDA 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
Revolution Wind has applied for an OCS Air Permit from the EPA. EPA published the proposed permit for public comment on March 31, 2023. The proposed permit, EPA's Fact Sheet, and

supporting information are posted on EPA's webpage[43]. 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 Revolution Wind OCS source's includes emissions from vessels installing the WTGs and the OSSs, engines on vessels that meet the definition of an OCS source, and engines (including any generators) on the WTGs and OSSs. 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 OSSs. The BA notes that Revolution 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 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 inter-array and export cable installation including the sea-to-shore transition, turbidity resulting from project

[43] https://www.epa.gov/caa-permitting/permit-documents-revolution-wind-llcs-offshore-wind-energy-development-project; last accessed July 10, 2023.

activities including dredging, cable installation, foundation installation, and installation of scour protection, project lighting during construction, and seabed disturbance from potential UXO/MEC detonations. Noise associated with these activities is discussed in Section 7.1; associated vessel activities are discussed in Section 7.2.

7.3.1 Cable Installation

As described in Section 3.2.3 above, a number of cables will be installed as part of the Revolution Wind project. Activities associated with cable installation include seabed preparation, cable laying, and activities to support the sea to shore transition at the RWEC landfall location at Quonset Point, North Kingstown, Rhode Island. Effects of these activities are described here.

Revolution Wind is proposing to lay the inter-array cable and offshore export cable using cable installation equipment that would include either a jet plow or mechanical plow. Cable laying and burial may occur simultaneously using a lay and bury tool, or the cable may be laid on the seabed and then trenched post-lay. The burial method will be dependent on suitable seabed conditions and sediments along the cable route.

If seabed conditions do not permit burial of inter-array or export cables, Revolution Wind is proposing to employ other methods of cable protection such as: (1) rock berm, (2) concrete mattresses, (3) frond mattresses, and (4) rock bags (Revolution Wind BA, 2023). 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. Revolution Wind anticipates up to 10 percent of the route (10% in federal waters and up to 5% in state waters are anticipated to require secondary cable protection) for each cable comprising the RWEC will require additional protection measures. Effects of habitat conversion resulting from cable protection are addressed in Section 7.4.

The offshore export cables will connect with onshore export cables using HDD. As described in Section 3.2.3.1, multiple methods are being proposed for sea to shore construction, one of which will be used. Noise associated with installation and removal of the casing pipe and sheet pile cofferdam alternatives is considered in Section 7.1. Mechanical dredging for the exit pit would occur in association with the sheet pile or no containment alternatives.

7.3.1.1 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/MECs, and other marine debris. Additionally, large boulders that cannot be avoided would be relocated from the cable path with a boulder grab or boulder plow. 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, therefore, the effects from this activity are discountable.

7.3.1.2 Cable Laying
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, therefore, the effects from this activity are discountable. Effects of turbidity from cable laying are considered below.

7.3.1.3 Sea to Shore Transition
As noted above, the offshore export cables will connect with onshore export cable at Quonset Point via HDD. The HDD methodology will involve drilling underneath the seabed and the intertidal area using a drilling rig positioned onshore. A temporary cofferdam or casing pipe with goal posts may be utilized for HDD operations. Noise associated with sheet pile and casing pipe installation is addressed in Section 7.1. Depending on the construction alternative selected, excavation of two offshore exit pits (one per cable), each measuring up to 182 ft. x 113 ft. x 14 ft. (55 m x 34 m x 4 m) would be necessary. The HDD exit pits will be at the approximate 15 ft. (4.6 m) water depth contour. It is our understanding that the construction alternative selected may be influenced by time of year restrictions, project logistics, and timing of the issuance of permits/authorizations.

Excavation of the exit pits would be carried out with a mechanical dredge. 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, ESA listed whales are extremely unlikely to occur in Narragansett Bay. Due to their lack of presence in this area, we do not expect any ESA listed whales to be exposed to effects of dredging. Even if whales were present in the dredged area, they are far too large to

be susceptible to capture or entrapment by a mechanical dredge. As such, mechanical dredging will have no effect on any ESA listed whales.

Sea Turtles
Occasional, transient sea turtles may be seasonally present in Narragansett Bay and may be present in the area where mechanical dredging is planned. However, sea turtles 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 generally 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 and be unable to escape. 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 few Atlantic sturgeon are anticipated to occur, 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 Turbidity from Cable Installation and Dredging Activities
Installation of the Revolution Wind export cable and inter-array cable would disrupt bottom habitat and suspend sediment in the water column. 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 Revolution Wind Farm Area (see COP, Section 4.3.2.2 and Appendix J for detailed descriptions; Revolution Wind BA 2023). Cable installation would produce the most extensive measurable suspended sediment impacts on the surrounding environment. Cable installation would generate localized plumes of suspended sediments with maximum TSS concentrations ranging from 50 to 100 mg/L extending from 1,296 ft. (395 m) to 853 ft.(260 m) from IAC installation activities and from 1,542 ft. (470 m) to 1,476 ft. (450 m) for the RWEC and OSS installation in federal waters (RPS 2021). TSS concentrations ranging from 50 to 100 mg/L for RWEC installation in Rhode Island state waters will extend from 4,528 ft. (1,380 m) to 4,134 ft. (1,260 m), respectively. Modeling results indicate that TSS concentrations

greater than 100 mg/L do not persist in any given location outside of Narragansett Bay for longer than three hours (RPS 2021). RPS (2021) estimated that sediment plumes would resettle and TSS concentrations would return to background levels within approximately 5 hours of disturbance. Sediments at the sea-to-shore transition site have a greater concentration of silts that require longer to settle out of the water column. TSS concentrations above 100 mg/L would persist around the sea-to-shore transition site for over 24 hours. All sediment impacts would be localized around the source of disturbance and intermittent in association with the duration of bed-disturbing activities.

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 m 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 7.3.3.

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 TSS 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. TSS plumes >100 mg/L could persist up to 36 hours in the inshore portions of the RWEC corridor but do not persist in any given location outside of Narragansett Bay for longer than three hours (RPS 2021). Atlantic sturgeon within 395 m of the cable laying operations for the Revolution Wind export cable in federal waters would be exposed to TSS at 50 to 100 mg/L. Elevated TSS levels associated with Revolution Wind export cable-OSS installation are not expected to persist for more than 36 hours for inshore waters and no longer than 5 hours for waters outside of Narragansett Bay. 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.

7.3.3 Impacts of Cable Installation Activities on Prey

Here we consider the potential effects of cable installation on 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. 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 Revolution Wind 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.

7.3.3.1 Effects of Cable Installation Activities on the Prey Base of ESA Listed Species in the Action Area

Dredging
The only ESA listed species expected to forage in the areas where dredging will occur are occasional sea turtles or Atlantic sturgeon that may forage opportunistically if there were suitable forage present. Dredging will result in a temporary loss of benthic prey in the areas being dredged. However, given that this area is rarely used for foraging, the areas impacted are very small, and any losses of benthic resources will be small and temporary, effects to Atlantic sturgeon and sea turtles are expected to be so small that they cannot be meaningfully measured, detected, or evaluated and will be insignificant. The discussion that follows focuses on effects to prey along the cable routes outside of the areas at the HDD exit pits.

Exposure to Increased Turbidity

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 the 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 m 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 days, 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 and there will be no effects to these listed species as a result of the impacts of turbidity/sedimentation on prey.

Benthic Invertebrates
In the BA, BOEM indicates that an area approximately 25 ft. wide along the cable corridor and 30 ft. at the splice vaults 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, therefore, the effects from this activity are discountable.

SAV/Eelgrass (Zostera marina)
A pre-construction and installation SAV survey will be completed and construction/installation of cofferdams and cables will be carried out in a manner that avoids impacts to SAV to the greatest extent practicable. In general, SAV provides important nursery and foraging habitat for ESA listed sea turtles. Sea turtle occurrence in Narragansett Bay, where any impacts from the sea to shore transition would be experienced, is rare. Given the small area of SAV impacted and the limited use of these areas by sea turtles, effects to sea turtle prey and foraging habitat will be too small to meaningfully measure, detect, or evaluate, and therefore, are insignificant.

Water Withdrawal for Jet Trenching
As described in the COP (Section 4.3.3.2), fish eggs and larvae (ichthyoplankton), as well as zooplankton, are expected to be entrained during jet trencher embedment of the IAC. Jet trencher equipment uses seawater to circulate through hydraulic motors and jets during installation. Although this seawater is released back into the ocean, survival rates of entrained eggs, larvae, and zooplankton are unknown and it is possible that all entrained organisms will be killed. Only early life stages may be affected by jet plow entrainment; later life stages will not be affected. These will be one-time losses and will occur over a short period. A previous assessment conducted for the South Fork Wind Farm found that the total estimated losses of zooplankton and ichthyoplankton from jet trencher entrainment were less than 0.001% of the total zooplankton and ichthyoplankton abundance present in the project area, which encompassed a linearly buffered region of 15 km around the export cable and 25 km around the wind farm (INSPIRE Environmental, 2018b). We would expect similar impacts from the Revolution Wind cable installation. Given the extremely small, localized, and one-time losses of ichthyloplankton, we expect any effects to the forage base for ESA listed species would be equally small, localized, and temporary. As such, effects to ESA listed species are expected to be so small that they cannot be meaningfully measured, detected, or evaluated and are therefore, insignificant.

7.3.4 Turbidity during WTG and OSS Foundation 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. Similarly, effects to listed

species from any effects to prey would be too small to meaningfully measure, detect, or evaluate, and therefore, are insignificant.

7.3.5 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, Revolution Wind 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, therefore, the effects from this activity are 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 over 600 km), there is no potential for project lighting to impact the orientation of any sea turtle hatchlings.

7.3.6 ***UXO/MEC Detonation - Seabed Disturbance and Turbidity***

The proposed action includes the detonation of up to 13 UXOs/MECs. Therefore, we are assessing the potential effects to the seabed from potential UXO/MEC blasting/detonation. 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 UXO/MECs. Generally, it can be assumed that the detonation of a UXO/MEC 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/MEC, the existing seabed conditions, and the UXO/MEC detonation method. Revolution Wind proposes to first avoid interaction with any existing UXOs/MECs. If avoidance cannot be achieved, physical relocation through a "Lift and Shift" strategy where a UXO/MEC is moved to another suitable location would be next. In situations where UXOs/MECs 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/MEC 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/MEC 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/MEC detonation, it is likely that the seabed around the location of the UXO/MEC will be disturbed. Given the sandy substrate in areas where UXO/MEC 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. Revolution Wind would also bury cables to a target burial depth of approximately 4 – 6 ft (1.2 – 1.8 m) 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 Revolution Wind (i.e., up to 275 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 512 to 514 milligauss (mG; 51.5 microteslas [μT]) (NOAA 2021).

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 Revolution Wind Farm inter-array cable and Revolution Wind 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. (2021) calculated that the maximum induced electrical field strength from the Revolution Wind inter-array cable and the Revolution Wind export cable would be 0.7 mV/m or less, which is above the detection threshold for this species. Additionally, 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 will 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

Revolution 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 Revolution Wind 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 ft 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 Revolution Wind export cables, but only in close proximity to cable segments lying on the bed surface. Individual marine mammals would have to be within 3 ft (1 m) 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 Revolution Wind Wind Farm inter-array cable and Revolution 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
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 cables is detectable. We have considered whether magnetic fields associated with the operation of the cables could impact benthic organisms that serve as sturgeon and sea turtle prey. 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 OSS. 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.

RWF construction and installation vessels would introduce stationary and mobile artificial light sources to the marine component of the action area. Construction and installation and O&M lighting will be limited to the minimum necessary to ensure safety and compliance with applicable regulations. RWF will also use Aircraft Detection Lighting System (ALDS) (or similar system), pursuant to approval by the FAA and commercial and technical feasibility at the time of FDR/FIR approval. Each WTG will be marked and lit with both USCG and approved aviation lighting. 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 640 km), there is no potential for project lighting to impact the orientation of any sea turtle hatchlings in known nesting beaches. While we recognize that rare nesting events have been recorded in New York and New Jersey, these remain unexpected events that require human intervention (i.e., nest relocation) to produce successful hatchlings and this does not change our conclusions regarding the impacts of project lighting.

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 Revolution Wind 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 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 (12 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 32.6 m. 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 Revolution Wind 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 occur in low densities 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 4.6 ft (1.4 m) in height and would have an area of 0.7 acres per monopile.

The footprint of 79 WTGs foundations and two OSS foundations and associated scour protection in the form of boulders and concrete mats would permanently modify approximately 64 acres of seabed. In addition, approximately 128.2 acres of the seabed would be permanently modified in order to protect inter-array, export, and interconnection cables. In total, permanent habitat disturbance of 192.2 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 Revolution Wind foundations, cables, and associated scour protection would transform 121.5 acres (0.49 km^2) of soft bottom habitat into coarse, hard bottom habitat. For context, lease area OCS-A 0486 is approximately 97,500 acres. 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 constructed 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 Revolution Wind 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, just over 0.3% (and an even smaller percentage 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 Revolution Wind WFA is located within multiple defined marine areas. Here, we consider the best available information on how the presence and operation of the 79 Revolution Wind WTGs and 2 OSSs 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 that help inform the potential effects offshore wind farms may have on the oceanic and atmospheric environment; summaries of several of these studies, which in our view represent the best available science on operational effects to oceanic and atmospheric conditions, 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 a windfarm) and were carried out in Europe, specifically the North Sea, where commercial-scale offshore wind farms are already in operation. At various scales, documented effects include increased turbulence, changes in sedimentation, decreased dissolved oxygen, 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. As described in the Environmental Baseline section, offshore construction for the

Vineyard Wind 1 and South Fork Wind projects, both in the same area as Revolution Wind, began in the summer of 2023, thus there are not yet any available studies about the effects of either project on oceanographic or atmospheric conditions.

Background Information on Oceanic and Atmospheric Conditions in the Project Area
At the broadest scale, the proposed Revolution Wind project is located within the Southern New England sub-region of the U.S. Northeast Shelf Large Marine Ecosystem, and the northern end of the Mid-Atlantic Bight (Kaplan 2011). The region is a dynamic area between southward flowing cool arctic waters and northward flowing warm tropical waters, with complex seasonal physical dynamics, which support a diverse marine ecosystem. The physical oceanography of this region is influenced by local bathymetry, freshwater input from multiple rivers and estuaries, large-scale atmospheric patterns, and tropical and winter coastal storm events. Weather-driven surface currents, fronts, upwelling, tidal mixing, and estuarine outflow all contribute to driving water movement both at local and regional scales (Kaplan 2011). These dynamic regional ocean properties support a diverse and productive ecosystem that undergoes variability across multiple time scales.

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 such as 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, marine mammal and sea turtle abundance, insight to detect changes in the environment, and other research needs. In the waters of the Revolution Wind WFA and surrounding areas along the continental shelf, the broad, year-round pattern of currents are generally understood. Water flows south along the western margins of the Gulf of Maine due to a cyclonic gyre before splitting near the northern portion of the Great South Channel (east of Cape Cod), with one branch flowing northeast along the northern edge of Georges Bank, and the other west either over or around the outer edge of Nantucket Shoals, continuing westward along the continental shelf of southern New England towards the Mid-Atlantic Bight. This westward non-tidal circulation flow is constant with little variability between seasons (Bigelow 1927, Pettigrew et al. 2005, Kraus, Kenney and Thomas 2019). The Nantucket Shoals region is characterized by tidal front activity that overlaps with right whale distribution and serves to aggregate prey for a variety of higher trophic species (Ullman and Cornillon 2001, White and Viet 2020, Quintana-Rizzo et al. 2021).

On a seasonal scale, the greater Mid-Atlantic Bight region experiences one of the largest transitions in stratification in the entire Atlantic 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 Revolution Wind 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 et 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). In the southern New England region, a northeastward propagating tidal wave interacts with the unique topography of Nantucket Shoals to cause upwelling, convergence, and a rotary current around Nantucket Shoals (White and Viet 2020).

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. ESA listed species in the southern New England region (the larger region that includes both the Rhode Island and Massachusetts WEA [RI/MA WEA] and Massachusetts WEA [MA WEA]) primarily feed on five prey resources - zooplankton, pelagic fish, gelatinous organisms, marine vegetation, and benthic invertebrates. Of the listed species in the area, North Atlantic right whales are the only obligate zooplanktivores. ESA listed large whales and sea turtles have been observed foraging in both the RI/MA and MA WEAs, including the area where the proposed Revolution Wind project will be constructed (Leiter et al. 2017). High densities of North Atlantic right whales and leatherback sea turtles are often observed around Nantucket Shoals, a bathymetric feature to the east of the Revolution Wind WFA (Dodge et al. 2014, Kraus et al. 2016, Leiter et al. 2017, Stone et al. 2017, and Quintana-Rizzo et al. 2021). Nantucket Shoals supports frontal zones that likely aggregate prey (White and Viet 2020). The influence of this bathymetric feature on prey is particularly relevant to North Atlantic right whales and leatherback sea turtles as their prey is planktonic (copepods. and gelatinous organisms, respectively). As described above, physical and oceanographic features are the primary drivers that control aggregations and concentrations of plankton. The distribution of *Calanus* sp. (the primary forage of right whales) is largely driven by season, water movement, and their daily vertical migration (Baumgartner et al. 2007). Other listed species, which eat fish, cephalopods, crustaceans, and marine vegetation, are not as closely tied to physical oceanographic features that concentrate prey, given those species' prey are either more stationary on the seafloor or are more able to move independent of typical ocean currents.

Since around 2010, North Atlantic right whales have been sighted more frequently in southern New England waters than in previous time periods (O'Brien et al. 2022). The southern New England region is primarily the area south of Martha's Vineyard and Nantucket to the shelf edge and bounded to the east by Nantucket Shoals and Block Island to the west. There is a seasonal dynamic of this habitat usage, with some inter-annual variability. Right whales are predominantly on Nantucket Shoals and along the western and southern edges of the Shoals during the fall (September – November), remain in this area in the highest densities during the winter (December – February) and then shift their distribution to areas across portions of the RI/MA and MA WEAs and waters immediately south throughout the spring (March – May). In the spring, right whales have been sighted in and immediately adjacent to the Revolution Wind WFA (Stone et al. 2017, Quintana-Rizzo et al. 2021). Summer (June – August) is when right whale density is lowest in this area generally, and in the Revolution Wind WFA specifically. North Atlantic right whale observations including feeding behavior and surface active groups have been observed throughout the year (Kraus et al. 2016, Leiter et al. 2017, Stone et al. 2017, Quintana-Rizzo et al. 2021, Estabrook et al. 2022, O'Brien et al. 2022). In more recent years, right whales have been observed on Nantucket Shoals starting in August with whales present throughout the southern New England region through the spring. Mean residency time is estimated to be 1-2 weeks (Quintana-Rizzo et al. 2021). Both the estimated abundance of right whales and unique individuals per unit of survey effort increased from 2013-2019 (O'Brien et al. 2022). It is important to note that the Nantucket Shoals area does not overlap with the Revolution Wind WFA; the WFA is farther west. North Atlantic right whale high use areas (also referred to in some literature as "hotspots," which are often defined as season−period combinations with greater than 10 right whale sightings and clusters within a 90% confidence level) are primarily nearby, but outside, the footprint of the Revolution Wind WFA. The exception is that during March - May, these high use areas overlap portions of the southern and eastern part of the Revolution Wind WFA (Quintana-Rizzo et al. 2021). During spring (March-May) in 2011- 2015 and 2017-2019, the eastern portion of the Revolution Wind WFA and adjacent waters to the southwest were high use areas for right whales, with both feeding and social behavior (social active groups) observed. Feeding behavior has been observed in all seasons, whereas social behavior has been observed primarily in the winter and spring (Leiter et al. 2017, Stone et al. 2017, Quintana-Rizzo et al. 2021). A species distribution model that incorporated the primary prey (*Calanus finmarchicus*) of North Atlantic right whales and environmental covariates predicted areas of high foraging habitat suitability in southern New England (Pendelton et al. 2012), and a separate density model (Roberts et al. 2023) for right whales also predicted areas of high density for right whales in southern New England waters and seasonally in the Revolution Wind WFA.

As mentioned above, currents flow into southern New England waters from the Gulf of Maine; these currents are thought to transport *Calanus* sp. into the area. Oceanographic and physical features in the southern New England region can then act to concentrate *Calanus* sp. and other copepods. Little is confirmed about the specific oceanographic processes driving right whale feeding habitat in the southern New England region, but right whale distribution, and leatherback distribution are likely linked to the distribution and availability of planktonic prey distributed and aggregated by currents and oceanographic conditions. Sei and fin whales have been often observed during the spring and summer throughout the RI/MA WEA and MA WEA, with feeding behavior observed during both periods (Kraus et al. 2016, Stone et al. 2017), however both species eat small schooling fish as well as plankton and cephalopods.

Summary of Available Information on the Effects of Offshore Wind Farms on Environmental Conditions

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 were 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 Revolution Wind 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 megawatt. 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 Revolution Wind 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 (~20+ km) 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 km) 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 km) 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 km) (Siedersleben et al. 2018). On the U.S. northeast shelf, wind wakes emerging from simulations of full lease area buildouts were shown to combine and extend as far as 93 miles (150 km) 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 km) 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 10 km 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 km). Second, the thermocline exhibited diagonal excursions, with maximum vertical displacement of 46 ft. (14 m) over a dipole dimension of 6–7 miles (10–12 km). 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 km 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. (2021) 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 southern New England lease areas. Results of the hydrodynamic modeling suggested that the extraction of wind energy by offshore wind facilities in the southern New England lease areas 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 ft. (0.75 m) inside the facility, by up to 1.48 ft. (0.45 m) just outside the facility, and up to 0.49 ft. (0.15 m) 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-mm 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 mm), 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. (2021) 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 ft. (1 to 2 m) and retention of colder water within the footprint of the modeled wind facility through the summer months (Johnson et al. 2021). The study also suggested that the thermocline would, on average, move deeper in both the spring and summer, with more cold water retained within the footprint of the offshore wind facility (Johnson et al. 2021). The results of Johnson et al. (2021) 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. 2021). Additionally, while Johnson et al. (2021) 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 kilometers 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 offshore wind farm 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 offshore wind farm 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 (i.e., the foundation structure itself) may alter the structure of fronts, which could affect distribution of prey and lead to effects to the marine vertebrates that use these oceanic fronts 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 form, potentially resulting in more retention of plankton in the region when combined with 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 are yet to be 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

The influence of altered atmospheric and hydrodynamic turbulence on the vertical mixing of the water column may impact the delivery of nutrients to the euphotic zone, the upper layer of the water column that receives sufficient light penetration for photosynthesis, and which generally occurs within the upper 100–170 ft. (30–52 m) of the water column in the northeast shelf (Ma and Smith 2022). Seasonal mixing of the water column provides nutrients to support phytoplankton growth, with primary production at deeper depths being limited by lack of sunlight (Dorrell et al. 2022). 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 will 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 offshore wind farm, 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 macro and microzooplankton). However, given that there are significant differences in the location and conditions between the site in China and the Revolution Wind location (e.g., tidal flat/intertidal zone vs. 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 Revolution 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 offshore wind farm 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 an offshore wind farm 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 Revolution Wind Farm

The predominant wind direction in the Revolution Wind WFA is from the southwest, with some variability from the west, northwest, and northeast (COP 2022 citing Saha et al. 2010). The predominant flow of water is southwest and west, with some variability due to season, tides, winds, and bathymetry (RI CRMC 2020).

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 Revolution Wind project 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 Revolution Wind project, there is uncertainty about how offshore wind farms in the action area may alter oceanographic processes and the biological systems that rely on them. However, based on observed and modeled results described in the best available information, we do expect effects to occur, but there is uncertainty regarding the scale/magnitude and extent of these effects in the context of the southern New England ecosystem. 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 Revolution Wind project (79 WTGs and their foundations and up to two OSSs and their foundations) and its specific geographic location and that the analysis and conclusions reached here 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 79 WTGs and their monopole foundations and up to two OSSs and their monopole foundations for the Revolution Wind project would lead to ocean warming that could affect ESA listed whales, sea turtles or fish or that there is the potential for the Revolution Wind project to contribute to or exacerbate warming ocean conditions; if anything, the project may result in minor, localized cooling. Based on the available information, it is likely that the Revolution Wind 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 on a scale of hundreds of meters and up to 1 km from each foundation (Floeter et al. 2017, van Berkel et al. 2020) and documented changes in mixed layer depth and thermocline conditions in the form of a dipole extending up to 12 km at one wind farm (Floeter et al. 2022), while alterations to wind fields and the ocean–atmosphere interface have been modeled as modifying both atmospheric and oceanographic patterns on large spatial scales of to tens of kilometers (Gill et al. 2020, Christiansen et al. 2022). As noted above, oceanic response to an altered wind field is predicted to extend greater than 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 southern New England and the greater Mid-Atlantic Bight region to our consideration of the potential effects of the Revolution Wind 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 southern New England and the greater Mid-Atlantic Bight region (Castelao, Glenn, and Schofield, 2010). The conditions in the North Sea are more representative of weaker stratification, similar to conditions seen in southern New England and the Mid-Atlantic Bight during the spring or fall (van Leeuwen et al. 2015). 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 and potential for increased turbulence during this period when waters are more unstable than during highly stratified conditions in the summer (Kohut and Brodie 2019, Miles et al. 2021).

Offshore wind energy development is likely to alter the atmospheric and the physical and biological oceanographic environment due to the influence of the energy extraction 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 Revolution Wind project (81 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-trophic level prey species that support listed 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 are in operation in the region nor along any coast of the United States to evaluate potential impacts of the proposed Revolution Wind 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, Floeter 2022); 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 (primarily 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 zooplankton, 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. Increased mixing may also increase the nutrient supply to the upper water column and in turn cause phytoplankton blooms, thus creating a food source for zooplankton. 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 that 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 southern New England area and the greater Mid-Atlantic Bight region as a whole, the scale of the proposed Project (no more than 79 WTG monopole foundations and 2 OSS monopole foundations) and the footprint of the WFA (97,500-acres, 395 km^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 oceanographic, atmospheric, or hydrodynamic effects from the proposed Revolution Wind project 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 Rhode Island or broader Mid-Atlantic Bight region in a way that would have more than insignificant effects to listed species. We do expect localized impacts to oceanic conditions that would extend tens of kilometers from the outermost row of foundations in the Revolution Wind lease area that would vary directionally based on the direction of the wind and flow of water (Gill et al. 2020, Christiansen et al. 2022, Floeter et al. 2022). However, based on the available information presented above and the location of the Revolution Wind WFA relative to the predominant westward flow of water in the southern New England region, we do not expect the impacts to oceanic conditions resulting from the Revolution Wind project to affect the oceanographic forces transporting plankton into the area from the east. Some copepod species are resident in southern New England and thus may not be advected into the region, however the best available information indicates that the dominant flow bringing some zooplankton species to the region - particularly the copepod *C. finmarchicus,* a primary food source for right whales - originate from the Gulf of Maine and wrap around Nantucket Shoals following bathymetric contours towards the Revolution Wind WDA. We do not expect the construction and operation of the Revolution Wind project to alter this broad current pattern, and thus expect any alteration of the biomass of plankton in the region, and therefore, the total food supply, to be so small that it cannot be meaningfully measured, evaluated, or detected; therefore, effects would be insignificant.

Given that right whale foraging appears to occur within the Revolution Wind WFA (Leiter et al. 2017, Quintana-Rizzo et al. 2021) rather than in the lee of it (with the lee assumed to be to the northeast based on predominant wind direction), we would expect individual turbine/near-field effects to be the primary drivers of changes in zooplankton distribution rather than far-field effects from energy extraction in the lee of the wind farm.

Although uncertainty remains as to the magnitude and intensity of effects offshore wind farms may have on altering oceanographic processes, studies demonstrate increased turbulence is expected to occur in the wake of turbine (and OSS) foundations. These turbulence wakes have been detected up to 300 m from turbine foundations (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 Revolution Wind project that would be a distance of 96 to 120 m from the 12-m diameter piles used for the 79 WTGs and would be a distance of 120 to 150 m from the 15-m diameter piles used for the 2 OSSs. We expect that any effects on the distribution or density of zooplankton prey due to turbulence from the foundation would be limited to the area where changes in turbulence would be experienced. These anticipated localized changes down-current of the foundations of the wind turbines could result in localized changes in plankton distribution and abundance within discrete areas of the Revolution Wind WFA extending up to 300 m down-current from each foundation (Floeter et al. 2017). Based on the spacing of the turbines (1.8 km x 1.8 km), the available information suggests limited opportunity for these areas to interact and overlap which is expected to limit the impact of the distribution of plankton to small, discrete areas within the Revolution Wind WFA. 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, 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.

As noted above, North Atlantic right whales are the only ESA listed obligate zooplanktivores in the action area, feeding exclusively on copepods, which are primarily aggregated by physical and oceanographic features. Based on observations of right whales and abundance of *C. finmarchicus*, Record et al. (2019) hypothesized that a 40,000 m^2 threshold for *C. finmarchicus* represents the regional copepod abundance at which high-density, exploitable, small-scale patches within a region are likely to occur. Mayo and Marx (1990) and Murison and Gaskin (1989) estimated the immediate decision-making threshold for right whale feeding to be approximately 1,000 m^3 for Cape Cod Bay and the Bay of Fundy, respectively. Kenney et al. (1986) estimated the minimum concentrations necessary for right whale feeding to provide a net energetic benefit over the long term to be in the 10^5–10^6 m^3 range. While we do not expect the Revolution Wind WTGs and the foundations to affect the abundance of copepods in the WFA area or broader region, the distribution of copepods in the Revolution Wind WFA may be affected. This disruption would likely occur if/when there is consistent wind and water movement in a particular direction, as stable and consistent conditions have the greatest influence. Given the predominant direction of water movement (southwest, west) and wind flow (from the southwest) and the potential area (up to 300 m from each foundation as described above) impacted by the presence of foundations, redistribution of prey in the Revolution Wind WFA would only be expected under some conditions and only within 300 m of each foundation. We expect that these geographically limited impacts on the distribution of plankton could reduce the density of copepods and it is possible that density could be reduced below the feeding thresholds of right whales. Increased mixing may also increase the nutrient supply to the upper water column and in turn cause phytoplankton blooms, thus creating a food source for zooplankton. However, given that the areas impacted would be limited to discrete areas within 300 m of each foundations and right whale foraging behavior is limited in the Revolution Wind WFA, we expect the effects on foraging right whales would be so small that they cannot be meaningfully measured, evaluated, or detected and are therefore, insignificant. We do not expect there to be any lost or disrupted foraging events. 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 and are therefore, insignificant.

Farther-field atmospheric effects that may occur downwind with consistent and stable wind directions of the Revolution Wind WFA may alter the spatial distribution of primary productivity; however, this area would likely be tens of kilometers to the northeast of the WFA given predominant wind direction, an area where right whales have not been observed consistently nor in high densities. We do not anticipate a larger disruption to conditions that would aggregate prey in or outside the WFA due to the scale of the project and its location at the western edge of the southern New England region and away from Nantucket Shoals and the predominant tidal jet along the edge of Nantucket Shoals. We have made this conclusion in consideration of the *Environmental Baseline,* which includes consideration of the operational effects of the Vineyard Wind 1 and South Fork projects.

In summary, based on the best available scientific information pertaining to the effects of offshore wind farms on oceanic and atmospheric conditions, we expect the presence and operation of the proposed Revolution Wind project to have localized effects to the distribution and aggregation of the planktonic prey of listed species, however, we do not expect any overall reduction in the amount of prey in the action area. Any effects to foraging individual right, fin, or sei 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. Fin and sei whales may also forage on small schooling fish and cephalopods, given these prey species are free swimming, any effects to sei or fin whales are extremely unlikely to occur. Similarly, 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 these prey typically occur further offshore and are free swimming. As no effects to sperm whale prey are anticipated, we do not expect any effects to sperm whales.

We note that as the scale of offshore wind development in southern New England and the greater Mid-Atlantic Bight region increases and the number of WTGs and OSSs increases, the scope and scale of potential hydrodynamic impacts may also increase and influence the environmental baselines for future projects. Our Biological Opinions prepared for the Vineyard Wind 1, South Fork Wind, and Ocean Wind 1 projects assessed the construction, operation, and decommissioning of each project and concluded that there may be localized changes in the Vineyard Wind 1, South Fork, and Ocean Wind 1 lease areas and surrounding waters within a few hundred meters to tens of kilometers down-current/downwind of the foundations and WTGs, with effects on zooplankton prey limited to the area within a few hundred meters of each foundation. The Vineyard Wind 1 project will be 62 WTGs and 63 foundations located approximately 26 kilometers to the east of the proposed Revolution Wind project. The presence of structures and operation of the Vineyard Wind 1 project may have oceanographic, hydrodynamic, and atmospheric effects; however, given the dominant wind direction, and the expected distance of these effects (and need for consistent and stable atmospheric conditions to induce such effects), we do not expect them to typically overlap or interact with the area affected by the Revolution Wind project. The South Fork Wind project will consist of 12 WTGs and 13 foundations located directly adjacent to the south from the proposed Revolution Wind project. Even considering the anticipated effects of the Revolution Wind project in light of the 12 WTGs and 13 foundations of the South Fork Project, any effects to ESA listed species from the Revolution Wind project would be so small that they cannot be meaningfully measured, evaluated, or detected. The Ocean Wind 1 project is approximately 340 km to the southwest of the Revolution Wind project and once built will be too far away for oceanographic, hydrodynamic, or atmospheric effects to impact the Revolution Wind WFA. Therefore, while in the future there may be additive effects resulting from the buildout of multiple adjacent lease areas, the conclusions reached in this analysis do not change when considering the effects in the context of the *Environmental Baseline*.

7.5 Effects of Marine Resource Survey and Monitoring Activities

Revolution Wind will carry out survey and monitoring activities in and near the WDA as part of the proposed action for consultation in this opinion. As described in Section 3.0 of this Opinion, these will include: otter trawl, ventless trap, and acoustic telemetry to characterize fisheries resources in the WDA; benthic monitoring to document the disturbance and recovery of marine benthic habitat and communities resulting from the construction and installation of Revolution Wind project components in the WDA and along the offshore export cable corridors; and deployment of PAM buoys or autonomous PAM devices to record ambient noise and characterize the presence of protected species, specifically marine mammals and cod vocalizations. 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 survey gear and the other sampling and monitoring methodologies, and then analyze risk and determine likely effects to sea turtles, listed whales, and Atlantic sturgeon. Section 7.1 of the Opinion addresses the effects of noise during surveys, including HRG surveys; as noted there, the operating frequencies of the SSS and MBES equipment proposed for use in the benthic monitoring mean that no effects to ESA listed species will occur even if individuals are exposed to the noise from that equipment. 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 Other Buoy Deployments

Benthic Sampling
Revolution 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 acoustic survey and remotely operated vehicle (ROV) imaging techniques. Surveys will be conducted at WTG-associated sites at one, two, three, and five years post construction; cable associated sites at one, two, and three years post construction with additional years if needed if significant difference between reference and control sites are present in year three. All survey equipment will be deployed from contracted scientific research vessels. Targeted high-resolution acoustic surveys (SSS and MBES) will be conducted over the selected IAC corridors prior to boulder relocation and again after all construction is complete to map boulder locations within the survey areas. 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 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 temporary loss of benthic resources in the disturbed areas. ROV operation and SPI/PV surveys will affect an extremely small area at each survey location (~1.5 $m^{2)}$. Any loss of benthic resources will be small, temporary, and localized to the areas disturbed by survey activities; recolonization is expected to be rapid. These temporary, isolated reductions in the amount of benthic resources in an area 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 that may forage on these benthic resources (i.e., Atlantic sturgeon and some sea turtles) will be so small that they cannot be meaningfully measured, detected, or evaluated, effects are insignificant.

Acoustic Telemetry Monitoring
Revolution Wind will capture and tag 150 tuna and sharks (50 annually from 2023-2025) using rod and reel from a charter or commercial fishing vessel operating in or near the WDA. Atlantic sturgeon and sea turtles are occasionally captured with rod and reel; however, these events are generally rare in New England waters. We have determined that capture of any sea turtles or Atlantic sturgeon is extremely unlikely to occur. This is because of the limited amount of fishing effort, the short set time for rod and reel fishing (only a few minutes), and the dispersed nature of sea turtle and sturgeon occurrence in the area where surveys will occur which makes co-occurrence extremely unlikely. Based on this analysis, effects to Atlantic sturgeon and sea turtles are extremely unlikely to occur and therefore, discountable. No interactions between the rod and reel fishing activities and ESA listed whales are anticipated.

Revolution Wind will deploy six telemetry receivers to complement an existing receiver array to detect the tuna and sharks that are tagged as well as other individual fish and turtles that are tagged and may occur in the area. The receivers will be set using ropeless technology; this means that there will be no vertical lines associated with the moorings and therefore, no risk for entanglement of listed species in the mooring systems. Operationally, the acoustic receiver devices just record the presence of nearby tagged animals.

No effects to ESA listed species are anticipated to result from acoustic telemetry surveys other than general vessel activities, which are considered in Section 7.2 above. This is because no listed species will be tagged and the deployed receivers will utilize ropeless technology negating any entanglement risk, and there are no effects to ESA listed species from this type of passive monitoring.

Passive Acoustic Monitoring
PAM is used to measure, monitor, record, and determine the sources of sound in underwater environments. Moored PAM systems or autonomous PAM devices will be used prior to, during, and following Revolution Wind construction. PAM will be used to characterize the presence of marine mammals and cod 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 autonomous PAM devices that may operate at the surface or operate throughout the water column. These vehicles produce virtually no self-generated noise and travel at slow operational speeds (~0.25 m/s) as they collect data. 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 and are therefore, discountable.

Other Buoy Deployments
BOEM has indicated that one or more data collection buoys may be deployed in the WDA to provide weather and other date in the project area. Best management practices for moored buoys used for data collection associated with offshore wind projects are described in June 29, 2021 informal programmatic consultation between NMFS/GARFO and BOEM on certain geophysical and geotechnical survey activities and data collection buoy deployment (see Appendix C of this Opinion). BOEM has indicated that any data collection buoys deployed as part of the Revolution Wind project will be consistent with the best management practices and project design criteria included in the June 2021 consultation. Therefore, consistent with the conclusions of the 2021 programmatic, we expect any effects to ESA listed species to be extremely unlikely to occur and therefore, discountable.

7.5.2 Assessment of Risk of Interactions with Otter Trawl Gear
Revolution Wind will conduct up to four years of otter trawl surveys (up to 2 years pre/during construction and 2 years post-construction) to assess the finfish community in the northern portion of the Revolution Wind WFA and two adjacent reference areas. As described in Section 3.0, the surveys will be adapted to Northeast Area Monitoring and Assessment Program (NEAMAP) protocols. Approximately 180 tows will be conducted each year across the Revolution WFA and two reference areas, during daylight hours (after sunrise and before sunset) for 20 minutes each with a target tow speed of 2.9 to 3.3 knots.

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, 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 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 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 Revolution Wind 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 beam and bottom otter trawl survey gear.

During the spring and fall bottom trawl surveys conducted by the NEFSC from 1963-2017, 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 50 loggerhead, 34 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. However, based on the best available information as cited herein, we anticipate 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, 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
We have considered the available data sets to best predict the number of sea turtles that may be incidentally captured in the proposed trawl surveys. The largest and longest duration data sets for surveys in the general area of the Revolution Wind WDA are the NEAMAP and NEFSC bottom trawl surveys. Both surveys occur in the spring and fall using trawl gear. The NEAMAP survey area is farther inshore but overlaps with the control area that will be sampled for the Revolution Wind trawl surveys while the NEFSC survey area occurs farther offshore and

overlaps with the WFA. We have also considered information on interactions with sea turtles and commercial trawl fisheries available from fisheries observer data (Murray 2020).

We reviewed records for sea turtles captured in the NEFSC spring (March-May) and fall (September-October) trawl surveys from 2012-2022 for trawls above 39° N (excluding the Gulf of Maine). This is the geographic area determined to best predict capture rates in a trawl survey carried out in or around the southern New England wind energy areas. For the 2012-2022 fall surveys, three loggerhead sea turtle captures were documented over 1,716 tows; this is a capture rate of 0.00175 loggerhead sea turtles per tow. The NEFSC surveys did not capture any sea turtles during spring surveys in this geographic area; however, the surveys are conducted in early spring, likely before sea turtles arrive in the area. Revolution Wind is proposing to carry out 45 tows in all four seasons. We do not expect sea turtles to occur in the area during the winter and the NEFSC spring survey data would suggest that no sea turtles would be captured in the spring surveys. Applying the fall capture rate to the 90 summer and fall surveys (as we expect similar abundance of sea turtles in the area in the summer and fall months), results in a prediction of 0.16 loggerheads captured per year or 0.64 loggerheads over the four year survey period.

Murray (2020) estimated the interaction rates of sea turtles in the US commercial bottom trawl fisheries along the Atlantic coast between 2014-2018 using fisheries observer data. In this analysis, a total of 5,227 days fished were observed from 2014-2018 in bottom trawl fisheries in the Georges Bank and Mid-Atlantic, which represented 13% of commercial trawl fishing effort across both regions. During this period, NEFOP observers documented 50 loggerhead turtle interactions in bottom trawl gear, 48 of which occurred in the Mid-Atlantic; observers also recorded 5 Kemp's ridley turtles, 3 leatherback turtles, and 2 green turtles. These data overlap temporally and spatially with the survey area and the seasons that surveys will occur; however, there are differences in the trawl gear used in commercial fisheries compared to the gear that will be used in the proposed survey. Therefore, because other data sources are available that better align with the proposed surveys, we are not using the interaction rate for commercial trawl fisheries to predict the number of sea turtles likely to be captured in the Revolution Wind surveys. However, we note that the Murray (2020) dataset demonstrates that all the sea turtle species that occur in the survey area are vulnerable to capture in commercial trawl gear.

The Revolution Wind trawl survey will use the same trawl design as the NEAMAP survey carried out by the Virginia Institute of Marine Science (VIMS); the NEAMAP survey area overlaps with the Revolution Wind reference area and is adjacent to the area within the Revolution Wind WFA where trawl surveys are proposed. The NEAMAP nearshore trawl survey began in 2007. The majority of captures of sea turtles in the NEAMAP survey (2008-2022) have been loggerheads (50), followed by Kemp's ridley (34). Only one green sea turtle has been captured and there have been no captures of leatherback sea turtles. Sea turtles have been captured in the spring and fall surveys. Using this data to calculate a rate of sea turtle captures per tow and applying that to the number of tows planned by Revolution Wind, we would predict the capture of 1.5 loggerheads, 1.02 Kemp's ridley, zero leatherbacks, and 0.03 green sea turtles per year. Over the up to four-year survey period, we would predict the capture of 6 loggerheads, 4.08 Kemp's ridley, zero leatherbacks, and 0.12 green sea turtles.

Given the geographic distribution of the proposed Revolution Wind surveys, it is likely that the number of sea turtles captured would fall between the number predicted using the NEFSC dataset and the NEAMAP dataset. However, the generally shallow depths of the area where the Revolution Wind surveys will take place suggests that the NEAMAP survey data would be a better predictor of sea turtle interactions than the NEFSC survey which occurs in deeper, more offshore waters. We note that neither survey has ever captured a leatherback sea turtle; therefore, despite Murray (2020) documenting past captures of leatherback sea turtles in commercial trawl gear and predicting future interaction rates, we do not expect the Revolution Wind survey to result in the capture of a leatherback sea turtle. Therefore, considering the best available data presented herein, we expect up to 6 loggerheads, up to 4 Kemp's ridleys, and up to 1 green sea turtle will be captured over the four-year survey period.

Based on the analysis by Sasso and Epperly (2006) and Epperly et al. (2002) discussed above, 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 Revolution Wind 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 with no impacts to the health or fitness of any individual. No serious injury or mortality of any sea turtle is anticipated to occur as a result of the trawl surveys and all captured turtles are expected to be quickly released back into the water alive.

Table 7.5.1. Estimated captures of sea turtles by species from Revolution Wind trawl surveys over the four-year duration.

Species	Total Estimated Captures Over Four Years
Loggerhead	6
Kemp's ridley	4
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 Revolution Wind 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 the 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
Atlantic sturgeon are generally benthic oriented but 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 areas to be surveyed year-round. In the marine environment, Atlantic sturgeon are most often captured in depths less than 50 m. Some information suggests that captures in otter trawl gear are most likely to occur in waters with depths less than 30 m (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 commercial otter trawl gear is approximately 5 percent. Atlantic sturgeon are also captured incidentally in trawls used for scientific studies, including the standard NEFSC bottom trawl surveys and both the spring and fall NEAMAP bottom trawl surveys. The shorter tow durations and careful handling of any sturgeon once on deck during fisheries research surveys, compared to commercial fishing operations, 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; hundreds of individuals of a wide range of sizes have been captured with no mortalities recorded. To date, no serious injuries or mortalities of any sturgeon have been recorded in those surveys.

Estimating Interactions with and Mortality of Sturgeon
We have considered the available data sets to best predict the number of Atlantic sturgeon that may be incidentally captured in the proposed trawl surveys. The largest and longest duration data sets for surveys in the general area of the Revolution Wind WDA are the NEAMAP and NEFSC bottom trawl surveys. The NEAMAP survey area is farther inshore but overlaps with the control area that will be sampled for the Revolution Wind trawl surveys while the NEFSC survey area occurs farther offshore and overlaps with the area within the WFA where the trawl survey is proposed.

We reviewed records for Atlantic sturgeon captured in the NEFSC spring (March-May) and fall (September-October) trawl surveys from 2012-2022 for trawls above 39° N (excluding the Gulf of Maine); this geographic area was considered the best predictor for interaction rates in the southern New England wind energy areas. Three Atlantic sturgeon were captured in the spring surveys from 2012-2022; considering the total of over 1,796 tows, this results in an interaction rate of 0.00167 sturgeon per tow During these same years, 1 Atlantic sturgeon was captured in the fall surveys; considering the total of over 1,716 tows, this results in an interaction rate of 0.00058 sturgeon per tow. Averaging the two interaction rates for a yearly rate, results in an interaction rate of 0.00113 sturgeon per tow. Applying the NEFSC annual interaction rate (0.00113 sturgeon/tow) to the 180 tows planned for the Revolution Wind surveys predicts 0.203 Atlantic sturgeon captured per year. Over a four year survey period, this would result in a predicted total capture of 0.811 Atlantic sturgeon.

The NEAMAP survey has captured 492 sturgeon from 2008-2022 and averages 300 tows per year, this equates to a capture rate of 0.109 sturgeon per tow. Using this data, we would predict the capture of 20 Atlantic sturgeon per year in the Revolution Wind surveys, resulting in a total predicted capture of 80 Atlantic sturgeon.

South Fork Wind has carried out trawl and gillnet surveys in their lease area, which is immediately adjacent to the Revolution Wind lease area. From fall 2021 through spring 2023, South Fork has captured five Atlantic sturgeon in gillnets (the gillnet survey is no longer being carried out) and five Atlantic sturgeon in trawls. All five Atlantic sturgeon captured in the trawl survey to date have been released alive with no serious injuries observed. The trawl survey design is equivalent to that proposed for the Revolution Wind survey. The capture of 5 Atlantic sturgeon in 1.5 years of trawl surveys in the adjacent lease area using equivalent survey methods indicates that the encounter rate predicted using the NEFSC survey data (0.81 sturgeon over 4 years) would significantly underestimate the capture of Atlantic sturgeon in the Revolution Wind survey. Therefore, we have determined that using the NEAMAP data provides the best predictor of the number of Atlantic sturgeon likely to be captured in the Revolution Wind trawl surveys. As such, we expect up to 80 Atlantic sturgeon will be captured over the four-year survey period.

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. The best available information on the composition of the mixed stock of Atlantic sturgeon in Atlantic coastal waters is the mixed stock analysis carried out by Kazyak et al. (2021). 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 that belong to each DPS in a number of geographic areas. This study confirmed significant movement of sturgeon between regions irrespective of their river of origin. The Revolution Wind survey area falls within the "MID Offshore" area described in that paper. Using that data, we expect that Atlantic sturgeon in the area where trawl surveys will occur 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 in this area. Using this data, we predict that the up to 80 Atlantic sturgeon expected to be captured in the Revolution Wind trawl surveys will consist of individuals from the 5 DPSs as described in Table 7.5.2 below. Based on the information presented above and in consideration of the short tow times and priority handling of any sturgeon that are captured in the trawl net, we do not anticipate the serious injury or mortality of any Atlantic sturgeon captured in the trawl gear. Individuals may experience minor abrasions or scrapes but these are expected to be fully recoverable in a short period of time with no effects on individual health or fitness.

Table 7.5.2. Estimated capture of Atlantic sturgeon by DPS in Revolution Wind 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 to whole animals to generate the total estimate.

Bottom Trawl	Total Estimated Captures Over Four Years
Total	**80**
New York Bight (55.3%)	45
Chesapeake (22.9%)	18
South Atlantic (13.6%)	11
Carolina (5.8%)	5
Gulf of Maine (1.6%)	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 Trap Surveys
As described in Section 3.0, standard and ventless trap gear will be used in a BACI sampling design to evaluate changes in the distribution and abundance of lobster and Jonah crab in the Revolution Wind WFA and adjacent reference areas in the Revolution Wind WDA to evaluate changes in Jonah crab, lobster, whelk and assess structure-associated finfish species as bycatch, such as black sea bass, scup, and tautog. The BACI trap survey will be conducted with 16 10-trap trawls in the two impact areas within the Revolution Wind WFA and 10 10-trap trawls in each of the two reference areas adjacent to the east and west of the Revolution Wind WFA that will be sampled twice per month (5-day soaks) from May-November. Each trawl will be comprised of six ventless traps and four standard vented traps. A gradient sampling design will also be incorporated within the Revolution Wind ventless trap survey impact area during the operational phase of the project. The purpose of the gradient sampling design is to assess whether lobsters, Jonah crabs, or rock crabs occur in higher abundance near the foundation locations, relative to other locations within the Revolution Wind ventless trap survey impact area. During the operational phase of the project, four foundation locations in the Revolution

Wind ventless trap survey impact area will be selected at random, and ten trap trawls of ventless traps will be intentionally set with the mid-point of the trawl as close to the foundation as possible. Each randomly selected foundation location will be sampled twice per month (5-day soaks). The gradient survey will follow the same protocols and sampling season (May-November) as the BACI survey. Trap trawls (multiple traps linked together by sinking groundline) will be used where each trap is spaced 30.5 m apart. All trap gear will follow all applicable regulations and will employ "ropeless" methodology, which will eliminate vertical lines and surface buoys except for when trap trawls will be hauled to the surface by the vessel conducting the survey. No wet storage of trap gear is proposed; as such, the gear will be removed from the water between monthly survey periods and at the end of the survey season.

ESA Listed Whales

Factors Affecting Interactions and Existing Information on Interactions

Any line in the water column, including line resting on or floating above, the seafloor set in areas where whales occur, theoretically has the potential to entangle a whale (Hamilton et al. 2019, Johnson et al. 2005). Entanglements may involve the head, flippers, or fluke; effects range from no apparent injury to death. Large whales are generally vulnerable to entanglement in vertical and groundlines associated with trap/pot gear.

The general scenario that leads to a whale becoming entangled in gear begins with a whale encountering gear. It may move along the line until it comes up against something such as a buoy or knot. When the animal feels the resistance of the gear, it is likely to thrash, which may cause it to become further entangled in the lines associated with gear. The buoy may become caught in the whale's baleen, against a pectoral fin, or on some other body part. Consistent with the best available information on gear configurations to reduce entanglement risk, all applicable gear modifications and amendments and risk reduction measures will be consistent with the requirements and regulations implementing the Atlantic Large Whale Take Reduction Plan (50 CFR Parts 229 and 697) for the Northeast lobster and Jonah crab trap/pot fisheries. As explained above, there will be no vertical lines attached to the survey gear; thus, there will be no lines between the bottom and the surface. The only lines associated with the surveys will be the sinking groundlines resting on the bottom that are attaching traps together in a trawl.

Blue, Sei, and Sperm Whales

Blue, sei, and sperm whales typically occur in deep, offshore waters near or beyond the continental shelf break; this is well offshore of where the trap and pot surveys will take place. Records of observed sei and sperm whale entanglements are limited due to their offshore distribution, while this may reduce the potential for observations it also reduces the overlap between many fisheries and these species. From 2016-2020, in the western North Atlantic there was 1 mortality, 1 serious injury, and 1 non-serious injury from entanglement for sei whales and no documented interactions between fishing gear and blue or sperm whales (Henry et al. 2022). Although entanglements has been documented for sei whales, the fishing gear in these cases involved the use of buoys/vertical lines which pose a much higher risk to all whale species as the line is present in the entire water column. The use of ropeless gear with only sinking groundlines greatly reduces any risk to blue, sei, and sperm whales given the line is in contact with the seafloor. These species are also rare to the survey area and thus potential for co-occurrence is low.

In order for a blue, sei, or sperm whale to be vulnerable to entanglement in the trap survey gear, the whale would have to first co-occur in time and space with that gear, that is it would need to be in the same area that the traps are being fished and the whales would need to be moving along the seafloor and interact with the groundline with either their open mouth, flippers, or tail. During retrieval of each trap trawl, the survey vessel would be hauling gear and thus the groundline connecting to each trap would be in the water column at this point, however, this would only be for a short time (minutes) as the gear is being actively hauled. As the survey vessels will have a lookout for protected species, no gear would be retrieved or deployed if protected species are observed, thus further reducing any risk for interaction while the gear is being hauled. Given the rarity of blue, sei, and sperm whales in the survey area, the relatively small amount of gear (40 total trawls with 10 traps each periodically deployed between May-November each year) that will be utilized over the course of five years, and ropeless trap gear (with no vertical lines or buoys) that will be used and thus require a blue, sei, or sperm whale to physically interact with the groundline resting on the seafloor, it is extremely unlikely that a blue, sei, or sperm whale would encounter this gear; therefore, effects are discountable. We do not expect the entanglement of any blue, sei, or sperm whales to occur in the gear set for Revolution Wind's ventless trap surveys.

Fin and North Atlantic Right Whales
Fin whales and North Atlantic right whales may occur year round in the area where the trap surveys will take place. Fin whales are most likely to occur in the area in the summer (June – September). North Atlantic right whales are most likely to occur in the area from December through May, with the highest probability of occurrence extending from January through April. The trap survey, which will result in gear set intermittently from May – November, will occur at the time of year when the lowest numbers of right whales occur in the survey area.

The Environmental Impact Statement (EIS) prepared for the Atlantic Large Whale Take Reduction Plan (ALWTRP EIS, NMFS 2021b) determined that entanglement in commercial fisheries gear represents the highest proportion of all documented serious and non-serious incidents reported for fin whales and right whales. Entanglement risk primarily occurs with the vertical line of trap/pot gear, but groundlines also pose a risk as right whales have been shown to utilize the entire water column (Hamilton and Kraus 2019). Fin whales may also use the entire water column, however, they are not known to feed right above the seafloor given there feeding mechanism (lunge feeding) and prey (small schooling fish, krill) (Friedlaender et al. 2020). For a fin or right whale to interact with the groundline, it must also interact with the seafloor. In an analysis of the North Atlantic right whale photo-identification catalog, sightings of right whales with seafloor sediment on their bodies showed that between 1980 and 2016, there were 2,053 detections of right whales with 'mud' on their bodies. Although these sightings were throughout their range and in all months, 92.7% of all detections occurred in the Bay of Fundy in the summer (Hamilton and Kraus 2019). Right whale dive behavior demonstrates that whales may be feeding just above the seafloor at times (Baumgartner et al. 2017). There are no records of fin whale entanglements in groundlines. Entanglement in the groundline of trap/pot gear is rare for right whales, as it requires the animal to maneuver themselves under the groundline and then wrap themselves. The use of sinking groundline makes this even less likely to occur.

In order for a fin or right whale to be vulnerable to entanglement in the trap survey gear, the whale would have to first co-occur in time and space with that gear, that is it would need to be in the same area that the traps are being fished and the whales would need to be moving along the seafloor and interact with the groundline with either their open mouth, flippers, or tail in a way that resulted in entanglement. Fin whales are common throughout the southern New England region during the time of year the trap surveys will be conducted, however, fin whales are not known to interact with the seafloor when they feed, and there have not been any interactions of fin whale entanglements in groundlines. During the time of year when the trap surveys will be conducted (May-November), right whales are at their lowest density in the areas where the trap surveys will be conducted. Thus, we expect few instances of overlap in space/time between right whales and the survey gear. Additionally, as established above, entanglement would require an individual to move at least part of its body underneath the sinking groundline and become wrapped.

During retrieval of each trap trawl, the survey vessel would be hauling gear and thus the groundline connecting to each trap would be in the water column at this point, however, this would only be for a short internment time as the gear is being actively hauled. As the survey vessels will have a lookout for protected species, no gear would be retrieved or deployed if protected species are observed, thus further reducing any risk for interaction while the gear is being hauled.

Given the small amount of gear 40 total trawls (BACI and gradient study combined) with 10 traps periodically deployed between May-November each year) that will be utilized over the course of five years, the ropeless trap gear (with no vertical lines or buoys) that will be used and thus require a fin or right whale to physically interact with the groundline resting on the seafloor, the fact that no fin whale entanglements in groundlines have been reported, and the time of year when surveys will occur is when right whale occurrence is lowest in the survey area, it is extremely unlikely that a fin or right whale would encounter this gear and effects are discountable. No entanglement or other interactions between right or fin whales and the ventless trap survey gear is anticipated.

Effects to Prey

The proposed trap survey activities will not have any effects on the availability of prey for right, fin, sei, and sperm whales. Right whales and sei whales feed on copepods (Perry et al. 1999). Copepods are very small organisms that will pass through trap/pot gear rather than being captured in it. Similarly, fin whales feed on krill and small schooling fish (e.g., sand lance, herring, mackerel) (Aguilar 2002). The size of the trap/pot gear is too large to capture any fish that may be prey for listed whales. Sperm whales feed on deep water species that do not overlap with the study area where trap and pot activities will occur.

Sea Turtles

Factors Affecting Interactions and Existing Information on Interactions

Available entanglement data for sea turtles indicate they may be vulnerable to entanglement in trap/pot gear, primarily the vertical lines; however, the trap gear used for the Revolution Wind survey will not use vertical lines. Thus, the only entanglement risk to sea turtles is the sinking groundline. Sea turtles in the survey area are too big to be caught in the traps themselves since the vents/openings leading inside are far smaller (5 inches) than any of these species. Given data documented in the GAR STDN database, leatherback sea turtles seem to be the most vulnerable turtle to entanglement in vertical lines of fixed fishing gear in the action area. Long pectoral flippers may make leatherback sea turtles more vulnerable to entanglement. In 2007, a leatherback sea turtle was entangled in the lines connecting whelk pots (GAR STDN, unpublished data).

Leatherbacks entangled in fixed gear are often restricted with the vertical buoy line wrapped tightly around the flippers multiple times suggesting entangled leatherbacks are typically unable to free themselves from the gear (Hamelin et al. 2017). Leatherback entanglements in trap/pot gear may be more prevalent at certain times of the year when they are feeding on jellyfish in nearshore waters (i.e., Cape Cod Bay) where trap/pot fishing gear is concentrated. Hard-shelled turtles also entangle in vertical lines of trap/pot gear. Due to leatherback sea turtles large size, they likely have the strength to wrap fixed fishing gear lines around themselves, whereas small turtles such as Kemp's ridley or smaller juvenile hard-shelled turtles likely do not. However, entanglement in the groundline of trap/pot gear is rare as it requires the animal to maneuver themselves under the groundline and then wrap themselves.

Records of stranded or entangled sea turtles show entanglement of trap/pot lines around the neck, flipper, or body of the sea turtle; these entanglements can severely restrict swimming or feeding (Balazs 1985). Constriction of a sea turtle's neck or flippers can lead to severe injury or mortality. While drowning is the most serious consequence of entanglement, constriction of a sea turtle's flippers can amputate limbs, also leading to death by infection or to impaired foraging or swimming ability. If the turtle escapes or is released from the gear with line attached, the flipper may eventually become occluded, infected, and necrotic. Entangled sea turtles can also be more vulnerable to collision with boats, particularly if the entanglement occurs at or near the surface (Lutcavage et al. 1997).

Estimating Interactions with Sea Turtles
Small turtles such as Kemp's ridley or smaller juvenile hard-shelled turtles likely do not have the strength to maneuver themselves under the groundline and then wrap themselves in it. Due to the size of Kemp's ridley and green sea turtles in the areas where the trap survey will be conducted, interactions with these species in the groundlines of the trap gear are extremely unlikely to occur.

Larger turtles such as loggerhead turtles or leatherback turtles may forage along the seafloor and have the strength to maneuver themselves under the groundline and then wrap themselves in it, however, given the groundline is in contact with the seafloor it is unlikely sea turtles would come in contact with it. This risk is further reduced by the small amount of gear that will be set and the short duration that it will be present. During retrieval of each trap trawl, the survey vessel would be hauling gear and thus the groundline connecting to each trap would be in the water column at this point, however, this would only be for a short internment time as the gear is being actively hauled. As the survey vessels will have a lookout for protected species, no gear would be retrieved or deployed if protected species are observed, thus further reducing any risk for interaction while the gear is being hauled. Based on this information, it is extremely unlikely that loggerhead or leatherback turtles will be captured or entangled in the trap gear deployed as part of the proposed surveys. Therefore, effects are discountable and we do not expect any sea turtles to be entangled in the proposed trap survey.

Effects to Prey

Sea turtle prey items such as horseshoe crabs, other crabs, whelks, and fish may be removed from the marine environment as bycatch in trap/pot gear. None of these are typical prey species of leatherback sea turtles or of neritic juvenile or adult green sea turtles. Therefore, the Revolution Wind trap survey 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 the species that may be caught as bycatch in the trap/pot gear. 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

Entanglement or capture of Atlantic sturgeon in trap gear is extremely unlikely. To become captured or entangled in the trap gear, sturgeon would either need to enter the trap or become wrapped in the sinking groundline between each trap. A review of all available information resulted in several reported captures of Atlantic sturgeon in trap/pot gear in Chesapeake Bay as part of a reward program for reporting Atlantic sturgeon in Maryland, yet all appeared to be juveniles no greater than two feet in length. Juvenile Atlantic sturgeon do not occur in the area where the Revolution Wind surveys will take place. In addition, there has been one observed interaction, in 2006, on a trip where the top landed species was blue crab (NEFSC observer/sea sampling database, unpublished data). No incidents of trap/pot gear captures or entanglements of sturgeon have been reported in ten federal fisheries ((1) American lobster, (2) Atlantic bluefish, (3) Atlantic deep-sea red crab, (4) mackerel/squid/butterfish, (5) monkfish, (6) Northeast multispecies, (7) Northeast skate complex, (8) spiny dogfish, (9) summer flounder/scup/black sea bass, and (10) Jonah crab fisheries). The proposed surveys conducted by Revolution Wind are aimed to replicate a number of these fisheries to assess the impact of offshore wind development in the WDA. The traps used in the survey are 16 inches high, 40 inches long, and 21 inches wide with 5-inch entrance hoops and constructed with 1-inch square rubber coated 12-gauge wire, given these dimensions, an adult sturgeon would not be able to enter the 5-inch entrance hoop and thus capture is extremely unlikely to occur. Although Atlantic sturgeon may feed along the seafloor in the Revolution Wind WDA, we do not expect them to move beneath the sinking groundline and then wrap themselves in the groundline and become entangled. Based on this information, it is extremely unlikely that Atlantic sturgeon from any DPS will be captured or entangled in the trap gear deployed as part of the proposed surveys. Therefore, effects are discountable and we do not expect the entanglement of any Atlantic sturgeon. We do not anticipate any take of Atlantic sturgeon through interactions with trap surveys.

Effects to Prey

The trap and pot gear that will be used to assess lobster and crab species and structure-associated fish species are considered to have low impact to bottom habitat, and is unlikely to incidentally capture Atlantic sturgeon invertebrate prey. Given this information, it is extremely unlikely the trap/pot activities conducted by Revolution Wind will have an effect on Atlantic sturgeon prey.

7.5.4 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 ventless traps will be set on the ocean floor, which could result in disturbance of benthic resources. Acoustic receivers and 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 ventless traps will rest on the seafloor, Carmichael et al. (2015) found that 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 otter trawl may 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 and are thus insignificant. Similarly, the deployment of moored PAM or other data collection buoys would result in minor impacts to the substrate and benthic habitat. Given the small number of moored buoys, the dispersed nature of their deployment, 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 and are thus insignificant.

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 high levels compared to the larger surrounding region (COP 2022). Fishing activity includes a variety of fixed gear (e.g. gillnets, pot/traps, hook and line) and mobile gear fisheries (e.g. trawl (bottom and mid-water)) and dredge (clam and scallop) including American lobster, Atlantic herring, bluefish, Jonah crab, hakes, squid, butterfish, channeled whelk, summer flounder, scup, black sea bass, Atlantic mackerel, striped bass, tautog, weakfish, bonito, cunner, spot, conger eel, sea robbins, spiny dogfish, monkfish, Northeast multispecies (groundfish), skates, Atlantic sea scallops, and ocean quahog (BOEM 2023, NOAA 2023). Fishing effort is highly variable due to factors including target species distribution and abundance, environmental conditions, fishing regulations, season, and market value. Within the Revolution Wind lease area (as explained in Section 3.0, the Revolution Wind WFA is co-extensive with lease area OCS-A 0486), the bottom trawl, targeting multiple species, was the primary commercial fishing gear utilized in terms of value and landings. The primary landed commercial species in tonnage were Atlantic herring, silver hake, and monkfish, while American lobster, Atlantic sea scallops, monkfish, and skates which were the most economically valuable species within the Revolution Wind Study Area (NOAA 2023, NOAA 2019c, ACCSP 2019). 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 monkfish, ocean quahogs, scallops, Atlantic herring, and non-days-at-sea fisheries (silver hake, lobster, summer flounder, and other species); based on the VMS data, for many of these target species most of the commercial fishing activity is located in the western and northern portions of the Revolution Wind Lease Area, with monkfish being widespread throughout the lease area. 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 3.9.2.2 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 due to construction activities and the presence of structures (BOEM 2023). 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, construction activities, and the structures themselves (wind turbine generators, scour protection, and cables). Impacts to fishing operations during the operational phase may result from habitat conversion, safety concerns operating around structures, and other factors that may affect access (increased user conflicts, increased insurance rates, etc.).

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., Atlantic cod, longfin squid), 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 habitat conversion associated with the footprint of temporary and permanent disturbance (4,291 acres of temporary disturbance and 583 acres of permanent disturbance) impacted by construction or decommissioning and short construction (within 2 years) and decommissioning periods (within 2 years) (BOEM 2023).

During the operational phase of the project, the potential impacts to fishing activity are primarily anticipated from accessibility issues due to the presence and spacing of WTGs and the OSSs as well as avoidance of the inter-array and export cable routes due to concerns related to avoiding the 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., habitat conversion due to foundations and scour/cable protection and associated changes to predator/prey relationships, 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 (approximately 1x1 nautical miles) may impede fishing operations for certain gear types. Finally, 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, vessel size, and fishery targeted. 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 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 Atlantic herring, groundfish, scallops, and ocean quahog 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. Research has shown that fishermen's adaptive behavior differs for various reasons. Some vessels may chose not to resume fishing in the lease area and portions of the cable corridor due to potential operational safety risks, while others may continue operations in other areas near their traditional fishing grounds, yet others may leave the fishery entirely (O'Farrell et al. 2019, Papaioannou et al. 2021). 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, distance from home ports, and existing fishing regulations limiting where/when vessels can use certain gears, all of which limit the potential for significant geographic shifts in distribution of fishing effort. For example, if fishing effort were to shift for longfin squid, effort may shift northeast or southwest outside of the WDA to other areas of similar squid availability south of Martha's Vineyard/Nantucket and Long Island.

Fishing vessel activity (transit and active fishing) is high throughout the southern New England region and Mid-Atlantic Bight as a whole, with higher levels of effort occurring outside of the WDA than within the WDA for particular fisheries in specific areas. 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, species availability, weather conditions, vessel congestion, and other factors (e.g., insurance premiums). 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 Revolution 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). In general, 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; however, as explained below we expect any increase in risk of interactions with sea turtles resulting from the proposed action to be so small that it cannot be meaningfully measured, detected, or evaluated and is therefore insignificant.

The area where the proposed Revolution Wind Farm is planned to be built overlaps with Cox Ledge, an area with complex habitat that already supports moderate to high levels of recreational fishing activity, primarily in the summer (DOC 2021). The habitat is primarily composed of coarser material such as gravel or small cobble and boulder fields, and it supports a moderate level of recreational fishing activity, primarily in the summer (BOEM 2023). 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 (79) 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 including entanglement, bycatch, or incidental hooking/capture; 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[44], 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; therefore, effects to listed species are insignificant.

7.7 Repair and Maintenance Activities

Revolution Wind 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 Revolution Wind Export Cable 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

[44] https://boston.cbslocal.com/2021/07/13/block-island-whale-boat-rescue/

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.

Project components would be inspected routinely with the frequency dependent on the component (see Table 3.5.3-1 in the COP). 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. Revolution Wind states that preventative maintenance activities will be planned for periods of low wind and good weather (typically in the spring and summer).

BOEM has indicated that given the burial depth (4-6 ft., 1-2 m, below sea floor) of the inter-array cable and the Revolution Wind Export Cable-Offshore, displacement, or damage by vessel anchors or fishing gear is unlikely. Mechanical inspections of the Revolution Wind Export Cable would include a cable burial assessment and debris field inspection. Revolution Wind 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. This conclusion is made in consideration of any repairs or additions to cable protection that is placed during cable installation.

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 Failure of Foundations, WTGs, and OSSs

In this Section, we consider the “low probability events” that were identified by BOEM in the Revolution Wind 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. Here, we consider effects of these events on ESA listed species.

7.8.1 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 (see Sections below for consideration of the failure of structures). 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 7,634 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 2022). As explained above, catastrophic loss of any of the structures is extremely unlikely; therefore, the spill of oil from these structures is also extremely unlikely to occur. Modeling presented by BOEM in the BA (from Bejarano et al. 2013) indicates that there is a 0.01% chance of a "catastrophic release" of oil from the wind facility in any given year. Given the 35-year life of this project, the modeling supports our determination that such a release is extremely unlikely to occur and therefore, effects are discountable.

The Bejarano et al. (2013) modeling indicates the only incidents calculated to occur as a result of the Revolution Wind project over its anticipated operational lifespan 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 and effects are discountable.

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.

7.8.2 Vessel Collision/Allision with Foundation

A vessel striking a wind turbine theoretically could result in a spill of oil and/or other chemicals contained in the WTG or OSS or catastrophic failure/collapse of the foundation and a WTG or OSS. Effects of oil and chemical spills are addressed below. However, there are several measures in place that ensure such an event is extremely unlikely 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 (i.e., oil/chemical spill, being struck by a failing structure) are extremely unlikely to occur and therefore, are discountable.

7.8.2 Failure of WTGs and OSSs due to Weather Event

As explained in the COP (2022) and DEIS (Section 2.2), Revolution Wind 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. In the COP, Revolution Wind states that the WTG support structures (i.e., towers and foundations) will be designed to withstand 500-year hurricane wind and wave conditions, and the external platform level will be designed above the 1,000-year wave scenario. The OSSs will be designed to at least the 5,000-year hurricane wind and wave conditions in accordance with the American Petroleum Institute standards.

Few hurricanes pass through New England. As described in the NRSA (citing NOAA hurricane database), 80 tropical and extra tropical storms have passed within 5 degrees of the WDA between 1969 and 2019 (DNV GL 2020), with only 15% being Category 2 hurricanes or higher. 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. The greatest threat of tropical and extra tropical storms is in September and October (DNV GL 2020). As described in the Navigational Risk Assessment (DNV GL 2020), a 17.5-year time series of hourly wind speed indicates a mean wind speed of 14.1 knots (7.2.0 m/s) at 33 ft. (10 m) with the highest wind speeds occurring between November and February. The maximum hourly average was 55.1 knots. 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 obtained a maximum wave height of 30 ft. (9 m) south of Block Island (Scripps Buoy 44097) during Hurricane Sandy in 2012. Revolution Wind 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 and OSSs will meet design criteria to withstand extreme weather conditions that may be faced in the future. This includes consideration of 50-year 10 minute wind speed values and ocean forces for WTGs and 100-year 10 minute wind speed values and ocean forces for OSSs. 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 2 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 for WTGs are based on 50-year return interval site-specific conditions for most operating load cases with a 500-year abnormal "robustness" load case check (a 500-year event has a 0.2% chance of occurring in any given year). The requirements for extreme metocean loading for OSSs are based on 100-year return interval site-specific conditions for most operating load cases with a 10,000-

year abnormal "robustness" load case check for OSSs. 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 2023).

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 25-35 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 25-35 years, any associated potential impacts to listed species resulting from foundation failure and associated debris and/or release or oil or other chemicals, as well as the strike of a listed species by a failing structure, are also extremely unlikely and therefore, discountable.

7.8.3 Failure of WTGs due to Seismic Activity

The Project is not within an active plate boundary area associated with an elevated seismic hazard, however earthquakes can occur in intra-plate areas. Data compiled by the Northeast States Emergency Consortium (NESEC) reports that 408 earthquakes strong enough to be felt were reported in Massachusetts over a 348 year period. Of these only two were considered "Damaging Earthquakes", a magnitude 5.6 in 1727 and a magnitude 6.2 in 1755. In Rhode Island there have only been 34 earthquakes reported between 1766 and 2016, none of which were considered "Damaging Earthquakes" (NESEC 2019). The closest cluster of micro-seismicity is associated with the Ramapo Fault Zone. Running southwest to northeast, it spans the northern portion of the state and has approximate endings near Schaefferstown, PA and Haverstraw, NY. 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 that would be caused by a WTG's structural or equipment failure are extremely unlikely to occur and therefore, discountable.

7.9 Project Decommissioning

According to 30 CFR Part 585 and other BOEM requirements, Revolution Wind 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 ft. (4.6 m) below the mudline (30 CFR § 585.910(a)). The portion buried below 15 ft. (4.6 m) 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. Revolution Wind 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 Revolution Wind 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 at least 4 to 6 ft. below the mudline.

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, Revolution Wind 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. Revolution Wind 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 3.6 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. Therefore, any effects to listed species are either extremely unlikely to occur and therefore discountable or will be so small that they cannot be meaningfully measured, detected, or evaluated and therefore, insignificant.

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 Revolution Wind 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 (44097) 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 2023). Based on current predictions (IPCC 2014[45]), 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

[45] 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).

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 WDA 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 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 WDA 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 WDA 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 WDA 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 WDA 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 WDA, 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 m 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 Revolution Wind 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 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 and FEIS. 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, Vineyard Wind, and Ocean Wind 1 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 effects and corresponding risk posed to ESA-listed species and designated critical habitat affected 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 of"). 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 as a whole for the conservation of a listed species." (40 CFR 402.02) "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, consistent with the definition of "jeopardize the existence of" (50 C.F.R. §402.02) for purposes Sections 7(a)(2) and 7(b)of the federal Endangered Species Act and its implementing regulations.

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 will travel. NMFS completed ESA consultation on the construction and operation of the Paulsboro facility in 2022; in the July 2022 Opinion, we considered effects of all vessels using these ports over a 10-year period and the risk of vessel strike to Atlantic and shortnose sturgeon from those vessel operations. In the July 2022 Opinion, 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 Opinion that would be attributable to the Revolution Wind vessels. As described in sections 2, 6, and 7 of this Opinion, based on the number of vessel trips to Paulsboro identified in BOEM's BA, we have determined that Revolution Wind vessels utilizing the Paulsboro Marine Terminal will strike and kill up to one shortnose sturgeon while transiting the Delaware River. The effects of these vessel trips are included in the Environmental Baseline for the Revolution Wind project. We have not identified any effects of the Revolution Wind project on shortnose sturgeon that are beyond what was considered in the Paulsboro consultation. As such, consistent with the conclusions of the Paulsboro consultation 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 Atlantic sturgeon

In the *Effects of the Action* section above, we determined that 80 Atlantic sturgeon (1 Gulf of Maine, 45 New York Bight, 18 Chesapeake Bay, 11 South Atlantic, and 5 Carolina) are likely to be captured and released alive with only minor, recoverable injuries over the four 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 cables, 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 Revolution Wind vessels utilizing the Paulsboro Marine Terminal will strike and kill up to one New York Bight DPS Atlantic sturgeon while transiting the Delaware River. The effects of these vessel trips and the loss of this individual from the New York Bight DPS is included in the Environmental Baseline for the Revolution 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"[46] 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. 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 Revolution Wind 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 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 Gulf of Maine DPS Atlantic sturgeon to be struck by any project vessels. We do not expect the operation or existence of the turbines and other facilities, including the electric cables, to result in any

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[46] 84 FR 18243; April 30, 2019 - Listing and Recovery Priority Guidelines.

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 Gulf of Maine DPS Atlantic sturgeon and there will be no effects on reproduction. 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; (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[47]). 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 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 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

[47] Available online at: https://media.fisheries.noaa.gov/dam-migration/ats_recovery_outline.pdf; last accessed July 1, 2023

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 effects of the proposed action are not likely to appreciably reduce the likelihood of both the survival and recovery of the Gulf of Maine DPS of Atlantic sturgeon. These conclusions were made in consideration of the threatened status of the Gulf of Maine DPS of Atlantic sturgeon, the effects of the action, 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.

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 up to one New York Bight DPS Atlantic sturgeon resulting from Revolution Wind vessels transiting in the Delaware River to/from the Paulsboro Marine Terminal. 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 Revolution Wind 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 Revolution Wind vessels transiting to/from the 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 45 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 up to one New York Bight DPS Atlantic sturgeon resulting from Revolution Wind 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 no more than 1 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 effects of the proposed action are not likely to appreciably reduce the likelihood of both the survival and recovery of the New York Bight DPS of Atlantic sturgeon. These conclusions were made in consideration of the endangered status of the New York Bight DPS of Atlantic sturgeon, the effects of the action, 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.

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. 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 Revolution Wind 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 Chesapeake Bay DPS 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 Chesapeake Bay DPS Atlantic sturgeon to be struck by any project vessels. 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. There will be no effects on reproduction. 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; (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 effects of the proposed action are not likely to appreciably reduce the likelihood of both the survival and recovery of the Chesapeake Bay DPS of Atlantic sturgeon. These conclusions were made in consideration of the endangered status of the Chesapeake Bay DPS of Atlantic sturgeon, the effects of the action 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.

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[48] 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, 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 Revolution Wind 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 5 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 Carolina DPS Atlantic sturgeon to be struck by any project vessels. 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

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[48]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).

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 effects of the proposed action are not likely to appreciably reduce the likelihood of both the survival and recovery of the Carolina DPS of Atlantic sturgeon. These conclusions were made in consideration of the endangered status of the Carolina DPS of Atlantic sturgeon, the effects of the action, 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.

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. 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 Revolution Wind 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 Atlantic sturgeon are the non-lethal capture of 11 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 South Atlantic DPS Atlantic sturgeon to be struck by any project vessels. 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. There will be no effects on reproduction. 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; (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 effects of the proposed action are not likely to appreciably reduce the likelihood of both the survival and recovery of the South Atlantic DPS of Atlantic sturgeon. These conclusions were made in consideration of the status of the South Atlantic DPS of Atlantic sturgeon, the effects of the action, 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.

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 discountable. We expect that project vessels will strike and kill no more than 5 leatherback, 6 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 discountable. 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 exposure to noise 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. We have determined the number of exposures that will meet the ESA definition of harassment; no behavioral disturbances will be severe enough to meet the ESA definition of harm.

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 Revolution 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 6 individuals due to vessel strike over the 39-year construction, operations and decommissioning period and the capture of up to 6 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 14 loggerhead sea turtles to noise that will result in TTS and/or behavioral disturbance. No more than 1 loggerhead sea turtles is expected to be exposed to noise during UXO detonations that will result in TTS. . 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 6 loggerheads over the 39-year life of the project.

The 15 loggerhead sea turtles that experience harassment due to exposure to pile driving or UXO detonation 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 (approximately 3.7 hours for an individual exposed to noise during WTG foundation installation and 6.3 hours for an individual exposed to noise during OSS foundation installation). 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 6 loggerhead sea turtles in the action area over the 39 year life of the project (inclusive of 2 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 2007a). 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 6 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 5 individuals would represent approximately 0.038% of the population. If the total NRU population was limited to 1,272 sea turtles (the number of nesting females), and all 6 individuals originated from that population, the loss of those individuals would represent approximately 0.5% 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 this DPS of loggerheads because the DPS is widely geographically distributed, it is not known to have low levels of genetic diversity, there are several thousand individuals in the DPS population and the number of loggerheads in the DPS is likely to be stable or increasing over the time period considered here.

Based on the information provided above, the death of 6 loggerheads 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 DPS will continue to persist into the future with sufficient resilience to allow for recovery and eventual delisting). The actions will not affect this loggerheads in a way that prevents the DPS 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 in this DPS from completing their entire life cycle, including reproduction, sustenance, and shelter. This is the case because: (1) the death of 6 loggerheads represents an extremely small percentage of the species as a whole; (2) the death of 6 loggerheads will not change the status or trends of any recovery unit or the DPS as a whole; (3) the loss of 6 loggerheads is not likely to have an effect on the levels of genetic heterogeneity in the population; (4) the loss of 6 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 DPS 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 this DPS of 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 6 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 this DPS of 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 effects of the proposed action 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, the effects of the action, 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 8 individuals due to exposure to pile driving noise; 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. 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 8 green sea turtles that experience 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 (approximately 3.7 hours for an individual exposed to noise during WTG foundation installation and 6.3 hours for an individual exposed to noise during OSS foundation installation). 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 DPS 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 DPS's 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 this green sea turtle will not appreciably reduce the likelihood of survival for this DPS of 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: this DPS of 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 this DPS of 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 this DPS of 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 DPS for this species' nesting trend is increasing; (2) the death of 1 green sea turtles represents an extremely small percentage of the DPS as a whole; (3) the loss of 1 green sea turtles will not change the status or trends of the DPS 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 DPS 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 the DPS's 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 this DPS of 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 this DPS of 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 in this DPS. Also, it is not expected to modify, curtail or destroy the range of the DPS 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 trend for this DPS of the species. 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 this DPS of 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 in this DPS 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 this DPS 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 DPS 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 effects the proposed actions are not likely to appreciably reduce the likelihood of both the survival and recovery of the North Atlantic DPS of green sea turtles. These conclusions were made in consideration of the threatened status of the North Atlantic DPS of green sea turtles, the effects of the action, 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 2019). 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. While we reference the DPSs and stocks to analyze the status and trends of various populations, our jeopardy analysis is based on 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 (inclusive of TTS) of 6 individuals due to exposure to impact pile driving noise and 1 individual due to exposure to UXO detonation. We also expect that 5 leatherbacks 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 5leatherback sea turtles 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 (approximately 3.7 hours for an individual exposed to noise during WTG foundation installation and 6.3 hours for an individual exposed to noise during OSS foundation installation). 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 5 leatherbacks over the life span of the project represents an extremely small percentage of the number of leatherbacks in the North Atlantic, just 0.02% 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 5 leatherbacks over 39 years 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 5 leatherbacks 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 5 leatherbacks 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 5 leatherbacks 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 5 leatherback is not likely to have an effect on the levels of genetic heterogeneity in the population; (4) the loss of 5 leatherbacks 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 5 leatherbacks 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 these 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 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 above do not change.

Based on the analysis presented herein, the effects of the proposed action, are 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 endangered status of leatherback sea turtles, the effects of the action, 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 an endangered species 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 7 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. 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 4 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 7 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 (approximately 3.7 hours for an individual exposed to noise during WTG foundation installation and 6.3 hours for an individual exposed to noise during OSS foundation installation). 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 nesting female 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[49];
2. An increase in the recruitment of hatchlings[50];
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,
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

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[49] 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

[50] 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).

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 effects of the proposed action, resulting in the mortality of one Kemp's ridleys, are 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, effects of the action, 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. No injury of any kind, including PTS is anticipated. 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 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 adverse 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 Revolution Wind project, which requires authorizations from a number of federal agencies as described in section 3 of this Opinion, on the ESA-listed species 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 represented in an action area and the species the population supports...

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 and exercising our best professional judgment, as explained in section 7 of this Opinion, we expect the effects of exposure to noise from impact pile driving and UXO detonations to have adverse, but temporary, effects on the behavior of individual blue, fin, right, sei, and sperm whales. 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). While 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, as explained in section 7 of this Opinion, 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 *Status of the Species* 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 continue 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.

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 Revolution Wind project.

Based on the type of survey gear that will be deployed, we concluded that all effects to right whales from the surveys of fishery resources planned by Revolution Wind and considered as part of the proposed action will be insignificant or discountable. We have concluded that capture or entanglement of a right whale and any associated injury or mortality is not an expected outcome of the Revolution Wind 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.

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 22 North Atlantic right whales to experience TTS, temporary behavioral disturbance (approximately 3.7 hours for an individual exposed to noise during WTG foundation installation and 6.3 hours for an individual exposed to noise during OSS foundation installation), and associated temporary physiological stress during the construction period due to exposure to impact pile driving noise. We also expect no more than 12 right whales to experience TTS as a result of exposure to noise from UXO detonation. Given the very short duration of exposure to noise from UXO detonation (one second), any behavioral disturbance would be limited to that short period. 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 34 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 Revolution 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, any effects of TTS on 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 are expected to be minor and temporary. 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; approximately 3.7 hours for an individual exposed to noise during WTG foundation installation and 6.3 hours for an individual exposed to noise during OSS foundation installation. 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, or socializing. As explained in the effects analysis, if suitable densities of copepod prey are present, right whales may forage in the WDA; however, the WDA is outside of the areas where right whales are documented to aggregate and persist 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 22 right whales exposed to harassing levels of noise during pile driving 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 on a single day.

A single impact pile driving event will take approximately 3.7 hours for WTG foundation installation and 6.3 hours for OSS foundation installation; therefore, even in the event that the 22 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 approximately 3.7 hours for an individual exposed to noise during WTG foundation installation and 6.3 hours for an individual exposed to noise during OSS foundation installation. 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 Level B harassment threshold extends approximately 4 km for WTG foundations and up to 4.7 km for OSS foundations. 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 3.8 -4.7 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 25-32 minutes, but at the median speed observed in Hatin et al. (1.3 kph, 2013), it would take the animal approximately 2.9 – 3.6 hours to move out of the noisy area. However, given the requirements for visual and PAM clearance, it is unlikely that any right whale would be closer than the minimum visibility distance (2.3 or 4.4 km for a WTG foundation and 1.6 or 2.7 km for an OSS foundation depending on the season). 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 WTG monopile and 6.3 hours for an OSS monopile). Given the extremely short duration of UXO detonation (one second), we do not expect exposure to result in avoidance or displacement.

There would likely be an energetic cost associated with any temporary displacement or change in migratory route, and disruption of a single foraging event, 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). Similarly, the disruption of a single foraging event lasting for a few hours on a single day is not expected to affect the health of an animal, even an animal in poor condition. The energetic consequences of the evasive behavior and delay in resting or foraging for a few hours on a single day 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 to occur as a result of noise exposure and the accompanying behavioral response. 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 long-term effects to affected individuals.

As explained in section 7 of this Opinion, the only adverse effects to North Atlantic right whales expected to result from the Revolution Wind project are the temporary behavioral disturbance and/or temporary threshold shift (minor and temporary hearing impairment), inclusive of masking and stress, as a result of exposure to noise during impact pile driving and UXO detonations; these adverse effects meet NMFS interim ESA definition of harassment. These adverse effects will be experienced by up to 34 individual right whales as a result of exposure to noise from pile driving or UXO detonation (22 from impact pile driving, 12 from UXO detonation). As explained in section 7 of this Opinion, these effects do not meet the ESA definition of harm. No harm, 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.

As described in greater detail in Section 7.1, while of the anticipated behavioral disruptions, TTS, masking, and stress that are anticipated to result from exposure to noise during pile driving and UXO detonation, will meet the ESA definition of harassment, there will not be long-term fitness consequences to any of the up to 34 individual North Atlantic right whales that will be harassed. Our analysis considered the overall number of exposures to acoustic stressors that are expected to result in harassment, inclusive of behavioral responses, TTS, masking, additional energy expenditure 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 Revolution Wind project; therefore, we do not expect this harassment to reduce the likelihood of successful migration, breeding, calving, or nursing.

In summary, while we expect the proposed action to result in the harassment of 34 right whales, we do not expect any harm, 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 22 individuals exposed to pile driving noise and 12 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.

For the reasons presented herein, the effects of the proposed action are 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, the effects of the action, 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, the only adverse effects to fin whales expected to result from the Revolution Wind 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 33 individual fin whales as a result of exposure to noise from pile driving or 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 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 Revolution Wind project.

Based on the type of survey gear that will be deployed, we determined that effects to fin whales from the surveys of fishery resources planned by Revolution Wind and considered as part of the proposed action are extremely unlikely to occur. As such, capture or entanglement of a fin whale and any associated injury or mortality is not an expected outcome of the Revolution Wind 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.

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 16 fin whales to experience TTS, temporary behavioral disturbance (approximately 3.7 hours for an individual exposed to noise during WTG foundation installation and 6.3 hours for an individual exposed to noise during OSS foundation installation), and associated temporary physiological stress during the construction period due to exposure to impact pile driving noise. We also expect no more than 17 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 33 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 Revolution 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 approximately 3.7 hours for an individual exposed to noise during WTG foundation installation and 6.3 hours for an individual exposed to noise during OSS foundation installation. 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. 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 33 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 on a single day.

A single impact pile driving event will take approximately 3.7 hours for WTG foundation installation and 6.3 hours for OSS foundation installation; therefore, even in the event that the 16 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 approximately 3.7 hours for an individual exposed to noise during WTG foundation installation and 6.3 hours for an individual exposed to noise during OSS foundation installation. 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 approximately 3.5 km from the pile being driven. 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 3.5 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. Given the extremely short duration of UXO detonation (one second), we do not expect exposure to result in avoidance or displacement.

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 explained in section 7 of this Opinion, the only adverse effects to fin whales expected to result from the Revolution Wind project are the temporary behavioral disturbance and/or temporary threshold shift (minor and temporary hearing impairment), inclusive of masking and stress, as a result of exposure to noise during impact pile driving and UXO detonations; these adverse effects meet NMFS interim ESA definition of harassment. The proposed action will result in the harassment, but not harm, of 33 individual fin whales; no harm, 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.

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 Revolution Wind project. Because we do not anticipate fitness consequences to individual fin whales to result from instances of TTS and behavioral disturbance due to acoustic stressors that we have determined meets the ESA definition of harassment but not harm, we do not expect 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 16 individuals exposed to pile driving noise and 17 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 effects of the proposed action are not likely to appreciably reduce the likelihood of both the survival and recovery of fin whales in the wild by reducing the reproduction, numbers, or distribution of that species. These conclusions were made in consideration of the endangered status of fin whales, the effects of the action, 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. 2022). However, as described in Hayes et al. 2022 (the most recent stock assessment report), there is considerable uncertainty in this estimate and there are insufficient data to determine population trends for the Nova Scotia stock of sei whales (Hayes et al. 2021). As described in the Status of the Species, a robust estimate of worldwide abundance is not available. The most recent abundance estimate for the North Atlantic is an estimate of 10,300 whales in 1989 (Cattanach et al. 1993 as cited in (NMFS 2011a). 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 (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, the only adverse effects to sei whales expected to result from the Revolution Wind 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 16 individual sei whales as a result of exposure to noise from pile driving or 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 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 Revolution Wind 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 Revolution 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 Revolution Wind 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.

Up to 16 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, inclusive of masking and stress, that would meet the NMFS interim definition of ESA harassment but not harm. 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 8 sei whales to experience TTS, temporary behavioral disturbance (approximately 3.7 hours for an individual exposed to noise during WTG foundation installation and 6.3 hours for an individual exposed to noise during OSS foundation installation), and associated temporary physiological stress during the construction period due to exposure to impact pile driving noise. We also expect no more than 8 sei 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 long-term 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 16 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 Revolution 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, approximately 3.7 hours for an individual exposed to noise during WTG foundation installation and 6.3 hours for an individual exposed to noise during OSS foundation installation. 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 in the WDA. 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 16 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.

A single impact pile driving event will take approximately 3.7 hours for WTG foundation installation and 6.3 hours for OSS foundation installation; therefore, even in the event that the 8 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 approximately 3.7 hours for an individual exposed to noise during WTG foundation installation and 6.3 hours for an individual exposed to noise during OSS foundation installation. 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 approximately 3.5 km from the pile being driven. 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 3.5 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.

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/orbehavioral disturbance that meet the ESA definition of harassment but not harm to result in fitness consequences to the up to 16 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 Revolution Wind project. Because we do not anticipate fitness consequences to individual sei whales to result from the ESA harassment resulting from TTS, behavioral disturbance, and associated stress, due to exposure to acoustic stressors, we do not expect any 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 Revolution Wind 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 Revolution Wind project will not affect the status or trend of sei whales; this is because it will not result in the 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 8 individuals exposed to pile driving noise and 8 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 by reducing the reproduction, numbers, or distribution of that species. 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. (2021) 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 in the North Atlantic is the sum of the 2016 surveys— 4,349 (CV=0.28) (Hayes et al. 2021).

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 Revolution Wind 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 5 individual sperm whales as a result of exposure to noise from impact pile driving (3) and UXO detonation (2). 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 Revolution Wind project.

Based on the type of survey gear that will be deployed, any effects to sperm whales from the surveys of fishery resources planned by Revolution Wind and considered as part of the proposed action are extremely unlikely to occur. As such, capture or entanglement of a sperm whale and any associated injury or mortality is not an expected outcome of the Revolution Wind 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 5) are expected to be exposed to pile driving or UXO detonation 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 sperm 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 sperm whales to experience TTS, temporary behavioral disturbance (approximately 3.7 hours for an individual exposed to noise during WTG foundation installation and 6.3 hours for an individual exposed to noise during OSS foundation installation), and associated temporary physiological stress during the construction period due to exposure to impact pile driving noise. We also expect no more than 2 sei whale to experience TTS as a result of exposure to noise from UXO detonation. We have determined that the effects experienced by these five sperm whales meet the ESA definition of harassment, but not harm. 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 5 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 Revolution 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 approximately 3.7 hours for an individual exposed to noise during WTG foundation installation and 6.3 hours for an individual exposed to noise during OSS foundation installation. 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 approximately 3.7 hours for WTG foundation installation and 6.3 hours for OSS foundation installation; therefore, even in the event that the 3 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 approximately 3.7 hours for an individual exposed to noise during WTG foundation installation and 6.3 hours for an individual exposed to noise during OSS foundation installation. 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 approximately 3.5 km from the pile being driven,. 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 3.5 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 disturbance that we have determined meet the ESA definition of harassment, but not harm, to result in fitness consequences to the up to 5 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 Revolution Wind project.

We do not expect any injury, 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 three individuals exposed to pile driving noise and two individuals exposed to UXO detonations; 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 by reducing the reproduction, numbers, or distribution of that species.. 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 Revolution Wind 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 2 individual blue whales as a result of exposure to noise from impact pile driving (1) and UXO detonation (1). 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 Revolution Wind project.

Based on the type of survey gear that will be deployed, effects to blue whales from the surveys of fishery resources planned by Revolution Wind and considered as part of the proposed action are extremely unlikely to occur. As such, capture or entanglement of a blue whale and any associated injury or mortality is not an expected outcome of the Revolution Wind 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.

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 approximately 3.7 hours for an individual exposed to noise during WTG foundation installation and 6.3 hours for an individual exposed to noise during OSS foundation installation. 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.

A single impact pile driving event will take approximately 3.7 hours for WTG foundation installation and 6.3 hours for OSS foundation installation; therefore, even in the event that the 2 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 approximately 3.7 hours for an individual exposed to noise during WTG foundation installation and 6.3 hours for an individual exposed to noise during OSS foundation installation. 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 approximately 3.5 km from the pile being driven. 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 3.5 km radius that will experience noise above the 160 dB re 1uPa threshold), we would expect a blue 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 long-term costs to affected individuals**.**

As described in detail in Section 7.1, we do not anticipate these instances of TTS and behavioral disturbance that meet the ESA harassment but not harm, to result in fitness consequences to the up to 2 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 Revolution Wind project.

In summary, 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 1 blue whale to experience TTS, temporary behavioral disturbance (approximately 3.7 hours for an individual exposed to noise during WTG foundation installation and 6.3 hours for an individual exposed to noise during OSS foundation installation), and associated temporary physiological stress during the construction period due to exposure to impact pile driving noise and 1 blue whale to experience TTS due to 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). We have determined that the effects experienced by these two blue whales meet the ESA definition of harassment, but not harm.

As explained in section 7.1, we have also considered whether TTS, masking, or avoidance behaviors experienced by the 2 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 Revolution 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 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 1 individual exposed to pile driving noise and 1 individual exposed to UXO detonation; 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 by reducing the reproduction, numbers, or distribution of that species. 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. The proposed action is not likely to adversely affect giant manta rays, hawksbill sea turtles, Rice's whale, or critical habitat designated for the New York Bight DPS of Atlantic sturgeon. We have determined that the project will have no effect on any species of ESA listed corals, the Gulf of Maine DPS of Atlantic salmon, Gulf sturgeon, Nassau Grouper, the Northeast Atlantic DPS of loggerhead sea turtles, Oceanic whitetip shark, smalltooth sawfish, or critical habitat designated for the North Atlantic right whale, or the Northwest Atlantic DPS of loggerhead sea turtles.

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, Revolution Wind, LLC has applied for an MMPA ITA; a decision regarding issuance of the ITA is expected in fall 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 Revolution 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 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. With the exception of vessel strikes of up to 1 shortnose sturgeon and up to 1 Atlantic sturgeon from vessels transiting to/from the Paulsboro Marine Terminal, 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 Revolution 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
North Atlantic DPS green sea turtle	1
Kemp's ridley sea turtle	1
Leatherback sea turtle	5
Northwest Act DPS Loggerhead sea turtle	6

The incidental take (serious injury or mortality) of up to one shortnose sturgeon and up to one New York Bight DPS Atlantic sturgeon is expected as a result of vessels under contract to Revolution Wind 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 Paulsboro Opinion) to ensure that: All incidental take reasonably certain to occur as a result of the Revolution Wind 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 four-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	45	None
Chesapeake Bay DPS Atlantic sturgeon	18	None
South Atlantic DPS Atlantic sturgeon	11	None
Carolina DPS Atlantic sturgeon	5	None
NA DPS green sea turtle	1	None
Kemp's ridley sea turtle	4	None
Leatherback sea turtle	None	None
NWA DPS Loggerhead sea turtle	6	None

If any additional surveys are planned or the survey duration is extended, consultation may need to be reinitiated.

Pile Driving

We calculated the number of whales and sea turtles expected likely to be harassed (Temporary Threshold Shift and/or Behavioral Disturbance) due to exposure to pile driving noise based on the proposed construction scenario (i.e., 79 total WTG foundations and 2 OSS foundations, meeting the isopleth distances identified for 10 dB attenuation). For ESA listed whales, this is consistent with the amount of Level B harassment from impact pile driving that NMFS OPR is proposing to authorize through the MMPA ITA.

Species	Take due to Exposure to Pile Driving Noise	
	Impact Pile Driving	
	Injury (PTS)	Harassment (TTS/Behavior)
North Atlantic right whale	None	22
Fin whale	None	16
Sei Whale	None	8
Sperm whale	None	3
Blue whale	None	1
NA DPS green sea turtle	None	8
Kemp's ridley sea turtle	None	7
Leatherback sea turtle	None	6
NWA DPS Loggerhead sea turtle	None	14

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., 13 detonations, meeting the isopleth distances identified for 10 dB attenuation). The numbers below are the amount of take anticipated in consideration of 13 UXO detonations total. For ESA listed whales, this is consistent with the amount of Level B harassment from UXO detonation that NMFS OPR is proposing to authorize through the MMPA ITA.

Species	UXO Detonation	
	Injury (PTS)	Harassment (TTS)
North Atlantic right whale	None	12
Fin whale	None	17
Sei Whale	None	8
Sperm whale	None	2
Blue whale	None	1
NA DPS green sea turtle	None	None
Kemp's ridley sea turtle	None	None
Leatherback sea turtle	None	1
NWA DPS Loggerhead sea turtle	None	1

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 Revolution 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 Section 3 of this Opinion, including Appendix A and B, 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 Section 3, inclusive of measures in Appendix A and B 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 GARFO for actions similar to the Revolution Wind 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 Sections 2 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 Revolution Wind WDA and the Paulsboro Marine Terminal 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 Revolution 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.

Reasonable and Prudent Measures

We have determined the following RPMs are necessary and appropriate to minimize, document, and report the impacts of incidental take of threatened and endangered species that occurs during implementation of the proposed action:

1. Effects to ESA listed whales and sea turtles must be minimized during pile driving.
2. Effects to ESA listed whales and sea turtles must be minimized during UXO/MEC detonations.
3. Vessels operated by Revolution Wind or under contract to Revolution 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 or any subsequently issued Opinion that replaces that Opinion 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 allowed to gather information on the implementation of measures, and the effectiveness of those measures, to minimize and monitor incidental take during activities described in this Opinion, including its Incidental Take Statement.

Terms and Conditions

To be exempt from the prohibitions of Section 9 of the ESA, the federal action agencies (BOEM, BSEE, USACE, and NMFS OPR, each consistent with their own legal authority) – and Revolution Wind (the lessee and applicant), must comply with the following terms and conditions (T&C), 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 Revolution 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 for ESA listed whales, to the extent that the final MMPA ITA requires additional measures from those in the proposed ITA (which are incorporated into the proposed action) to minimize effects of pile driving and/or UXO/MEC detonations on ESA listed whales, Revolution Wind must comply with those measures. To facilitate implementation of this requirement:

    a. BOEM must require, through an enforceable condition of their approval of Revolution Wind's Construction and Operations Plan, that Revolution 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.

    a. NMFS OPR must ensure compliance with all mitigation measures as prescribed in the final ITA. We expect this will be carried out through NMFS OPR's review of plans and monitoring reports submitted by Revolution Wind over the life of the MMPA ITA and taking any responsive action within its statutory and regulatory authority it deems necessary to ensure compliance based on the foregoing review.

    b. The USACE must review the final MMPA ITA as issued by NMFS OPR and determine if an amendment or revision is necessary to the permit issued to Revolution Wind by USACE to incorporate any new or revised measures for pile driving or related activities addressed in the USACE permit, to ensure 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; and, if necessary, exercise its regulatory authority to make appropriate amendments or revisions.

2. To implement the requirements of RPM 1, the following measures must be implemented by Revolution Wind:

   a. Consistent with the measures incorporated into the proposed action, Revolution Wind must implement Sound Field Verification (SFV) on at least the first three monopiles installed (see also T&C 11.e. below). If any of the SFV measurements from any pile indicate that the distance to any isopleth of concern is larger than those modeled assuming 10 dB attenuation (see Tables 7.1.8, 7.1.9, 7.1.23, 7.1.24, 7.1.31. 7.1.32), before the next pile is installed Revolution Wind must:

      i. Identify additional noise attenuation measures that are expected to reduce sound levels to the modeled distances (e.g., add noise attenuation device, adjust hammer operations, adjust noise mitigation system [NMS]); provide an explanation to NMFS GARFO and NMFS OPR supporting that determination; and, deploy those additional measures on any subsequent piles that are installed (e.g., if threshold distances are exceeded on pile 1 then additional measures must be deployed before installing pile 2).

      ii. If any of the SFV measurements indicate that the distances to level A thresholds for ESA listed whales or PTS peak or cumulative thresholds for sea turtles are larger than the modeled distances (assuming 10 dB attenuation, see Tables 7.1.8, 7.1.9, 7.1.23, 7.1.24, 7.1.31. 7.1.32), the clearance and shutdown zones (see Table 11.1) for subsequent piles must be increased so that they are at least the size of the distances to those thresholds as indicated by SFV (e.g., if threshold distances are exceeded on pile 1 then the clearance and shutdown zones for pile 2 must be expanded). For every 1,500 m that a marine mammal clearance or shutdown zone is expanded, additional PSOs must be deployed from additional platforms to ensure adequate and complete monitoring of the expanded shutdown and/or clearance zone; Revolution Wind must submit a proposed monitoring plan describing the location of all PSOs for approval by NMFS GARFO. In the event that the clearance or shutdown zone for sea turtles needs to be expanded, Revolution Wind must submit a proposed monitoring plan for the expanded zones to NMFS GARFO for approval.

      iii. If after implementation of 2.a.i, any subsequent SFV measurements are still larger than those modeled assuming 10 dB attenuation, Revolution Wind must either install an additional noise attenuation device (e.g., additional bubble curtain) or modify the pile driving operations (e.g., reduced hammer energy) in a way that is expected to reduce noise and reduce the distance to thresholds of concern to no greater than the modeled distances (assuming 10 dB attenuation). Additionally, Revolution Wind must provide an explanation to NMFS GARFO and NMFS OPR supporting that determination and deploy those additional noise attenuation measures on any subsequent piles that are installed (e.g., if threshold distances are still exceeded on pile 2 the additional measures must be deployed for pile 3).

iv. Following installation of the pile with additional noise attenuation measures required by 2.a.iii, if SFV results indicate that any isopleths of concern are still larger than those modeled assuming 10 dB attenuation, before any additional piles can be installed, Revolution Wind must determine, in cooperation with NMFS GARFO/OPR, BOEM BSEE, and USACE, what additional noise attenuation measures can be implemented. Revolution Wind must either implement those measures or, if no additional measures are identified, then pile installation must continue with implementation of the enhanced noise attenuation measures required by 2.a.i and 2.a.iii and any expanded clearance and shutdown zone sizes (and any required additional PSOs). Additionally, Revolution Wind must continue SFV for two additional piles with enhanced sound attenuation measures and submit the interim reports as required above (for a total of at least three piles with consistent noise attenuation measures). NMFS GARFO/OPR, BOEM, BSEE, and USACE will meet as soon as possible following completion of the SFV required here (with the goal of meeting within one week of the results being available) to discuss the results and whether reinitiation of this consultation is necessary based on the requirements of 50 CFR 402.16 .

v. Following installation of the pile with additional noise attenuation measures required by 2.a.iii, if SFV results indicate that all isopleths of concern are within distances to isopleths of concern modeled assuming 10 dB attenuation, SFV must be conducted on two additional piles (for a total of at least three piles with consistent noise attenuation measures). If the SFV results from all three of those piles are within the distances to isopleths of concern modeled assuming 10 dB attenuation, then Revolution Wind must continue to implement the additional sound attenuation measures and upon NMFS approval can revert to the original clearance and shutdown zones (Table 11.1) or continue with the expanded clearance and shutdown zones with additional PSOs.

b. Revolution Wind must submit a Noise Attenuation System (NAS) inspection/performance report to NMFS GARFO (nmfs.gar.incidental-take@noaa.gov) within 72 hours of the performance test, which must occur prior to the first pile installation as well as any additional piles for which SFV is conducted. This report must be submitted as soon as it is available, but no later than when the interim SFV report is submitted for the respective pile.

3. To implement the requirements of RPM 2, the following measures must be implemented by Revolution Wind:

   a. Establish a clearance zone for sea turtles extending 500 m around any planned UXO/MEC detonations. Maintain the clearance zone for at least 60 minutes prior to any UXO/MEC detonation. This requirement expands the size of the clearance zone identified by BOEM as part of the proposed action. Revolution Wind must ensure that there is sufficient PSO coverage to reliably document sea turtle presence within the clearance zone as described in the Marine Mammal and Sea Turtle Monitoring Plan. In the event that a PSO detects a sea turtle inside the 500 m clearance zone, detonation will be delayed until the sea turtle has not been observed for 30 minutes or has been observed to leaving the clearance zone.

b. Provide NMFS GARFO with notification of planned UXO/MEC 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/MEC. 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).

c. Consistent with requirements of NMFS OPR, Revolution Wind must implement SFV on all UXO/MEC detonations (see also T&C 11e below) as described in the SFV Plan. If any of the SFV measurements from any detonations indicate that the distance to any isopleth of concern is larger than those modeled assuming 10 dB attenuation (see Tables 7.1.15, 7.1.16, 7.1.17, 7.1.27, 7.1.28,7.1.33), before the next detonation Revolution Wind must:

    i. Identify additional noise attenuation measures (e.g., add noise attenuation device, adjust noise mitigation system) that are expected to reduce sound levels to the modeled distances; provide an explanation to NMFS GARFO and NMFS OPR supporting that determination; and, deploy those additional measures for any subsequent detonations (e.g., if threshold distances are exceeded on detonation 1 then additional measures must be deployed for detonation 2).

    ii. If any of the SFV measurements indicate that the distances to any isopleths of concern for ESA listed whales or sea turtles are larger than the modeled distances (assuming 10 dB attenuation, see Tables 7.1.15, 7.1.16, 7.1.17, 7.1.27, 7.1.28, 7.1.33), the clearance zones for subsequent piles must be increased as indicated by SFV (e.g., if threshold distances are exceeded on UXO/MEC then the clearance zones for UXO/MEC must be expanded). For every 1,500 m that a zone is expanded, additional PSOs must be deployed from additional platforms to ensure adequate and complete monitoring of the expanded shutdown and/or clearance zone; Revolution Wind must submit a proposed monitoring plan describing the location of all PSOs for approval by NMFS GARFO. In the event that the clearance or shutdown zone for sea turtles needs to be expanded, Revolution Wind must submit a proposed monitoring plan for the expanded zones to NMFS GARFO for approval.

iii. Following detonation of UXO/MEC with additional noise attenuation measures required by 3.c.i, if SFV results indicate that any isopleths of concern are larger than those modeled assuming 10 dB attenuation, before any additional UXO/MEC can be detonated, Revolution Wind must determine, in cooperation with NMFS GARFO/OPR, BOEM, BSEE, and USACE, what additional noise attenuation measures can be implemented; identified measures must be implemented. If no additional measures are identified, then detonation must continue with implementation of the enhanced sound attenuation measures required by 3.c.i. and any expanded zone sizes (and any required additional PSOs). NMFS GARFO/OPR, BOEM, BSEE, and USACE will meet as soon as possible following a determination that no additional attenuation measures can be implemented (with the goal of meeting within one week) to discuss the results of SFV for UXO/MEC detonations and whether reinitiation of this consultation is necessary based on the requirements of 50 CFR 402.16 .

4. To implement the requirements of RPM 3, the following conditions must be implemented:

   a. BOEM or BSEE must require that Revolution Wind document and report the number of vessel calls to the Paulsboro Marine Terminal. This must be included in the monthly project reports submitted to NMFS GARFO over the life of the project (see Term and Condition 6.g. below).

   b. BOEM must ensure that Revolution Wind is aware of and complies with, and Revolution Wind must comply with, the terms and conditions of the July 19, 2022 Paulsboro Biological Opinion and ITS and any subsequent Opinion or amended ITS that results from reinitiation of the 2022 Opinion[51]. For ease of reference those measures are included here:

      i. No later than March 1 of each year, report the number of vessel port 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 (NAPRegulatory@usace.army.mil) and NMFS GARFO (nmfs.gar.incidental-take@noaa.gov). (Reference: RPM 1, Term and Condition 1 of the 2022 Paulsboro Biological Opinion).

      ii. 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

[51] In the event that the 2022 Paulsboro Opinion is replaced as a result of reinitiation, or its ITS is amended, NMFS GARFO will strive to provide a copy of any new Opinions or amended ITS to BOEM Revolution Wind within three business days of its availability and BOEM will alert Revolution Wind of to any changes to that Opinion's RPMs or Terms and Conditions that they must comply with in order to be covered by any incidental take exemption provided with that Opinion's ITS. NMFS GARFO will also notify the other action agencies about any new Paulsboro Opinion for awareness.

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.

5. To implement the requirements of RPM 4, Revolution Wind must file a report with NMFS GARFO (nmfs.gar.incidental-take@noaa.gov) and BSEE (protectedspecies@bsee.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(s), location of PSOs and any factors that impaired visibility or detection ability, time of first and last detection of the animal(s), distance of animal at first detection, closest point of approach of animal to pile, behavioral observations of the animal(s), time the PSO called for shutdown, hammer log (number of strikes, hammer energy), time the pile driving began and stopped, and any measures implemented (e.g., reduced hammer energy) prior to shutdown. 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 Revolution Wind must implement the following reporting requirements necessary to document the amount or extent of incidental take that occurs during all phases of the proposed action:

   a. All observations or interactions with sea turtles or sturgeon that occur during the fisheries monitoring surveys 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 Revolution 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 to document the DPS of origin; the only exception to this requirement is when additional handling of the sturgeon would result in an imminent risk of injury to the fish or the survey personnel handling the fish, 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 project personnel, Revolution Wind must ensure the sighting is immediately reported to

NMFS. If immediate reporting is not possible, the report must be made within 24 hours of the sighting.

i. The report must be made to the appropriate geographic reporting line:

- If in the Northeast Region (ME to VA/NC border) call (866-755-6622).
- If in the Southeast Region (NC to FL) call (877-WHALE-HELP or 877-942-5343).
- If calling the hotline is not possible, reports can also be made to the U.S. Coast Guard via channel 16 or through the WhaleAlert app (http://www.whalealert.org/).

The sighting report must include the time (note time format, e.g., UTC, EST), date, and location (latitude/longitude in decimal degrees) of the sighting, number of whales, animal description/certainty of sighting (provide photos/video if taken), lease area/project name, PSO/personnel name, PSO provider company (if applicable), and reporter's contact information.

ii. If a North Atlantic right whale is detected at any time by PSOs/PAM Operators via PAM, Revolution Wind must ensure the detection is reported as soon as possible and no longer than 24 hours after the detection to NMFS via the 24-hour North Atlantic right whale Detection Template (https://www.fisheries.noaa.gov/resource/document/passive-acoustic-reporting-system-templates). Calling the hotline is not necessary when reporting PAM detections via the template.

iii. A summary report must be sent within 24 hours to NMFS GARFO (nmfs.gar.incidental-take@noaa.gov) and NMFS OPR (PR.ITP.MonitoringReports@noaa.gov) with the above information and confirmation the sighting/detection was reported to the respective hotline, the vessel/platform from which the sighting/detection was made, activity the vessel/platform was engaged in at time of sighting/detection, project construction and/or survey activity ongoing at time of sighting/detection (e.g., pile driving, cable installation, HRG survey), distance from vessel/platform to animal at time of initial sighting/detection, closest point of approach of whale to vessel/platform, vessel speed, and any mitigation actions taken in response to the sighting.

c. In the event of a suspected or confirmed vessel strike of any ESA listed species, including a sea turtle or sturgeon, by any project vessel in any location, including the sighting/observation of any injured sea turtle/sturgeon or sea turtle/sturgeon parts, Revolution Wind or their contractors must report the incident or sighting to NMFS GARFO (nmfs.gar.incidental-take@noaa.gov; for marine mammals to the NOAA stranding hotline: Maine-Virginia, report to 866-755-6622, and from North Carolina-Florida to 877-942-5343 and for sea turtles from Maine-Virginia, report to 866-755-6622, and from North Caroline-Florida to 844-732-8785, as well as BSEE (protectedspecies@bsee.gov) as soon as feasible. The report must include the following information: (A) Time (note time format), date, and location (latitude/longitude in decimal degrees) of the incident; (B) Species identification (if known) or description of the animal(s) involved; (C) Vessel's speed 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 (if applicable); (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.

d. In the event that an injured or dead whale, sea turtle, or Atlantic sturgeon is sighted, Revolution Wind or their contractor must report the incident to NMFS GARFO (nmfs.gar.incidental-take@noaa.gov). Additionally, injured or dead whales must be reported to the NOAA stranding hotline: Maine-Virginia, report to 866755-6622, and from North Carolina-Florida to 877-942-5343 and for sea turtles from Maine-Virginia, report to 866-755-6622, and from North Caroline-Florida to 844-732-8785, 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 (note time format), date, and location (latitude/longitude in decimal degrees) of the first discovery (and updated location information if known and applicable); (B) Species identification (if known) or description of the animal(s) involved; (C) Condition of the animal(s) (including carcass condition if the animal is dead); (D) Observed behaviors of the animal(s), if alive; (E) If available, photographs or video footage of the animal(s); and (F) General circumstances under which the animal was discovered. 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. Revolution Wind must compile and submit weekly reports during pile driving that document the pile ID, type of pile, pile diameter, start and finish time of each pile driving event, hammer log (number of strikes, max hammer energy, duration of piling) per pile, any changes to noise attenuation systems and/or hammer schedule, details on the deployment of PSOs and PAM operators, including the start and stop time of associated observation periods by the PSOs and PAM Operators, and a record of all observations/detections of marine mammals and sea turtles including time (UTC) of sighting/detection, species ID, behavior, distance (meters) from vessel to animal at time of sighting/detection (meters), animal distance (meters) from pile installation vessel, vessel/project activity at time of sighting/detection, platform/vessel name, and mitigation measures taken (if any) and reason. Sightings/detections during pile driving activities (clearance, active pile driving, post-pile driving) and all other (transit, opportunistic, etc.) sightings/detection must be reported and identified as such. These weekly reports must be submitted to NMFS GARFO (nmfs.gar.incidental-take@noaa.gov), BOEM, and BSEE by Revolution Wind or the PSO providers and can consist of QA/QC'd raw data. Weekly reports are due on Wednesday for the activities occurring the previous week (Sunday – Saturday, local time).

f. Revolution Wind must compile and submit reports following any UXO/MEC detonation that provide details on the UXO/MEC that was detonated (e.g., charge size), location of the detonation, the start and stop of associated observation periods by the PSOs and PAM Operators, details on the deployment of PSOs and PAM Operators, and a record of all observations of marine mammals and sea turtles including time (UTC) of sighting/detection, species ID, behavior, distance (meters) from vessel to animal at time of sighting/detection, vessel activity, platform/vessel name, and mitigation measures taken (if any). 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), BOEM, and BSEE by Revolution Wind or the PSO providers and can consist of QA/QC'd 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. Starting in the first month that in-water activities occur (e.g., cofferdam installation, fisheries surveys), Revolution Wind must compile and submit monthly reports that include a summary of all project activities carried out in the previous month, including dates and location of any fisheries surveys carried out, vessel transits (name, type of vessel, number of transits, vessel activity, and route (this includes transits from all ports, foreign and domestic)), and number of piles installed and pile IDs, and all sightings/detections of ESA listed whales, sea turtles, and sturgeon, inclusive of any mitigation measures taken as a result of those observations. Sightings/detections must include species ID, time, date, initial detection distance, vessel/platform name, vessel activity, vessel speed, bearing to animal, project activity, and if any mitigation measures taken. 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.

h. Revolution Wind must submit to NMFS GARFO (nmfs.gar.incidental-take@noaa.gov) an annual report describing all activities carried out to implement their Fisheries Research and Monitoring Plan. This report must include a summary of all activities conducted, the dates and locations of all ventless trap surveys and otter trawl surveys, number of sets and soak duration for all ventless trap surveys and tows and duration for all trawl surveys summarized by month, number of vessel transits, and a summary table of any observations and captures of ESA listed species during these surveys. The report must also summarize all acoustic telemetry and benthic monitoring activities that occurred, inclusive of vessel transits. Each annual report is due by February 15 (i.e., the report of 2023 activities is due by February 15, 2024).

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) (or the soonest time the relevant information is available (but at least 30 calendar days prior to the initiation of pile driving), BOEM and/or BSEE must provide NMFS GARFO (nmfs.gar.incidental-take@noaa.gov) with the following information: number and size of foundations to be installed to support wind turbine generators and offshore substations, installation method for the sea to shore transition (i.e., casing pipe, cofferdam, no containment), 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 Revolution Wind must submit an Observer Training Plan for Trawl Surveys as soon as possible after issuance of this Opinion but no later than seven calendar days prior to the start of trawl surveys. BOEM, BSEE, and Revolution Wind must obtain NMFS GARFO's concurrence with this plan prior to the start of any trawl surveys. At least one of the survey staff onboard the trawl survey vessels must have completed NMFS Northeast Fisheries Observer Program (NEFOP) training within the last 5 years or other training in protected species identification and safe handling (inclusive of taking genetic samples from Atlantic sturgeon), documentation of training must be submitted to NMFS GARFO at least 7 calendar days prior to the start of the trawl surveys and at any later time that a different NEFOP trained observer is deployed on the survey. If Revolution Wind will deploy non-NEFOP trained survey personnel in lieu of NEFOP-trained observers, BOEM, BSEE, and/or Revolution Wind must submit a plan to NMFS describing the training that will be provided to those survey observers. This plan must include a description of the elements of the training (i.e., curriculum, virtual or hands on, etc.) and identify who will carry out the training and their qualifications. Once the training is complete, confirmation of the training and a list of trained survey staff must be submitted to NMFS; this list must be updated if additional staff are trained for future surveys. In all cases, a list of trained survey staff must be submitted to NMFS at least one business day prior to the beginning of the survey.

10. To implement RPM 5, the plans identified below must be submitted to NMFS GARFO at nmfs.gar.incidental-take@noaa.gov by BOEM, BSEE, and/or Revolution Wind. For

each plan, within 45 calendar days of receipt of the plan, NMFS GARFO will provide comments to BOEM, BSEE, and Revolution Wind, including a determination as to whether the plan is consistent with the requirements outlined in this ITS and/or in Section 3 of this Opinion. If the plan is determined to be inconsistent with these requirements, BOEM, BSEE and/or Revolution Wind must resubmit a modified plan that addresses the identified issues within 30 days of the receipt of the comments but at least 15 calendar days before the start of the associated activity; at that time, BOEM, BSEE and NMFS GARFO and OPR will discuss a timeline for review and approval of the modified plan. If further revisions are necessary, at all times, NMFS GARFO, BOEM, and BSEE will be provided at least three business days for review and whenever possible, NMFS GARFO, BOEM, and BSEE will aim to provide responses within four business days. BOEM, BSEE and Revolution Wind must receive NMFS GARFO's concurrence with these plans before the identified activity is carried out:

a. Passive Acoustic Monitoring Plan for Pile Driving. BOEM, BSEE, and/or Revolution Wind must submit this Plan to NMFS GARFO at least 180 calendar days before impact pile driving is planned. BOEM, BSEE, and Revolution 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 and hardware, the calibration data, bandwidth capability and sensitivity of hydrophones, and 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 and include all procedures, documentation, and protocols including information (i.e., testing, reports, equipment specifications) to support that it will be able to detect vocalizing whales within the clearance and shutdown zones, including deployment locations, procedures, detection review methodology, and protocols; hydrophone detection ranges with and without foundation installation activities and data supporting those ranges; communication time between call and detection, and data transmission rates between PAM Operator and PSOs on the pile driving vessel; where PAM Operators will be stationed relative to hydrophones and PSOs on pile driving vessel calling for delay/shutdowns; and a full description of all proposed software, call detectors, and filters. The Plan must also incorporate the requirements relative to North Atlantic right whale reporting in 6.b.

b. BOEM, BSEE, and/or Revolution Wind must submit full detection data, metadata, and location of recorders (or GPS tracks, if applicable) from all real-time hydrophones used for monitoring during construction within 90 calendar days after pile-driving has ended and instruments have been pulled from the water. Reporting must use the webform templates on the NMFS Passive Acoustic Reporting System website at https://www.fisheries.noaa.gov/resource/document/passive-acoustic-reporting-system-templates. BOEM, BSEE, and/or Revolution Wind must submit the full acoustic recordings from all the real-time hydrophones to the National Centers for Environmental Information (NCEI) for archiving within 90 calendar days after pile-driving has ended and instruments have been pulled from the water. Confirmation of both submittals must be sent to NMFS GARFO.

c. Marine Mammal and Sea Turtle Monitoring Plan – Pile Driving and UXO/MEC Detonation. BOEM, BSEE, and/or Revolution Wind must submit this Plan (or Plans, if separate Pile Driving and UXO/MEC Detonation plans are developed) to NMFS GARFO at least 180 calendar days before any pile driving for foundation installation or any UXO/MEC detonation is planned. BOEM, BSEE, and/or Revolution Wind must obtain NMFS GARFO's concurrence with this Plan(s) prior to the start of any pile driving for foundation installation or carrying out any UXO/MEC detonation. The Plan(s) must include: a description of how all relevant mitigation and monitoring requirements contained in the incidental take statement will be implemented, a pile driving installation summary and sequence of events, a description of all training protocols for all project personnel (PSOs, PAM Operators, trained crew lookouts, etc.), a description of all monitoring equipment and evidence (i.e., manufacturer's specifications, reports, testing) that it can be used to effectively monitor and detect ESA listed marine mammals and sea turtles in the identified clearance and shutdown zones (i.e., field data demonstrating reliable and consistent ability to detect ESA listed large whales and sea turtles at the relevant distances in the conditions planned for use), communications and reporting details, and PSO monitoring and mitigation protocols (including number and location of PSOs) for effective observation and documentation of sea turtles and ESA listed marine mammals during all pile driving events and UXO/MEC detonations. The Plan(s) must demonstrate sufficient PSO and PAM Operator staffing (in accordance with watch shifts), PSO and PAM Operator schedules, and contingency plans for instances if additional PSOs and PAM Operators are required. The Plan must detail all plans and procedures for sound attenuation, including procedures for adjusting the noise attenuation system(s) and available contingency noise attenuation measures/systems if distances to modeled isopleths of concern are exceeded during SFV. The plan must also describe how Revolution Wind would determine the number of sea turtles exposed to noise above the 175 dB harassment threshold during impact pile driving of WTG and OSS foundations and how Revolution Wind would determine the number of ESA listed whales exposed to noise above the Level B harassment threshold during impact pile driving of WTG and OSS foundations.

d. Reduced Visibility Monitoring Plan/Nighttime Pile Driving Monitoring Plan. BOEM, BSEE, and/or Revolution Wind must submit this Plan or Plans (if separate Daytime Reduced Visibility and Nighttime Monitoring Plans are prepared) to NMFS GARFO at least 180 calendar days before impact pile driving is planned to begin. BOEM, BSEE, and Revolution Wind must obtain NMFS GARFO's concurrence with this Plan(s) prior to the start of pile driving. This Plan(s) must contain a thorough description of how Revolution Wind will monitor pile driving activities during reduced visibility conditions (e.g. rain, fog) and at night, including proof of the efficacy of monitoring devices (e.g., mounted thermal/infrared camera systems, hand-held or wearable night vision devices

NVDs, 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 (WTG foundations: May - November, 2300 m and December, 4,400 m; OSS foundations: May - November 1,600 m and 2,700 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 before and during impact pile driving, nighttime pile driving (unless a pile was initiated 1.5 hours prior to civil sunset) may not occur. Additionally, this Plan must contain a thorough description of how Revolution Wind will monitor pile driving activities during daytime when unexpected changes to lighting or weather occur during pile driving that prevent visual monitoring of the full extent of the clearance and shutdown zones.

e. Sound Field Verification Plan - Monopile Installation and UXO/MEC Detonation. BOEM, BSEE, and/or Revolution Wind must submit this Plan (or Plans, if separate Pile Driving SFV Plans and UXO/MEC SFV Plans are prepared) to NMFS GARFO at least 180 calendar days before impact pile driving or UXO detonation is planned to begin. BOEM, BSEE, and Revolution Wind must obtain NMFS GARFO's concurrence with this Plan(s) prior to the start of pile driving or UXO detonation activities. To validate the estimated sound field, SFV measurements will be conducted during pile driving of the first three monopiles installed over the course of the Project, with noise attenuation activated. The Plan(s) must describe how the first three monopile installation sites and installation scenarios (i.e., hammer energy, number of strikes) are representative of the rest of the monopile installations and, therefore, why these monopile installations would be representative of the remaining monopile installations. If the monitored pile locations are different from the ones used for exposure modeling, justification must be provided for why these locations are representative of the modeling. In the case that these sites are not determined to be representative of all other monopile installation sites, Revolution Wind must include information on how additional monopiles/sites would be selected for SFV. The Plan(s) must also include the piling schedule and sequence of events, communication and reporting protocols, methodology for collecting, analyzing, and preparing SFV data for submission to NMFS GARFO including instrument deployment, locations of all hydrophones including direction and distance from the pile, hydrophone sensitivity, recorder/measurement layout, and analysis methods, and a template of the interim report to be submitted. The Plan must also identify the number and location of hydrophones that will be reported in the SFV Interim Reports and any additional hydrophone locations that will be included in the final report(s). The Plan must describe how the effectiveness of the sound attenuation methodology would be evaluated based on the results. The Plan must address how Revolution Wind will implement Terms and Condition 2a (see above) which includes, but is not limited to identifying additional noise attenuation measures (e.g., add noise attenuation device, adjust hammer operations, adjust NMS) that will be applied to reduce sound levels if measured distances are greater than those modeled.

i. SFV Interim Reports - Pile Driving. Revolution Wind must provide, as soon as they are available but no later than 48 hours after the installation of each of the first three monopiles, the initial results of the SFV measurements to NMFS GARFO in an interim report. If technical or other issues prevent submission within 48 hours, Revolution Wind must notify NMFS GARFO within that 48-hour period with the reasons for delay and provide an anticipated schedule for submission of the report. This report is required for each of the first three monopiles installed and any additional piles for which SFV is required. The interim report must include data from hydrophones identified for interim reporting in the SFV Plan and include a summary of pile installation activities (pile diameter, pile weight, pile length, water depth, sediment type, hammer type, total strikes, total installation time [start time, end time], duration of pile driving, max single strike energy, NAS deployments), pile location, recorder locations, modeled and measured distances to thresholds, received levels (rms, peak, and SEL) results from Conductivity, Temperature, and Depth (CTD) casts/sound velocity profiles, signal and kurtosis rise times, pile driving plots, activity logs, weather conditions. If there are any updates to the requirements to the contents of the Interim Plan, including availability of a template, this will be provided to Revolution Wind as soon as any such updates are available. Requirements for actions to be taken based on the results of the SFV are identified in 2.a. above.

ii. SFV Interim Reports - UXO/MEC Detonation. Revolution Wind must provide, as soon as they are available but no later than 48 hours after each detonation of a UXO/MEC, the initial results of the SFV measurements to NMFS GARFO in an interim report. If technical or other issues prevent submission within 48 hours, Revolution Wind must notify NMFS GARFO within that 48-hour period with the reasons for delay and provide an anticipated schedule for submission of the report. The interim report must include data from all hydrophones identified for interim reporting in the SFV Plan and include a summary of the UXO/MEC detonation activity (location, water depth, sediment type, charge size, detonation time, etc.), description of the noise attenuation system and its effectiveness (including photos and/or videos of the bubble curtain), UXO/MEC location, recorder locations, modeled and measured distances to thresholds, received levels (rms, peak, and SEL) results from Conductivity, Temperature, and Depth (CTD) casts/sound velocity profiles, and weather conditions. If there are any updates to the requirements to the contents of the Interim Plan, including availability of a template, this will be provided to Revolution Wind as soon as any such updates are available.

iii. The final results of SFV for monopile installations must be submitted as soon as possible, but no later than within 90 days following completion of pile driving of the three or more monopiles for which SFV was carried out.

iv. The final results of SFV for UXO/MEC detonations must be submitted as soon as possible, but no later than within 90 days following detonation of each device. The final results of SFV monitoring for pile driving and UXO/MEC detonation must include results for all hydrophones.

f. Vessel Strike Avoidance Plan. BOEM, BSEE, and/or Revolution Wind must submit this plan to NMFS GARFO as soon as possible after issuance of this Biological Opinion but no later than 90 days prior to the planned start of in-water construction activities outside of Narragansett Bay (including cable installation). The Plan must provide details on all relevant mitigation and monitoring measures for listed species, vessel transit protocols from all planned ports, vessel-based observer protocols for transiting vessels, communication and reporting plans, proposed alternative monitoring equipment to maintain vessel strike avoidance zones in varying weather conditions, darkness, sea states, and in consideration of the use of artificial lighting. If Revolution Wind plans to implement PAM in any transit corridor to allow vessel transit above 10 knots, 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. PAM information should follow what is required to be submitted for the PAM Plan in 10.a.

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, Revolution 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.

Table 11.1. Clearance and Shutdown Zones for ESA Listed Species - Impact Pile Driving and UXO/MEC Detonations

Species	Clearance Zone (m)	Shutdown Zone (m)
Impact Pile Driving Minimum visibility zones (WTG foundations: May - November, 2300 m and December, 4,400 m; OSS foundations: May - November 1,600 m and 2,700 m December)		

North Atlantic right whale – visual PSO	Minimum visibility zone plus any additional distance observable by the visual PSOs	Minimum visibility zone plus any additional distance observable by the visual PSOs
North Atlantic right whale – PAM WTG	3,900 (4,300)	3,900 (4,300)
North Atlantic right whale – PAM OSS	4,100 (4,700)	4,100 (4,700)
Blue, fin, sei, and sperm whale – WTG foundation	2,300 (4,400)	2,300 (4,400)
Blue, fin, sei, and sperm whale – OSS foundation	1,600 (2,700)	1,600 (2,700)
Sea Turtles	500	500
UXO/MEC Detonations		
NARW, blue, fin, and sei whale	10,000	NA
Sperm whale	2,000	NA
Sea Turtles	472	NA

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 requirements for sound field verification (SFV) and outlines general measures to be implemented as a result of SFV. Term and Condition 2 is necessary and appropriate to provide clarification of the required steps related to sound field verification and measures to be implemented as a result of sound field verification.

RPM 2/Term and Condition 3

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 (480 m). The measure included in Term and Condition 2a would expand the size of the clearance zone to 500 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 3b 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. Term and Condition 3c is necessary and appropriate to provide clarification of the required steps related to sound field verification and measures to be implemented as a result of sound field verification.

RPM 3 /Term and Conditions 4

As explained above, take that may occur of Atlantic and shortnose sturgeon as a result of vessel strike is expected to occur from Revolution Wind vessels transiting in the Delaware River/Bay as they move to/from the Paulsboro Marine Terminal. In this Opinion, we have identified the portion of the take identified in the Paulsboro Biological Opinions that will be attributable to Revolution Wind vessels. That take is exempted through the Incidental Take Statement issued with NMFS' Biological Opinions for that port project. Here, we identify the relevant RPMs and Terms and Conditions from that ITS that must be complied with in order for the relevant take exemption to apply.

RPM 4/Term and Conditions 5-6

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 Revolution 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 Revolution 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 Revolution 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 Revolution 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 implement the following Conservation Recommendations consistent with their authorities:

1. Work with the lessee to develop a construction schedule that further reduces potential exposure of North Atlantic right whales to noise from pile driving and UXO/MEC detonations including expanding the time of year restriction on UXO/MEC detonations to include May and avoiding impact pile driving in May and December.
2. Collect data to add to the limited information we have on underwater noise generated during vibratory pile driving for installation and removal of sheet piles and on operational noise of the direct drive wind turbines in the action area.
    i. If sheet pile cofferdams are used at the sea-to-shore transition, sound field verification should be carried out during installation and removal of at least one cofferdam.
    ii. A study to document operational noise during a variety of wind and weather conditions should be carried out.
3. Support research and development of technology to aid in the minimization of risk of vessel strikes on marine mammals, sea turtles, and Atlantic sturgeon.
4. Support development of regional monitoring of project and cumulative effects through the Regional Wildlife Science Collaborative for Offshore Wind (RWSC).
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 ecological and oceanographic conditions including protected species distribution, prey distribution, pelagic habitat, and habitat usage.
6. Support research into understanding the effects of offshore wind on regional oceanic and atmospheric conditions through modeling and data collection, and assessment of 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 Revolution Wind WFA and surrounding waters, and methods for survey adaptation to the presence of wind turbines.
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 Revolution Wind WDA and support the deployment of acoustic tags on sea turtles and sturgeon and other acoustically tagged species.
10. Support research regarding the abundance and distribution of Atlantic sturgeon in the Revolution Wind WFA 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. Require the lessee to send all acoustic telemetry metadata and detections to the Mid-Atlantic Acoustic Telemetry Observation System (MATOS) database via https://matos.asascience.com/ for coordinated tracking of marine species over broader spatial scales in US Animal Tracking Network and Ocean Tracking Network.
12. Conduct or support long-term ecological monitoring to document the changes to the ecological communities on, around, and between foundations and other benthic areas disturbed by the proposed Project.
13. Develop or support the development of a PAM array in the Revolution Wind WDA to monitor changes in ambient noise and use of the area by baleen whales (and other marine mammals) during the life of the Project, including construction, and to detect small-scale changes at the scale of the Revolution Wind 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 Van Parijs et al. 2021 for specific details. Resulting data products should be provided according to https://www.fisheries.noaa.gov/resource/document/passive-acoustic-reporting-system-templates.
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. Conduct regular surveys and removal of marine debris from project infrastructure.
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 Revolution Wind 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.

14.0 LITERATURE CITED

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APPENDIX A.
Measures Included in BOEM's BA that are Part of the Proposed Action for the ESA Consultation

BA Table 3.18. Environmental Protection Measures Proposed by Revolution Wind and Included in BOEM's BA as Part of the Proposed Action*

*we note that not all of these measures may be related to avoiding, minimizing, or monitoring effects to ESA listed species or their habitats; however, as they were included in BOEM's BA as commitments made by Revolution Wind, we are repeating them in full here.

EPM Number	Project Phase	EPM	Description
Provided in COP Table 4.7-2			
Fin-1	Construction and installation	Cable burial risk assessment	To the extent feasible, installation of the IAC, OSS-link cable, and RWEC will occur using equipment such as mechanical cutter, mechanical plow, or jet plow. The feasibility of cable burial equipment will be determined based on an assessment of sea floor conditions and the Cable Burial Risk Assessment.
Fin-2	Construction and installation	TOY restrictions	Based on the coordination with RIDEM and NOAA NMFS to date, in general, offshore site preparation for and installation of the RWEC-RI north of the Convention on the International Regulations for Preventing Collisions at Sea ("COLREGS") line of demarcation will occur between the day after Labor Day and February 1 to avoid and minimize impacts to winter flounder (*Pseudopleuronectes americanus*) and shellfish. Revolution Wind will continue to coordinate with RIDEM and NOAA NMFS regarding TOY restrictions through the permitting process and will adhere to requirements imposed by these agencies. NOTE: The permit issued by RI DEM (after the BA was submitted) allows this work to occur between August 31 and January 31.
Fin-3, MM-8, and ST-8	Construction and installation	Cable burial risk assessment	To the extent feasible, the RWEC, IAC, and OSS-link cable will typically target a burial depth of 4 to 6 ft (1.2 to 1.8 m) below sea floor. The target burial depth will be determined based on an assessment of sea floor conditions, sea floor mobility, the risk of interaction with external hazards such as fishing gear and vessel anchors, and a site-specific Cable Burial Risk Assessment.
Fin-4	Construction and installation	Cable burial risk assessment	DP vessels will be used for installation of the IACs, OSS-link cable, and RWEC to the extent practicable.
Fin-5	Preconstruction	Anchoring plan	A plan for vessels will be developed prior to construction to identify no-anchorage areas to avoid documented sensitive resources.

EPM Number	Project Phase	EPM	Description
Fin-6	Preconstruction, construction and installation, and post-construction	Fisheries and benthic monitoring studies	Revolution Wind is committed to collaborative science with the commercial and recreational fishing industries pre-, during, and post-construction. Fisheries and benthic monitoring studies are being planned to assess the impacts associated with the Project on economically and ecologically important fisheries resources. These studies will be conducted in collaboration with the local fishing industry and will build upon monitoring efforts being conducted by affiliates of Revolution Wind at other wind farms in the region.
Fin-7, MM-5, and ST-5	Construction and installation, O&M, and decommissioning	Spill prevention and control measures	Revolution Wind will require all construction and operations vessels to comply with regulatory requirements related to the prevention and control of spills and discharges.
Fin-8, MM-6, and ST-6	Construction and installation, O&M, and decommissioning	OSRP	Accidental spill or release of oils or other hazardous materials will be managed through the OSRP.
Fin-9	Construction and installation	Soft start before pile driving	A ramp-up or soft start will be used at the beginning of each pile segment during impact pile driving and/or vibratory pile driving to provide additional protection to mobile species in the vicinity by allowing them to vacate the area prior to the commencement of pile-driving activities.
Fin-10	Construction and installation and O&M	Lighting minimization	Construction and operational lighting will be limited to the minimum necessary to ensure safety and compliance with applicable regulations.
Fin-11, MM-7, and ST-7	Construction and installation, O&M, and decommissioning	Marine debris awareness training	All vessels will comply with USCG and EPA regulations that require operators to develop waste management plans, post informational placards, manifest trash sent to shore, and use special precautions such as covering outside trash bins to prevent accidental loss of solid materials. Vessels will also comply with BOEM lease stipulations that require adherence to NTL 2015-G03, which instructs operators to exercise caution in the handling and disposal of small items and packaging materials, requires the posting of placards at prominent locations on offshore vessels and structures, and mandates a yearly marine trash and debris awareness training and certification process.
Fin-12	Construction and installation	TOY restrictions	Revolution Wind will continue to coordinate with RIDEM and NOAA NMFS regarding TOY restrictions through the permitting process and will adhere to requirements imposed by these agencies.

EPM Number	Project Phase	EPM	Description
Fin-13, MM-9, and	Construction and installation, post-construction and installation monitoring	Gear identification	To facilitate identification of gear on any entangled animals, all trap/pot gear used in the surveys would must be uniquely marked to distinguish it from other commercial or recreational gear.
ST-14	Construction and installation, postconstruction and installation monitoring	Fisheries and benthic habitat monitoring	Revisions to the COP March 2023 version of Appendix Y, Fisheries Research and Benthic Monitoring Plan, include additional measures to reduce potential impacts to protected species. The ventless trap and pot gear will employ ropeless technology or grappling techniques that will eliminate the need for buoy lines and surface floats. To mitigate unmarked gear, the applicant would post the gear positions in an online gear tracking application until such a point, if any, where downlines and markers are permitted. As an additional mitigation measure, the researchers for the Revolution Wind ventless lobster trap survey would remove gear from the lease area between sampling periods as to reduce risk of loss. *NOTE: this condition was added after the BA was submitted, to address the commitment to “ropeless” technology for the ventless trap survey
Ben-8	Construction and installation	Submerged aquatic vegetation (SAV) study	A preconstruction SAV survey will be completed to identify any new or expanded SAV beds. The Project design will be refined to avoid impacts to SAV to the greatest extent practicable.
MM-1	Construction and installation	Establishment of pre-clearance and shutdown zones for impact pile driving	Pre-clearance and shutdown zones for marine mammals and sea turtles will be established for impact and vibratory pile-driving activities.
MM-2, and ST-2	Construction and installation	Impact and vibratory pile-driving mitigation measures	The following measures will be implemented for impact and vibratory pile-driving activities. These measures will include seasonal restrictions, soft-start measures, shutdown procedures, marine mammal and sea turtle monitoring protocols, the use of qualified and National Oceanic and Atmospheric Administration (NOAA)-approved Protected Species Observers (PSO), and noise attenuation systems such as bubble curtains, as appropriate.
MM-3, and ST-3	Construction and installation, O&M, and decommissioning	Vessel speed restrictions	Vessels will follow NOAA guidelines for marine mammal and sea turtle strike avoidance measures, including vessel speed restrictions.
MM-4, and ST-4	Construction and installation, O&M, and decommissioning	Marine mammal, sea turtle, and marine debris awareness training	All personnel working offshore will receive training on marine mammal and sea turtle awareness and marine debris awareness. Training records must be maintained and provided to BOEM and BSEE upon request or provided in annual reporting requirements.

EPM Number	Project Phase	EPM	Description
MM-10	Construction and installation and post-construction and installation	MMPA application measures	Revolution Wind is committed to minimizing impacts to marine mammal species through a comprehensive monitoring and mitigation program. The mitigation measures identified in the MMPA petition for Incidental Take Regulations (ITR) application to be implemented include, but are not limited to, the following: 1. Noise attenuation through use of a noise mitigation system; 2. Seasonal restrictions; 3. Standard PSO training and equipment requirements; 4. Visual monitoring; including low visibility monitoring tools; 5. Passive acoustic monitoring; 6. Establishment and monitoring of shutdown zones 7. Pre-start clearance; 8. Ramp-up (soft-start) procedures; 9. Operations monitoring; 10. Operational shutdowns and delay; 11. Sound source measurements of at least one foundation installation 12. Survey sighting coordination; 13. Entanglement reduction measures during fishery and benthic monitoring surveys; 14. 15. Vessel strike avoidance procedures; and 16. Data recording and reporting procedures.
ST-1	Construction and installation	Establishment of clearance and/or shutdown exclusion and monitoring zones for impact pile driving	Clearance and shutdown zones for marine mammals and sea turtles will be established for impact and vibratory pile-driving activities.

* For additional details on these mitigation and monitoring measures refer to COP Appendix B, Protected Species Mitigation and Monitoring Plan

BA Table 3.19. Proposed Additional Mitigation, Monitoring and Reporting Measures included in BOEM's BA

Mitigation, Monitoring and Reporting Measure Number	Proposed Project Phase	Mitigation or Monitoring Measure	Description
1	Construction and installation, O&M, and decommissioning	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 must 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 must 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 via TIMSWeb with a notification email (at marinedebris@bsee.gov).
2	Construction and installation	Marine debris elimination	Materials, equipment, tools, containers, and other items used in OCS activities which could be lost or discarded overboard must be clearly marked with the vessel or facility identification. All markings must clearly identify the owner and must be durable enough to resist the effects of the environmental conditions to which they may be exposed.

Mitigation, Monitoring and Reporting Measure Number	Proposed Project Phase	Mitigation or Monitoring Measure	Description
3	Construction and installation	Incorporate MMPA requirements	The measures required by the final MMPA LOA for Incidental Take Regulations (ITRs) will be incorporated into COP approval, and BOEM and/or BSEE will monitor compliance with these measures.

4	Construction, O&M, and decommissioning	Passive acoustic monitoring (PAM)	Use PAM buoys or autonomous PAM devices to record ambient noise, marine mammals, and cod vocalizations in the Lease Area before, during, and immediately after construction (at least 25 years of operation (or as may be extended) to monitor Project noise. The archival recorders must have a minimum capability of detecting and storing acoustic data on anthropogenic noise sources (such as vessel noise, pile driving, WTG operation, and whale detections), marine mammals, and cod vocalizations in the Lease Area. Monitoring would also occur during the decommissioning phase. The total number of PAM stations and array configuration will depend on the size of the zone to be monitored, the amount of noise expected in the area, and the characteristics of the signals being monitored to accomplish both monitoring during constructions, and also meet post-construction monitoring needs. Results must be provided within 90 days of construction completion and again within 90 days of the 1-year, 2-year, and 3-year anniversary of collection. The underwater acoustic monitoring must follow standardized measurement and processing methods and visualization metrics developed by the Atlantic Deepwater Ecosystem Observatory Network (ADEON) for the U.S. Mid- and South Atlantic OCS (see https://adeon.unh.edu/). At least two buoys must be independently deployed within or bordering the Lease Area or one or more buoys must be deployed in coordination with other acoustic monitoring efforts in the RI/MA and MA WEAs. As an alternative to conducting PAM in its project area, the lessee may opt to meet this monitoring requirement through an annual deposit to BOEM's Environmental Studies Program in support of its Partnership for an Offshore Wind Energy Regional Observation Network (POWERON) initiative. The lessee's contribution would cover activities within its lease area, such as the purchase of instruments, annual deployments and refurbishment, data processing, and long-term data archiving. Funding from BOEM, other partners, and potentially other lessees will support long-term PAM throughout the region which will enable broader-scale analyses on cumulative effects to marine species. Under this option, the lessee will be expected to cooperate with the POWERON team to facilitate deployment and retrieval of instruments within the project area. If necessary, the lessee may request temporary withholding of the public release of acoustic

Mitigation, Monitoring and Reporting Measure Number	Proposed Project Phase	Mitigation or Monitoring Measure	Description
			data that has been collected within its project area.
5	Construction and installation	PAM plan	BOEM, BSEE, and USACE would ensure that Revolution Wind prepares a PAM Plan that describes all proposed equipment, deployment locations, detection review methodology and other procedures, and protocols related to the required use of PAM for monitoring. This plan would be submitted to BOEM (renewable_reporting@boem.gov) and BSEE (via TIMSWeb with a notification email at protectedspecies@bsee.gov)) for review and concurrence preferably 180 days but no later than 120 days prior to the planned start of pile driving. Reporting to BSEE would follow JOINT NTL 2023-N01, Appendix B.

6	Construction and installation	Pile driving monitoring plan	BOEM BSEE, and USACE would ensure that Revolution Wind prepares and submits a *Pile Driving Monitoring Plan* to NMFS and BSEE (via TIMSWeb and notification email at protectedspecies@bsee.gov) and BOEM ((at renewable_reporting@boem.gov) for review and concurrence preferably 180 days but no later than 120 days before start of pile driving. Reporting to BSEE would follow JOINT NTL 2023-N01, Appendix B. As part of the plan, no pile installation will occur from January 1 to April 30 to avoid times of year when NARW are present in higher densities in the project action area. 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 including not initiating pile driving earlier than 1 hour after civil sunrise or later than 1.5 hours prior to civil sunset. Pile driving at night may only occur with prior approval of an AMP. 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 shutdown procedures outlined in the Protected Species Mitigation Monitoring Plan (PSMMP). The Lessee would notify BOEM and NMFS of any shutdown occurrence during piling driving operations within 24 hours of the occurrence unless otherwise authorized by BOEM and NMFS. The AMP should include, but is not limited to the following information:

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			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 Revolution 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. For mammals see Appendix B MMPA rule.
7	Construction and installation	Protected species observers (PSO) coverage	BOEM, BSEE, and USACE would ensure that PSO coverage is sufficient to reliably detect marine mammals and sea turtles at the surface in clearance and shutdown zones to execute any pile driving delays or shutdown requirements. 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 must be deployed. Determinations prior to construction would be based on review of the *Pile Driving Monitoring Plan*. Determinations during construction must be based on review of the weekly pile driving reports and other information, as appropriate.

Mitigation, Monitoring and Reporting Measure Number	Proposed Project Phase	Mitigation or Monitoring Measure	Description
8	Construction and installation	Shutdown and clearance zones for marine mammals	Per the petition for ITR, the following summer and winter shutdown zones were requested for WTG and OSS installation, assuming a summer (April – November) and winter (December – March) sound speed profile determined from the modeling conducted by LGL (2022a): WTG [and OSS] summer distances – April – November: Mysticete whales (LFCs): 2,300 m [1,600 m] NARW visual detection: any distance [same] NARW acoustic detection:3,900 m [4,100 m] Sperm whale: 2,300m [1,600 m] WTG [and OSS] winter distances – December – March: Mysticete whales (LFCs): 4,400 m [2,700 m] NARW visual detection: any distance [same] NARW acoustic detection:4,400 m [4,700m] Sperm whale: 4,400m [2,700] *Note that shutdown zones and clearance zones are the same.*
9	Construction and installation	Sound field verification	NMFS, BOEM, BSEE, and USACE would ensure that if the clearance and/or shutdown zones are expanded, PSO coverage is sufficient to reliably monitor the expanded clearance and/or shutdown zones. Additional observers must be deployed on additional platforms for every 1,500 m that a clearance or shutdown zone is expanded beyond the distances modeled prior to verification. To validate the estimated sound field, sound field verification measurements will be conducted during pile driving of the first three monopiles installed over the course of the Project, with noise attenuation activated. A Sound Field Verification Plan will be submitted to NMFS, BOEM, USACE and BSEE for review and approval preferably 180 days but no later than 120 days prior to planned start of pile driving. This plan will describe how Revolution Wind will ensure that the first three monopile installation sites selected for sound field 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 sound field verification. This plan will also include methodology for collecting, analyzing, and preparing SFV data for submission to NMFS. The plan will describe how the effectiveness of the sound attenuation methodology will be evaluated based on the results. In the event that Revolution Wind obtains technical information that indicates a subsequent monopile is likely to produce larger sound fields, SFV will be conducted for those subsequent monopiles.

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10	Construction and installation	Shutdown zones and clearance zone adjustment	BOEM, BSEE, and NMFS may consider adjustments in the pre-start clearance and/or shutdown zones based on the initial sound field verification (SFV) measurements. Revolution Wind will provide the initial results of each SFV measurement to BOEM, BSEE, and NMFS in an interim report after each monopile installation. Interim reports must be submitted as soon as they are available but no later than 48 hours after each installation. Revolution 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. If initial SFV measurements indicate distances to the isopleths are less than the distances predicted by modeling assuming 10-dB attenuation, Revolution Wind may request a modification of the clearance and shutdown zones for impact pile driving. For a modification request to be considered, Revolution Wind must have conducted SFV on at least three piles to verify that zone sizes are consistently smaller than predicted by modeling. If initial SFV measurements from any foundation indicate distances to the isopleths are greater than the distances predicted by modeling, Revolution Wind will implement additional sound attenuation measures prior to conducting additional pile driving. Additional measures may include improving the efficacy of the implemented noise attenuation technology and/or modifying the piling schedule to reduce the sound source. If modeled zones cannot be achieved by these corrective actions, Revolution Wind must install an additional noise mitigation system to achieve the modelled ranges. Each sequential modification will be evaluated empirically by SFV of three additional foundations with the new sound attenuation technology. Additionally, in the event that SFV measurements continue to indicate distances to isopleths corresponding to Level A harassment and Level B harassment thresholds are consistently greater than the distances predicted by modeling, BOEM, BSEE, or NMFS may expand the relevant clearance and shutdown zones and associated monitoring measures.
11	Construction and installation	Clearance and Shutdown zone for sea turtles	BOEM, BSEE, and USACE would ensure that Revolution Wind would monitor a 500 m clearance and shutdown zone for sea turtles for the full duration of all pile driving activities and for 30 minutes following the cessation of pile driving activities and record all observations in order to ensure that all take that occurs is documented.

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12	Construction and installation, O&M, and decommissioning	Reporting of all NARW sightings	If a NARW is observed at any time by PSOs or personnel on any Project vessels, during any Project-related activity or during vessel transit, Revolution Wind must report the sighting information to NMFS as soon as feasible and no later than within 24 hours after conclusion of the detection event the time, location, number of animals, closest point of approach of animals, animal behavior, activities at time of detection, vessel speed, and any mitigation measures implemented) via the WhaleAlert app (http://www.whalealert.org/); NMFS Right Whale Sighting Advisory System hotline (phone), and PR.ITP.MonitoringReports@noaa.gov.

13	Construction and installation, O&M, and decommissioning	Vessel strike avoidance measures for sea turtles	Between June 1 and November 30, Revolution Wind must have a trained lookout posted on all vessel transits during all phases of the Project to observe for sea turtles. The trained lookout must communicate any sightings, in real time, to the captain so that the requirements in (e) below can be implemented. a. The trained lookout must 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. b. The trained lookout must maintain a vigilant watch and monitor a Vessel Strike Avoidance Zone (500 m) at all times to maintain minimum separation distances from ESA listed species. Alternative monitoring technology (e.g., night vision, thermal cameras, etc.) must 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 must be their designated role and primary responsibility while the vessel is transiting. Any designated crew lookouts must receive training on protected species identification, vessel strike minimization procedures, how and when to communicate with the vessel captain, and reporting requirements. c. If a sea turtle is sighted within 100 m or less of the operating vessel's forward path, the vessel operator must slow down to 4 knots (unless unsafe to do so) and then proceed away from the turtle at a speed of 4 knots or less until there is a separation distance of at least 100 m at which time the vessel may resume normal operations. If a sea turtle is sighted within 50 m of the forward path of the operating vessel, the vessel operator must shift to neutral when safe to do so wait for the turtle to pass beyond 50m and then engage engines and travel away from the turtle at a speed of 4 knots until a separation distance of 100 m is observed. The vessel may resume normal operations once it has passed the turtle. d. Vessel captains/operators must 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,

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			vessels must slow to 4 knots while transiting through such areas. e. All vessel crew members must be briefed in the identification of ESA listed species of sea turtles and in regulations and best practices for avoiding vessel collisions. Reference materials must 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) must 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. f. 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 must be reported to NMFS and BSEE within 24 hours. g. If a vessel is carrying a PSO or trained lookout for the purposes of maintaining watch for North Atlantic right whales (NARW), an additional lookout is not required and this PSO or trained lookout must maintain watch for whales, giant manta rays, and sea turtles.
14	Construction and installation	Sampling gear	All sampling gear must be hauled out at least once every 30 days, and all gear must be removed from the water and stored on land between survey seasons to minimize risk of entanglement.
15	Construction and installation	Lost survey gear	If any survey gear is lost, all reasonable efforts that do not compromise human safety must be undertaken to recover the gear. All lost gear must be reported to NMFS (nmfs.gar.incidental-take@noaa.gov) and BSEE (via TIMSWeb and notification email at marinedebris@bsee.gov) within 24 hours of the documented time of missing or lost gear. This report must include information on any markings on the gear and any efforts undertaken or planned to recover the gear.

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16	Construction and installation	Training	At least one of the survey staff onboard the trawl surveys and ventless trap surveys must 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 must be available on board each survey vessel. BOEM and BSEE would ensure that Revolution 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.
17	Construction and installation	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).

18	Construction and installation	Sea turtle/Atlantic sturgeon identification and data collection	Any sea turtles or Atlantic sturgeon caught and/or retrieved in any fisheries survey gear must first be identified to species or species group. Each ESA listed species caught and/or retrieved must then be properly documented using appropriate equipment and data collection forms. Biological data, samples, and tagging must 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 must be followed (https://media.fisheries.noaa.gov/2021-11/Sturgeon-Sea-Turtle-Take-SOPs-external-11032021.pdf). b. Survey vessels must 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 must be recorded on the take reporting form (see below). c. Genetic samples must 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 must be done in accordance with the Procedures for Obtaining Sturgeon Fin Clips (https://media.fisheries.noaa.gov/dam-migration/sturgeon_genetics_sampling_revised_june_2019.pdf). a. Fin clips must 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 mustbe made for shipping and analysis in advance of submission of any samples; these arrangements must be confirmed in writing to NMFS within 60 days of the receipt of this ITS. Results of genetic analysis, including assigned DPS of origin must be submitted to NMFS within 6 months of the sample collection.

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			b. Subsamples of all fin clips and accompanying metadata forms must 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 must be documented with required measurements and photographs. The animal's condition and any marks or injuries must be described. This information would be entered as part of the record for each incidental take. A NMFS Take Report Form must 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).

19	Construction and installation	Sea turtle/Atlantic sturgeon handling and resuscitation guidelines	Any sea turtles or Atlantic sturgeon caught and retrieved in gear used in fisheries surveys must 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 must 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 must have copies of the sea turtle handling and resuscitation requirements found at 50 CFR 223.206(d)(1) prior to the commencement of any on-water activity (download at: https://media.fisheries.noaa.gov/dam-migration/sea_turtle_handling_and_resuscitation_measures.pdf). These handling and resuscitation procedures must 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 must 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 must be made to resuscitate any Atlantic sturgeon that are unresponsive or comatose by providing a running source of water over the gills as described in the Sturgeon Resuscitation Guidelines (https://media.fisheries.noaa.gov/dam-migration/sturgeon_resuscitation_card_06122020_508.pdfhttps://media.fisheries.no

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			aa.gov/dammigration-miss/Resuscitation-Cards-120513.pd. 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 must 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 must ultimately be released according to established protocols and whenever at-sea conditions are safe for those releasing the animal(s) to do so.

20	Construction and installation	Take notification	GARFO PRD and BSEE must 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 and DOI (BOEM and BSEE) must be notified within 24 hours of any interaction with a sea turtle or sturgeon (nmfs.gar.incidental-take@noaa.gov and DOI via TIMSWeb and notification email at protectedspecies@bsee.gov). The report must 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, ventless trap); (4) soak time, gear configuration and any other pertinent gear information; (5) time and date of the interaction; and (6) identification of the animal to the species level. Additionally, the e-mail must 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 must be submitted as soon as possible; late reports must be submitted with an explanation for the delay. b. At the end of each survey season, a report must be sent to NMFS that compiles all information on any observations and interactions with ESA listed species. This report must 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 must be comprehensive of all activities, regardless of whether ESA listed species were observed.
21	Construction and installation, O&M, and	Monthly/ annual reporting requirements	BOEM and BSEE would ensure that Revolution Wind submits regular reports (in consultation with NMFS) necessary to document the amount or extent of take that occurs during all phases of the

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	decommissioning		proposed action. Details of reporting must be coordinated between Revolution Wind, NMFS, BOEM and BSEE. All reports would be sent to: nmfs.gar.incidental-take@noaa.gov and via TIMSWeb and notification email at protectedspecies@bsee.gov.

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22	O&M and decommissioning	Vessel strike protected species observer requirements	Protected Species Observer Requirements (Construction)(Operations)(Decommissioning). The Lessee must ensure that vessel operators and crew members maintain a vigilant watch for marine mammals and sea turtles, and reduce vessel speed, alter the vessel's course, or stop the vessel as necessary to avoid striking marine mammals or sea turtles. All vessels must have a visual observer on board who is responsible for monitoring the vessel strike avoidance zone for marine mammals and sea turtles. Visual observers may be PSO or crew members, but crew members responsible for these duties must be provided sufficient training by the Lessee 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; Vessel Communication of Threatened and Endangered Species Sightings (Planning) (Construction) (Operations) (Decommissioning). The Lessee must ensure that whenever multiple Project vessels are operating, any detections of ESA listed species (marine mammals and sea turtles) are communicated in near real time to these personnel on the other Project vessels: Protected Species Observer (PSO), vessel captains, or both. 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; Any observations of any large whale by any of the Lessee's staff or contractor, including vessel crew, must be communicated immediately to PSOs and all vessel captains to increase situational awareness.

23	O&M and decommissioning	Vessel Speed Requirements	Between November 1st and April 30th, all vessels, regardless of size, must operate at 10 kts or less when traveling between the lease area and ports in New Jersey, New York, Maryland, Delaware, and Virginia; 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; 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; If a vessel is traveling at greater than 10 knots, in addition to the required dedicated visual observer, the Lessee 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; 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; 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);

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;

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;

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);

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

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, the Lessee must cease operations until the marine mammal has moved

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			more than 10 m on a path away from the activity to avoid direct interaction with equipment.
23			
23	Construction and installation, O&M, and decommissioning	Data collection BA BMPs	BOEM and BSEE would ensure that all Project Design Criteria and Best Management Practices incorporated in the Atlantic Data Collection consultation for Offshore Wind Activities (Baker and Howson 2021) shall be applied to activities associated with the construction, maintenance, and operations of the Revolution Wind Project as applicable.
25	Construction, O&M	Vessel speed restriction	All vessels, regardless of size, would comply with a 10-knot speed restriction in any Seasonal Management Area (SMA), Dynamic Management Area (DMA), or Slow Zone*.
26	Construction and installation, O&M, and decommissioning	Anchoring plan	Given the extent of complex habitats in the RWF, BOEM and BSEE should require the applicant to develop an anchoring plan to ensure anchoring is avoided and minimized in complex habitats during construction and maintenance of the Project. This plan should specifically delineate areas of complex habitat around each turbine and cable locations, and identify areas restricted from anchoring. Anchor chains should include mid-line buoys to minimize impacts to benthic habitats from anchor sweep where feasible.

Mitigation, Monitoring and Reporting Measure Number	Proposed Project Phase	Mitigation or Monitoring Measure	Description
29	Construction and installation	MEC/UXO Disposal	For MEC/UXO that are positively identified in proximity to planned activities on the sea floor, several alternative strategies will be considered prior to detonating the MEC/UXO in place. These may include relocating the activity away from the MEC/UXO (avoidance), moving the MEC/UXO away from the activity (lift and shift), cutting the MEC/UXO open to apportion large ammunition or deactivate fused munitions, using shaped charges to reduce the next explosive yield of an MEC/UXO (low-order detonation), or using shaped charges to ignite the explosive materials and allow them to burn at a slow rate rather than detonate instantaneously (deflagration). Only after these options are considered would a decision to detonate the MEC/UXO in place be made. If deflagration is conducted, mitigation and a monitoring measure would must be implemented as if it was a high order detonation based on MEC/UXO size. For detonations that cannot be avoided due to safety considerations, a number of mitigation measures will be employed by Revolution Wind. No more than a single MEC/UXO will be detonated in a 24-hour period. LGL (2022a) outlined several mitigation measures, including: • Monitoring equipment • Pre-start clearance • Visual monitoring • Acoustic monitoring • Use of noise attenuation devices capable of achieving a minimum of 10 dB of sound source attenuation • Seasonal restrictions, limiting detonation activities to the period from May 1 to November 30 • Post MEC/UXO detonation monitoring, and • Sound measurements

* On August 1, 2022, NMFS published a proposed rule for changes to NARW vessel speed regulations to further reduce the likelihood of mortalities and serious injuries from vessel collisions (87 Federal Register [FR] 46921. If the proposed rule becomes final, BOEM would require appropriate restrictions per area.

Appendix B.

Mitigation Requirements Included in the MMPA Proposed Rule (87 FR 79072, December 23, 2022).

a) ***General Conditions*:**

1) A copy of any issued LOA must be in the possession of Revolution Wind and its designees, all vessel operators, visual protected species observers (PSOs), passive acoustic monitoring (PAM) operators, pile driver operators, and any other relevant designees operating under the authority of the issued LOA;
2) Revolution Wind must conduct briefings between construction supervisors, construction crews, and the PSO and PAM team prior to the start of all construction activities, and when new personnel join the work, in order to explain responsibilities, communication procedures, marine mammal monitoring and reporting protocols, and operational procedures. An informal guide must be included with the Marine Mammal Monitoring Plan to aid personnel in identifying species if they are observed in the vicinity of the project area;
3) Revolution Wind must instruct all vessel personnel regarding the authority of the PSO(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;
4) Revolution Wind must ensure that any visual observations of an ESA listed marine mammal are communicated to PSOs and vessel captains during the concurrent use of multiple project-associated vessels (of any size; *e.g.,* construction surveys, crew/supply transfers, etc);
5) If an individual from a species for which authorization has not been granted, or a species for which authorization has been granted but the authorized take number has been met, is observed entering or within the relevant Level B harassment zone for each specified activity, pile driving and pneumatic hammering 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, pneumatic hammering, 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;
6) Prior to and when conducting any in-water construction activities and vessel operations, Revolution Wind personnel (*e.g.*, vessel operators, PSOs) must use available sources of information on North Atlantic right whale presence in or near the project area including daily monitoring of the Right Whale Sightings Advisory System, and monitoring of Coast Guard VHF Channel 16 throughout the day to receive notification of any sightings and/or information associated with any Slow Zones (*i.e.*, Dynamic Management Areas (DMAs) and/or acoustically-triggered slow zones) to provide situational awareness for both vessel operators and PSOs; and

7) Any marine mammals observed within a clearance or shutdown zone must be allowed to remain in the area (*i.e.*, must leave of their own volition) prior to commencing impact and vibratory pile driving activities, pneumatic hammering, or HRG surveys.
8) Revolution Wind must treat any large whale sighted by a PSO or acoustically detected by a PAM operator as if it were a North Atlantic right whale, unless a PSO or a PAM operator confirms it is another type of whale.

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 Revolution Wind project area;
   ii) Training on making observations in both good weather conditions (*i.e.*, clear visibility, low winds, low sea states) and bad weather conditions (*i.e.*, fog, high winds, high sea states, with glare);
   iii) Training on information and resources available to the project personnel regarding the applicability of Federal laws and regulations for protected species;
   iv) Observer training related to these vessel strike avoidance measures must be conducted for all vessel operators and crew prior to the start of in-water construction activities; and
   v) Confirmation of marine mammal observer training (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 Revolution 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 knots (kns);
   iii) Year-round and when a vessel is in transit, all vessel operators must continuously monitor US Coast Guard VHF Channel 16, over which North Atlantic right whale sightings are broadcasted. At the onset of transiting and at least once every four hours, vessel operators and/or trained crew members must monitor the project's Situational Awareness System, WhaleAlert, and the Right Whale Sighting Advisory System (RWSAS) for the presence of North Atlantic right whales Any observations of any large whale by any Revolution Wind staff or contractors, including vessel crew, must be communicated immediately to PSOs, PAM operator, and all vessel captains to increase situational awareness. Conversely, any large whale observation or detection via a sighting network (*e.g.*, Mysticetus) by PSOs or PAM operators must be conveyed to vessel operators and crew;

iv) Any observations of any large whale by any Revolution 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) In the event that any Slow Zone (designated as a DMA) is established that overlaps with an area where a project-associated vessel would operate, that vessel, regardless of size, will transit that area at 10 kns or less;
vii) Between November 1st and April 30th, all vessels, regardless of size, would operate port to port (specifically from ports in New Jersey, New York, Maryland, Delaware, and Virginia) at 10 kns or less, except for vessels while transiting in Narragansett Bay or Long Island Sound which have not been demonstrated by best available science to provide consistent habitat for North Atlantic right whales;
viii) All vessels, regardless of size, must immediately reduce speed to 10 kns 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;
ix) All vessels, regardless of size, must immediately reduce speed to 10 kns or less when a North Atlantic right whale is sighted, at any distance, by anyone on the vessel;
x) If a vessel is traveling at greater than 10 kns, in addition to the required dedicated visual observer, Revolution 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 kns or less for 12 hours following the detection. Each subsequent detection triggers an additional 12-hour period at 10 kns or less. A slowdown in the transit corridor expires when there has been no further visual or acoustic detection of North Atlantic right whales in the transit corridor for 12 hours;
xi) 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 proposed action. 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;
xii) 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 kns 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 herein;

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

xiv) 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;

xv) 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);

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

xvii) 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, Revolution 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; and

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

c) 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 nautical mile (nmi) of the sampling station; and
iii) During daytime sampling for the research trawl surveys, Revolution 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) Research trawl bottom times must be limited to 20 minutes;
ii) Ventless trap surveys must utilize sinking ground lines and all lines will have breaking strength of less than 1,700 pounds and sinking groundlines. Sampling gear must be hauled at least once every 30 days, and the gear must be removed from the water at the end of each sampling season;
iii) The permit number must be written clearly on buoy and any lines that go missing must be reported to NOAA Fisheries' Greater Atlantic Regional Fisheries Office (GARFO) Protected Resources Division as soon as possible;
iv) If marine mammals are sighted near the proposed sampling location, trawl or ventless trap gear must be delayed until the marine mammal(s) has left the area;
v) If a marine mammal is determined to be at risk of interaction with the deployed gear, all gear must be immediately removed;
vi) Marine mammal monitoring must occur during daylight hours and begin prior to the deployment of any gear (*e.g.*, trawls) and continue until all gear has been retrieved; and
vii) 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 must either be moved to another location or activities must be suspended 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 three foundation monopiles may be installed per day;
iii) Revolution Wind must not initiate pile driving earlier than 1 hour after civil sunrise or later than 1.5 hours prior to civil sunset, unless Revolution Wind submits and NMFS approves an Alternative Monitoring Plan as part of the Pile Driving and Marine Mammal Monitoring Plan that reliably demonstrates the efficacy of their night vision devices; and
iv) Monopiles must be no larger than 15 m in diameter, representing the larger end of the tapered 7/15 m monopile design. The minimum amount of hammer energy necessary to effectively and safely install and maintain the integrity of the piles must be used. Maximum hammer energies must not exceed 4,000 kilojoules (kJ).

2) *Noise Abatement Systems.*
i) Revolution 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;
(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 air flow rate of at least 0.5 $m^3/(min*m)$. The bubble curtain(s) must surround 100 percent of the piling perimeter throughout the full depth of the water column. In the unforeseen event of a single compressor malfunction, the offshore personnel operating the bubble curtain(s) must make appropriate adjustments to the air supply and operating pressure such that the maximum possible sound attenuation performance of the bubble curtain(s) is achieved;
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; and
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 Revolution 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 Revolution Wind uses a noise mitigation device in addition to the BBC, Revolution Wind must maintain similar quality control measures as described here.

3) *Sound Field Verification*.
i) Revolution Wind must perform sound field verification (SFV) during all impact pile driving of the first three monopiles and must empirically determine source levels (peak and cumulative sound exposure level), the ranges to the isopleths corresponding to the Level A harassment (PTS) and Level B harassment thresholds, and estimated transmission loss coefficients;
ii) If a subsequent monopile installation location is selected that was not represented by previous three locations (*i.e.*, substrate composition, water depth), SFV must be conducted;
iii) Revolution Wind may estimate ranges to the Level A harassment and Level B harassment isopleths by extrapolating from in situ measurements conducted at several distances from the monopiles, and must measure received levels at a standard distance of 750 m from the monopiles;
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, Revolution 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, Revolution Wind must expand the clearance and shutdown zones according to those identified through SFV, in consultation with NMFS;

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

vi) 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), Revolution Wind may request a modification of the clearance and shutdown zones for impact pile driving of monopiles and UXO/MEC detonations. For a modification request to be considered by NMFS, Revolution Wind must have conducted SFV on three or more monopiles and on all detonated UXOs/MECs thus far to verify that zone sizes are consistently smaller than predicted by modeling (assuming 10-dB attenuation). Regardless of SFV measurements, the clearance and shutdown zones for North Atlantic right whales must not be decreased;

vii) If a subsequent monopile installation location is selected that was not represented by previous locations (*i.e.*, substrate composition, water depth), SFV must be conducted. If a subsequent UXO/MEC charge weight is encountered and/or detonation location is selected that was not representative of the previous locations (*i.e.*, substrate composition, water depth), SFV must be conducted;

viii) Revolution Wind must submit a SFV Plan at least 180 days prior to the planned start of impact pile driving and any UXO/MEC detonation activities. The plan must describe how Revolution Wind would ensure that the first three monopile foundation installation sites selected and each UXO/MEC detonation scenario (*i.e.*, charge weight, location) selected for SFV are representative of the rest of the monopile installation sites and UXO/MEC scenarios. In the case that these sites/scenarios are not determined to be representative of all other monopile installation sites and UXO/MEC detonations, Revolution Wind must include information on how additional sites/scenarios 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. Revolution 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 after each UXO/MEC detonation; and

ix) The SFV plan must also include how operational noise would be monitored. Revolution Wind must estimate source levels (at 10 m from the operating foundation) based on received levels measured at 50 m, 100 m, and 250 m from the pile foundation. These data must be used to identify estimated transmission loss rates. Operational parameters (*e.g.*, direct drive/gearbox information, turbine rotation rate) as well as sea state conditions and information on nearby anthropogenic activities (*e.g.*, vessels transiting or operating in the area) must be reported.

4) *Protected Species Observer and Passive Acoustic Monitoring Use.*

i) Revolution Wind must have a minimum of four PSOs actively observing marine mammals before, during, and after (specific times described below) the installation of monopiles. 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 eighteen months elapsed since the conclusion of the at-sea experience. Concurrently, at least one acoustic PSO (*i.e.*, passive acoustic monitoring (PAM) operator) must be actively monitoring for marine mammals before, during and after impact pile driving with PAM; and

ii) All visual PSOs and PAM operators used for the Revolution Wind project must meet the requirements and qualifications described in § 217.275 (a) and (b), and (c), respectively and as applicable to the specified activity.

5) *Clearance and Shutdown Zones*.

i) Revolution 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) Revolution Wind must use visual PSOs and PAM operators to monitor the area around each foundation pile before, during and after pile driving. PSOs must visually monitor clearance zones for marine mammals for a minimum of 60 minutes prior to commencing pile driving. At least one PAM operator must review data from at least 24 hours prior to pile driving and actively monitor hydrophones for 60 minutes prior to pile driving. Prior to initiating soft-start procedures, all clearance zones must be 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 (minimum visibility zone size dependent on season);

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. The specific time periods are 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 within the PAM clearance zone during the 60-minute monitoring period. Any large whale sighting by a PSO or detected by a PAM operator that cannot be identified by species 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 shutdown of impact pile driving;

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

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 must be delayed until the animal has been visually observed exiting the clearance zone or until a specific time period has elapsed with no further sightings. The specific time periods are 15 minutes for small odontocetes and 30 minutes for all other species.

e) *Cofferdam or Casing Pipe Installation*.

1) Daily Restrictions

i) Revolution Wind must conduct vibratory pile driving or pneumatic hammering during daylight hours only;

ii) [Reserved].

2) *PSO Use*.

i) All visual PSOs used for the Revolution Wind project must meet the requirements and qualifications described in § 217.275 (a) and (b), as applicable to the specified activity; and

ii) Revolution Wind must have a minimum of two PSOs on active duty during any installation and removal of the temporary cofferdams, or casing pipes and goal posts. 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 for the entire visual clearance zone and as much of the Level B harassment zone, as possible.

3) Clearance and Shutdown Zones

i) Revolution Wind must establish and implement clearance and shutdown zones as described in the LOA;

ii) Prior to the start of pneumatic hammering or 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 and hammering 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 or hammering has begun, the PSO must call for a temporary shutdown of vibratory pile driving or hammering;

v) Revolution Wind must immediately cease pile driving or pneumatic hammering if a PSO calls for shutdown, unless shutdown is not practicable due to imminent risk of injury or loss of life to an individual, pile refusal, or pile instability; and

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*.**

1) General.

i) Revolution Wind shall only detonate a maximum of 13 UXO/MECs, of varying sizes;

ii) Upon encountering a UXO/MEC of concern, Revolution Wind may only resort to high-order removal (*i.e.*, detonation) if all other means of removal are impracticable;

iii) Revolution 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 the maximum noise attenuation levels practicable.

2) *Seasonal and Daily Restrictions*.

i) Revolution Wind must not detonate UXOs/MECs from December 1 through April 31, annually; and

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

3) PSO and PAM Use.

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

ii) Revolution Wind must use at least 2 visual PSOs on each platform (*i.e.*, vessels, plane) and one acoustic PSO to monitor for marine mammals in the clearance zones prior to detonation. If the clearance zone is larger than 2 km (based on charge weight), Revolution Wind must deploy a secondary PSO vessel. If the clearance is larger than 5 km (based on charge weight), an aerial survey must be conducted.

4) *Clearance Zones*.

i) Revolution 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 prior to detonation and the zone must be acoustically cleared during this time; and

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, Revolution 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); and

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

iii) Any large whale sighted by a PSO within 1 km of the boomer, sparker, or CHIRP that cannot be identified by species must be treated as if it were a North Atlantic right whale.

2) *PSO Use.*

i) Revolution Wind must use at least one PSO during daylight hours and two PSOs during nighttime operations, per vessel;

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); and

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

iii) Prior to starting the survey and after receiving confirmation from the PSOs that the clearance zone is clear of any marine mammals, Revolution 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) Revolution Wind must establish and implement clearance zones as described in the LOA;

ii) Revolution 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 a specific time period has elapsed with no further sighting. The specific time period is 15 minutes for small odontocetes and seals, and 30 minutes for all other species;

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, Revolution 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, and 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) Revolution Wind must immediately shutdown any boomer, sparker, or CHIRP acoustic source if a marine mammal is sighted entering or within its respective shutdown zones. 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; and (C) 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.

5) Autonomous surface vehicle (ASV) use

(i) The ASV must remain with 800 m (2,635 ft) of the primary vessel while conducting survey operations;

(ii) Two PSOs must be stationed on the mother vessel at the best vantage points to monitor the clearance and shutdown zones around the ASV;

(iii) At least one PSO must monitor the output of a thermal.high-definition camera installed on the mother vessel to monitor the field-of-view around the ASV using a hand-held tablet; and

(iv) During periods of reduced visibility (*e.g.*, darkness, rain, or fog), PSOs must use night-vision goggles with thermal clip-ons and a hand-held spotlight to monitor the clearance and shutdown zones around the ASV.

§ 217.275 Requirements for monitoring and reporting.

(a) *PSO Qualifications.* Revolution Wind must employ qualified, trained visual and acoustic PSOs to conduct marine mammal monitoring during activities associated with construction. PSO requirements are as follows:

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

2) All PSOs must be approved by NMFS. Revolution Wind must submit PSO resumes for NMFS' review and approval at least 60 days prior to commencement of in-water construction activities requiring PSOs. Resumes must include dates of training and any prior NMFS approval, as well as dates and description of last experience, and must be accompanied by information documenting successful completion of an acceptable training course. NMFS shall be allowed three weeks to approve PSOs from the time that the necessary information is received by NMFS, after which PSOs meeting the minimum requirements will automatically be considered approved;

3) PSOs must have visual acuity in both eyes (with correction of vision being permissible) sufficient enough to discern moving targets on the water's surface with the ability to estimate the target size and distance (binocular use is allowable);

4) All PSOs must be trained in marine mammal identification and behaviors and must be able to conduct field observations and collect data according to assigned protocols.

Additionally, PSOs must have the ability to work with a.ll required and relevant software and equipment necessary during observations.

5) PSOs must have sufficient writing skills to document all observations, including but not limited to:
   i) The number and species of marine mammals observed;
   ii) The dates and times of when in-water construction activities were conducted;
   iii) The dates and time when in-water construction activities were suspended to avoid potential incidental injury of marine mammals from construction noise within a defined shutdown zone; and
   iv) Marine mammal behavior.
6) All PSOs must be able to communicate orally, by radio, or in-person with Revolution Wind project personnel;
7) PSOs must have sufficient training, orientation, or experience with construction operations to provide for their own personal safety during observations;
   i) All PSOs must complete a Permits and Environmental Compliance Plan training and a two-day refresher session that will be held with the PSO provider and Project compliance representative(s) prior to the start of construction activities;
   ii) [Reserved];
8) At least one PSO must have prior experience working as an observer. Other PSOs may substitute education (*i.e.*, degree in biological science or related field) or training for experience;
9) One PSO for each activity (*i.e.*, foundation installation, cofferdam or casing pipe installation and removal, HRG surveys, UXO/MEC detonation) must be designated as the "Lead PSO". The Lead PSO must have a minimum of 90 days of at-sea experience working in an offshore environment and would be required to have no more than eighteen months elapsed since the conclusion of their last at-sea experience;
10) At a minimum, at least one PSO located on each observation platform (either vessel-based or aerial-based) must have a minimum of 90 days of at-sea experience working in an offshore environment and would be required to have no more than eighteen months elapsed since the conclusion of their last at-sea experiences. Any new and/or inexperienced PSOs would be paired with an experienced PSO;
11) PSOs must monitor all clearance and shutdown zones prior to, during, and following impact pile driving, vibratory pile driving, pneumatic hammering, UXO/MEC detonations, and during HRG surveys that use boomers, sparkers, and CHIRPs (with specific monitoring durations described in § 217.275(b)(2)(iii), § 217.275(b)(3)(iv), § 217.275(b)(4)(ii), and § 217.275(b)(5)(iii). PSOs must also monitor the Level B harassment zones and document any marine mammals observed within these zones, to the extent practicable;
12) PSOs must be located on the best available vantage point(s) on the primary vessel(s) (*i.e.*, pile driving vessel, UXO/MEC vessel, HRG survey vessel) and on other dedicated PSO vessels (*e.g.*, additional UXO/MEC vessels) or aerial platforms, as applicable and necessary, to allow them appropriate coverage of the entire visual shutdown zone(s), clearance zone(s), and as much of the Level B harassment zone as possible. These vantage points must maintain a safe work environment; and

13) Acoustic PSOs must complete specialized training for operating passive acoustic monitoring (PAM) systems and must demonstrate familiarity with the PAM system on which they must be working. PSOs may act as both acoustic and visual observers (but not simultaneously), so long as they demonstrate that their training and experience are sufficient to perform each task.

b) *PSO Requirements.*

1) General.

i) All PSOs must be located at the best vantage point(s) on the primary vessel, dedicated PSO vessels, and aerial platform in order to ensure 360° visual coverage of the entire clearance and shutdown zones around the vessels, and as much of the Level B harassment zone as possible;

ii) During all observation periods, PSOs must use high magnification (25x) binoculars, standard handheld (7x) binoculars, and the naked eye to search continuously for marine mammals. During impact pile driving and UXO/MEC detonation events, at least one PSO on the primary pile driving or UXO/MEC vessels must be equipped with Big Eye binoculars (*e.g.*, 25 x 150; 2.7 view angle; individual ocular focus; height control) of appropriate quality. These must be pedestal mounted on the deck at the most appropriate vantage point that provides for optimal sea surface observation and PSO safety; and

iii) PSOs must not exceed four consecutive watch hours on duty at any time, must have a two-hour (minimum) break between watches, and must not exceed a combined watch schedule of more than 12 hours in a 24-hour period.

(2) *WTG and OSS Foundation Installation.*

(i) At least four PSOs must be actively observing marine mammals before, during, and after installation of foundation piles (monopiles). At least two PSOs must be stationed and observing on the pile driving vessel and at least two PSOs must be stationed on a secondary, PSO-dedicated vessel. Concurrently, at least one acoustic PSO (*i.e.*, passive acoustic monitoring (PAM) operator) must be actively monitoring for marine mammals with PAM before, during and after impact pile driving;

(ii) If PSOs cannot visually monitor the minimum visibility zone at all times using the equipment described in § 217.275(b)(1)(ii), impact pile driving operations must not commence or must shutdown if they are currently active;

(iii) All PSOs, including PAM operators, must begin monitoring 60 minutes prior to pile driving, during, and for 30 minutes after an activity. The impact pile driving of monopiles must only commence when the minimum visibility zone is fully visible (*e.g.*, not obscured by darkness, rain, fog, etc.) and the clearance zones are clear of marine mammals for at least 30 minutes, as determined by the Lead PSO, immediately prior to the initiation of impact pile driving;

(iv) For North Atlantic right whales, any visual or acoustic detection must trigger a delay to the commencement of pile driving. In the event that a large whale is sighted or acoustically detected that cannot be confirmed by species, it must be treated as if it were a North Atlantic right whale; and

(v) Following a shutdown, monopile installation must not recommence until the minimum visibility zone is fully visible and clear of marine mammals for 30 minutes.

(3) *Cofferdam or Casing Pipe Installation and Removal*.

(i) At least two PSOs must be on active duty during all activities related to the installation and removal of cofferdams or casing pipes and goal post sheet piles;

(ii) These PSOs must be located at appropriate vantage points on the vibratory pile driving or pneumatic hammering platform or secondary platform in the immediate vicinity of the vibratory pile driving or pneumatic hammering platforms;

(iii) PSOs must ensure that there is appropriate visual coverage for the entire clearance zone and as much of the Level B harassment zone as possible; and

(iv) PSOs must monitor the clearance zone for the presence of marine mammals for 30 minutes before, throughout the installation of the sheet piles and casing pipes, and for 30 minutes after all vibratory pile driving or pneumatic hammering activities have ceased. Sheet pile or casing pipe installation shall only commence when visual clearance zones are fully visible (*e.g.*, not obscured by darkness, rain, fog, etc.) and clear of marine mammals, as determined by the Lead PSO, for at least 30 minutes immediately prior to initiation of vibratory pile driving or pneumatic hammering.

(4) *UXO/MEC Detonations*.

(i) At least two PSOs must be on active duty on each observing platform (*i.e.*, vessel, plane) prior to, during, and after UXO/MEC detonations. Concurrently, at least one acoustic PSO (*i.e.*, passive acoustic monitoring (PAM) operator) must be actively monitoring for marine mammals with PAM before, during and after UXO/MEC detonations;

(ii) All PSOs, including PAM operators, must begin monitoring 60 minutes prior to UXO/MEC detonation, during detonation, and for 30 minutes after detonation; and

(iii) Revolution Wind must ensure that clearance zones are fully (100 percent) monitored.

(5) *HRG Surveys*.

(i) Between 4 and 6 PSOs must be present on every 24-hour survey vessel and 2 to 3 PSOs must be present on every 12-hour survey vessel. At least one PSO must be on active duty during HRG surveys conducted during daylight and at least two PSOs must be on activity duty during HRG surveys conducted at night;

(ii) During periods of low visibility (*e.g.*, darkness, rain, fog, etc.), PSOs must use alternative technology (*i.e.*, infrared/thermal camera) to monitor the clearance and shutdown zones;

(iii) PSOs on HRG vessels must begin monitoring 30 minutes prior to activating boomers, sparkers, or CHIRPs, during use of these acoustic sources, and for 30 minutes after use of these acoustic sources has ceased;

(iv) Any observations of marine mammals must be communicated to PSOs on all nearby survey vessels during concurrent HRG surveys; and

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

c)PAM Operator Requirements.

1) General.

(i) PAM operators must have completed specialized training for operating PAM systems prior to the start of monitoring activities, including identification of species-specific mysticete vocalizations (*e.g.*, North Atlantic right whales);

(ii) During use of any real-time PAM system, at least one PAM operator must be designated to monitor each system by viewing data or data products that would be streamed in real-time or in near real-time to a computer workstation and monitor;

(iii) PAM operators may be located on a vessel or remotely on-shore but must have the appropriate equipment (*i.e.*, computer station equipped with a data collection software system (*i.e.*, Mysticetus or similar system) and acoustic data analysis software) available wherever they are stationed;

(iv) Visual PSOs must remain in contact with the PAM operator currently on duty regarding any animal detection that would be approaching or found within the applicable zones no matter where the PAM operator is stationed (*i.e.*, onshore or on a vessel);

(v) The PAM operator must 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 that the designated crewmember implement the necessary mitigation procedures (*i.e.*, delay or shutdown);

(vi) PAM operators must be on watch for a maximum of four consecutive hours, followed by a break of at least two hours between watches; and

(vii) A Passive Acoustic Monitoring Plan must be submitted to NMFS for review and approval at least 180 days prior to the planned start of monopile installation. The authorization to take marine mammals would be contingent upon NMFS' approval of the PAM Plan.

2) WTG and OSS Foundation Installation.

i) Revolution Wind must use a minimum of one PAM operator before, during, and after impact pile driving activities. The PAM operator must assist visual PSOs in ensuring full coverage of the clearance and shutdown zones;

ii) PAM operators must assist the visual PSOs in monitoring by conducting PAM activities 60 minutes prior to any impact pile driving, during, and after for 30 minutes for the appropriate size PAM clearance zone (dependent on season). The entire minimum visibility zone must be clear for at least 30 minutes, with no marine mammal detections within the visual or PAM clearance zones prior to the start of impact pile driving;

iii) Any acoustic monitoring during low visibility conditions during the day would complement visual monitoring efforts and would cover an area of at least the Level B harassment zone around each monopile foundation;

iv) Any visual or acoustic detection within the clearance zones must trigger a delay to the commencement of pile driving. In the event that a large whale is sighted or acoustically detected that cannot be identified by species, it must be treated as if it were a North Atlantic right whale. Following a shutdown, monopile installation shall not recommence until the minimum visibility zone is fully visible and clear of marine mammals for 30 minutes and no marine mammals have been detected acoustically within the PAM clearance zone for 30 minutes; and

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

3) *UXO/MEC Detonation(s)*.

i) Revolution Wind must use a minimum of one PAM operator before, during, and after UXO/MEC detonations. The PAM operator must assist visual PSOs in ensuring full coverage of the clearance and shutdown zones;

ii) PAM must be conducted for at least 60 minutes prior to detonation, during, and for 30 minutes after detonation;

iii) The PAM operator must monitor to and beyond the clearance zone for large whales; and

iv) Revolution Wind must prepare and submit a UXO/MEC and Marine Mammal Monitoring Plan to NMFS for review and approval at least 180 days before the start of any UXO/MEC detonations. The plan must include final project design and all information related to visual and PAM PSO monitoring protocols for UXO/MEC detonations.

(d) Data Collection and Reporting.

1) Prior to initiation of project activities, Revolution Wind must demonstrate in a report submitted to NMFS (at *itp.esch@noaa.gov* and *pr.itp.monitoringreports@noaa.gov*) that all required training for Revolution Wind personnel (including the vessel crews, vessel captains, PSOs, and PAM operators) has been completed;

2) Revolution Wind must use a standardized reporting system during the effective period of the proposed regulations and LOA. All data collected related to the Revolution Wind project must be recorded using industry-standard softwares (*e.g.*, Mysticetus or a similar software) that is installed on field laptops and/or tablets. For all monitoring efforts and marine mammal sightings, Revolution Wind must collect the following information and report it to NMFS:

(i) Date and time that monitored activity begins or ends;
(ii) Construction activities occurring during each observation period;
(iii) Watch status (*i.e.*, sighting made by PSO on/off effort, opportunistic, crew, alternate vessel/platform);
(iv) PSO who sighted the animal;
(v) Time of sighting;
(vi) Weather parameters (*e.g.*, wind speed, percent cloud cover, visibility);
(vii) Water conditions (*e.g.*, sea state, tide state, water depth);
(viii) All marine mammal sightings, regardless of distance from the construction activity;
(ix) Species (or lowest possible taxonomic level possible);

(x) Pace of the animal(s);
(xi) Estimated number of animals (minimum/maximum/high/low/best);
(xii) Estimated number of animals by cohort (*e.g.*, adults, yearlings, juveniles, calves, group composition, etc.);
(xiii) Description (*i.e.*, as many distinguishing features as possible of each individual seen, including length, shape, color, pattern, scars or markings, shape and size of dorsal fin, shape of head, and blow characteristics);
(xiv) Description of any marine mammal behavioral observations (*e.g.*, observed behaviors such as feeding or traveling) and observed changes in behavior, including an assessment of behavioral responses thought to have resulted from the specific activity;
(xv) Animal's closest distance and bearing from the pile being driven, UXO/MEC, or specified HRG equipment and estimated time entered or spent within the Level A harassment and/or Level B harassment zones;
(xvi) Construction activity at time of sighting (*e.g.*, vibratory installation/removal, impact pile driving, UXO/MEC detonation, construction survey), use of any noise attenuation device(s), and specific phase of activity (*e.g.*, ramp-up of HRG equipment, HRG acoustic source on/off, soft start for pile driving, active pile driving, post-UXO/MEC detonation, etc.);
(xvii) Marine mammal occurrence in Level A harassment or Level B harassment zones;
(xviii) Description of any mitigation-related action implemented, or mitigation-related actions called for but not implemented, in response to the sighting (*e.g.*, delay, shutdown, etc.) and time and location of the action; and
(xix) Other human activity in the area.

3) For all real-time acoustic detections of marine mammals, the following must be recorded and included in weekly, monthly, annual, and final reports:
    (i) Location of hydrophone (latitude & longitude; in Decimal Degrees) and site name;
    (ii) Bottom depth and depth of recording unit (in meters);
    (iii) Recorder (model & manufacturer) and platform type (*i.e.,* bottom-mounted, electric glider, etc.), and instrument ID of the hydrophone and recording platform (if applicable);
    (iv) Time zone for sound files and recorded date/times in data and metadata (in relation to UTC. *i.e.*, EST time zone is UTC-5);
    (v) Duration of recordings (start/end dates and times; in ISO 8601 format, yyyy-mm-ddTHH:MM:SS.sssZ);
    (vi) Deployment/retrieval dates and times (in ISO 8601 format);
    (vii) Recording schedule (must be continuous);
    (viii) Hydrophone and recorder sensitivity (in dB *re. 1 μPa*);
    (ix) Calibration curve for each recorder;
    (x) Bandwidth/sampling rate (in Hz);
    (xi) Sample bit-rate of recordings; and,
    (xii) Detection range of equipment for relevant frequency bands (in meters).

4) For each detection, the following information must be noted:
    (i) Species identification (if possible);

(ii) Call type and number of calls (if known);
(iii) Temporal aspects of vocalization (date, time, duration, etc.; date times in ISO 8601 format);
(iv) Confidence of detection (detected, or possibly detected);
(v) Comparison with any concurrent visual sightings;
(vi) Location and/or directionality of call (if determined) relative to acoustic recorder or construction activities;
(vii) Location of recorder and construction activities at time of call;
(viii) Name and version of detection or sound analysis software used, with protocol reference;
(ix) Minimum and maximum frequencies viewed/monitored/used in detection (in Hz); and
(x) Name of PAM operator(s) on duty.

5) *Weekly Reports.*

(i) Revolution Wind must compile and submit weekly PSO, PAM, and sound field verification (SFV) reports to NMFS (at *itp.esch@noaa.gov* and *PR.ITP.monitoringreports@noaa.gov*) that document the daily start and stop of all pile driving, HRG survey, or UXO/MEC detonation activities, the start and stop of associated observation periods by PSOs, details on the deployment of PSOs, a record of all detections of marine mammals (acoustic and visual), any mitigation actions (or if mitigation actions could not be taken, provide reasons why), and details on the noise abatement system(s) used and its performance. Weekly reports are due on Wednesday for the previous week (Sunday – Saturday) and must include the information required under this section. The weekly report will also identify which turbines become operational and when (a map must be provided). Once all foundation pile installation is completed, weekly reports are no longer required;
(ii) [Reserved].

6) *Monthly Reports.*

(i) Revolution Wind must compile and submit monthly reports to NMFS (at *itp.esch@noaa.gov* and *PR.ITP.monitoringreports@noaa.gov*) that include a summary of all information in the weekly reports, including project activities carried out in the previous month, vessel transits (number, type of vessel, and route), number of piles installed, number of UXO/MEC detonations, all detections of marine mammals, and any mitigative action taken. Monthly reports are due on the 15th of the month for the previous month. The monthly report must also identify which turbines become operational and when (a map must be provided). Once foundation installation is complete, monthly reports are no longer required;
(ii) [Reserved].

7) *Annual Reports.*

(i) Revolution Wind must submit an annual report to NMFS (at *itp.esch@noaa.gov* and *PR.ITP.monitoringreports@noaa.gov*) no later than 90 days following the end of a given calendar year. Revolution Wind must provide a final report within 30 days following resolution of comments on the draft report. The report must detail the following information and the information specified in § 217.275(d)(2)(i-xix), § 217.275(d)(3)(i-xii), and § 217.275(d)(4)(i-x):

(A) The total number of marine mammals of each species/stock detected and how many were within the designated Level A harassment and Level B harassment zones with comparison to authorized take of marine mammals for the associated activity type;

(B) Marine mammal detections and behavioral observations before, during, and after each activity;

(C) What mitigation measures were implemented (*i.e.*, number of shutdowns or clearance zone delays, etc) or, if no mitigative actions was taken, why not;

(D) Operational details (*i.e.*, days of impact and vibratory pile driving, days/amount of HRG survey effort, total number and charge weights related to UXO/MEC detonations, etc.);

(E) SFV results;

(F) Any PAM systems used;

(G) The results, effectiveness, and which noise abatement systems were used during relevant activities (*i.e.*, impact pile driving, UXO/MEC detonation);

(H) Summarized information related to Situational Reporting; and

(I) Any other important information relevant to the Revolution Wind project, including additional information that may be identified through the adaptive management process.

(ii) The final annual report must be prepared and submitted within 30 calendar days following the receipt of any comments from NMFS on the draft report. If no comments are received from NMFS within 60 calendar days of NMFS' receipt of the draft report, the report must be considered final.

8) *Final Report*.

(i) Revolution Wind must submit its draft final report to NMFS (at *itp.esch@noaa.gov* and *PR.ITP.monitoringreports@noaa.gov*) on all visual and acoustic monitoring conducted under the LOA within 90 calendar days of the completion of activities occurring under the LOA. A final report must be prepared and submitted within 30 calendar days following receipt of any NMFS comments on the draft report. If no comments are received from NMFS within 30 calendar days of NMFS' receipt of the draft report, the report shall be considered final.

(ii) [Reserved].

9) Sound Field Verification Reporting.

(i) Revolution Wind must provide the initial results of the SFV measurements to NMFS in an interim report after each monopile foundation installation for the first three monopiles piles, and for each UXO/MEC detonation as soon as they are available, but no later than 48 hours after each installation or detonation. Revolution Wind must also provide interim reports on any subsequent SFV on foundation piles within 48 hours. The interim report must include hammer energies used during pile driving or UXO/MEC weight (including donor charge weight), peak sound pressure level (SPL_{pk}) and (1) median, (2) mean, (3) maximum, and (4) minimum root-mean-square sound pressure level that contains 90 percent of the acoustic energy (SPL_{rms}) and single strike sound exposure level (SEL_{ss});

(ii) The final results of SFV of monopile installations must be submitted as soon as possible, but no later than within 90 days following completion of impact pile driving of monopiles and UXO/MEC detonations. The final report must include, at minimum, the following:

(A) Peak sound pressure level (SPL_{pk}), root-mean-square sound pressure level that contains 90 percent of the acoustic energy (SPL_{rms}), single strike sound exposure level (SEL_{ss}), integration time for SPL_{rms}, spectrum, and 24-hour cumulative SEL extrapolated from measurements at specified distances (*e.g.*, 750 m). All these levels must be reported in the form of (1) median, (2) mean, (3) maximum, and (4) minimum. The SEL and SPL power spectral density and one-third octave band levels (usually calculated as decidecade band levels) at the receiver locations should be reported;

(B) The sound levels reported must be in median and linear average (*i.e.*, average in linear space), and in dB;

(C) A description of depth and sediment type, as documented in the Construction and Operation Plan, at the recording and pile driving locations;

(D) Hammer energies required for pile installation and the number of strikes per pile;

(E) Hydrophone equipment and methods (*i.e.*, recording device, bandwidth/sampling rate, distance from the pile where recordings were made; depth of recording device(s));

(F) Description of the SFV PAM hardware and software, including software version used, calibration data, bandwidth capability and sensitivity of hydrophone(s), any filters used in hardware or software, any limitations with the equipment, and other relevant information;

(G) Description of UXO/MEC, weight, including donor charge weight, and why detonation was necessary;

(H) Local environmental conditions, such as wind speed, transmission loss data collected on-site (or the sound velocity profile), baseline pre- and post-activity ambient sound levels (broadband and/or within frequencies of concern);

(I) Spatial configuration of the noise attenuation device(s) relative to the pile;

(J) The extents of the Level A harassment and Level B harassment zones; and

(K) A description of the noise abatement system and operational parameters (*e.g.*, bubble flow rate, distance deployed from the pile, etc.) and any action taken to adjust the noise abatement system.

10) *Situational Reporting*. Specific situations encountered during the development of Revolution Wind shall require immediate reporting to be undertaken. These situations and the relevant procedures are described below.

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

(ii) When an observation of a marine mammal occurs during vessel transit, the following information must be recorded:

(A) Time, date, and location;

(B) The vessel's activity, heading, and speed;

(C) Sea state, water depth, and visibility;

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

(E) Initial distance and bearing to marine mammal from vessel and closest point of approach; and

(F) Any avoidance measures taken in response to the marine mammal sighting.

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

(iv) In the event that the personnel involved in the activities defined in § 217.270(a) discover a stranded, entangled, injured, or dead marine mammal, Revolution Wind must immediately report the observation to the NMFS Office of Protected Resources (OPR), the NMFS Greater Atlantic Stranding Coordinator for the New England/Mid-Atlantic area (866-755-6622), and the U.S. Coast Guard within 24 hours. If the injury or death was caused by a project activity, Revolution Wind must immediately cease all activities until NMFS OPR is able to review the circumstances of the incident and determine what, if any, additional measures are appropriate to ensure compliance with the terms of the LOA. NMFS may impose additional measures to minimize the likelihood of further prohibited take and ensure MMPA compliance. Revolution Wind may not resume their activities until notified by NMFS. The report must include the following information:

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

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

(C) Condition of the animal(s) (including carcass condition if the animal is dead);
(D) Observed behaviors of the animal(s), if alive;
(E) If available, photographs or video footage of the animal(s); and
(F) General circumstances under which the animal was discovered.

(v) In the event of a vessel strike of a marine mammal by any vessel associated with the Revolution Wind Offshore Wind Farm Project, Revolution Wind must immediately report the strike incident to the NMFS OPR and the GARFO within and no later than 24 hours. Revolution Wind must immediately cease all activities until NMFS OPR is able to review the circumstances of the incident and determine what, if any, additional measures are appropriate to ensure compliance with the terms of the LOA. NMFS may impose additional measures to minimize the likelihood of further prohibited take and ensure MMPA compliance. Revolution Wind may not resume their activities until notified by NMFS. The report must include the following information:
(A) Time, date, and location (latitude/longitude) of the incident;
(B) Species identification (if known) or description of the animal(s) involved;
(C) Vessel's speed leading up to and during the incident;
(D) Vessel's course/heading and what operations were being conducted (if applicable);
(E) Status of all sound sources in use;
(F) Description of avoidance measures/requirements that were in place at the time of the strike and what additional measures were taken, if any, to avoid strike;
(G) Environmental conditions (*e.g.*, wind speed and direction, Beaufort sea state, cloud cover, visibility) immediately preceding the strike;
(H) Estimated size and length of animal that was struck;
(I) Description of the behavior of the marine mammal immediately preceding and following the strike;
(J) If available, description of the presence and behavior of any other marine mammals immediately preceding the strike;
(K) Estimated fate of the animal (*e.g.*, dead, injured but alive, injured and moving, blood or tissue observed in the water, status unknown, disappeared); and
(L) To the extent practicable, photographs or video footage of the animal(s).

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
GREATER ATLANTIC REGIONAL FISHERIES OFFICE
55 Great Republic Drive
Gloucester, MA 01930

June 29, 2021

James F. Bennett
Program Manager, Office of Renewable Energy Programs
U.S. Department of the Interior
Bureau of Ocean Energy Management
45600 Woodland Road, VAM-OREP
Sterling, Virginia 20166

Dear Mr. Bennett:

We have completed consultation pursuant to section 7 of the Endangered Species Act (ESA) of 1973, as amended, concerning the effects of certain site assessment and site characterization activities to be carried out to support the siting of offshore wind energy development projects off the U.S. Atlantic coast. The Bureau of Ocean Energy Management (BOEM) is the lead federal agency for this consultation. BOEM's request for consultation included a biological assessment (BA) that was finalized in February 2021 and was supplemented with modified Project Design Criteria (PDC) and supplemental information through June 11, 2021. The activities considered in this consultation may occur in the three Atlantic Renewable Energy Regions (North Atlantic Planning Area, Mid-Atlantic Planning Area, and South Atlantic Planning Area; see Figure 1 in Appendix A) and adjacent coastal waters over the next 10 years (i.e., June 2021 – June 2031). Other action agencies include the U.S. Army Corps of Engineers (USACE), the U.S. Department of Energy (DOE), the U.S. Environmental Protection Agency (EPA), and the National Marine Fisheries Service's (NMFS) Office of Protected Resources (OPR).

ACTION AREA AND PROPOSED ACTIONS

As defined in 50 CFR 402.02, "programmatic consultation is a consultation addressing an agency's multiple actions on a program, region, or other basis. Programmatic consultations allow NMFS to consult on the effects of programmatic actions such as: (1) Multiple similar, frequently occurring, or routine actions expected to be implemented in particular geographic areas; and, (2) A proposed program, plan, policy, or regulation providing a framework for future proposed actions." This programmatic consultation considers category 1--multiple similar, frequently occurring, or routine actions expected to be implemented in particular geographic areas.

The survey activities considered in this consultation are geophysical and geotechnical surveys and the deployment, operation, and retrieval of environmental data collection buoys. These frequent, similar activities are expected to be implemented along the U.S. Atlantic coast in the three Atlantic Renewable Energy Regions (North Atlantic Planning Area, Mid-Atlantic Planning Area, and South Atlantic Planning Area). The meteorological buoys and geophysical and geotechnical surveys are expected to occur to support the potential future siting of offshore wind turbines, cables, and associated offshore facilities such as substations or service platforms.

Action Agencies
As noted above, the activities considered here may be authorized, funded, or carried out by BOEM, the DOE, the EPA, the USACE, and NMFS. The roles of these action agencies are described here.

BOEM
The Outer Continental Shelf Lands Act (OCSLA), as amended, mandates the Secretary of the Interior (Secretary), through BOEM, to manage the siting and development of the Outer Continental Shelf (OCS) for renewable energy facilities. BOEM is delegated the responsibility for overseeing offshore renewable energy development in Federal waters (30 C.F.R. Part 585). Through these regulations, BOEM oversees responsible offshore renewable energy development, including the issuance of leases for offshore wind development. This consultation considers the effects of certain data collection activities (geophysical and geotechnical surveys and deployment of meteorological buoys) that may be undertaken to support offshore wind development. BOEM regulations require that a lessee provide the results of shallow hazard, geological, geotechnical, biological, and archaeological surveys with its Site Assessment Plan and Construction and Operations Plan (see 30 C.F.R. 585.610(b) and 30 C.F.R. 585.626(a)). BOEM also funds data collection projects, such as seafloor mapping through the Environmental Studies Program (ESP). The activities considered here may or may not occur in association with a BOEM lease. This consultation does not obviate the need for an appropriate consultation to occur on lease issuance or the approval of a Site Assessment Plan or Construction and Operations Plan.

DOE
The DOE's Office of Energy Efficiency and Renewable Energy (EERE) provides federal funding (financial assistance) in support of renewable energy technologies. EERE's Wind Energy Technologies Office invests in energy science research and development activities that enable the innovations needed to advance U.S. wind systems, reduce the cost of electricity, and accelerate the deployment of wind power, including offshore wind. EERE's Water Power Technologies Office enables research, development, and testing of emerging technologies to advance marine energy. DOE's financial assistance in support of renewable energy projects could have consequences for listed species in federal or state waters. Data collection activities that may be supported by DOE and are considered in this programmatic consultation include deployment of meteorological buoys and geotechnical and geophysical surveys.

EPA
Section 328(a) of the Clean Air Act (CAA) (42 U.S.C. § 7401 *et seq.*) as amended by Public Law 101-549 enacted on November 15, 1990, required the EPA to establish air pollution control requirements for OCS sources subject to the OCSLA for all areas of the OCS, except those located in the Gulf of Mexico west of 87.5 degrees longitude (near the border of Florida and Alabama),[1] in order to attain and maintain Federal and State ambient air quality standards and comply with the provisions of part C of title I of the Act.[2] To comply with this statutory mandate, on September 4, 1992, EPA promulgated "Outer Continental Shelf Air Regulations" at 40 C.F.R. part 55. (57 Fed. Reg. 40,791). 40 C.F.R part 55 also established procedures for

[1] Public Law 112-74, enacted on December 23, 2011, amended § 328(a) to add an additional exception from EPA regulation for OCS sources "located offshore of the North Slope Borough of the State of Alaska."
[2] Part C of title I contains the Prevention of Significant Deterioration of Air Quality (PSD) requirements.

implementation and enforcement of air pollution control requirements for OCS sources. 40 C.F.R. § 55.2 states:

> OCS source means any equipment, activity, or facility, which:
> (1) Emits or has the potential to emit any air pollutant;
> (2) Is regulated or authorized under OCSLA (43 U.S.C. § 1331 *et seq.*); and,
> (3) Is located on the OCS or in or on waters above the OCS.
> This definition shall include vessels only when they are:
> (1) Permanently or temporarily attached to the seabed and erected thereon and used for the purpose of exploring, developing, or producing resources therefrom …; or
> (2) Physically attached to an OCS facility, in which case only the stationary sources aspects of the vessels will be regulated.

As described in the BA, where activities considered in this consultation emit or will have the potential to emit air pollutants and are located on the OCS or in or on waters above the OCS, the activities may be subject to the 40 C.F.R. part 55 requirements, including the 40 C.F.R. § 55.6 permitting requirements. Such activities are expected to be limited to vessel operations and some meteorological buoys.

USACE

Of the activities considered in this consultation, the deployment of meteorological buoys and carrying out geotechnical surveys may require authorization from the USACE. The USACE has regulatory responsibilities under Section 10 of the Rivers and Harbors Act of 1899 to approve/permit any structures or activities conducted below the mean high water line of navigable waters of the United States. The USACE also has responsibilities under Section 404 of the Clean Water Act (CWA) to prevent water pollution, obtain water discharge permits and water quality certifications, develop risk management plans, and maintain such records. A USACE Nationwide Permit (NWP) 5 or Regional General Permit (RGP) for Scientific Measurement Devices is required for devices and scientific equipment whose purpose is to record scientific data through such means as meteorological stations (which would include buoys); water recording and biological observation devices, water quality testing and improvement devices, and similar structures. In New England States, RGPs are required instead of the NWP. As stated in both types of permit, "*upon completion of the use of the device to measure and record scientific data, the measuring device and any other structures or fills associated with that device (e.g., foundations, anchors, buoys, lines, etc.) must be removed to the maximum extent practicable and the site restored to preconstruction elevations,*" as prescribed by Section 404 of the CWA (U. S. Army Corps of Engineers 2012).

Consideration of Potential Issuance of Incidental Harassment Authorizations for Survey Activities

The Marine Mammal Protection Act (MMPA), and its implementing regulations, allows, upon request, the incidental take of small numbers of marine mammals by U.S. citizens who engage in a specified activity (other than commercial fishing) within a specified geographic region. Incidental take is an unintentional, but not unexpected, "take." Upon receipt and review of an adequate and complete application, NMFS OPR may authorize the incidental take of marine mammals incidental to the marine site characterization surveys pursuant to the MMPA, if the required findings are made. Proponents of some survey activities considered here may be required to obtain Incidental Take Authorizations (ITAs) under the MMPA. Therefore, the Federal actions considered in this consultation include the issuance of ITAs for survey activities described herein. Those ITAs may or may not provide MMPA take authorization for marine mammal species that are also listed under the ESA. As noted above, we have determined that all activities considered (inclusive of all PDC and BMPs) in this consultation will have no effect or are not likely to adversely affect any species listed under the ESA. By definition, that means that no take, as defined in the ESA, is anticipated. However, given the differences in the definitions of "harassment" under the MMPA and ESA, it is possible the site characterization surveys could result in harassment, as defined under the MMPA, but meet the ESA definition of "not likely to adversely affect." This consultation addresses such situations.

Under the MMPA (16 U.S.C. §1361 et seq.), take is defined as "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal" and further defined by regulation (50 C.F.R. §216.3). Harassment is defined under the MMPA as any act of pursuit, torment, or annoyance which: has the potential to injure a marine mammal or marine mammal stock in the wild (Level A Harassment); or 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). 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.

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[3] 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 Marine Mammals section of this letter.

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. As explained below, we determined that the effects to ESA-listed marine mammals resulting from the survey activities considered here would be insignificant and not result in harassment per NMFS' interim guidance on harassment under the ESA.

[3] NMFS Policy Directive 02-110-19; available at *https://media.fisheries.noaa.gov/dam-migration/02-110-19.pdf*; last accessed March 25, 2021.

Activities Considered in this Programmatic Consultation

The survey activities that are considered here consist of high resolution geophysical (HRG) and geotechnical surveys designed to characterize benthic and subsurface conditions and deployment, operation, and retrieval of environmental data collection buoys. A complete description of representative survey equipment to be used is included in Appendix A (Tables A.1 and A.2). Additionally, this consultation considers effects of deploying, operating, and retrieving buoys equipped with scientific instrumentation to collect oceanographic, meteorological, and biological data. All activities considered here will comply with a set of PDC (see Appendix B). We also consider the effects of vessel traffic associated with these activities. All vessels carrying out these activities, including during transits, will comply with measures outlined in Appendix B regardless of the equipment used or the sound levels/frequency at which equipment is operating. This consultation does not consider the effects of any survey activities that have the potential to result in directed or incidental capture or collection of any ESA-listed species (e.g., trawl surveys in areas where ESA-listed sea turtles occur).

This consultation does not evaluate the construction of any commercial electricity generating facilities or transmission cables with the potential to export electricity. Consistent with our understanding of the relevant regulations, BOEM has indicated that any such proposals for installation of electricity generating facilities (i.e., installation of wind turbines) or transmission cables would be a separate federal action (including authorization from BOEM) requiring a separate section 7 consultation. “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; see also 50 CFR §402.17). The construction, operation, and/or decommissioning of any offshore wind facility or appurtenant facilities (e.g., cables, substations, etc.) are not consequences of the proposed survey activities considered here as they are not reasonably certain to occur. As such, this consultation does not consider these activities.

Action Area

The action area is defined by regulation as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action" (50 CFR 402.02). The Action Area for this consultation includes the areas to be surveyed and where buoys will be deployed, areas where increased levels of noise will be experienced as well as the vessel transit routes between existing Atlantic coast ports and the survey area. This area encompasses all effects of the proposed action considered here.

Surveys considered in this programmatic consultation will take place at depths 100-meters (m) or less within the three Atlantic Renewable Energy Regions (North Atlantic Planning Area, Mid-Atlantic Planning Area, and South Atlantic Planning Area) located on the Atlantic Outer Continental Shelf (OCS) and may also occur along potential cable corridor routes in nearshore waters of Atlantic coast states. The three planning areas extend from the US/Canada border in the north to Palm Bay, Florida in the south. The North, Mid-Atlantic, and South Atlantic planning areas together extend seaward from the U.S./Canadian border in the North to Palm Bay, Florida in the South. For the purposes of this consultation, the action area includes the Atlantic Renewable Energy Regions in OCS waters out to the 100 m depth contour in the North Atlantic, extending from waters offshore Maine to New Jersey; Mid-Atlantic, extending from waters offshore Delaware to North Carolina; and the South Atlantic extending from waters offshore South Carolina to east-central Florida and the adjacent coastal waters to the Atlantic coast (see Figure 1 in Appendix A for map of the action area). The offshore extent of the action area is defined by the anticipated maximum water depth where potential offshore wind facilities could be constructed. The seaward limit for siting a wind energy facility on the OCS is approximately 25 nautical miles (nm) (46.3 kilometers [km]) from shore or 100 m (328 feet [ft.]) water depth due to economic viability limitations. The current fixed foundation technologies are limited to depths of about 60 m. Although the majority of site assessment and site characterization activities will occur in water <60 m to accommodate the depth limitations in support of fixed foundations for wind turbine generators, floating foundations may be used in water depths >60 m in the future.

IMPLEMENTATION, TRACKING, AND REPORTING FOR THIS PROGRAMMATIC CONSULTATION

As noted above, activities considered in this consultation may be authorized, funded, or carried out by one or more action agencies. When one of these action agencies identifies a proposed activity that they believe falls within the scope of this programmatic consultation, they will first identify a lead action agency for the review (we anticipate that in most cases this will be BOEM). They will then review the activity to confirm that it is consistent with the activities covered by this consultation, including a review to confirm that all relevant PDCs (as outlined in Appendix B) will be implemented. The lead action agency for the activity will send written correspondence to the NMFS Greater Atlantic Regional Fisheries Office (GARFO) (nmfs.gar.esa.section7@noaa.gov) providing a brief summary of the proposed activity, including location and duration, and the agency's determination that the proposed activity is consistent with the scope of activities considered in this consultation. The action agency will also confirm in writing that all relevant PDCs will be implemented. If NMFS GARFO has any questions about the activity or determines it is not within the scope of this consultation, a written reply will be provided to the action agency within 15 calendar days. Activities that are determined to not be within the scope of this consultation can be modified by the action agency to bring them within the scope of this consultation or the action agency can request a stand-alone ESA section 7 consultation outside of this programmatic consultation.

To provide flexibility while maintaining the intent of this programmatic consultation, if an action agency proposes use of an equipment type different than described in this consultation, but can demonstrate that the acoustic characteristics are similar to the representative equipment described in Table A.2 and that implementation of the PDCs will result in the same effects considered here, this can be described when the survey plan is transmitted to us. Similarly, it is possible to consider modifications to the PDCs for a particular survey plan when the lead action agency can demonstrate that the same conservation benefit or risk reduction can be achieved with an alternate proposal.

In order to track activities carried out under this programmatic consultation, by February 15 of each year, BOEM, as the lead agency for this programmatic consultation, will provide a written report to NMFS documenting the activities that occurred under the scope of this consultation in the previous year (e.g., the report for 2021 activities will be due by February 15, 2022). This annual report will also transmit any monitoring reports and any reports of instances where PDCs were not implemented (e.g., where human safety prevented implementation of an otherwise required speed reduction). Following the receipt of the annual report, a meeting will be held if necessary to review and update any PDCs and to update the list of representative equipment.

ESA-LISTED SPECIES AND CRITICAL HABITAT CONSIDERED IN THIS CONSULTATION

In their BA, BOEM described the ESA-listed species and critical habitats that occur along the U.S. Atlantic coast. Of the species listed in the BA, we have determined that oceanic whitetip shark (*Carcharhinus longimanus*), Nassau grouper (*Epinephelus striatus*)[4], staghorn coral (*Acropora cervicornis*), elkhorn coral (*Acropora palmata*), pillar coral (*Dendrogyra cylindrus*), rough cactus coral (*Mycetophyllia ferox*), lobed star coral (*Orbicella annularis*), mountainous star coral (*Orbicella faveolata*), and boulder star coral (*Orbicella franksi*) do not occur in the action area.

ESA-Listed Species in the Action Area

The following listed species occur in the action area and are considered in this consultation:

Table 1. ESA-listed species that may be affected by the proposed action.

Common Name	Scientific Name	ESA Status
Marine Mammals – Cetaceans		
North Atlantic right whale	*Eubalaena glacialis*	Endangered
Fin Whale	*Balaenoptera physalus*	Endangered
Sei Whale	*Balaenoptera borealis*	Endangered
Sperm Whale	*Physeter macrocephalus*	Endangered
Blue whale	*Balaenoptera musculus*	Endangered
Sea Turtles		
Loggerhead turtle - Northwest Atlantic DPS	*Caretta*	Threatened
Green turtle - North Atlantic DPS and South Atlantic DPS	*Chelonia mydas*	Threatened
Kemp's ridley turtle	*Lepidochelys kempii*	Endangered

[4] Nassau grouper may occur in nearshore and offshore waters in the Florida Straits Planning Area but are not known to occur in nearshore or offshore waters of the South Atlantic Planning Area (NMFS 2013)

Leatherback turtle	*Dermochelys coriacea*	Endangered
Hawksbill turtle	*Eretmochelys imbricata*	Endangered
	Fishes	
Atlantic salmon	*Salmo salar*	Endangered
Atlantic sturgeon	*Acipenser oxyrinchus*	Endangered
New York Bight DPS		Endangered
Chesapeake Bay DPS		Endangered
Carolina DPS		Endangered
South Atlantic DPS		Endangered
Gulf of Maine DPS		Threatened
Giant Manta Ray	*Manta birostris*	Threatened
Shortnose sturgeon	*Acipenser brevirostrum*	Endangered
Smalltooth sawfish	*Pristis pectinate*	Endangered

BOEM has determined the proposed action is not likely to adversely affect any of these species. We concur with this determination based on the rationale presented below. More information on the status of the species and critical habitat considered in this consultation, as well as relevant listing documents, status reviews, and recovery plans, can be found within the BA and on NMFS webpages accessible at: *https://www.greateratlantic.fisheries.noaa.gov/protected/section7/listing/index.html*, *https://sero.nmfs.noaa.gov/protected_resources/section_7/threatened_endangered/index.html*, and *https://www.fisheries.noaa.gov/species-directory*.

Critical Habitat in the Action Area

The action area overlaps, at least in part, with critical habitat designated for all five DPSs of Atlantic sturgeon, North Atlantic right whales, and the Northwest Atlantic Ocean DPS of loggerhead sea turtles. While critical habitat is designated for some of the other species considered in this consultation, that critical habitat does not occur in the action area. Critical habitat for the Gulf of Maine DPS of Atlantic salmon is limited to certain mainstem rivers in the State of Maine. At this time, we do not know of any geotechnical or geophysical survey activities that are likely to occur in those waters. As such, the proposed action will not overlap with critical habitat designated for the Gulf of Maine DPS of Atlantic salmon. BOEM determined that the activities considered here may affect, but are not likely to adversely affect critical habitat designated for the five DPSs of Atlantic sturgeon or the Northwest Atlantic DPS of loggerhead sea turtles. We concur with these determinations based on the rationale presented in the Effects of the Action section below.

BOEM determined that the activities considered here would have no effect on critical habitat designated for North Atlantic right whales. We agree with this determination as described briefly below.

Critical Habitat designated for the North Atlantic Right Whale
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). Geophysical and geotechnical surveys and met buoy deployment may occur in Unit 1 and Unit 2. Note that there are seasonal restrictions on certain acoustic survey equipment in Unit 1 and Unit 2 (PDC 4); however, these seasonal restrictions are in place to further reduce the potential for effects to right whales in these areas and are not related to effects on the features of that critical habitat.

Consideration of Potential Effects to 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.

The activities considered here will not affect the physical oceanographic conditions and structures of the region that distribute and aggregate *C. finmarchicus* for foraging. This is because the activities considered here have no potential to affect currents and circulation patterns, flow velocities, bathymetric features (basins, banks, and channels), oceanic fronts, density gradients, or temperature regimes. Therefore, we have determined that the activities considered in this programmatic consultation 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.

The activities considered here will have no effect on the features of Unit 2; this is because geophysical and geotechnical surveys, met buoys, and vessel operations do not affect sea surface state, water temperature, or water depth. Therefore, we have determined that the activities considered in this programmatic consultation will have no effect on Unit 2 of right whale critical habitat

EFFECTS OF THE ACTION ON NMFS LISTED SPECIES AND CRITICAL HABITAT

Potential effects of the proposed action on listed species can be broadly categorized into the following categories: (1) effects to individual animals of exposure to noise associated with the survey activities (HRG, geotechnical), (2) effects of buoy deployment, operation, and retrieval; (3) effects to habitat from survey activities (including consideration of effects to Atlantic sturgeon and loggerhead critical habitat), and (4) effects of vessel use.

Effects of Exposure to Noise Associated With Survey Activities

Here we consider effects of noise associated with HRG and geotechnical surveys on ESA-listed species. Noise associated with meteorological buoys and vessel operations is discussed in those sections of this consultation.

Acoustic Thresholds

Due to the different hearing sensitivities of different species groups, NMFS uses different sets of acoustic thresholds to consider effects of noise on ESA-listed species. Below, we present information on thresholds considered for ESA-listed whales, sea turtles, and fish considered in this consultation.

ESA-listed 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[5]). 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).

[5] See *https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-acoustic-technical-guidance* for more information.

Table 2. Impulsive acoustic thresholds identifying the onset of permanent threshold shift and temporary threshold shift for ESA-listed whales (NMFS 2018).

Hearing Group	Generalized Hearing Range[6]	Permanent Threshold Shift Onset[7]	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

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. The two metrics also differ in regard to considering information on species hearing. 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.

Additionally, NMFS considers exposure to impulsive/intermittent noise greater than 160 dB re 1uPa rms to have the potential to result in Level B harassment, as defined under the MMPA (which does not necessarily equate to ESA harassment). This value is based on observations of behavioral responses of baleen whales (Malme et al. 1983; Malme et al. 1984; Richardson et al. 1986; Richardson et al. 1990), but is used for all marine mammal species.

Sea Turtles

In order to evaluate the effects of exposure to the survey noise by sea turtles, we rely on the available scientific literature. 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 (Ridgway et al. 1969, Lenhardt 1994, Bartol et al. 1999, Lenhardt 2002, Bartol and Ketten 2006). Currently, the best available data regarding the potential for noise to cause behavioral disturbance come from studies by O'Hara and Wilcox (1990) and McCauley et al. (2000), who experimentally examined behavioral responses of sea turtles in response to seismic airguns. O'Hara and Wilcox

[6] 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).

[7] $L_{pk,flat}$: 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 ($_{24h}$)

(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. (2000) reported a noticeable increase in swimming behavior for both green and loggerhead turtles at received levels of 166 dB re: 1 µPa (rms). At 175 dB re: 1 µPa (rms), both green and loggerhead turtles displayed increased swimming speed and increasingly erratic behavior (McCauley et al. 2000). Based on these data, we assume that sea turtles would exhibit a behavioral response when exposed to received levels of 175 dB re: 1 µPa (rms) and higher.

In order to evaluate the effects of exposure to the survey noise by sea turtles that could result in physical effects, we relied on the available literature related to the noise levels that would be expected to result in sound-induced hearing loss (i.e., temporary threshold shift (TTS) or permanent threshold shift (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 2017). 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 statistical 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 2017).

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 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 (Southall et al. 2007). 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 (SEL_{cum}) that incorporates both the auditory weighting function and the exposure duration (Table 3).

Table 3. Acoustic thresholds identifying the onset of permanent threshold shift and temporary threshold shift for sea turtles exposed to impulsive sounds (U.S. Navy 2017, McCauley et al. 2000).

Hearing Group	Generalized Hearing Range	Permanent Threshold Shift Onset	Temporary Threshold Shift Onset	Behavioral Response
Sea Turtles	30 Hz to 2 kHz	204 dB re: 1 µPa^2·s SEL$_{cum}$	189 dB re: 1 µPa^2·s SEL$_{cum}$	175 dB re: 1 µPa (rms)
		232 dB re: 1 µPa SPL (0-pk)	226 dB re: 1 µPa SPL (0-pk)	

Marine Fish

There are no criteria developed for considering effects to ESA-listed fish specific to HRG equipment. However, all of the equipment that operates within a frequency that these fish species are expected to respond to, produces intermittent or impulsive sounds; therefore, it is reasonable to use the criteria developed for impact pile driving, seismic, and explosives when considering effects of exposure to this equipment (FHWG 2008). However, unlike impact pile driving, which produces repetitive impulsive noise in a single location, the geophysical survey sound sources are moving; therefore, the potential for repeated exposure to multiple pulses is much lower when compared to pile driving. We expect fish to react to noise that is disturbing by moving away from the sound source and avoiding further exposure. Injury and mortality is only known to occur when fish are very close to the noise source and the noise is very loud and typically associated with pressure changes (i.e., impact pile driving or blasting).

The Fisheries Hydroacoustic Working Group (FHWG) was formed in 2004 and consists of biologists from NMFS, United States Fish and Wildlife Service, Federal Highway Administration, USACE, and the California, Washington, and Oregon Department of Transportations, 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 are onset of physiological effects (Stadler and Woodbury, 2009), and not levels at which fish are necessarily mortally damaged. These criteria were developed to apply to all fish species. The interim criteria are:

- Peak SPL: 206 dB re 1 µPa
- SELcum: 187 B 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 ESA-listed marine fish 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 noise source and the duration of exposure. The closer to the source and the greater the duration of the exposure, the higher likelihood of significant injury. 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.

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 (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.

HRG Acoustic Sources

HRG surveys are used for a number of site characterization purposes: locating shallow hazards, cultural resources, and hard-bottom areas; evaluating installation feasibility; assisting in the selection of appropriate foundation system designs; and determining the variability of subsurface sediments. The equipment typically used for these surveys includes: Bathymetry/Depth Sounder; Magnetometer; Seafloor Imagery/Side-Scan Sonar; Shallow and Medium (Seismic) Penetration Sub-bottom Profilers (e.g., CHIRPs, boomers, bubble guns). This consultation does not consider the use of seismic airguns because this equipment is not required for site characterization activities to support offshore wind development (due to the shallow sediment depths that need to be examined, compared to the miles into the seabed that are examined for oil and gas exploration where airguns are used).

As described in the BA, 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 (see tables in Appendix A). 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. PTS cumulative exposure distances were calculated for the low-frequency hearing group (sei, fin, and North Atlantic right whales), the mid-frequency group (sperm whales), and for a worst-case exposure scenario of 60 continuous minutes for sea turtles and fish.

Tables 4 and 5 describe the greatest distances to thresholds of concern for the various equipment types analyzed by BOEM. It is important to note that as different species groups have different hearing sensitivities, not all equipment operates within the hearing threshold of all species considered here. Complete tables are included in Appendix B of BOEM’s BA.

Table 1. Summary of greatest PTS Exposure Distances from mobile HRG Sources at Speeds of 4.5 knots.

HRG SOURCE	PTS DISTANCE (m)								
	Highest Source Level (dB re 1 μPa)	**Sea Turtles**		**Fish[b]**		**Baleen Whales**		**Sperm Whales[c]**	
Mobile, Impulsive, Intermittent Sources									
		Peak	*SEL*	*Peak*	*SEL*	*Peak*	*SEL*	*Peak*	*SEL*
Boomers, Bubble Guns	176 dB SEL 207 dB RMS 216 PEAK	0	0	3.2	0	0	0.3	0	0
Sparkers	188 dB SEL 214 dB RMS 225 PEAK	0	0	9	0	2	12.7	0	0.2
Chirp Sub-Bottom Profilers	193 dB SEL 209 dB RMS 214 PEAK	NA	NA	NA	NA	0	1.2	0	0.3
Mobile, Non-impulsive, Intermittent Sources									
Multi-beam echosounder (100 kHz)	185 dB SEL 224 dB RMS 228 PEAK	NA	NA	NA	NA	NA	NA	0	0.5
Multi-beam echosounder (>200 kHz) (mobile, non-impulsive, intermittent)	182 dB SEL 218 dB RMS 223 PEAK	NA	NA	NA	NA	NA	NA	NA	NA
Side-scan sonar (>200 kHz) (mobile, non-impulsive, intermittent)	184 dB SEL 220 dB RMS 226 PEAK	NA	NA	NA	NA	NA	NA	NA	NA

[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.

Using the same sound sources for the PTS analysis, BOEM calculated the distances to 175 dB re 1 μPa rms for sea turtles, 160 dB re 1 μPa rms for marine mammals, and 150 dB re 1 μPa rms for fish were calculated using a spherical spreading model (20 LogR) (Table 5). BOEM has conservatively used the highest power levels for each sound source reported in Crocker and Fratantonio (2016). Additionally, the spreadsheet and geometric spreading models do not consider the tow depth and directionality of the sources; therefore, these are likely overestimates of actual disturbance distances.

Table 5. Summary of greatest disturbance distances by equipment type.

HRG SOURCE	DISTURBANCE DISTANCE (m)			
	Sea Turtles (175 dB re 1uPa rms)	Fish (150 dB re 1uPa rms)	Baleen Whales (160 dB re 1uPa rms)	Sperm Whales (160 dB re 1uPa rms)
Boomers, Bubble Guns	40	708	224	224
Sparkers	90	1,996[a]	502	502
Chirp Sub-Bottom Profilers	2	32	10	10
Multi-beam Echosounder (100 kHz)	NA	NA	NA	<369[b]
Multi-beam Echosounder (>200 kHz)	NA	NA	NA	NA
Side-scan Sonar (>200 kHz)	NA	NA	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
b – this distance was recalculated using the NMFS spreadsheet following receipt of the BA.
NA = not applicable due to the sound source being out of the hearing range for the group.

Marine Mammals
Considering peak noise levels, the equipment resulting in the greatest isopleth to the marine mammal PTS threshold is the sparker (2.0 m for baleen whales, 0 m for sperm whales; Table A.3). Considering the cumulative threshold (24 hour exposure), the greatest distance to the PTS threshold is 12.7 m for baleen whales and 0.5 m for sperm whales. 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 (<13 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 clearance zone and the use of PSOs to all 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 sei, fin, or sperm whale, see PDC 4. Based on these considerations, it is extremely unlikely that any ESA-listed whale will be exposed to noise that could result in PTS.

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. NMFS has previously concluded that marine mammal communications would not likely be masked appreciably by the sub-bottom profiler signals given the directionality of the signals for most 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 (see for example, 86 FR 22160). Based on this, any effects of masking on ESA-listed whales will be insignificant.

For equipment that operates within the functional hearing range (7 Hz to 35 kHz) of baleen whales, the area ensonified by noise greater than 160 dB re: 1uPa rms will extend no further than 502 m from the source (sparkers; the distance for chirp (10 m) and boomers and bubble guns (224 m) is smaller (Table A.5)). For equipment that operates within the functional hearing range of sperm whales (150 Hz to 160 kHz), the area ensonified by noise greater than 160 dB re: 1uPa rms will extend no further than 369 m from the source (100 kHz Multi-beam echosounder; the distance for sparkers (502 m), boomers and bubble guns (224 m), and chirp (10 m) is smaller; Table A.5).

Given that the distance to the 160 dB re: 1 uPa rms threshold extends beyond the required Shutdown Zone, it is possible that ESA-listed 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 (502 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 breeding, 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. Because the effects of these temporary behavioral changes are so minor, 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."

Sea Turtles
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 A.4). Therefore, physical effects are extremely unlikely to occur.

As explained above, we assume 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 A.5). 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.

The risk of exposure to potentially disturbing levels of noise is reduced by the use of PSOs to monitor for sea turtles. As required by the PDC 4, 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 only seconds, 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 (seconds to 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 turtle that was within 90 m of the source would last for less than two minutes. We also note that, to minimize disturbance to the Northwest Atlantic Ocean DPS of loggerhead sea turtles, a voluntary pause in sparker operation will be implemented for all vessels operating in nearshore critical habitat for loggerhead sea turtles if any loggerhead or other sea turtle is observed within a 100 m Clearance Zone during a survey. This will further reduce the potential for behavioral disturbance.

Given the intermittent and short duration of exposure to any potentially disturbing noise from HGR equipment, major shifts in habitat use or distribution or foraging success are not expected. 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, and will be so small that they cannot be meaningfully measured, detected, or evaluated; therefore, effects are insignificant.

Marine Fish

Of the equipment that may be used for geophysical surveys, only equipment that operates at a frequency within the estimated hearing range of the ESA-listed fish that may occur in the action area (i.e., frequency less than 1 kHz; Lovell et al. 2005; Meyer et al. 2010) may affect these species. Generally, this includes sparkers, boomers, and bubble guns (see Table A.2). All other survey equipment operates at a frequency higher than the ESA-listed fish considered here are expected to hear; therefore, we do not expect any effects to ESA-listed fish exposed to increased underwater noise from the other higher frequency survey equipment. Due to their typically submerged nature, monitoring clearance or shutdown zones for marine fish is not expected to be effective. As required by PDC 4, the surveys will use a ramp up procedure; that is, noise producing equipment will not be used at full energy right away. This gives any fish in the immediate area a “warning” and an opportunity to leave the area before the full energy of the survey equipment is used.

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 (see Table A.4); 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 (Table A.4). This is extremely unlikely to occur given the dispersed nature of the distribution of ESA-listed fish 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 ESA-listed fish, including injury or mortality, are expected to result from exposure to noise from the geophysical surveys.

We use 150 dB re: 1 µPa root mean square (RMS) sound pressure level (SPL) as a threshold for examining the potential for behavioral responses to underwater noise by ESA-listed fish. This is supported by information provided in a number of studies (Andersson et al. 2007, Purser and Radford 2011, Wysocki et al. 2007). In the worst case, we expect that ESA-listed fish would completely avoid an area ensonified above 150 dB re: 1uPa rms for the period of time that noise in that area was elevated. 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 A.5). It is important to note that BOEM has conservatively used the highest power levels for each sound source reported in Crocker and Fratantonio (2016) to calculate these distances; thus, they likely overestimate actual sound fields.

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 and 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 or 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.

Acoustic Effects - Geotechnical Surveys

Geotechnical surveys generally do not use active acoustic sources, but may have some low-level ancillary sounds associated with them. As described in the BA, the loudest noises are from drilling associated with obtaining bore samples. Small-scale drilling noise associated with bore samples taken in shallow water has been measured to produce broadband sounds centered at 10 Hz with source levels at 71-89 dB re 1 µPa rms and 75-97 dB re 1 µPa peak depending on the water depth of the work site (Willis et al. 2010). Another study reported measured drilling noise from a small jack-up rig at 147 – 151 db re 1 µPa rms in the 1 Hz to 22 kHz range at 10 m from source (Erbe and McPherson 2017).

Noise associated with geotechnical surveys is below the level that we expect may result in physiological or behavioral responses by any ESA-listed species considered here. As such, effects to listed whales, sea turtles, or fish from exposure to this noise source are extremely unlikely to occur.

Meteorological Buoys

A meteorological buoy (met buoy) is designed to collect meteorological data for a period of four-five years. During this time, data will be collected and transmitted to onshore facilities. The operation of the meteorological data collection instrumentation (i.e., light detection and ranging remote sensing technology (LIDAR) and Acoustic Doppler Current Profilers (ADCP)) will have no effect on any listed species as it does not operate in any way that could result in effects to listed species. Bathymetric LIDAR uses water-penetrating green light to also measure seafloor and riverbed elevations. ADCP uses extremely high frequency sound (well above the hearing frequency of any species considered in this consultation) to measure water currents. No other acoustic effects from the deployment of the met buoys are anticipated.

Buoys 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 is addressed below. PDCs for siting the buoy will result in avoidance of anchoring buoys on any sensitive habitats (i.e., placement will occur on unconsolidated and uncolonized areas only, avoiding eelgrass, corals, etc.) (see PDC 1). Buoys will be anchored to a clump weight anchor and attached to the anchor with heavy chain. We have considered the potential for any listed species, including whales and/or sea turtles, to interact with the buoy and to become entangled in the buoy or mooring system and have determined that this is extremely unlikely to occur for the reasons outlined below.

In order for an entanglement to occur, an animal must first encounter the gear, which has an extremely low likelihood based on the number of buoys and total area where buoys may be deployed (Atlantic OCS). BOEM predicts that up to two met buoys could be deployed in any potential lease area, for a maximum of 60 buoys deployed in the entirety of the Atlantic OCS. Given the small number of buoys and their dispersed locations on the OCS, the potential for encounter between an individual whale or sea turtle and a buoy is extremely low. However even if there is co-occurrence between an individual animal and one or more buoys, entanglement is extremely unlikely to occur. This is because the buoy will be attached to the anchor with heavy gauge chain, which reduces the risk of entanglement due to the tension that the buoy will be under and the gauge of the chain, which prevents any slack in the chain that could result in an entanglement (see PDC 6). There have been no documented incidences of any listed species, including whales or sea turtles, entangled in United States Coast Guard navigational buoys, which have a similar mooring configuration to these met buoys, but also far outnumber the potential number of deployed met buoys (there are 1000s of navigational buoys within the range of ESA-listed whales and sea turtles and no recorded entanglements). Based on the analysis herein, it is extremely unlikely that any ESA-listed species will interact with the buoy and anchor system such that it becomes entangled. As such, effects are extremely unlikely to occur.

Effects to Habitat

Vibracores and grab samples may be used to document habitat types during geophysical and geotechnical survey activities. Both of these survey methods will result in temporary disturbance of the benthos and a potential temporary loss of benthic resources. Additionally, bottom disturbance will occur in the area where a met buoy is anchored.

The vibracores and grab samples will affect an extremely small area (approximately 0.1 to 2.7 ft^2) at each sampling location, with sampling locations several hundred meters apart. While the vibracore and grab sampler will take a portion of the benthos that will be brought onto the ship, because of the small size of the sample and the nature of the removal, there is little to no sediment plume associated with the sampling. While there may be some loss of benthic species at the sample sites, including potential forage items for listed species that feed on benthic resources, the amount of benthic resources potentially lost will be extremely small and limited to immobile individuals that cannot escape capture during sampling. As such a small area will be disturbed and there will be a large distance between disturbed areas, recolonization is expected to be rapid. The amount of potential forage lost for any benthic feeding species is extremely small, localized, and temporary. While the area of the bottom impacted by the anchoring of the met buoy is larger (i.e., several meters in diameter), as stated above, there will be a small number of buoys deployed along the entire Atlantic OCS. 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 in relation to remaining available habitat in the OCS 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.

Other Considerations – Geotechnical Surveys
The PDCs include a seasonal prohibition on any activities involving disturbance of the bottom in areas where early life stages of Atlantic or shortnose sturgeon may occur (see PDC 2). The seasonal prohibition is designed to avoid any activity that could disturb potential spawning or rearing substrate during the time of year that spawning or rearing may occur in that river. This PDC will also ensure that no bottom disturbing survey activities will occur at a time that eggs or other immobile or minimally mobile early life stages of sturgeon are present. This will ensure that sampling activities will not result in the disturbance, injury, or mortality of any sturgeon. Based on this, any effects to sturgeon spawning habitat or early life stages are extremely unlikely to occur.

Atlantic Sturgeon Critical Habitat
Critical habitat has been designated for all five DPSs of Atlantic sturgeon (82 FR 39160; effective date September 18, 2017). While there is no Atlantic sturgeon critical habitat in the three Atlantic Renewable Energy Regions located on the Atlantic OCS, survey activities along potential cable routes, including vessel transits, may occur within Atlantic sturgeon critical habitat. While BOEM anticipates that activities would be limited to overlapping with critical habitat designated in the Hudson, Delaware, and James rivers for the New York Bight and Chesapeake Bay DPSs respectively, the conclusions reached here apply to critical habitat designated for all five DPSs.

The PDCs include a seasonal prohibition on any geophysical and geotechnical survey activities involving disturbance of the bottom in freshwater (salinity less than 0.5 parts per thousand (ppt)) areas designated as critical habitat for any DPS of Atlantic sturgeon (see PDC # 2 for more detail). The PDCs also require operation of vessels in a way that ensures that vessel activities do not result in disturbance of bottom habitat.

In order to determine if the proposed action may affect critical habitat, we consider whether it would impact the habitat in a way that would affect its ability to support reproduction and recruitment. Specifically, we consider the effects of the action on the physical features of the proposed critical habitat. The Physical and Biological Features (PBFs) essential for Atlantic sturgeon conservation identified in the final rule (82 FR 39160) are:

> (1) Hard bottom substrate (e.g., rock, cobble, gravel, limestone, boulder, etc.) in low salinity waters (i.e., 0.0 to 0.5 ppt range) for settlement of fertilized eggs, refuge, growth, and development of early life stages;
>
> (2) Aquatic habitat with a gradual downstream salinity gradient of 0.5 up to as high as 30 ppt and soft substrate (e.g., sand, mud) between the river mouth and spawning sites for juvenile foraging and physiological development;
>
> (3) Water of appropriate depth and absent physical barriers to passage (e.g., locks, dams, thermal plumes, turbidity, sound, reservoirs, gear, etc.) between the river mouth and spawning sites necessary to support: (i) Unimpeded movement of adults to and from spawning sites; (ii) Seasonal and physiologically dependent movement of juvenile Atlantic sturgeon to appropriate salinity zones within the river estuary; and, (iii) Staging, resting, or holding of subadults or spawning condition adults. Water depths in main river channels must also be deep enough (e.g., at least 1.2 m) to ensure continuous flow in the main channel at all times when any sturgeon life stage would be in the river.
>
> (4) Water, between the river mouth and spawning sites, especially in the bottom meter of the water column, with the temperature, salinity, and oxygen values that, combined, support: (i) Spawning; (ii) Annual and interannual adult, subadult, larval, and juvenile survival; and, (iii) Larval, juvenile, and subadult growth, development, and recruitment (e.g., 13 degrees Celsius [°C] to 26 °C for spawning habitat and no more than 30 °C for juvenile rearing habitat, and 6 milligrams per liter (mg/L) dissolved oxygen (DO) or greater for juvenile rearing habitat).

PBF 1: Hard bottom substrate (e.g., rock, cobble, gravel, limestone, boulder, etc.) in low salinity waters (i.e., 0.0–0.5 ppt range) for settlement of fertilized eggs, refuge, growth, and development of early life stages

In considering effects to PBF 1, we consider whether the proposed action will have any effect on areas of hard substrate in low salinity waters that may be used for settlement of fertilized eggs, refuge, growth, and development of early life stages; therefore, we consider effects of the action on hard bottom substrate and any change in the value of this feature in the action area.

Vessel operations during transits or surveys would not affect hard bottom habitat in the part of the river with salinity less than 0.5 ppt, because they would not impact the river bottom in any way or change the salinity of portions of the river where hard bottom is found. Similarly, geophysical surveys use acoustics to accurately map the seafloor, which would not impact any hard bottom that is present.

Grab samples, geotechnical surveys, and any other activity that may affect hard bottom is prohibited in areas with salinity less than 0.5 ppt during the time of year that these areas may be used for spawning or rearing (PDC 2). Given the very small footprint of all survey activities that may affect the hard bottom (3-4 inch diameter area would be disturbed during sampling) and the spacing of sampling several hundred meters apart, any effects to hard bottom substrate from survey activities outside of the time of year when these areas may be used for spawning and rearing would be small, localized, and dispersed. Given the dynamic nature of river sediments and the small area that will be disturbed, we expect that substrate conditions will recover to pre-survey conditions within days to weeks of sampling occurring. As such, any effects to hard bottom substrate and the value of this feature in the action area or to any of the critical habitat units as a whole are temporary and so small that they cannot be meaningfully measured, evaluated, or detected and, therefore, are insignificant.

PBF 2: Aquatic habitat with a gradual downstream salinity gradient of 0.5 up to as high as 30 ppt and soft substrate (e.g., sand, mud) between the river mouth and spawning sites for juvenile foraging and physiological development

In considering effects to PBF 2, we consider whether the proposed action will have any effect on areas of soft substrate within transitional salinity zones between the river mouth and spawning sites for juvenile foraging and physiological development; therefore, we consider effects of the action on soft substrate and salinity and any change in the value of this feature in the action area.

Project vessels (whether transiting or surveying) do not have the potential to effect salinity. Vessels are expected to maintain a minimum of 4-feet clearance with the river bottom (see PDC 2) and, therefore, effects to the soft substrate are extremely unlikely. The vessels' operations would not preclude or significantly delay the development of soft bottom habitat in the transitional salinity zone because they would not impact salinity or the river bottom in any way. Similarly, geophysical surveys use acoustics to accurately map the bottom, which would not affect any soft substrate that is present.

Grab samples and geotechnical surveys may impact soft substrate; however, given the very small footprint of any such activities (3-4 inch diameter area would be disturbed during sampling) and the spacing of sampling locations several hundred meters apart, any effects to soft substrate would be small, localized, and dispersed. Given the dynamic nature of river sediments and the small area that will be disturbed, we expect that substrate conditions will recover to pre-survey conditions within days to weeks of sampling occurring. As such, any effects to soft substrate and the value of this feature in the action area, are extremely unlikely or so small that they cannot be meaningfully measured, evaluated, or detected.

PBF 3: Water absent physical barriers to passage between the river mouth and spawning sites

In considering effects to PBF 3, we consider whether the proposed action will have any effect on water of appropriate depth and absent physical barriers to passage (e.g., locks, dams, thermal plumes, turbidity, sound, reservoirs, gear, etc.) between the river mouth and spawning sites necessary to support: unimpeded movements of adults to and from spawning sites; seasonal and physiologically dependent movement of juvenile Atlantic sturgeon to appropriate salinity zones within the river estuary, and; staging, resting, or holding of subadults or spawning condition adults. We also consider whether the proposed action will affect water depth or water flow, as if water is too shallow it can be a barrier to sturgeon movements, and an alteration in water flow could similarly impact the movements of sturgeon in the river, particularly early life stages that are dependent on downstream drift. Therefore, we consider effects of the action on water depth and water flow and whether the action results in barriers to passage that impede the movements of Atlantic sturgeon.

Survey activities, including vessel transits, will have no effect on this feature as they will not have any effect on water depth or water flow and will not be physical barriers to passage for any life stage of Atlantic sturgeon that may occur in this portion of the action area. As explained above, noise associated with the geotechnical surveys is below the threshold that would be expected to result in any disturbance of sturgeon; therefore, noise associated with geotechnical surveys will not affect the habitat in any way that would affect the movement of Atlantic sturgeon. Similarly, while HRG surveys may affect the movement of individual sturgeon, the effects are short-term and transient; noise is not expected to result in a barrier to passage. Based on this analysis, any effects to PBF 3 will be insignificant.

PBF 4: Water with the temperature, salinity, and oxygen values that, combined, provide for DO values that support successful reproduction and recruitment and are within the temperature range that supports the habitat function

In considering effects to PBF 4, we consider whether the proposed action will have any effect on water, between the river mouth and spawning sites, especially in the bottom meter of the water column, with the temperature, salinity, and oxygen values that, combined, support: spawning; annual and interannual adult, subadult, larval, and juvenile survival; and larval, juvenile, and subadult growth, development, and recruitment. Therefore, we consider effects of the action on temperature, salinity and DO needs for Atlantic sturgeon spawning and recruitment. These water quality conditions are interactive and both temperature and salinity influence the DO saturation for a particular area. We also consider whether the action will have effects to access to this feature, temporarily or permanently and consider the effect of the action on the action area's ability to develop the feature over time. Survey activities, including vessel transit, will have no effect on this feature as they will not have any effect on temperature, salinity or dissolved oxygen.

Summary of effects to Atlantic sturgeon critical habitat

We have determined that the effects of the activities considered here will be insignificant on PBFs 1, 2, and 3, and will have no effects to PBF 4. As such, the activities considered here are not likely to adversely affect Atlantic sturgeon critical habitat designated for any of the five DPSs.

Critical Habitat Designated 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 North Atlantic Renewable Energy Region. Winter, breeding, and migratory habitat occur in the Mid-Atlantic and South Atlantic regions of the action areas; there is also a small amount of overlap with *Sargassum* critical habitat on the outer edges of the action area near the 100-m isobaths. Geophysical and geotechnical surveys and met buoy deployment may take place within this critical habitat. As explained below, the activities considered in this programmatic consultation are not likely to adversely affect critical habitat designated for the Northwest Atlantic Ocean DPS of loggerheads.

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. The occurrence of designated nearshore reproductive habitat in the action area is limited to the area between the beach to 1 mile offshore along the Atlantic coast from Cape Hatteras, North Carolina to the southern extent of the South Atlantic planning area along the Florida coast.

As described in the final rule, the primary constituent elements (PCE) 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.

Met buoys will only be deployed in federal waters; therefore, no met buoys will be deployed in nearshore reproductive habitat. HRG and geotechnical surveys and associated vessel transits could occur in this nearshore habitat. The intermittent noise associated with these activities will not be an obstruction to turtles moving through the surf zone; this is because the noise that can be perceived by sea turtles would dissipate to non-disturbing levels within 90 m of the moving source (see further explanation above) and the area with potentially disturbing levels of noise would be limited to one area within 90 m of the source at any given time. Therefore, given the small geographic area affected by noise and that these effects will be temporary (experienced for no more than 2 minutes in any given area), the effects to habitat are insignificant. Any lighting associated with the surveys would be limited to lights on vessels in the ocean, this lighting would not disorient turtles the way that artificial lighting along land can. Additionally, there are no mechanisms by which the HRG and geotechnical surveys and vessel activities would 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. The one area of winter critical habitat identified in the final rule extends from Cape Hatteras at the 20 m depth contour straight across 35.27° N. lat. to the 100 m (328 ft.) depth contour, south to Cape Fear at the 20 m (66 ft.) depth contour (approximately

33.47° N. lat., 77.58° W. long.) extending in a diagonal line to the 100 m (328 ft.) depth contour (approximately 33.2° N. lat., 77.32° W. long.). This southern diagonal line (in lieu of a straight latitudinal line) was chosen to encompass the loggerhead concentration area (observed in satellite telemetry data) and identified habitat features, while excluding the less appropriate habitat (e.g., nearshore waters at 33.2° N. lat.). 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.

Met buoy deployment/operation, HRG and geotechnical surveys, and 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 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. Two units of breeding critical habitat are identified in the final rule. One occurs in the action area – a concentrated breeding site located in the nearshore waters just south of Cape Canaveral, Florida. The 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.

Met buoys, HRG and geotechnical surveys, and vessel transits will not affect the habitat in the breeding units in a way that would change the density of reproductive male or female loggerheads. This is because (as explained fully above), any effects to distribution of sea turtles will be limited to intermittent, temporary disturbance limited to avoidance of an area no more than 90m from the survey vessel. The impacts to habitat from temporary increases in noise will be so small that they will be insignificant.

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. The final rule describes two units of constricted migratory corridor habitat. The constricted migratory corridor off North Carolina serves as a concentrated migratory pathway for loggerheads transiting to neritic foraging areas in the north, and back to winter, foraging, and/or nesting areas in the south. The constricted migratory corridor in Florida stretches from the westernmost edge of the Marquesas Keys (82.17° W. long.) to the tip of Cape Canaveral (28.46° N. lat.) and partially overlaps with the action area (i.e., the designated habitat extends further south than the action area). 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.

Noise associated with the survey activities considered here will have minor and temporary effects on winter habitat; however, as explained fully above, any effects to sea turtles will be limited to intermittent, temporary disturbance or avoidance of an area no more than 90m from the survey vessel. These temporary and intermittent increases in underwater noise will have insignificant effects on the conditions of the habitat that will not result in any decreased ability or availability of habitat for passage of sea turtles. No other activities will affect passage of loggerhead sea turtles in the wintering habitat.

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*. Two areas are identified in the final rule – the Atlantic Ocean area and the Gulf of Mexico area. The Atlantic Ocean area extends from the Gulf of Mexico along the northern/western boundary of the Gulf Stream and east to the outer edge of the U.S. EEZ. There is a small amount of overlap between the action area and the Atlantic Ocean *Sargassum* critical habitat unit on the outer edges of the action area near the 100-m isobaths. 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.

Given the distance from shore, met buoy deployment is not anticipated in areas designated as *Sargassum* critical habitat. The occasional project vessel transits, HRG and geotechnical surveys 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. This is because these activities do not affect hydrological or oceanographic processes, no *Sargassum* will be removed due to survey activities, and the intermittent noise associated with surveys will not affect the availability of prey within *Sargassum*.

Summary of effects to critical habitat

Any effects to designated critical habitat will be insignificant. Therefore, the survey activities considered in this programmatic consultation are not likely to adversely affect critical habitat designated for the Northwest Atlantic DPS of loggerhead sea turtles.

Vessel Traffic

The HRG and geotechnical surveys are carried out from vessels. Additionally, vessels will be used to transport met buoys to and from deployment sites and to carry out any necessary inspections. As described in BOEM’s BA, survey operations involve slow moving vessels, traveling at no more than 3-4.5 knots. HRG and geotechnical surveys typically involve one to three survey vessels operating within the area to be surveyed; up to approximately 36 areas may be surveyed over the 10-year period considered here. During transits to or from survey locations, these vessels would travel at a maximum speed of around 12 knots. Met buoy deployment, retrieval, and inspection will also involve one or two vessels at a time; a total of 60 buoys are considered in this consultation. These vessels will typically travel at speeds of 12 knots or less; however, service vessels (limited to one trip per month per buoy) may travel at speeds of up to 25 knots (BOEM 2021).

Marine Mammals

As detailed in Appendix B, a number of Best Management Practices (BMPs) (see PDC 5), designed to reduce the risk of vessel strike, will be implemented for all activities covered by this programmatic consultation, including the following requirements:

1. All vessel operators and crews will maintain a vigilant watch for marine mammals at all times, and slow down or stop their vessel to avoid any interaction.
2. PSOs monitoring a Vessel Strike Avoidance Zone during all vessel operations.
3. Complying with speed restrictions in North Atlantic right whale management areas including Seasonal Management Areas (SMAs), active Dynamic Management Areas (DMAs)/visually triggered Slow Zones.
4. Daily monitoring of the NMFS North Atlantic right whale reporting systems.
5. Reducing vessel speeds to ≤10 knots when mother/calf pairs, pods, or large assemblages of ESA-listed marine mammals are observed.
6. Maintaining >500 m separation distance from all ESA-listed whales or an unidentified large marine mammal; if a whale is sighted within 200 m of the forward path of the vessel, then reducing speed and shifting the engines into neutral, and must not be engaged until the whale has move outside of the vessel’s path and beyond 500 m.

An examination of all known ship strikes from all shipping sources (civilian and military) indicates vessel speed is a principal factor in whether a vessel strike results in death of a whale (Kelley et al. 2020; Knowlton and Kraus 2001; Laist et al., 2001; Jensen and Silber 2003; Vanderlaan and Taggart 2007). 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)). 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. Survey vessels will typically travel slowly (less than 4.5 knots) as necessary for data acquisition, will have PSOs monitoring for whales, and will adjust vessel operations as necessary to avoid striking whales during survey operations and transits. The only times that survey vessels will operate at speeds above 4 knots is during transit to and from the survey site where they may travel at speeds up to 12 knots (although several circumstances described below will restrict speed to 10 knots), a number of measures (see PDC 5) will be in place to minimize the risk of strike during these transits. Slow operating speeds mean that vessel operators have more time to react and steer the vessel away from a whale. The use of dedicated PSOs to keep a constant watch for whales and to alert vessel operators of any sightings also allows vessel operators to avoid striking any sighted whales.

As noted above, vessels used to inspect and maintain met buoys may travel at speeds up to 25 knots. This vessel traffic will be an extremely small increase in the amount of vessel traffic in the action area (i.e., if 60 buoys are deployed this would be a maximum of 60 trips per month spread out along the entire Atlantic OCS), which is transited by thousands of vessels each day. These vessels are subject to all of the vessel related BMPs (see PDC 5) noted above, including use of a dedicated lookout, vessel strike avoidance procedures, and requirements to slow down to 10 knots in areas where North Atlantic right whales have been documented (i.e., within SMAs, DMAs/visually triggered Slow Zones). Based on this analysis, it is extremely unlikely that a vessel associated with the survey activities considered here, when added to the environmental baseline, will strike an ESA-listed whale. We note that similar activities have taken place since at least 2012 in association with BOEM's renewable energy program and there have been no reports of any vessel strikes of marine mammals.

The frequency range for vessel noise (10 to 1000 Hz; MMS 2007) overlaps with the generalized hearing range for sei, fin, and right whales (7 Hz to 35 kHz) and sperm whales (150 Hz to 160 kHz) and would therefore be audible. 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 (BOEM 2015, Rudd et al. 2015). For ROVs, source levels may be as high as 160 dB (BOEM 2021). Given that the noise associated with the operation of project vessels is below the thresholds that could result in injury, no injury is expected.

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. 2007) 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. 2009). 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 1983), 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. 1995; Watkins 1981), and not consequential to the animals. 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 whales 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 whales are insignificant (i.e., so minor that the effect cannot be meaningfully evaluated or detected).

Sea Turtles

As detailed in Appendix B, a number of BMPs (see PDC 5), designed to reduce the risk of vessel strike, will be implemented for all activities covered by this programmatic consultation, including dedicated lookouts on board all transiting vessels, reduced speeds and avoidance of areas where sea turtles are likely to occur (e.g., Sargassum patches), and required separation distances from any observed sea turtles.

Sea turtles are vulnerable to vessel collisions because they regularly surface to breathe and often rest at or near the surface. Sea turtles often congregate close to shorelines during the breeding season, where boat traffic is denser (Schofield et al. 2007; Schofield et al. 2010) which can increase vulnerability to vessel strike in such areas, particularly by smaller, fast moving vessels. 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.

While research is limited on the relationship between sea turtles, vessel strikes and vessel speeds, sea turtles are at risk of vessel strike where they co-occur with vessels. Sea turtle detection is likely based primarily on the animal's ability to see the oncoming vessel, which would provide less time to react to vessels traveling at speeds at or above 10 knots (Hazel et al. 2007). 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, 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.

While vessel struck sea turtles have been observed throughout their range, including in the action area, the regions of greatest concern for vessel strike are 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 (NRC 1990). In general, the risk of strike for sea turtles is considered to be greatest in areas with high densities of sea turtles and small, fast moving vessels such as recreational vessels or speed boats (NRC 1990). Similarly, Foley et al. (2019) concluded that in a study in Florida, vessel strike risk for sea turtles was highest at inlets and passes. Stetzar (2002) reports that 24 of 67 sea turtles stranded along the Atlantic Delaware coast from 1994-1999 had evidence of boat interactions (hull or propeller strike); however, it is unknown how many of these strikes occurred after the sea turtle died. There are no estimates of the total number of sea turtles struck by vessels in the Atlantic Ocean each year. Foley et al. (2019), estimated that strikes by motorized watercraft killed a mean of 1,326–4,334 sea turtles each year in Florida during 2000–2014 (considering the Atlantic and Gulf coasts of Florida). As described in NRC 1990, vessel strike risk for sea turtles in the Atlantic Ocean is highest in Florida.

The proposed survey activities will result in an increase in vessel traffic in the action area. Compared to baseline levels of vessel traffic in the action area (in its entirety and in any particular portion), the survey vessels, which will be likely two or three vessels operating in a particular survey area at a time (and spaced such that the sound fields of any noise producing equipment do not overlap), represent an extremely small fraction of total vessel traffic. For example, the U.S. Coast Guard's Atlantic Coast Port Access Route Study (ACPARS; USCG 2015), reports nearly 36,000 unique vessel transits through wind energy areas and lease areas along the Atlantic Coast. Those vessel transits represent only a fraction of the total coastal traffic as the wind energy areas and lease areas are located further offshore than most of the routes used by coastal tug traffic, for example. The U.S. Coast Guard's New Jersey PARS (USCG 2021) reports between 77,000 and 80,000 unique trips annual in the Atlantic Ocean off a portion of the coast of New Jersey in 2017-2019. This data is not wholly representative of all vessel traffic in this area as it only includes vessels carrying AIS systems, which is only required for vessels 65 feet in length or greater (although smaller vessels can utilize AIS and some do). Even if there were 3-boat surveys occurring in each of the four lease areas located in the New Jersey PARS study area, this would represent an increase of 12 vessels off New Jersey in a single year; this represents an approximately 0.01% increase in vessel traffic in that area. We expect that this increase is similar in other portions of the action area. If we assume that any increase in vessel traffic in the action area would increase the risk of vessel strike to sea turtles, then we could also assume that this would result in a corresponding increase in the number of sea turtles struck by vessels. However, it is unlikely that all vessels represent an equal increase in risk and the slow speeds (up to 4.5 knots) that the majority of vessels considered here will typically be moving, requirements to monitor for sea turtles during vessel transits, avoid or slowdown in areas where sea turtles are likely to occur, and to maintain distance from any sighted turtles, means that the risk to sea turtles from the survey vessels is considerably less than other vessels, particularly small, fast vessels operating in nearshore areas where sea turtle densities are high.

An analysis conducted by NMFS Southeast Regional Office (Barnette 2018) considered sea turtle vessel strike risk in Florida; the portion of the action area where risk is considered highest due to the concentration of sea turtles and vessels. Barnette (2018) concluded that, when using the conservative mean estimate of a sea turtle strike every 193 years (range of 135-250 years) per vessel, it would require approximately 200 new vessels introduced to an area to potentially result in a single sea turtle strike in any single year. Considering that the proposed action will introduce significantly fewer vessels in any particular area and that survey vessels will increase vessel traffic in the action area by less than 0.01%, and the measures that will be in place to reduce risk of vessel strike, as well as the slow speed of the survey vessels, we conclude that any increase in the number of sea turtles struck in the action area because of the increase in traffic resulting from survey vessels added to the environmental baseline is extremely unlikely. Therefore, effects of this increase in traffic are extremely unlikely.

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.

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.

Marine Fish

The only listed fish in the action area that are known to be at risk of vessel strike are shortnose and Atlantic sturgeon and giant manta ray. Vessel activities will have no effect on Atlantic salmon or smalltooth sawfish. There is no information to indicate that Atlantic salmon are struck by vessels; therefore, we have concluded that strike is extremely unlikely to occur. A vessel strike to smalltooth sawfish is extremely unlikely; smalltooth sawfish are primarily demersal and rarely would be at risk from moving vessels. PDC 5 requires vessels to maintain sufficient clearance above the bottom and to reduce speeds to 5 knots or less in waters with less than 4 feet of clearance. These conditions, combined with the low likelihood of vessels operating in nearshore coastal waters of Florida where sawfish occur, is expected to eliminate risk of vessel strikes with smalltooth sawfish.

Giant Manta Ray
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, 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 giant manta ray is frequently observed in nearshore coastal waters and feeding at inlets along the east coast of Florida. As recreational vessel traffic is concentrated in and around inlets and nearshore waters, this overlap exposes the giant manta ray in these locations to an increased likelihood of potential vessel strike injury especially from faster moving recreational vessels. Yet, few instances of confirmed or suspected strandings of giant manta rays are attributed to vessel strike injury. 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.

While there is limited available information on the giant manta ray, we expect the circumstances and factors resulting in vessel strike injury are similar between sea turtles and the giant manta ray because these species are both found in nearshore waters (including in the vicinity of inlets where vessel traffic may also be concentrated) and may spend significant time at or near the surface. Therefore, consistent with Barnette 2018, we will rely on the more robust available data on sea turtle vessel strike injury to serve as a proxy for the giant manta ray. Because the activities considered here will result in far fewer than 200 new vessels, it is extremely unlikely that any giant manta rays will be struck by new or increased vessel traffic.

Sturgeon
Here, we consider whether the increase in vessel traffic is likely to increase the risk of strike for Atlantic or shortnose sturgeon in any part of the action area. Because the increase in traffic will be limited to no more than two or three survey vessels operating in an area being surveyed at one time, the increase in vessel traffic in any portion of the action area, as well as the action area as a whole, will be extremely small.

We do not expect shortnose sturgeon to occur along the survey routes in the Atlantic Ocean because coastal migrations are extremely rare. However, Atlantic sturgeon are present in this part of the action area. Both shortnose and Atlantic sturgeon may occur in nearshore waters and rivers and bays that may be surveyed for potential cable corridors and/or may be used for survey vessel transits to or from ports.

While we know that vessels and sturgeon co-occur in many portions of their range, we have no reports of vessel strikes outside of rivers and coastal bays. The risk of strike is expected to be considerably less in the Atlantic Ocean than in rivers. This is because of the greater water depth, lack of obstructions or constrictions and the more disperse nature of vessel traffic and more disperse distribution of individual sturgeon. All of these factors are expected to decrease the likelihood of an encounter between an individual sturgeon and a vessel and also increase the likelihood that a sturgeon would be able to avoid any vessel. While we cannot quantify the risk of vessel strike in the portions of the Atlantic Ocean that overlap with the action area, we expect the risk to be considerably lower than it is within the Delaware River, which is considered one of the areas with the highest risk of vessel strike for Atlantic sturgeon.

As evidenced by reports and collections of Atlantic and shortnose sturgeon with injuries consistent with vessel strike (NMFS unpublished data[8]), both species are struck and killed by vessels in the Delaware River. Brown and Murphy (2010) reported that from 2005-2008, 28 Atlantic sturgeon carcasses were collected in the Delaware River; approximately 50% showed signs of vessel interactions. Delaware Division of Fish and Wildlife has been recording information on suspected vessel strikes since 2005. From May 2005 – March 2016, they recorded a total of 164 carcasses, 44 of which were presumed to have a cause of death attributable to vessel interaction. Estimates indicate that up to 25 Atlantic sturgeon may be struck and killed in the Delaware River annually (Fox, unpublished 2016). Information on the number of shortnose sturgeon struck and killed by vessels in the Delaware River is currently limited to reports provided to NMFS through our sturgeon salvage permit. A review of the database indicates that of the 53 records of salvaged shortnose sturgeon (2008-2016), 11 were detected in the Delaware River. Of these 11, 6 had injuries consistent with vessel strike. This is considerably less than the number of records of Atlantic sturgeon from the Delaware River with injuries consistent with vessel strike (15 out of 33 over the same time period). Based on this, we assume that more Atlantic sturgeon are struck by vessels in the Delaware River than shortnose sturgeon.

Several major ports are present along the Delaware River. In 2014, there were 42,398 one-way trips reported for commercial vessels in the Delaware River Federal navigation channel (USACE 2014). In 2020, 2,195 cargo ships visited Delaware River ports[9]. Neither of these numbers include any recreational or other non-commercial vessels, ferries, tug boats assisting other larger vessels or any Department of Defense vessels (i.e., Navy, USCG, etc.).

If we assume that any increase in vessel traffic in the Delaware River would increase the risk of vessel strike to shortnose or Atlantic sturgeon, then we could also assume that this would result in

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[8] The unpublished data are reports received by NMFS and recorded as part of the sturgeon salvage program authorized under ESA permit 17273.

[9] *https://ajot.com/news/maritime-exchange-reports-2020-ship-arrivals*; last accessed March 24, 2021

a corresponding increase in the number of sturgeon struck and killed in the Delaware River. However, it is unlikely that all vessels represent an equal increase in risk, the slow speeds (4.5 knots) and shallower drafts of the survey vessels may mean that the risk to sturgeon is not as greater as faster moving deep draft cargo or tanker vessels as sturgeon may be able to more readily avoid the survey vessels and may not even overlap in the same part of the water column. The survey activities considered here will involve up to three slow-moving (up to 4.5 knots) vessels operating in a similar area. Sets of survey vessels will be dispersed along the coast and not co-occur in time or space. Even if there were four surveys in a year that transited the Delaware River (equivalent to the number of BOEM leases that are proximal to the entrance of Delaware Bay), that would be an increase of 12 vessels annually. Considering only the number of commercial one way trips in a representative year (42,398), an increase of 12 vessels operating in the Delaware River represents an approximately 0.03% increase in vessel traffic in the Delaware River navigation channel in a particular year. The actual percent increase in vessel traffic is likely even less considering that commercial traffic is only a portion of the vessel traffic in the river. Even in a worst-case scenario that assumes that all 25 Atlantic sturgeon struck and killed in the Delaware River in an average year occurred in the portion of the Delaware River that will be transited by the survey vessels, and that any increase in vessel traffic results in a proportionate increase in vessel strikes, this increase in vessel traffic would result in a hypothetical additional 0.0075 Atlantic sturgeon struck and killed in the Delaware River in a given year. Assuming a maximum case that four, 3-boat surveys transit the Delaware River every year for the 10 years considered here, that would result in a hypothetical additional 0.075 Atlantic sturgeon struck and killed in the Delaware River. Because we expect fewer strikes of shortnose sturgeon, the hypothetical increase in the number of struck shortnose sturgeon would be even less. Given this very small increase in traffic and the similar very small potential increase in risk of strike and a calculated potential increase in the number of strikes that is very close to zero, we conclude that any increase in the number of sturgeon struck because of the increase in traffic resulting from survey vessels operating in the Delaware River or Delaware Bay is extremely unlikely. BOEM has indicated that survey vessels may also transit the lower Chesapeake Bay and New York Bight/lower Hudson River. The risk of vessel strike in these areas is considered to be lower than in the Delaware River; thus, any prediction of vessel strike for the Delaware River can be considered a conservative estimate of vessel strike risk in other areas. Even applying this hypothetical increased risk for all three areas, we would estimate that a hypothetical additional 0.2 Atlantic sturgeon would be killed coast-wide over a 10-year period. As noted above, this is likely an overestimate given the slower speed of survey vessels compared to other vessels which is anticipated to reduce risk. Based on this analysis, effects of this increase in traffic are extremely unlikely. In addition, given the very small increase in risk and the calculated increase in strikes is close to zero, the effect of adding the survey vessels to the baseline cannot be meaningfully measured, detected, or evaluated; therefore, effects are also insignificant.

Vessel Noise

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. 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. 2004a). 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. (2015) 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 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 ESA-listed fish. Plus, 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, any effects of vessel noise on ESA-listed fish is considered insignificant (i.e., so minor that the effect cannot be meaningfully measured, detected, or evaluated).

Consideration of Effects of the Actions on Air Quality

In order to issue an OCS Air Permit for an activity considered in this consultation, EPA must conclude that the activity will not cause or contribute to a violation of applicable national ambient air quality standards (NAAQS) or prevention of significant deterioration (PSD) increments. The NAAQS are health-based standards that the EPA sets to protect public health with an adequate margin of safety. The PSD increments are designed to ensure that air quality in an area that meets the NAAQS does not significantly deteriorate from baseline levels. 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 PSD increments are designed to ensure that air quality in the area regulated by any OCS Air Permit do not significantly deteriorate from baseline levels, we 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.

CONCLUSIONS

As explained above, we have determined that the actions considered here are not likely to adversely affect any ESA-listed species or critical habitat. The requirements for reviewing survey activities as they are developed will ensure that surveys carried out under this programmatic consultation do not have effects that exceed those considered here.

Reinitiation of consultation is required and shall be requested by BOEM or by NMFS where discretionary federal involvement or control over the action has been retained or is authorized by law and "(a) If the amount or extent of taking specified in the incidental take statement is exceeded; (b) 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; (c) 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 (d) If a new species is listed or critical habitat designated that may be affected by the identified action." For the activities considered here, no take is anticipated or exempted; take is defined in the ESA as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in any such conduct." If there is any incidental take of a listed species, reinitiation would be required. As required by the PDCs outlined in Appendix B, all observations of dead or injured listed species should be reported to us immediately.

Should you have any questions regarding this consultation, please contact Julie Crocker of my staff at (978) 282-8480 or by e-mail (*Julie.Crocker@noaa.gov*).

Sincerely,

Jennifer Anderson

Jennifer Anderson
Assistant Regional Administrator
for Protected Resources

ec: Hooker, Baker - BOEM
Burns - GARFO HSED
Bernhart - SERO
Harrison, Daly, Carduner - OPR
DOE
EPA
USACE

File Code: Sec 7 BOEM OSW site assessment programmatic (2021)
ECO ID: GARFO-2021-0999

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Revision 1. September 2021.

Appendix A – Tables and Figures

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Figure 1. Action Area for this programmatic consultation.

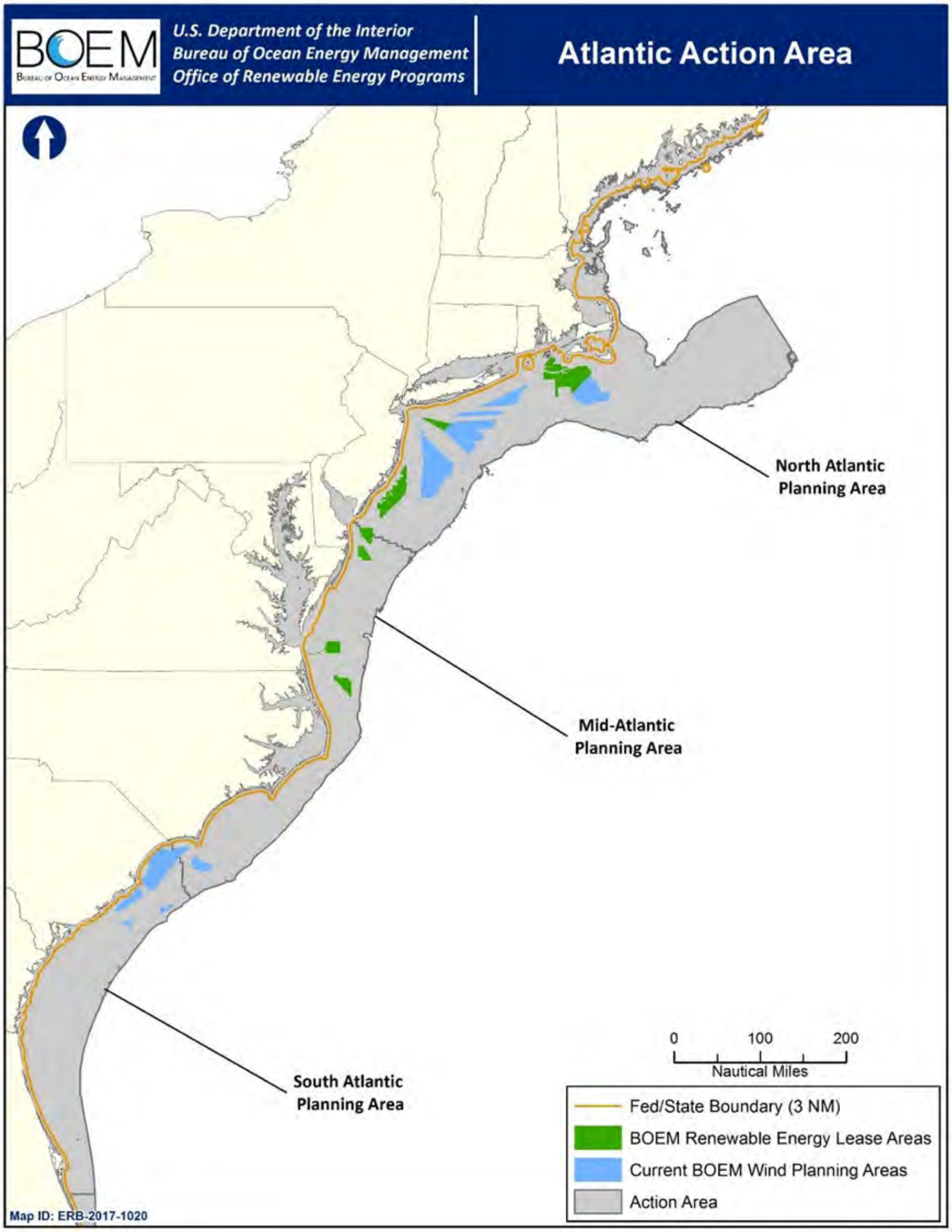

Table A.1 Description of Representative HRG Survey Equipment and Methods

Equipment Type	Data Collection and/or Survey Types	Description of the Equipment
Acoustic Corer™ (https://www.pangeosubsea.com/acoustic-corer/)	Stationary acoustic source deployed on the seafloor with low and mid frequency chirp sonars to detect shallow (15 m to 40 m) subsea hazards such as boulders, cavities, and abandoned infrastructure by generating a 3D, 12-m diameter "acoustic core" to full penetration depth (inset above).	A seabed deployed unit with dual subsurface scanning sonar heads attached to a 12-m boom. The system is set on a tripod on the seafloor. Each arm rotates 180 degrees to cover a full 360 degrees. Chirp sonars of different frequencies can be attached to each arm providing for multi-aspect depth resolution. Acoustic cores supplement geophysical surveys such as bore holes and Cone Penetration Testing.
Bathymetry/ multi-beam echosounder	Bathymetric charting	A depth sounder is a microprocessor-controlled, high-resolution survey-grade system that measures precise water depths in both digital and graphic formats. The system would be used in such a manner as to record with a sweep appropriate to the range of water depths expected in the survey area.
Magnetometer	Collection of geophysical data for shallow hazards and archaeological resources assessments	Surveys would be used to detect and aid in the identification of ferrous or other objects having a distinct magnetic signature. A sensor is typically towed as near as possible to the seafloor and anticipated to be no more than approximately 20 ft. (6 m) above the seafloor.
Shallow and Medium (Seismic) Penetration Profilers (i.e. Chirps, Sparkers, Boomers, Bubble Guns)	Collection of geophysical data for shallow hazards and archaeological resources assessments and to characterize subsurface sediments	High-resolution CHIRP System sub-bottom profiler or boomers are used to generate a profile view below the bottom of the seabed, which is interpreted to develop a geologic cross-section of subsurface sediment conditions under the track line surveyed. Another type of sub-bottom profiler that may be employed is a medium penetration system such as a boomer, bubble pulser or impulse-type system. Sub-bottom profilers are capable of penetrating sediment depth ranges of 10 ft. (3 m) to greater than 328 ft. (100 m), depending on frequency and bottom composition.
Side-Scan Sonar	Collection of geophysical data for shallow hazards and archaeological resources assessments	This survey evaluates surface and near-surface sediments, seafloor morphology, and potential surface obstructions (MMS, 2007a). A typical side-scan sonar system consists of a top-side processor, tow cable, and towfish with transducers (or "pingers") located on the sides. Typically, a lessee would use a digital dual-frequency side-scan sonar system with 300 to 500 kHz frequency ranges or greater to record continuous planimetric images of the seafloor.

Table A.2. Acoustic Characteristics of Representative HRG Survey Equipment. Note list of equipment is representative and surveys may use similar equipment and actual source levels may be below those indicated.

	Highest Measured Source Level (Highest Power Setting)						
HRG Source	**Source Setting**	**PK**	**RMS**	**SEL**	**Pulse Width (s)**	**Main Pulse Frequency (kHz)**	**Inter-Pulse Interval (s) (1/PPS)**
Mobile, Impulsive, Intermittent Sources							
AA200 Boomer Plate	250 J (low)	209	200	169	0.0008	4.3	1.0 (1 pps)
AA251 Boomer Plate	300 J (high)	216	207	176	0.0007	4.3	1.0 (1 pps)
Applied Acoustic Delta Sparker	2400 J at 1 m depth, 0.5 kHz	221	205	185	0.0095	0.5	.33333 (1-3 pps)
Applied Acoustic Dura-Spark	2400 J (high), 400 tips	225	214	188	0.0022	2.7	.33333 (1-3 pps)
Applied Acoustics S-Boom (3 AA252 boomer plates)	700 J	211	205	172	0.0006	6.2	1.0 (1 pps)
Applied Acoustics S-Boom (CSP-N Source)	1000 J	209	203	172	0.0009	3.8	.33333 (3 pps)
ELC820 Sparker	750 J (high) 1m depth	214	206	182	0.0039	1.2	1.0 (1 pps)
FSI HMS-620D Bubble Gun	Dual Channel 86 cm	204	198	173	0.0033	1.1	8.0 (1 per 8 s)
Mobile, Non-Impulsive, Intermittent Sources							
Bathyswath SWATHplus-M	100%, 234 kHz	223	218	180	0.00032	$\geq$200 kHz	0.2000 pps (unknown)
Echotrac CV100 Single-Beam Echosounder	Power 12, 80 cycles, 200 kHz	196	193	159	0.00036	$\geq$200 kHz	0.0500 (20 pps)
EdgeTech 424 with 3200-XS topside processor (Chirp)	100% power, 4-20 kHz	187	180	156	0.0046	7.2-11	.12500 (8 pps)

EdgeTech 512i Sub-bottom Profiler, 8.9 kHz (Chirp)	100% power, 2-12 kHz	186	180	159	0.0087	6.3-8.9	.12500 (8 pps)
EdgeTech 4200 Side-Scan	100%, 100 kHz (also a 400 kHz setting)	206	201	179	0.0072	100 kHz	.03333 (30 pps)
Klein 3000 Side-Scan	132 kHz (also capable of 445 kHz)	224	219	184	0.000343	132 kHz	.03333 (30 pps)
Klein 3900 Side-Scan	445 kHz	226	220	179	0.000084	≥200 kHz	unreported
Knudsen 3202 Sub-bottom Profiler (2 transducers), 5.7 kHz	Power 4	214	209	193	0.0217	3.3-5.7	0.25000 (4 pps)
Reson Seabat 7111 Multibeam Echosounder	100 kHz	228	224	185	0.00015	100 kHz	0.0500 (20 pps)
Reson Seabat T20P Multibeam Echosounder	200, 300, or 400 kHz	221	218	182	0.00025	≥200 kHz	0.0200 (50 pps)

Source: Highest reported source levels reported in Crocker and Fratantonio (2016).

Table 1. Predicted isopleths for peak pressure (using 20 LogR) and cSEL using NOAA's general spreadsheet tool (December 2020 Revision) to predict cumulative exposure distances using the highest power levels were used for each sound source reported in Crocker and Fratantonio (2016).

HRG SOURCE	PTS INJURY DISTANCE (m)							
	Low Frequency Cetaceans		Mid Frequency Cetaceans		High Frequency Cetaceans		Seals (Phocids)	
	PK	SEL	PK	SEL	PK	SEL	PK	SEL
AA200 Boomer Plate	0	0.1	0	0	2.2	0.9	0	0.0
AA251 Boomer Plate	0	0.3	0	0	5.0	4.7	0.0	0.2
Applied Acoustics S-Boom (3 AA252 boomer plates)	0	0.1	0	0.0	2.8	5.6	0	0.1
Applied Acoustics S-Boom (CSP-N Source)	0	0.3	0	0	2.2	3.7	0	0.2
FSI HMS-620D Bubble Gun (impulsive)	0	0	0	0	1.3	0	0	0
ELC820 Sparker (impulsive)	0	3.2	0	0	4.0	0.7	0.0	0.7

HRG SOURCE	PTS INJURY DISTANCE (m)							
	Low Frequency Cetaceans		Mid Frequency Cetaceans		High Frequency Cetaceans		Seals (Phocids)	
	PK	SEL	PK	SEL	PK	SEL	PK	SEL
Applied Acoustics Dura-Spark (impulsive)	2.0	12.7	0	0.2	14.1	47.3	2.2	6.4
Applied Acoustics Delta Sparker (impulsive)	1.3	5.7	0	0	8.9	0.1	1.4	0.3
EdgeTech 424 Sub-bottom profiler 3200-XS, 7.2 kHz	—	0	—	0	—	0.0	—	0
EdgeTech 512i Sub-bottom Profiler, 6.39 kHz	—	0	—	0	—	0.0	—	0
Knudsen 3202 Chirp Sub-bottom profiler (2 transducers), 5.7 kHz	—	1.2	—	0.3	—	35.2	—	<1
Reson Seabat 7111 Multibeam Echosounder,100 kHz	—	0	—	0.5	—	251.4	—	0.0
Reson Seabat T20P Multibeam Echosounder	—	0	—	0	—	0	—	0
Bathyswath SWATHplus-M	—	0	—	0	—	0	—	0
Echotrac CV100 Single-Beam Echosounder	—	0	—	0	—	0	—	0
Klein 3000 Side-Scan, 132 kHz	—	0	—	0.4	—	193.6	—	0.0
Klein 3000 Side-Scan, 445 kHz	—	0	—	0	—	0	—	0
Klein 3900 Side-Scan, 445 kHz	—	0	—	0	—	0	—	0

Table A.4. PTS distance for sea turtles and listed fish for impulsive HRG sound sources (60 minutes duration using the highest power levels were used for each sound source reported in Crocker and Fratantonio (2016)).

HRG SOURCE		Sea Turtles*, ESA-listed Fish			
		PTS INJURY DISTANCE (m) for Impulsive HRG Sources			
	SEL Source level	Fish cSEL[a] Distance to 187 dB (m)	Turtle cSEL[a] Distance (m)	Peak Source Level	Fish Peak Distance to 206 dB (m)
AA200 Boomer Plate	169	0	0	209	1.4
AA251 Boomer Plate	176	0	0	216	3.2
Applied Acoustics S-Boom (3 AA252 boomer plates)	172	0	0	211	2.5
Applied Acoustics S-Boom (CSP-N Source)	172	0	0	209	1.4
FSI HMS-620D Bubble Gun (impulsive)	173	0	0	204	0
ELC820 Sparker (impulsive)	182	0	0	214	4.0

HRG SOURCE		Sea Turtles*, ESA-listed Fish			
		PTS INJURY DISTANCE (m) for Impulsive HRG Sources			
	SEL Source level	Fish cSEL[a] Distance to 187 dB (m)	Turtle cSEL[a] Distance (m)	Peak Source Level	Fish Peak Distance to 206 dB (m)
Applied Acoustics Dura-Spark (impulsive)	188	1.6	0	225	9.0
Applied Acoustics Delta Sparker (impulsive)	185	1.1	0	221	5.7
EdgeTech 424 Sub-bottom profiler 3200-XS, 7.2 kHz	156	NA	NA	187	NA
EdgeTech 512i Sub-bottom Profiler, 8.9 kHz	159	NA	NA	186	NA
Knudsen 3202 Chirp Sub-bottom profiler (2 transducers), 5.7 kHz	193	NA	NA	214	NA
Reson Seabat 7111 Multibeam Echosounder,100 kHz	185	NA	NA	228	NA
Reson Seabat T20P Multibeam Echosounder	182	NA	NA	221	NA
Bathyswath SWATHplus-M	180	NA	NA	223	NA
Echotrac CV100 Single-Beam Echosounder	159	NA	NA	196	NA
Klein 3000 Side-Scan, 132 kHz	184	NA	NA	224	NA
Klein 3000 Side-Scan, 445 kHz	179	NA	NA	226	NA
EdgeTech 4200 Side-Scan, 100 kHz	169	NA	NA	206	NA
EdgeTech 4200 Side-Scan, 400 kHz	176	NA	NA	210	NA

[a] = cSEL distances were calculated by 20 log(Source Level + 10 log(1800 sec) – Threshold Level)

NA = Frequencies are out of the hearing range of the sea turtles, sturgeon, and salmon

*Sea Turtle peak pressure distances for all HRG sources are below the threshold level of 232dB.

Table A.5. Disturbances distances for marine mammals (160 dB RMS), sea turtles (175 dB RMS), and fish (150 dB RMS) using 20LogR spherical spreading loss using the highest power levels were used for each sound source reported in Crocker and Fratantonio (2016).

HRG SOURCE	DISTANCE OF POTENTIAL DISTURBANCE (m)*		
	Marine Mammals	Sea Turtles	Fish
AA200 Boomer Plate	100	18	317
AA251 Boomer Plate	224	40	708
Applied Acoustics S-Boom (3 AA252 boomer plates)	178	32	563
Applied Acoustics S-Boom (CSP-N Source)	142	26	447

FSI HMS-620D Bubble Gun	80	15	252
ELC820 Sparker	200	36	631
Applied Acoustics Dura-Spark	502	90	1,996
Applied Acoustics Delta Sparker	178	32	563
EdgeTech 424 Sub-bottom Profiler, 7.2 and 11 kHz	10	2	32
EdgeTech 512i Sub-bottom Profiler	10	2	32
Knudsen 3202 Echosounder (2 transducers)	892	NA	NA
Reson Seabat 7111 Multibeam Echosounder[1]	NA	NA	NA
Reson Seabat T20P Multibeam Echosounder[1]	NA	NA	NA
Bathyswath SWATHplus-M	NA	NA	NA
Echotrac CV100 Single-Beam Echosounder[1]	NA	NA	NA
Klein 3000 Side-Scan, 132 kHz	NA	NA	NA
Klein 3000 Side-Scan, 445 kHz	NA	NA	NA
Klein 3900 Side-scan, 445 kHz	NA	NA	NA
EdgeTech 4200 Side-Scan, 100 kHz	NA	NA	NA
EdgeTech 4200 Side-Scan, 400 kHz	NA	NA	NA

NA = Not Audible

[1] These multi-beam echosounder and side-scan sonars are only audible to mid- and high-frequency hearing groups of marine mammals.

* Disturbance distances have been round up to the next nearest whole number.

APPENDIX B

Project Design Criteria (PDC) and Best Management Practices (BMPs) for Threatened and Endangered Species for Site Characterization and Site Assessment Activities to Support Offshore Wind Projects

Any survey plan must meet the following minimum requirements specified below, except when complying with these requirements would put the safety of the vessel or crew at risk.

PDC 1: Avoid Live Bottom Features

BMPs:

1. All vessel anchoring and any seafloor-sampling activities (i.e., drilling or boring for geotechnical surveys) are restricted from seafloor areas with consolidated seabed features.[1] All vessel anchoring and seafloor sampling must also occur at least 150 m from any known locations of threatened or endangered coral species. All sensitive live bottom habitats (eelgrass, cold-water corals, etc.) should be avoided as practicable. All vessels in coastal waters will operate in a manner to minimize propeller wash and seafloor disturbance and transiting vessels should follow deep-water routes (e.g., marked channels), as practicable, to reduce disturbance to sturgeon and sawfish habitat.

PDC 2: Avoid Activities that Could Affect Early Life Stages of Atlantic Sturgeon

BMP:

1. No geotechnical or bottom disturbing activities will take place during the spawning/rearing season within freshwater reaches of rivers where Atlantic or shortnose sturgeon spawning occurs. Any survey plan that includes geotechnical or other benthic sampling activities in freshwater reaches (salinity 0-0.5 ppt) of such rivers will identify a time of year restriction that will avoid such activities during the time of year when Atlantic sturgeon spawning and rearing of early life stages occurs in that river. Appropriate time of year restrictions include the following:

River	No Work Window	Area Affected
Hudson	April – July	Upstream of the Delaware Memorial Bridge
Delaware	April – July	Upstream of Newburgh, NY - Beacon Bridge/Rt 84

This table will be supplemented with additional rivers as necessary.

PDC 3: Marine Trash and Debris Awareness and Prevention

"*Marine trash and debris*" is defined as any object or fragment of wood, metal, glass, rubber, plastic, cloth, paper or any other solid, man-made item or material that is lost or discarded in the marine environment by the Lessee or an authorized representative of the Lessee (collectively, the

[1] Consolidated seabed features for this measure are pavement, scarp walls, and deep/cold-water coral reefs and shallow/mesophotic reefs as defined in the CMECS Geologic Substrate Classifications.

"Lessee") while conducting activities on the OCS in connection with a lease, grant, or approval issued by the Department of the Interior (DOI). To understand the type and amount of marine debris generated, and to minimize the risk of entanglement in and/or ingestion of marine debris by protected species, lessees must implement the following BMPS.

BMPs:

1. Training: All vessel operators, employees, and contractors performing OCS survey activities on behalf of the Lessee (collectively, "Lessee Representatives") must 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. The training videos, slides, and related material may be downloaded directly from the website. Lessee Representatives engaged in OCS survey activities must continue to develop and use a marine trash and debris awareness training and certification process that reasonably assures that they, as well as their respective employees, contractors, and subcontractors, are in fact trained. The training process must include the following elements:
    a. Viewing of either a video or slide show by the personnel specified above;
    b. An explanation from management personnel that emphasizes their commitment to the requirements;
    c. Attendance measures (initial and annual); and
    d. Recordkeeping and availability of records for inspection by DOI.

    By January 31 of each year, the Lessee must submit to DOI an annual report signed by the Lessee that describes its marine trash and debris awareness training process and certifies that the training process has been followed for the previous calendar year. You must send the reports via email to *renewable_reporting@boem.gov* and to *marinedebris@bsee.gov*.

2. Marking: Materials, equipment, tools, containers, and other items used in OCS activities which are of such shape or configuration that they are likely to snag or damage fishing devices, and could be lost or discarded overboard, must be clearly marked with the vessel or facility identification and properly secured to prevent loss overboard. All markings must clearly identify the owner and must be durable enough to resist the effects of the environmental conditions to which they may be exposed.

3. Recovery: Lessees must recover marine trash and debris that is lost or discarded in the marine environment while performing OCS activities when such incident is likely to: (a) cause undue harm or damage to natural resources, including their physical, atmospheric, and biological components, with particular attention to those that could result in the entanglement of or ingestion by marine protected species; or (b) significantly interfere with OCS uses (e.g., are likely to snag or damage fishing

equipment, or present a hazard to navigation). Lessees must notify DOI when recovery activities are (i) not possible because conditions are unsafe; or (ii) not practicable because the marine trash and debris released is not likely to result in any of the conditions listed in (a) or (b) above. The lessee must recover the marine trash and debris lost or discarded if DOI does not agree with the reasons provided by the Lessee to be relieved from the obligation to recover the marine trash and debris. If the marine trash and debris is located within the boundaries of a potential archaeological resource/avoidance area, or a sensitive ecological/benthic resource area, the Lessee must contact DOI for approval prior to conducting any recovery efforts.

Recovery of the marine trash and debris should be completed immediately, but no later than 30 days from the date in which the incident occurred. If the Lessee is not able to recover the marine trash or debris within 48 hours (*See* BMP 4. Reporting), the Lessee must submit a recovery plan to DOI explaining the recovery activities to recover the marine trash or debris ("Recovery Plan"). The Recovery Plan must be submitted no later than 10 calendar days from the date in which the incident occurred. Unless otherwise objected by DOI within 48 hours of the filing of the Recovery Plan, the Lessee can proceed with the activities described in the Recovery Plan. The Lessee must request and obtain approval of a time extension if recovery activities cannot be completed within 30 days from the date in which the incident occurred. The Lessee must enact steps to prevent similar incidents and must submit a description of these actions to BOEM and BSEE within 30 days from the date in which the incident occurred.

4. Reporting: The Lessee must report all marine trash and debris lost or discarded to DOI (using the email address listed on DOI's most recent incident reporting guidance). This report applies to all marine trash and debris lost or discarded, and must be made monthly, no later than the fifth day of the following month. The report must include the following:

    a. Project identification and contact information for the lessee, operator, and/or contractor;
    b. The date and time of the incident;
    c. The lease number, OCS area and block, and coordinates of the object's location (latitude and longitude in decimal degrees);
    d. A detailed description of the dropped object to include dimensions (approximate length, width, height, and weight) and composition (e.g., plastic, aluminum, steel, wood, paper, hazardous substances, or defined pollutants);
    e. Pictures, data imagery, data streams, and/or a schematic/illustration of the object, if available;
    f. Indication of whether the lost or discarded item could be a magnetic anomaly of greater than 50 nanoTesla (nT), a seafloor target of greater than 0.5 meters (m), or a sub-bottom anomaly of greater than 0.5m when operating a magnetometer or gradiometer, side scan sonar, or sub-bottom profile in accordance with DOI's applicable guidance;
    g. An explanation of how the object was lost; and

h. A description of immediate recovery efforts and results, including photos.

In addition to the foregoing, the Lessee must submit a report within 48 hours of the incident ("48-hour Report") if the marine trash or debris could (a) cause undue harm or damage to natural resources, including their physical, atmospheric, and biological components, with particular attention to those that could result in the ingestion by or entanglement of marine protected species; or (b) significantly interfere with OCS uses (e.g., are likely to snag or damage fishing equipment, or present a hazard to navigation). The information in the 48-hour Report would be the same as that listed above, but just for the incident that triggered the 48-hour Report. The Lessee must report to DOI if the object is recovered and, as applicable, any substantial variation in the activities described in the Recovery Plan that were required during the recovery efforts. Information on unrecovered marine trash and debris must be included and addressed in the description of the site clearance activities provided in the decommissioning application required under 30 CFR § 585.906. The Lessee is not required to submit a report for those months in which no marine trash and debris was lost or discarded.

PDC 4: Minimize Interactions with Listed Species during Geophysical Survey Operations
To avoid injury of ESA-listed species and minimize any potential disturbance, the following measures will be implemented for all vessels operating impulsive survey equipment that emits sound at frequency ranges <180 kHz (within the functional hearing range of marine mammals)[2] as well as CHIRP sub bottom profilers. The Clearance Zone is defined as the area around the sound source that needs to be visually cleared of listed species for 30 minutes before the sound source is turned on. The Clearance Zone is equivalent to a minimum visibility zone for survey operations to begin (*See* BMP 6). The Shutdown Zone is defined as the area around the sound source that must be monitored for possible shutdown upon detection of protected species within or entering that zone. For both the Clearance and Shutdown Zones, these are minimum visibility distances and for situational awareness PSOs should observe beyond this area when possible.

BMPs:

1. For situational awareness a Clearance Zone extending at least (500 m in all directions) must be established around all vessels operating sources <180 kHz.
    a. The Clearance Zone must be monitored by approved third-party PSOs at all times and any observed listed species must be recorded (see reporting requirements below).
    b. For monitoring around the autonomous surface vessel (ASV) where remote PSO monitoring must occur from the mother vessel, a dual thermal/HD camera must 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 must be able to monitor the real-time output of the camera on hand-held computer tablets. Images from the cameras must be able to be captured and reviewed to assist in verifying species identification. A monitor must also be installed in the bridge displaying the real-time images from the thermal/HD camera installed on

[2] Note that this requirement does not apply to Parametric Subbottom Profilers, Ultra Short Baseline, echosounders or side scan sonar; the acoustic characteristics (frequency, narrow beam width, rapid attenuation) are such that no effects to listed species are anticipated.

the front of the ASV itself, providing a further forward view of the craft. In addition, night-vision goggles with thermal clip-ons and a handheld spotlight must be provided and used such that PSOs can focus observations in any direction around the mother vessel and/or the ASV.

2. To minimize exposure to noise that could be disturbing, Shutdown Zone(s) (500 m for North Atlantic right whales and 100 m for other ESA-listed whales visible at the surface) must be established around the sources operating at <180 kHz being towed from the vessel .
    a. The Shutdown Zone(s) must be monitored by third-party PSOs at all times when noise-producing equipment (<180 kHz) is being operated and all observed listed species must be recorded (see reporting requirements below).
    b. If an ESA-listed species is detected within or entering the respective Shutdown Zone, any noise-producing equipment operating below 180 kHz must be shut off until the minimum separation distance from the source is re-established (500 m for North Atlantic right whales and 100 m for other ESA-listed species, including other ESA-listed marine mammals) and the measures in (5) are carried out.
        i. A PSO must notify the survey crew that a shutdown of all active boomer, sparker, and bubble gun acoustic sources below 180 kHz is immediately required. The vessel operator and crew must comply immediately with any call for a shutdown by the PSO. Any disagreement or discussion must occur only after shutdown.
    c. If the Shutdown Zone(s) cannot be adequately monitored for ESA-listed species presence (i.e., a PSO determines conditions, including at night or other low-visibility conditions, are such that listed species cannot be reliably sighted within the Shutdown Zone(s), no equipment operating at <180 kHz can be deployed until such time that the Shutdown Zone(s) can be reliably monitored.
3. Before any noise-producing survey equipment (operating at <180 kHz) is deployed, the Clearance Zone (500 m for all listed species) must be monitored for 30 minutes of pre-clearance observation.
    a. If any ESA-listed species is observed within the Clearance Zone during the 30-minute pre-clearance period, the 30-minute clock must be paused. If the PSO confirms the animal has exited the zone and headed away from the survey vessel, the 30-minute clock that was paused may resume. The pre-clearance clock will reset to 30 minutes if the animal dives or visual contact is otherwise lost.
4. When technically feasible, a “ramp up” of the electromechanical survey equipment must occur at the start or re-start of geophysical survey activities. A ramp up must begin with the power of the smallest acoustic equipment for the geophysical survey at its lowest power output. When technically feasible the power will then be gradually turned up and other acoustic sources added in a way such that the source level would increase gradually.
5. Following a shutdown for any reason, ramp up of the equipment may begin immediately only if: (a) the shutdown is less than 30 minutes, (b) visual monitoring of

the Shutdown Zone(s) continued throughout the shutdown, (c) the animal(s) causing the shutdown was visually followed and confirmed by PSOs to be outside of the Shutdown Zone(s) (500 m for North Atlantic right whales and 100 m for other ESA-listed species, including other ESA-listed marine mammals) and heading away from the vessel, and (d) the Shutdown Zone(s) remains clear of all listed species. If all (a, b, c, and d) the conditions are not met, the Clearance Zone (500 m for all listed species) must be monitored for 30 minutes of pre-clearance observation before noise-producing equipment can be turned back on.

6. In order for geophysical surveys to be conducted at night or during low-visibility conditions, PSOs must be able to effectively monitor the Clearance and Shutdown Zone(s). No may occur if the Clearance and Shutdown Zone(s) cannot be reliably monitored for the presence of ESA-listed species to ensure avoidance of injury to those species.
    a. An Alternative Monitoring Plan (AMP) must be submitted to BOEM (or the federal agency authorizing, funding, or permitting the survey) detailing the monitoring methodology that will be used during nighttime and low-visibility conditions and an explanation of how it will be effective at ensuring that the Shutdown Zone(s) can be maintained during nighttime and low-visibility survey operations. The plan must be submitted 60 days before survey operations are set to begin.
    b. The plan must include technologies that have the technical feasibility to detect all ESA-listed whales out to 500 m and sea turtles to 100 m.
    c. PSOs should be trained and experienced with the proposed alternative monitoring technology.
    d. The AMP must describe how calibration will be performed, for example, by including observations of known objects at set distances and under various lighting conditions. This calibration should be performed during mobilization and periodically throughout the survey operation.
    e. PSOs shall make nighttime observations from a platform with no visual barriers, due to the potential for the reflectivity from bridge windows or other structures to interfere with the use of the night vision optics.
7. To minimize risk to North Atlantic right whales, no surveys may occur in Cape Cod Bay from January 1 - May 15 of any year (in an area beginning at 42°04′56.5″ N-070°12′00.0″ W; thence north to 42°12′00.0″ N-070°12′00.0″ W; thence due west to charted mean high water line; thence along charted mean high water within Cape Cod Bay back to beginning point).
8. Sound sources used within the North Atlantic right whale Critical Habitat Southeastern U.S. Calving Area (i.e., Unit 2) during the calving and nursing season (December-March) shall operate at frequencies <7 kHz and >35 kHz (functional hearing range of right whales) at night or low visibility conditions.
9. At times when multiple survey vessels are operating within a lease area, adjacent lease areas, or exploratory cable routes, a minimum separation distance (to be determined on a survey specific basis, dependent on equipment being used) must be maintained between survey vessels to ensure that sound sources do not overlap.
10. To minimize disturbance to the Northwest Atlantic Ocean DPS of loggerhead sea turtles, a voluntary pause in sparker operation should be implemented for all vessels

operating in nearshore critical habitat for loggerhead sea turtles. These conditions apply to critical habitat boundaries for nearshore reproductive habitats LOGG N-3 through LOGG N-16 (79 FR 39855) from April 1 to September 30. Following pre-clearance procedures, if any loggerhead or other unidentified sea turtles is observed within a 100 m Clearance Zone during a survey, sparker operation should be paused by turning off the sparker until the sea turtle is beyond 100 m of the survey vessel. If the animal dives or visual contact is otherwise lost, sparker operation may resume after a minimum 2-minute pause following the last sighting of the animal.

11. Any visual observations of listed species by crew or project personnel must be communicated to PSOs on-duty.
12. During good conditions (e.g., daylight hours; Beaufort scale 3 or less) when survey equipment is not operating, to the maximum extent practicable, PSOs must conduct observations for protected species for comparison of sighting rates and behavior with and without use of active geophysical survey equipment. Any observed listed species must be recorded regardless of any mitigation actions required.

PDC 5: Minimize Vessel Interactions with Listed Species
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 such incidents occur, they must be reported as outlined below under Reporting Requirements (PDC 8). The Vessel Strike Avoidance Zone is defined as 500 m or greater from any sighted ESA-listed species or other unidentified large marine mammal.

BMPs:

1. Vessel captain and crew must maintain a vigilant watch for all protected species and slow down, stop their vessel, or alter course, as appropriate and regardless of vessel size, to avoid striking any listed species. The presence of a single individual at the surface may indicate the presence of submerged animals in the vicinity; therefore, precautionary measures should always be exercised. If pinnipeds or small delphinids of the following genera: Delphinus, Lagenorhynchus, Stenella, and Tursiops are visually detected approaching the vessel (i.e., to bow ride) or towed equipment, vessel strike avoidance and shutdown is not required.
2. Anytime a survey vessel is underway (transiting or surveying), the vessel must maintain a 500 m minimum separation distance and a PSO must monitor a Vessel Strike Avoidance Zone (500 m or greater from any sighted ESA-listed species or other unidentified large marine mammal visible at the surface) to ensure detection of that animal in time to take necessary measures to avoid striking the animal. If the survey vessel does not require a PSO for the type of survey equipment used, a trained crew lookout may be used (see #3). For monitoring around the autonomous surface vessels, regardless of the equipment it may be operating, a dual thermal/HD camera must 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. A dedicated operator must be able to monitor the real-time output of the camera on hand-held computer tablets. Images from the cameras must be able to be captured and reviewed to assist in verifying species identification. A monitor must also be

installed in the bridge displaying the real-time images from the thermal/HD camera installed on the front of the ASV itself, providing a further forward view of the craft.

a. Survey plans must include identification of vessel strike avoidance measures, including procedures for equipment shut down and retrieval, communication between PSOs/crew lookouts, equipment operators, and the captain, and other measures necessary to avoid vessel strike while maintaining vessel and crew safety. If any circumstances are anticipated that may preclude the implementation of this PDC, they must be clearly identified in the survey plan and alternative procedures outlined in the plan to ensure minimum distances are maintained and vessel strikes can be avoided.
b. All vessel crew members must be briefed in the identification of protected species that may occur in the survey area and in regulations and best practices for avoiding vessel collisions. Reference materials must be available aboard all project vessels for identification of listed species. The expectation and process for reporting of protected species sighted during surveys must 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.
c. The Vessel Strike Avoidance Zone(s) are a minimum and must be maintained around all surface vessels at all times.
d. If a large whale is identified within 500 m of the forward path of any vessel, the vessel operator must steer a course away from the whale at 10 knots (18.5 km/hr) or less until the 500 m minimum separation distance has been established. Vessels may also shift to idle if feasible.
e. If a large whale is sighted within 200 m of the forward path of a vessel, the vessel operator must reduce speed and shift the engine to neutral. Engines must not be engaged until the whale has moved outside of the vessel's path and beyond 500 m. If stationary, the vessel must not engage engines until the large whale has moved beyond 500 m.
f. If a sea turtle or manta ray is sighted within the operating vessel's forward path, the vessel operator must slow down to 4 knots (unless unsafe to do so) and steer away as possible. The vessel may resume normal operations once the vessel has passed the individual.
g. During times of year when sea turtles are known to occur in the survey area, vessels must avoid transiting through areas of visible jellyfish aggregations or floating vegetation (e.g., sargassum lines or mats). In the event that operational safety prevents avoidance of such areas, vessels must slow to 4 knots while transiting through such areas.
h. Vessels operating in water depths with less than 4 ft. clearance between the vessel and the bottom should maintain speeds no greater than 4 knots to minimize vessel strike risk to sturgeon and sawfish.

3. To monitor the Vessel Strike Avoidance Zone, a PSO (or crew lookout if PSOs are not required) must be posted during all times a vessel is underway (transiting or surveying) to monitor for listed species in all directions.

    a. Visual observers monitoring the vessel strike avoidance zone can be either PSOs or crew members (if PSOs are not required). If the trained lookout is a vessel crew member, this must be their designated role and primary responsibility while the vessel is transiting. Any designated crew lookouts must receive training on protected species identification, vessel strike minimization procedures, how and when to communicate with the vessel captain, and reporting requirements. All observations must be recorded per reporting requirements.
    b. Regardless of monitoring duties, all crew members responsible for navigation duties must receive site-specific training on ESA-listed species sighting/reporting and vessel strike avoidance measures.
4. Regardless of vessel size, vessel operators must reduce vessel speed to 10 knots (18.5 mph) or less while operating in any Seasonal Management Area (SMA), Dynamic Management Area (DMA)/Slow Zones triggered by visual detection of North Atlantic right whales. The only exception to this requirement is for vessels operating in areas within a DMA/visually triggered Slow Zone where it is not reasonable to expect the presence of North Atlantic right whales (e.g. Long Island Sound, shallow harbors). Reducing vessel speed to 10 knots or less while operating in Slow Zones triggered by acoustic detections of North Atlantic right whales is encouraged.
5. Vessels underway must not divert their course to approach any listed species.
6. All vessel operators must check for information regarding mandatory or voluntary ship strike avoidance (SMAs, DMAs, Slow Zones) and daily information regarding North Atlantic right whale sighting locations. These media may include, but are not limited to: NOAA weather radio, U.S. Coast Guard NAVTEX and channel 16 broadcasts, Notices to Mariners, the Whale Alert app, or WhaleMap website.
    a. North Atlantic right whale Sighting Advisory System info can be accessed at: https://apps-nefsc.fisheries.noaa.gov/psb/surveys/MapperiframeWithText.html
    b. Information about active SMAs, DMAs, and Slow Zones can be accessed at: https://www.fisheries.noaa.gov/national/endangered-species-conservation/reducing-vessel-strikes-north-atlantic-right-whales

PDC 6: Minimize Risk During Buoy Deployment, Operations, and Retrieval
Any mooring systems used during survey activities prevent any potential entanglement or entrainment of listed species, and in the unlikely event that entanglement does occur, ensure proper reporting of entanglement events according to the measures specified below.

BMPs:
1. Ensure that any buoys attached to the seafloor use the best available mooring systems. Buoys, lines (chains, cables, or coated rope systems), swivels, shackles, and anchor designs must prevent any potential entanglement of listed species while ensuring the safety and integrity of the structure or device.
2. All mooring lines and ancillary attachment lines must use one or more of the following measures to reduce entanglement risk: shortest practicable line length, rubber sleeves, weak-links, chains, cables or similar equipment types that prevent lines from looping, wrapping, or entrapping protected species.
3. Any equipment must be attached by a line within a rubber sleeve for rigidity. The length of the line must be as short as necessary to meet its intended purpose.

4. During all buoy deployment and retrieval operations, buoys should be lowered and raised slowly to minimize risk to listed species and benthic habitat. Additionally, PSOs or trained project personnel (if PSOs are not required) should monitor for listed species in the area prior to and during deployment and retrieval and work should be stopped if listed species are observed within 500 m of the vessel to minimize entanglement risk.
5. If a live or dead marine protected species becomes entangled, you must immediately contact the applicable NMFS stranding coordinator using the reporting contact details (see Reporting Requirements section) and provide any on-water assistance requested.
6. All buoys must be properly labeled with owner and contact information.

PDC 7: Protected Species Observers
Qualified third-party PSOs to observe Clearance and Shutdown Zones must be used as outlined in the conditions above.

BMPs:
1. All PSOs must have completed an approved PSO training program and must receive NMFS approval to act as a PSO for geophysical surveys. Documentation of NMFS approval for geophysical survey activities in the Atlantic and copies of the most recent training certificates of individual PSOs' successful completion of a commercial PSO training course with an overall examination score of 80% or greater must be provided upon request. Instructions and application requirements to become a NMFS-approved PSO can be found at: *www.fisheries.noaa.gov/national/endangered-species-conservation/protected-species-observers*.
2. In situations where third-party party PSOs are not required, crew members serving as lookouts must receive training on protected species identification, vessel strike minimization procedures, how and when to communicate with the vessel captain, and reporting requirements.
3. PSOs deployed for geophysical survey activities must be employed by a third-party observer provider. While the vessel is underway, they must have no other tasks than to conduct observational effort, record data, and communicate with and instruct relevant vessel crew to the presence of listed species and associated mitigation requirements. PSOs on duty must be clearly listed on daily data logs for each shift.
    a. Non-third-party observers may be approved by NMFS on a case-by-case basis for limited, specific duties in support of approved, third-party PSOs.
4. A minimum of one PSO (assuming condition 5 is met) must be on duty observing for listed species at all times that noise-producing equipment <180 kHz is operating, or the survey vessel is actively transiting during daylight hours (i.e. from 30 minutes prior to sunrise and through 30 minutes following sunset). Two PSOs must be on duty during nighttime operations. A PSO schedule showing that the number of PSOs used is sufficient to effectively monitor the affected area for the project (e.g., surveys) and record the required data must be included. PSOs must not be on watch for more than 4 consecutive hours, with at least a 2-hour break after a 4-hour watch. PSOs must not be on active duty observing for more than 12 hours in any 24-hour period.
5. Visual monitoring must occur from the most appropriate vantage point on the associated operational platform that allows for 360-degree visual coverage around the vessel. If

360-degree visual coverage is not possible from a single vantage point, multiple PSOs must be on watch to ensure such coverage.

6. Suitable equipment must be available to each PSO to adequately observe the full extent of the Clearance and Shutdown Zones during all vessel operations and meet all reporting requirements.
    a. Visual observations must be conducted using binoculars and the naked eye while free from distractions and in a consistent, systematic, and diligent manner.
    b. Rangefinders (at least one per PSO, plus backups) or reticle binoculars (e.g., 7 x 50) of appropriate quality (at least one per PSO, plus backups) to estimate distances to listed species located in proximity to the vessel and Clearance and Shutdown Zone(s).
    c. Digital full frame cameras with a telephoto lens that is at least 300 mm or equivalent. The camera or lens should also have an image stabilization system. Used to record sightings and verify species identification whenever possible.
    d. A laptop or tablet to collect and record data electronically.
    e. Global Positioning Units (GPS) if data collection/reporting software does not have built-in positioning functionality.
    f. PSO data must be collected in accordance with standard data reporting, software tools, and electronic data submission standards approved by BOEM and NMFS for the particular activity.
    g. Any other tools deemed necessary to adequately perform PSO tasks.

PDCs 8: Reporting Requirements

To ensure compliance and evaluate effectiveness of mitigation measures, regular reporting of survey activities and information on listed species will be required as follows.

BMPs:

1. Data from all PSO observations must be recorded based on standard PSO collection and reporting requirements. PSOs must use standardized electronic data forms to record data. The following information must be reported electronically in a format approved by BOEM and NMFS:
   Visual Effort:
    a. Vessel name;
    b. Dates of departures and returns to port with port name;
    c. Lease number;
    d. PSO names and affiliations;
    e. PSO ID (if applicable);
    f. PSO location on vessel;
    g. Height of observation deck above water surface (in meters);
    h. Visual monitoring equipment used;
    i. Dates and times (Greenwich Mean Time) of survey on/off effort and times corresponding with PSO on/off effort;
    j. Vessel location (latitude/longitude, decimal degrees) when survey effort begins and ends; vessel location at beginning and end of visual PSO duty shifts; recorded at 30 second intervals if obtainable from data collection software, otherwise at practical regular interval;

k. Vessel heading and speed at beginning and end of visual PSO duty shifts and upon any change;
l. Water depth (if obtainable from data collection software) (in meters);
m. Environmental conditions while on visual survey (at beginning and end of PSO shift and whenever conditions change significantly), including wind speed and direction, Beaufort scale, Beaufort wind force, swell height (in meters), swell angle, precipitation, cloud cover, sun glare, and overall visibility to the horizon;
n. Factors that may be contributing to impaired observations during each PSO shift change or as needed as environmental conditions change (e.g., vessel traffic, equipment malfunctions);
o. Survey activity information, such as type of survey equipment in operation, acoustic source power output while in operation, and any other notes of significance (i.e., pre-clearance survey, ramp-up, shutdown, end of operations, etc.);

Visual Sighting (all Visual Effort fields plus):

a. Watch status (sighting made by PSO on/off effort, opportunistic, crew, alternate vessel/platform);
b. Vessel/survey activity at time of sighting;
c. PSO/PSO ID who sighted the animal;
d. Time of sighting;
e. Initial detection method;
f. Sightings cue;
g. Vessel location at time of sighting (decimal degrees);
h. Direction of vessel’s travel (compass direction);
i. Direction of animal’s travel relative to the vessel;
j. Identification of the animal (e.g., genus/species, lowest possible taxonomic level, or unidentified); also note the composition of the group if there is a mix of species;
k. Species reliability;
l. Radial distance;
m. Distance method;
n. Group size; Estimated number of animals (high/low/best);
o. Estimated number of animals by cohort (adults, yearlings, juveniles, calves, group composition, etc.);
p. Description (as many distinguishing features as possible of each individual seen, including length, shape, color, pattern, scars or markings, shape and size of dorsal fin, shape of head, and blow characteristics);
q. Detailed behavior observations (e.g., number of blows, number of surfaces, breaching, spyhopping, diving, feeding, traveling; as explicit and detailed as possible; note any observed changes in behavior);
r. Mitigation Action; Description of any actions implemented in response to the sighting (e.g., delays, shutdown, ramp-up, speed or course alteration, etc.) and time and location of the action.
s. Behavioral observation to mitigation;
t. Equipment operating during sighting;
u. Source depth (in meters);

   v. Source frequency;
   w. Animal's closest point of approach and/or closest distance from the center point of the acoustic source;
   x. Time entered shutdown zone;
   y. Time exited shutdown zone;
   z. Time in shutdown zone;
   aa. Photos/Video

2. The project proponent must submit a final monitoring report to BOEM and NMFS (to *renewable_reporting@boem.gov* and *nmfs.gar.incidental-take@noaa.gov*) within 90 days after completion of survey activities. The report must fully document the methods and monitoring protocols, summarizes the survey activities and the data recorded during monitoring, estimates of the number of listed species that may have been taken during survey activities, describes, assesses and compares the effectiveness of monitoring and mitigation measures. PSO sightings and effort data and trackline data in Excel spreadsheet format must also be provided with the final monitoring report.
3. Reporting sightings of North Atlantic right whales:
   a. If a North Atlantic right whale is observed at any time by a PSO or project personnel during surveys or vessel transit, sightings must be reported within two hours of occurrence when practicable and no later than 24 hours after occurrence. In the event of a sighting of a right whale that is dead, injured, or entangled, efforts must be made to make such reports as quickly as possible to the appropriate regional NOAA stranding hotline (from Maine-Virginia report sightings to 866-755-6622, and from North Carolina-Florida to 877-942-5343). Right whale sightings in any location may also be reported to the U.S. Coast Guard via channel 16 and through the WhaleAlert App (http://www.whalealert.org/).
   b. Further information on reporting a right whale sighting can be found at: *https://apps-nefsc.fisheries.noaa.gov/psb/surveys/documents/20120919_Report_a_Right_Whale.pdf*
4. In the event of a vessel strike of a protected species by any survey vessel, the project proponent must immediately report the incident to BOEM (*renewable_reporting@boem.gov*) and NMFS (*nmfs.gar.incidental-take@noaa.gov*) and for marine mammals to the NOAA stranding hotline: from Maine-Virginia, report to 866-755-6622, and from North Carolina-Florida to 877-942-5343 and for sea turtles from Maine-Virginia, report to 866-755-6622, and from North Caroline-Florida to 844-732-8785. The report must include the following information:
   a. Name, telephone, and email or the person providing the report;
   b. The vessel name;
   c. The Lease Number;
   d. Time, date, and location (latitude/longitude) of the incident;
   e. Species identification (if known) or description of the animal(s) involved;
   f. Vessel's speed during and leading up to the incident;
   g. Vessel's course/heading and what operations were being conducted (if applicable);
   h. Status of all sound sources in use;

i. 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;
j. Environmental conditions (wave height, wind speed, light, cloud cover, weather, water depth);
k. Estimated size and length of animal that was struck;
l. Description of the behavior of the species immediately preceding and following the strike;
m. If available, description of the presence and behavior of any other protected species immediately preceding the strike;
n. Disposition of the animal (e.g., dead, injured but alive, injured and moving, blood or tissue observed in the water, last sighted direction of travel, status unknown, disappeared); and
o. To the extent practicable, photographs or video footage of the animal(s).

5. Sightings of any injured or dead listed species must be immediately reported, regardless of whether the injury or death is related to survey operations, to BOEM (*renewable_reporting@boem.gov*), NMFS (*nmfs.gar.incidental-take@noaa.gov*), and the appropriate regional NOAA stranding hotline (from Maine-Virginia report sightings to 866-755-6622, and from North Carolina-Florida to 877-942-5343 for marine mammals and 844-732-8785 for sea turtles). If the project proponent's activity is responsible for the injury or death, they must ensure that the vessel assist in any salvage effort as requested by NMFS. When reporting sightings of injured or dead listed species, the following information must be included:
   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.
6. Reporting and Contact Information:
   a. Dead and/or Injured Protected Species:
      1. NMFS Greater Atlantic Region's Stranding Hotline: 866-755-6622
      2. NMFS Southeast Region's Stranding Hotline: 877-942-5343 (marine mammals), 844-732-8785 (sea turtles)
   ii. Injurious Takes of Endangered and Threatened Species:
      1. NMFS Greater Atlantic Regional Office, Protected Resources Division (*nmfs.gar.incidental-take@noaa.gov*)
      2. BOEM Environment Branch for Renewable Energy, Phone: 703-787-1340, Email: *renewable_reporting@boem.gov*