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 Vineyard Wind 1 Offshore Energy Project (Lease OCS-A 0501) – Reinitiation
GARFO-2024-01318 (replaces GARFO-2021-01265)

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

DATE ISSUED: August 23, 2024

APPROVED BY: ______________________________
Michael Pentony
Regional Administrator

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1.0 INTRODUCTION

On September 11, 2020, we completed consultation with issuance of a Biological Opinion (hereinafter referred to as the 2020 Opinion) to the Bureau of Ocean Energy Management (BOEM), as the lead federal agency, in accordance with section 7 of the Endangered Species Act of 1973 (ESA), as amended, on the effects of the construction, operation, maintenance, and decommissioning of the Vineyard Wind 1 Offshore Wind Project (Lease OCS-A 0501). That consultation was reinitiated in May 2021; consultation was completed with issuance of a Biological Opinion (hereinafter referred to as the 2021 Opinion) to BOEM, as the lead federal agency, on October 18, 2021. The 2021 Opinion superseded and replaced the 2020 Opinion. This Biological Opinion upon completion and issuance to BOEM, as the lead federal agency, replaces and supersedes the 2021 Opinion for the proposed action. Vineyard Wind 1, LLC (Vineyard Wind) is in the process of constructing, and proposes to operate and eventually decommission, a commercial-scale offshore wind energy facility within Lease Area OCS-A 0501 that would generate approximately 800 megawatts (MW) of electricity.

BOEM is the lead federal agency for purposes of section 7 consultation; the other action agencies include the Bureau of Safety and Environmental Enforcement (BSEE), the U.S. Army Corps of Engineers (USACE), the U.S. Environmental Protection Agency (EPA), the U.S. Coast Guard (USCG), and the NMFS Office of Protected Resources (OPR). 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 the NMFS Greater Atlantic Regional Fisheries Office.

1.1 Events and New Information Triggering Reinitiation of Consultation

Vineyard Wind began pile driving for WTG and ESP foundation installation in June 2023. All pile driving was expected to be completed within a single construction season during the May 1, 2023 to April 30, 2024, effective period of the IHA issued by NMFS OPR in 2021. However, due to weather and other delays, only 47 of 62 planned monopile foundations had been installed. In December 2023, Vineyard Wind submitted an application to NMFS OPR for a new IHA to address the remaining 15 monopile foundations.

On May 23, 2024, NMFS OPR submitted a request to reinitiate consultation. As described in the referenced correspondence and supporting documentation, NMFS OPR determined that reinitiation of consultation is necessary to consider changes to the proposed actions that may affect listed species in a manner or to an extent not considered in our 2021 Opinion as well as the availability of new information that reveals effects of the action that may affect listed species in a manner or to an extent not previously considered (50 CFR 402.16(a)(2)-(3); Reinitiation Notice, 2021 Opinion, Section 13). Specifically, NMFS OPR is proposing to issue a new Incidental Harassment Authorization (IHA) to authorize the take of marine mammals incidental to the installation of 15 monopiles to complete foundation installation for the Vineyard Wind 1 project. Issuance of the new IHA is a federal action that requires section 7 consultation. However, rather than request a stand-alone consultation on the issuance of the new IHA, NMFS OPR and GARFO agreed that it is more efficient and reasonable to reinitiate the 2021 consultation which evaluated the effects of the entire Vineyard Wind proposed action which included the proposed Construction and Operation Plan as well as the initial IHA. The proposed IHA for installation of the remaining 15 monopiles has been developed in consideration of updated marine mammal density data which have become available since issuance of the previous IHA and the analysis of sound field verification (SFV) data collected by Vineyard Wind during the installation of 12 monopiles in 2023. Additionally, the proposed IHA includes modified mitigation and monitoring measures from those considered in the previously issued IHA.

Reinitiation of consultation is required and shall be requested by the action agency (i.e., NMFS OPR) 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 (4) If a new species is listed or critical habitat designated that may be affected by the identified action." In a July 1, 2024, letter to BOEM and NMFS OPR we noted our agreement with NMFS OPR's determinations that consultation must be reinitiated as triggers "2" and "3" have been met.

This constitutes NOAA's National Marine Fisheries Service's (NMFS) biological opinion (Opinion) issued to BOEM, as the lead federal agency, in accordance with section 7 of the Endangered Species Act of 1973 (ESA), as amended, on the effects of the proposed action, including its approval with conditions of the Construction and Operation Plan (COP) authorizing the construction, operation, maintenance, and decommissioning of the Vineyard Wind Offshore Wind Project under the Outer Continental Shelf Lands Act (OCSLA).

1.2 Regulatory Authorities and Permitting/Environmental Review History

The Energy Policy Act of 2005 (EPAct), Public Law 109-58, added section 8(p)(1)(c) to the Outer Continental Shelf Lands Act (OCSLA). The new section authorized the Secretary of Interior to issue leases, easements, and rights-of-way (ROW) in the 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 Vineyard Wind's Construction and Operations Plan (COP). Vineyard Wind filed their COP with BOEM on December 19, 2017[1] and filed a COP Addendum in May 2019. BOEM issued a Notice of Intent to prepare an Environmental Impact Statement (EIS) under the National Environmental Policy Act (NEPA) (42 USC § 4321 et seq.) on March 30, 2018, to assess the potential biological and physical environmental impacts of the Proposed Action and Alternatives (83 FR 13777) on the human environment. A draft EIS (DEIS) was published on December 7, 2018 and a supplemental DEIS was published on June 12, 2020.

On December 1, 2020, BOEM received a letter from Vineyard Wind withdrawing its COP. On January 22, 2021, Vineyard Wind submitted a letter rescinding its temporary COP withdrawal and requesting that BOEM resume review of the project. Vineyard Wind had paused the

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[1] The COP and other related documents, including the COP approval letter, are available online at:https://www.boem.gov/renewable-energy/state-activities/vineyard-wind-1. Last accessed July 15, 2024.

Department's consideration of its proposal while it reviewed whether the use of Haliade-X turbines warranted any modifications to their COP. In February 2021, BOEM resumed the environmental review of the Vineyard Wind Project and proceeded with the development of a Final EIS. A final EIS was published on March 12, 2021, and a Record of Decision issued on May 10, 2021.[2] BOEM approved the COP, subject to conditions, on July 15, 2021[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-2017-01206[4]) describing their proposed authorizations 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 December 26, 2018. The USACE New England District issued a permit, with special conditions, to Vineyard Wind on August 9, 2021. Additionally, the USACE issued supplements to the Record of Decision on August 6, 2021 and January 14, 2022. Work regulated and permitted by USACE, through section 10 of the Rivers and Harbors Act of 1899 and section 404 of the Clean Water Act, includes the construction of up to 100 offshore wind turbine generators (WTGs), scour protection around the base of the WTGs, up to two electrical service platforms (ESPs), inter-array cables connecting the WTGS to the ESPs, inter-link cables between ESPs (if two ESPs were placed), and two offshore export cables within a single 22.6 mile route within state waters, extending from the Vineyard Wind lease site to Covell's Beach in Barnstable, Massachusetts.

EPA Region 1 issued an OCS Air Permit to Vineyard Wind on May 19, 2021, with a modification issued on August 19, 2022[5]. The EPA issued the OCS air permit pursuant to section 328 of the Clean Air Act (CAA) and applicable rules and regulations promulgated under 40 C.F.R. part 55. EPA's permit contains the applicable requirements under 40 C.F.R. part 55; the permit includes emission limits, operating requirements and work practices, and testing, recordkeeping, and reporting requirements. Anticipated air emission sources are the marine vessels to be used to support construction and operation/maintenance, and any generators or other emission sources at the WTGs and offshore substation. EPA's OCS Air permit is included as an element of the proposed action in this Opinion. On June 28, 2019, EPA issued a draft permit for public comment (Docket # EPA-R01-OAR-2019-0355). In the fact sheet, EPA notes that as the decommissioning phase of the windfarm will occur well into the future, the EPA is unable to determine best achievable control technology (BACT) and lowest achievable emissions

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[2] These documents are available at https://www.boem.gov/renewable-energy/state-activities/vineyard-wind-1; last accessed July 15, 2024.

[3]https://www.boem.gov/sites/default/files/documents/renewable-energy/state-activities/VW1-COP-Project-Easement-Approval-Letter_0.pdf. Last accessed July 15, 2024.

[4]Public Notice is online at https://www.nae.usace.army.mil/Portals/74/docs/regulatory/PublicNotices/NAE-2017-01206.pdf. Last accessed July 15, 2024.

[5] The permit and accompanying records are available online at: https://www.epa.gov/caa-permitting/permit-documents-vineyard-wind-1-llcs-wind-energy-development-project-800mw-offshore (last accessed July 15, 2024).

reductions (LAER) for the decommissioning phase and will not be permitting this phase at this time. Therefore, this consultation does not consider any changes to EPA's action in regards to decommissioning. However, reinitiation of this consultation may be required to consider any changes to EPA's existing proposed action, or any new proposed action, regarding decommissioning.

Vineyard Wind 1 is authorized by the EPA for certain discharges at land based facilities under the NPDES General Permit for construction activities issued under the Clean Water Act. The EPA uses general permits issued under section 402 of the Clean Water Act (33 U.S.C. 1342 et seq.; CWA), to authorize routine discharges by multiple dischargers. Coverage for discharges under a general permit is granted to applicants after they submit a notice of intent to discharge (NOI). Once the NOI is submitted and any review period specified under the Construction General Permit has closed, the applicant is authorized to discharge under the terms of the general permit.

The USCG administers 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). PATON regulations require that individuals or organizations mark privately owned marine obstructions or other similar hazards with lighting and lettering. PATONS and federal aids to navigation (ATONS), including radar transponders, lights, sound signals, buoys, and lighthouses are located throughout the Project area. 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 marine mammals by U.S. citizens who engage in a specified activity (other than commercial fishing) within a specified geographic region. 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). On September 7, 2018, NMFS OPR received a request from Vineyard Wind for an incidental harassment authorization (IHA) to take marine mammals incidental to construction of an offshore wind energy project south of Massachusetts. Vineyard Wind submitted revised versions of the application on October 11, 2018 and on January 28, 2019. The application was deemed adequate and complete on February 15, 2019. Vineyard Wind's request is for take of 15 species of marine mammals by harassment. A notice of the proposed IHA was published in the *Federal Register* on April 30, 2019 (84 FR 18346). NMFS published a Notice of Issued IHA in the Federal Register on June 25, 2021 (86 FR 33810). The Issued IHA is available online (*https://www.fisheries.noaa.gov/action/incidental-take-authorization-vineyard-wind-1-llc-construction-vineyard-wind-offshore-wind*). The effective dates of the IHA were May 1, 2023 to April 30, 2024.

Conditions imposed by BOEM's COP approval, the USACE permit, and the IHA, limited pile driving to May 1 – December 31. In 2023, Vineyard Wind installed 47 of 62 planned monopile foundations, plus the ESP jacket foundation. On December 15, 2023, NMFS OPR received a request from Vineyard Wind for an IHA to take marine mammals incidental to the remaining turbine generator (WTG) monopile foundation installations. On April 23, 2024, NMFS OPR published a Notice in the *Federal Register* (89 FR 31008) describing their proposal to issue a new IHA to Vineyard Wind in response to their request for authorization to take marine mammals incidental to installing the remaining 15 monopiles to complete foundation installation for the Project. This new proposed action does not change the overall scope of the Project which will continue to consist of 62 WTGs, installed on monopile foundations, and 1 offshore substation installed on a jacket foundation, and associated cables. We note that this is fewer foundations than the number considered in our 2021 Opinion. More information on the new proposed IHA is presented in Section 3 below.

Vineyard Wind has obtained multiple Letters of Acknowledgement from NMFS for a number of fisheries surveys that have been carried out to date and may request future Letters of Acknowledgement. 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 exempt from any and all regulations promulgated under the Magnuson-Stevens Act, provided they continue to meet the definition of scientific research activities conducted from a scientific research vessel. To meet the definition of a scientific research vessel, the vessel must be conducting a scientific research activity and be under the direction of one of the following: Foreign government agency; U.S. Government agency; U.S. state or territorial agency; University (or other educational institution accredited by a recognized national or international accreditation body); International treaty organization; or, Scientific institution. In order to meet this definition, vessel activity must be dedicated to the scientific research activity, and cannot include commercial fishing. Scientific research activity includes, but is not limited to, sampling, collecting, observing, or surveying the fish or fishery resources within the Exclusive Economic Zone. Research topics include taxonomy, biology, physiology, behavior, disease, aging, growth, mortality, migration, recruitment, distribution, abundance, ecology, stock structure, bycatch or other collateral effects of fishing, conservation engineering, and catch estimation of fish species considered to be a component of the fishery resources. The issuance of a Magnuson-Stevens Act related Letter of Acknowledgement by NMFS is not a federal action subject to section 7 consultation because it does not approve, authorize, fund, or regulate any activity. However, as the action we are consulting on includes some fisheries surveys that may be carried out with a Magnuson-Stevens Act Letter of Acknowledgement, and these surveys' effects would not occur but for the Vineyard Wind project, it is appropriate to consider the effects of the fisheries surveys 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 Biological Assessment (BA) and request for initiation of ESA consultation on December 6, 2018, concurrent with its issuance of a Draft Environmental Impact Statement (DEIS) under the National Environmental Policy Act (NEPA). After reviewing the BA, we requested additional information in correspondence dated March 14 and April 3, 2019. BOEM responded to those requests in correspondence dated March 27 and April 10, 2019; consultation was initiated on April 10, 2019. The ESA consultation was paused between August 9, 2019 and May 19, 2020. In September 2019, BOEM announced that the permitting process for the project would be delayed to allow for additional review and development of a supplemental DEIS focused on cumulative effects. Additional information on the proposed action was provided to NMFS through July 2020, including supplemental analysis provided on May 19, 2020. A supplemental DEIS was issued on June 12, 2020. Consultation was completed with the issuance of a Biological Opinion to BOEM (as lead Federal agency) on September 11, 2020. On September 17, 2020, BOEM distributed the final Biological Opinion to representatives of the other action agencies.

On December 1, 2020, Vineyard Wind withdrew the COP from further consideration by BOEM to conduct additional technical and logistical reviews associated with the inclusion of the General Electric Haliade-X wind turbine generator (WTG) into the final Project design. In response to Vineyard Wind's letter, BOEM published a notice under the authority of NEPA informing the public that it was terminating the preparation and completion of the EIS (85 Fed. Reg. 81486, December 16, 2020). At no time did BOEM inform us that it would not rely on the 2020 Opinion, nor did BOEM ask us to withdraw it. By letter dated January 22, 2021, Vineyard Wind notified BOEM that it had completed its technical and logistical due diligence review and had concluded that inclusion of the Haliade-X turbines did not fall outside of the project design envelope being reviewed in the COP and requested BOEM to resume review of the COP. On March 3, 2021, under the authority of NEPA, BOEM published a notice in the Federal Register notifying stakeholders of the resumption of the NEPA process for the Vineyard Wind COP (86 FR 12494). The Final EIS (FEIS) was published on March 12, 2021. The Record of Decision (ROD) was signed by BOEM, the U.S. Army Corps of Engineers, and NMFS Office of Protected Resources on May 10, 2021. The ROD identified a number of surveys that BOEM was planning to require as conditions of COP approval. Several of these surveys were not considered in our September 11, 2020 Opinion. On July 15, 2021, BOEM issued a letter approving the COP subject to conditions identified with that letter.

On May 7, 2021, BOEM submitted a request to reinitiate consultation. As described in the May 7, 2021, letter, BOEM determined that reinitiation of consultation is necessary to consider effects of several surveys that were not considered in BOEM's 2019 Biological Assessment (BA) or our September 11, 2020, Biological Opinion. BOEM also noted that new information regarding the status of the North Atlantic right whale had become available since the consultation was completed. The May 7 letter transmitted a supplement to the 2019 BA. Consultation was completed with the issuance of a Biological Opinion to BOEM (as lead Federal agency) on

October 18, 2021; several non-substantive errors were identified in the Opinion following issuance and a corrected Opinion was transmitted to the action agencies on November 1, 2021.

As explained in section 1.1 above, on May 23, 2024, NMFS OPR submitted a request to reinitiate consultation. As described in the referenced correspondence and supporting documentation, NMFS OPR determined that reinitiation of consultation is necessary to consider changes to the proposed actions that may affect listed species in a manner or to an extent not considered in our October 2021 Biological Opinion as well as the availability of new information that reveals effects of the action that may affect listed species in a manner or to an extent not previously considered (50 CFR 402.16(a)(2)-(3); Reinitiation Notice, 2021 Opinion, Section 12). In a July 1, 2024, letter to BOEM and NMFS OPR we noted our agreement with NMFS OPR's determinations that consultation must be reinitiated as triggers "2" and "3" have been met.

On April 9, 2024, BOEM submitted a determination to us documenting their consideration of the effects of the remaining pile driving on ESA listed sea turtles and Atlantic sturgeon. BOEM concluded that while there was new information regarding effects of the action on these species, no triggers for reinitiation had been met. We have incorporated our consideration of relevant new information related to effects of the action on ESA listed whales, sea turtles, and Atlantic sturgeon in this new Opinion.

Consideration of 2021 Opinion

As noted, this Biological Opinion replaces and supersedes the 2021 Opinion for the proposed action. However, to the extent that our review of modifications to the proposed actions and their consequences as well as new information did not cause us to modify the analysis of effects in the 2021 Opinion, that analysis has been carried forward and incorporated in this Opinion. Otherwise, this Opinion updates changes in the proposed action since the 2021 Opinion was issued, analyzes the effects of those changes to listed species, and describes and assesses new information relevant to effects to listed species not considered in the 2021 Opinion.

Consideration of the 2024 ESA Section 7 Regulations

On April 5, 2024, NMFS and the U.S. Fish and Wildlife Service (FWS) published joint final revisions to the 2019 Section 7 regulations in the Federal Register (89 FR 24268). These updates to the regulations governing interagency consultation (50 CFR part 402) were effective on May 6, 2024. We are applying the updated regulations to this consultation. The 2024 regulatory changes, like those from 2019, were intended to improve and clarify the consultation process, and, with one exception from 2024 (offsetting reasonable and prudent measures), were not intended to result in changes to the Services' existing practice in implementing section 7(a)(2) of the Act (89 FR 24268; 84 FR 45015). We have considered the prior rules and affirm that the substantive analysis and conclusions articulated in this Biological Opinion and its Incidental Take Statement would not have been any different under the 2019 regulations or pre-2019 regulations.

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 electrical service platform (ESP) and the landfall sites in Massachusetts. The Wind Farm Area (WFA) is that portion of Vineyard Wind's lease (OCS-A 0501) where the wind turbine generators and ESP 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 and Rhode Island (i.e., the WDA plus these transit routes). The action area is defined in Section 3.4 below and includes the project area, WDA, and WFA as well as the portion of the Atlantic Ocean used by project vessels transiting from ports in the Canada and Europe.

3.1 Overview of Vineyard Wind Project

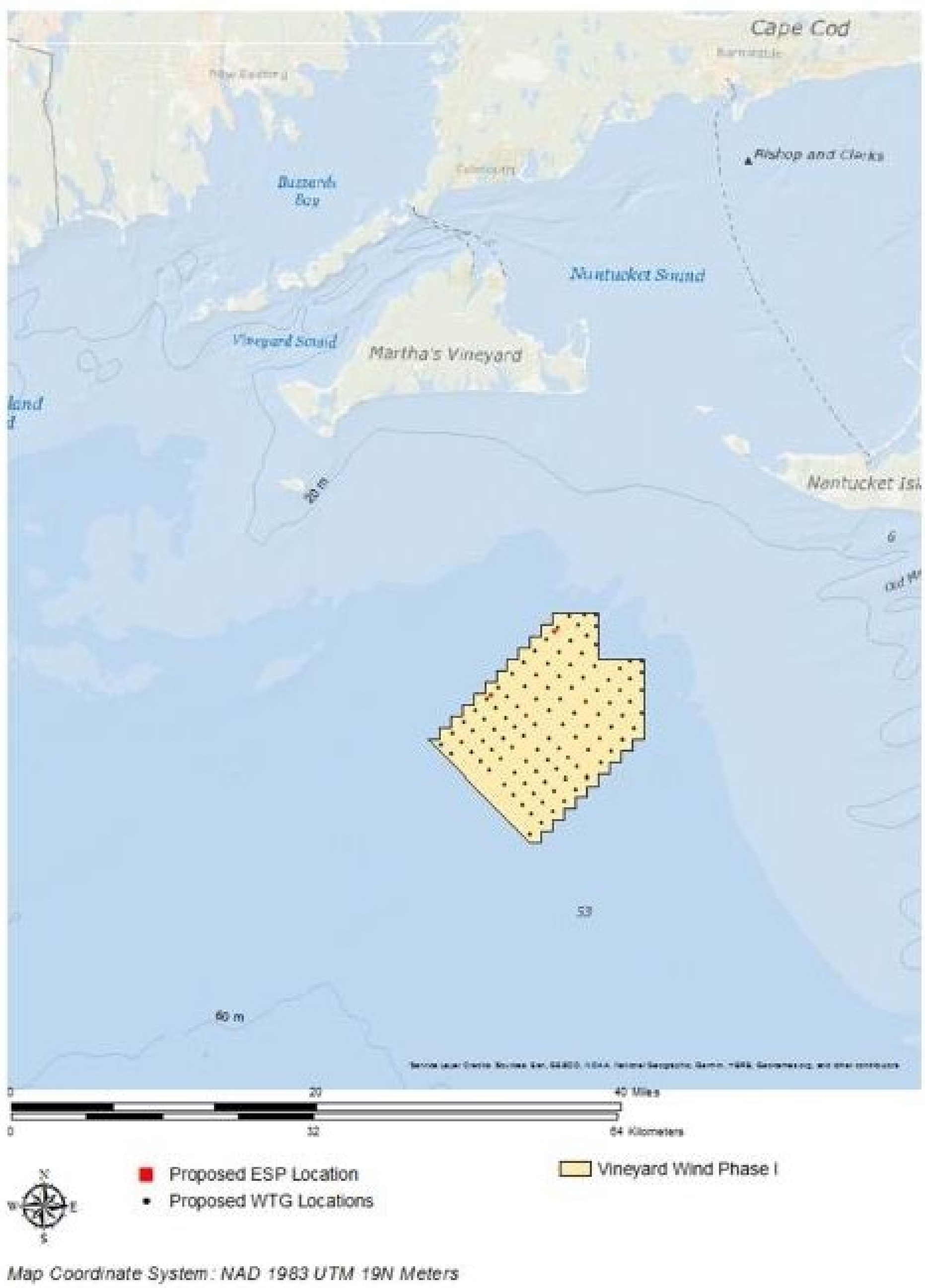
BOEM is the lead federal agency for the project for purposes of this ESA consultation and coordination under NEPA and other statutes. Through the approval of the COP with conditions, BOEM has authorized Vineyard Wind to construct, operate, maintain, and eventually decommission an approximately 800 megawatt (MW) offshore wind energy project in Lease Area OCS-A 0501, offshore Massachusetts. The other Federal actions identified above authorize various aspects of the project and associated activities. Here, for simplicity, we may refer to BOEM's authorization when that authorization may also include other Federal actions (e.g., construction of the wind turbines requires authorizations, permits, or approvals from BOEM, USACE, EPA, USCG, and NMFS OPR).

The Vineyard Wind project will consist of 62 offshore Wind Turbine Generators (WTG) (each placed on a monopile foundation support structure), an Electrical Service Platform (ESP) placed on a jacket foundation, an onshore substation, offshore and onshore cabling, and onshore operations & maintenance facilities. The location of the Lease Area is depicted in Figure 3.1. At its nearest point, the WDA is just over 23 km (14 miles (mi)) from the southeast corner of Martha's Vineyard and a similar distance from Nantucket. Water depths in the WDA range from approximately 37–49.5 meters (m) (121–162 feet (ft.)). The two submarine export cables have been installed along a route from the offshore substation to the landing point onshore at Covell's Beach in Barnstable. From the onshore cable landing site, the cables are installed underground along public roads to an onshore substation in Hyannis where electricity is delivered to the grid.

Our 2021 Opinion considered the effects of installation of up to 100 WTGs to achieve the 800 MW target; as noted, the Vineyard Wind project is now described as a maximum of 62 WTGs. The 62 WTG project is consistent with the reduced project size alternative identified in the FEIS and ROD (not to exceed 84 foundations) and the selection of the GE Haliade X 13-MW WTGs (total 806 MW for 62 WTGs). Therefore, this Opinion will consider the construction, operation, and decommissioning of 62 WTGs (47 foundations installed to date) and 1 ESP (installed in 2023) rather than 100 WTGs and 2 ESPs as described in the 2021 Opinion. Installation of the remaining 15 monopiles would occur during the effective period of the proposed IHA, as limited by time of year restrictions (January 1 – May 31). Therefore, we consider the remaining pile driving may occur between the issuance date of the LOA in August 2024 and December 31, 2024 and/or between June 1 and August, 2025. NMFS OPR has indicated that pile driving is expected to occur in Fall 2024 pending vessel availability and appropriate weather.

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 construction, operation and maintenance, and/or decommissioning phases of the project.

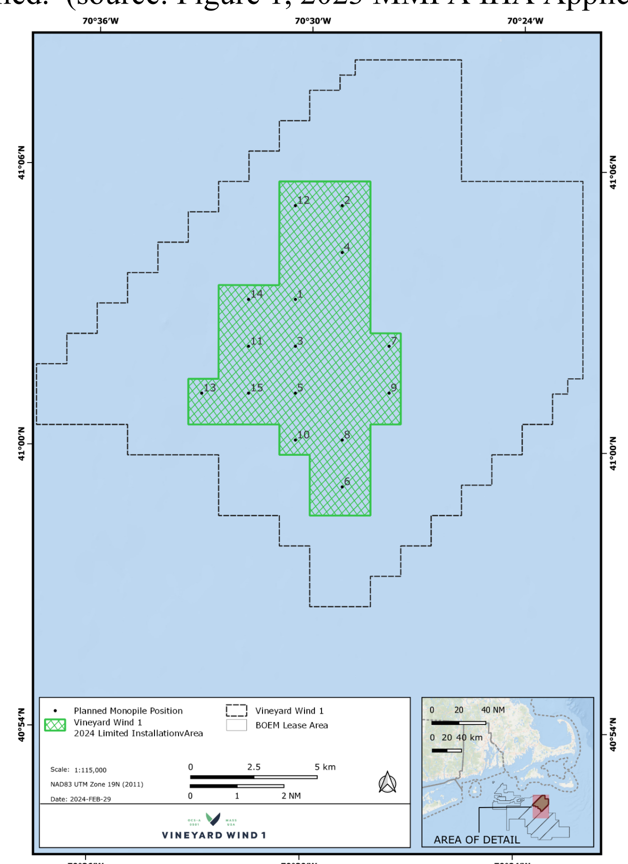
Figure 3.1 Vineyard Wind Lease Area (OCS-A 0501)



3.2 Construction

As explained above, project approvals, permits, and authorizations were issued in 2021. As required by the 2021 Opinion, Vineyard Wind has submitted various reports describing project activities and results of protected species monitoring. As noted, the Project consists of 62 offshore wind turbine generators (WTGs) and one electrical service platform (ESP), an onshore substation, offshore and onshore cabling, and onshore operations and maintenance facilities. Construction of the Vineyard Wind project is over 84% complete. Vineyard Wind began offshore installation of jacket and monopile foundations in June 2023; as of December 31, 2023, Vineyard Wind installed 47 monopile foundations. To date, construction of the onshore substation, offshore and onshore cabling, and ESP are complete and the installed WTGs are being energized to deliver power to the grid. The remaining in-water work for construction includes pile driving activities within a Limited Installation Area (LIA) that is approximately 64.3 square kilometers (km^2) (15,888.9 acres) of the 264.35037 km^2 (65,322.4 acres) Lease Area to install the remaining fifteen foundations (Figure 3.2). Vineyard Wind will conduct these activities in accordance with the monitoring and mitigation outlined in Section 11 of their 2023 IHA Application and the new final IHA to be issued by NMFS OPR. Installation of inter-array cabling and construction of WTGs, including installation of transition pieces and WTGs is ongoing on the installed foundations.

Figure 3.2 Location of the remaining MP foundations to be installed for the completion of the Project within the LIA, Lease Area OCS-A 0501. Numbers indicate the order in which the piles are expected to be installed. (source: Figure 1, 2023 MMPA IHA Application)



A complete description of activities planned for the construction phase, including installation of the ESP and project cables, is included in the 2021 Opinion; here, we describe the construction work that remains. Remaining work includes installation of 15 monopile foundations, associated inter-array cabling, and continued WTG installation on top of already installed foundations.

Wind Turbine Generators
Vineyard Wind is installing 62 WTGs of approximately 13 MW capacity extending up to 837 feet (255 m) above mean lower low water (MLLW) with a spacing between WTGs of approximately 0.75 to 1 nautical mile within the 75,614 acre (306 km^2) WDA. As noted above, 47 foundations have been installed to date and 15 remain to be installed. Vineyard Wind will mount the WTGs on monopile foundations. A monopile is a long steel tube driven 66 to 148 feet (20 to 45 m) into the seabed. The diameter of the monopiles will be 9.6 m. Each WTG would contain approximately 1,700 gallons (6,500 liters) of transformer oil and approximately 2,113.4 gallons (8,000 liters) of general oil (for hydraulics and gearboxes). Use of other chemicals would include diesel fuel, coolants/refrigerants, grease, paints, and sulphur hexafluoride. WTGs would be equipped with secondary containment sized according to the largest oil chamber.

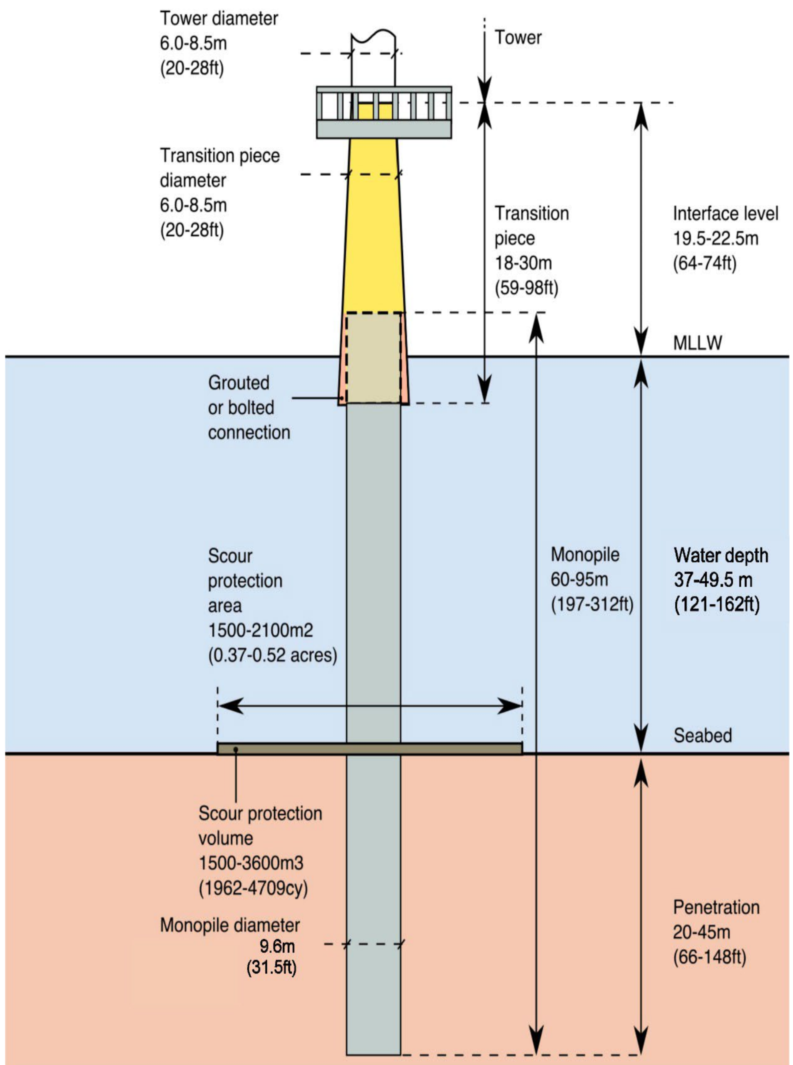
WTGs would include lighting and marking that complies with Federal Aviation Administration (FAA) and USCG standards, and is consistent with BOEM best practices. A detailed description of lighting and marking is provided in COP Volume I, Section 3.1 (Epsilon 2020).
BOEM indicated while anti-fouling paint is not necessary on most parts of the WTG and ESP foundations, anti-fouling paint may be used at each foundation in the immediate area of the opening for the cable pull-in (within an approximately 4-foot (1.2-m) diameter circle centered on the opening for the cable).

Foundation Installation
The remaining monopile foundations will be installed by a heavy lift vessel. Foundations are installed in batches of 5 or 6 which are loaded onto the installation vessel in Canada and transported to the lease area for installation. The installation vessel is expected to make only three round trips to Canada.

The installation vessel will upend the monopile with a crane, and place it in the gripper frame, before lowering the foundation to the seabed. To seat the foundation and protect against damage to the pile gripper and risks to human safety from pile run, there are a number of techniques contractors may use. As was done in 2023, the contractor may use a Monopile Installation Tool (MPIT) that creates buoyancy within the MP foundation using air pressure to control lowering through the pile run risk zone. As the foundation is lowered, air is released from the top of the MP foundation above the water surface until the pile is stabilized within the seabed. The duration of the MPIT process prior to pile driving is dependent upon the local soil conditions at each monopile location and can range between 6 and 15 hours. Once the monopile is lowered to the seabed, the crane hook is released, and the hydraulic hammer is picked up and placed on top of the monopile. Vineyard Wind anticipates using the MPIT tool for the remaining foundation installation.

Pile driving will begin with a 20-minute soft-start at reduced hammer energy to ensure that the monopile remains vertical and allow any motile marine life to leave the area before the pile driving intensity is increased. The intensity (i.e., hammer energy level) will be gradually increased based on the resistance that is experienced from the sediments. The soft-start procedure is detailed in Section 7.1 of this Opinion. The maximum hammer size for MP foundation installation is 4,000 kilojoules (kJ). As described by Vineyard Wind, a typical pile-driving operation has taken less than approximately two hours to achieve the target penetration depth (maximum: 1 h 57 min; average: 1 h 28 min). No more than one foundation will be driven into the seabed per day.

Figure 3.3. Schematic drawing of a monopile foundation, adapted from Figure 3.1-3 of the COP Volume I (Vineyard Wind 2020) to reflect the final monopile diameter of 9.6 m.



Other Construction Activities

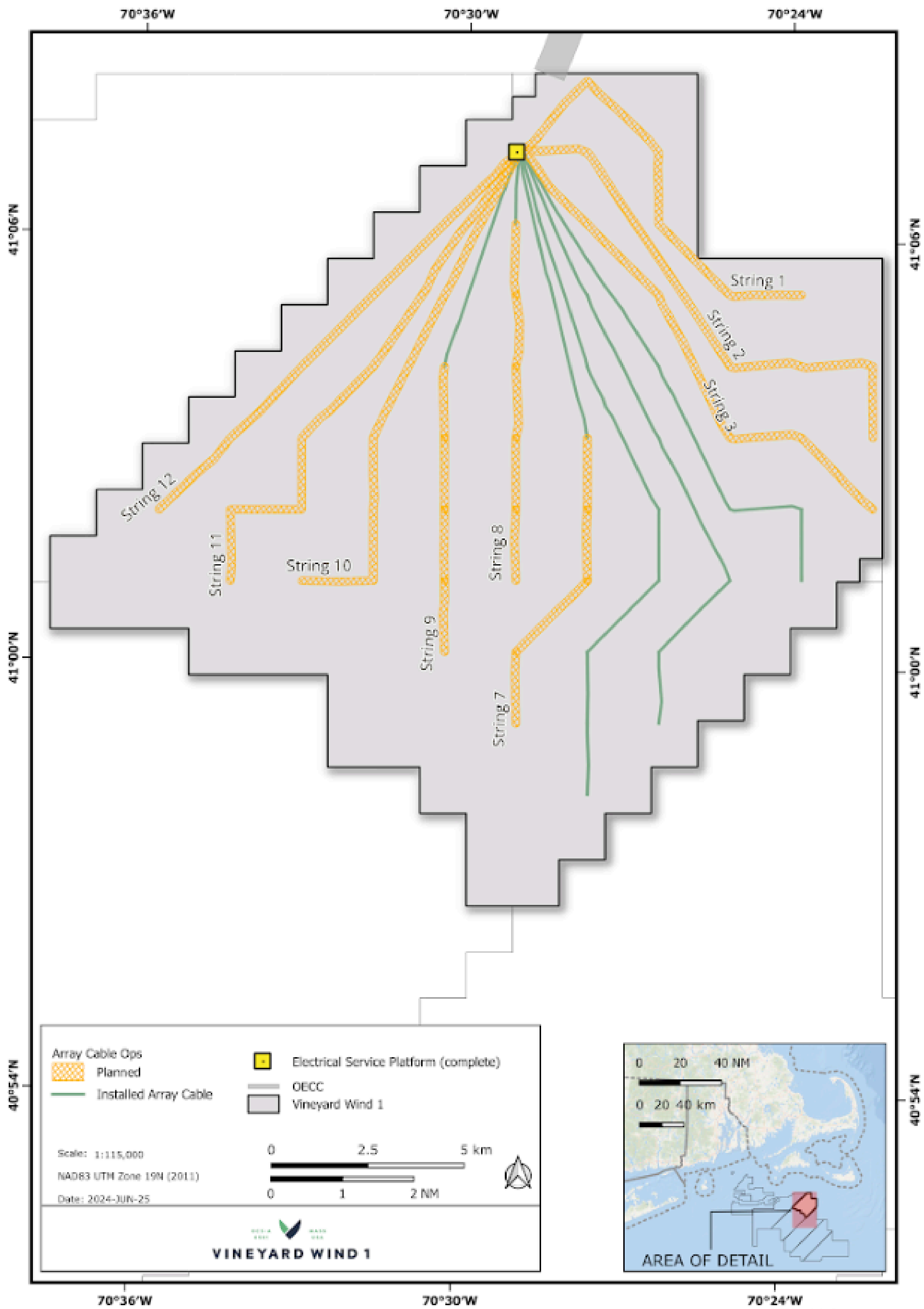
After MPs are installed, transition pieces and the WTGs are installed. Transition pieces contain work platforms and other ancillary structures and WTGs consist of a tower and the energy-generating components of the turbine. These are being installed atop foundations using jack-up vessels. Some inter-array cable installation remains to be completed. Inter-array cables connect WTGs to the ESP and are buried using a jet trencher after being placed on the seafloor. Details of inter-array cable installation are provided in Section 4.2.3.3.2 of the COP (Vineyard Wind 2020), Volume I. Briefly, this activity would include performing a pre-lay grapnel run to remove obstructions such as fishing gear from the seafloor, followed by cable laying on the seabed, and then burial of the cables using a jet trencher with scour added for cable protection as needed.

Scour protection has been placed around all foundations, consisting of rock and stone ranging from 4 to 12 inches (10 to 30 cm) diameter. The scour protection would be up to approximately 3 to 6 ft. (1 to 2 m) in height and would serve to stabilize the seabed near the foundations as well as the foundations themselves.

Cable Laying

The offshore export cable has been installed. Inter-array cable laying is in progress (see Figure 3.4, updated in July 2024). Inter-array cables will connect radial "strings" of 6 to 10 WTGs to the ESP. Vineyard Wind would bury the cables primarily using a jet plow, mechanical plow, and/or mechanical trenching, as suited for the bottom type in the immediate area. Prior to installation of the cables, a pre-lay grapnel run would be performed in all instances to locate and clear obstructions such as abandoned fishing gear and other marine debris. No seabed preparation activities (i.e., dredging) are currently proposed.

Figure 3.4 Completed and remaining array cables, as of July 2024. Source: https://www.vineyardwind.com/mariners-updates/105



For the inter-array cables, the expected installation method is to lay the cable section on the seafloor and then subsequently bury the cable. The estimated installation time for the inter-array cables is approximately four months for burial. Installation days are not continuous and do not include equipment preparation or down time that may result from weather or maintenance. More information on cable laying associated with the proposed project is provided in COP Volume I, Section 4.2.3 (Volume I; Epsilon 2020).

Vineyard Wind anticipates protection conduits installed at the approach to each WTG and ESP foundation would protect all offshore export cables and inter-array cables. In the event that cables cannot achieve proper burial depths or where the proposed offshore export cable crosses existing infrastructure, Vineyard Wind could use the following protection methods: (1) rock placement, (2) concrete mattresses, or (3) half-shell pipes or similar product made from composite materials (e.g., Subsea Product from Trelleborg Offshore) or cast iron with suitable corrosion protection.[6] Vineyard Wind has conservatively estimated up to 10 percent of the inter-array and offshore export cables would require one of these protective measures.

Construction-Related Vessel Activity
In the COP, Vineyard Wind conservatively estimated that during construction a maximum of approximately 46 vessels could be on-site (at the WDA or along the OECC) at any given time. On average, Vineyard Wind expects approximately 25 vessels would be at the WDA and along the OECC during the construction period. Many of these vessels will remain in the WDA or OECC for days or weeks at a time, potentially making only infrequent trips to port for bunkering and provisioning, as needed. However, the maximum number of vessels involved in the proposed Project area at one time is highly dependent on the Project's final schedule, the final design of the Project's components, and the logistics solution used to achieve compliance with the Jones Act. The Jones Act requires project components that move between U.S. ports be transported on Jones Act compliant, U.S.-flagged vessels. According to information provided to us by BOEM in July 2020, it was estimated that up to 16 different European-origin construction/installation vessels would be used over the course of the Project's offshore construction period. These vessels are expected to remain on site for the duration of the work that they are contracted to perform, which could range from two to twelve months. According to information presented to us by BOEM in July 2020, Vineyard Wind anticipated that monopiles, transition pieces, WTG components, ESP components, and offshore cables will be shipped from Europe, either directly to the WDA or first to a U.S. port before being transported to the WDA, for a total of approximately 122 round trips to transport project components from Europe. As described in the 2023 MMPA IHA Application, no additional transits from European ports are currently planned. We note that transition pieces, monopiles, and WTG towers have already been transported to marshalling ports in the U.S. and Canada.

COP Table 4.2-1 (Volume I, Section 4.2.4; Epsilon 2020) summarizes vessel details including type/class, number of each type, length, and speed for each proposed Project activity during construction, parts of the table are replicated below (Table 3.1). The maximum transit speed of these vessels while traveling to/from various ports to the WDA and OECC varies from 6 to 30 knots, with operational speeds being somewhat slower.

Table 3.1. Vessels to Be Used During the Construction Phase (from Table 4.2-1 in COP Volume I)

Role	Vessel Type	Max # of Vessels
Foundation Installation		
Marine Mammal Observers and Environmental Monitors	Fishing Vessel/ Crew Transfer Vessel	2-6
Scour Protection Installation	Fall Pipe Vessel	1
Overseas Foundation Transport	Heavy Cargo Vessel, Deck Carrier, and/or Semi-submersible Vessel	2-4
Foundation Installation (Possibly Including Grouting	Jack-up, Heavy Lift Vessel, or Semi- submersible Vessel	1-2
Noise Mitigation Vessel	DP-2 Support Vessel or Anchor Handling Tug Supply Vessel	1
Acoustic Monitoring	Multipurpose Support Vessel or Tug Boat	1
Secondary Work, Snagging, and Possibly Grouting	DP-2 Support Vessel or Tug Boat	1
Crew Transfer	Crew Transfer Vessel	3
Transport of Foundations to WDA	Barge	2-5
Transport of Foundations to WDA	Tugs	3-4
Tugboat to Support Main Foundation Installation Vessel(s)	Site Tug	1
ESP Installation		
ESP Installation	Floating Crane vessel or Semi- submersible Vessel	1
ESP Transport	Heavy Cargo Vessel, Deck Carrier, and/or Semi-submersible Vessel	1-2
ESP Transport (if required)	Tugs	2-4
Crew Transfer	Crew Transfer Vessel	1
Service Boat	Crew Transfer Vessel	1
Refueling Operations to ESP	Crew Transfer Vessel	1
Crew Hotel Vessel During Commissioning	Jack-up or Floatel Vessel	1
Offshore Export Cable Installation		
Pre-Lay Grapnel Run	Multipurpose Support Vessels	1
Pre-Installation Surveys	Multi-role survey vessel or Smaller Support Vessels	1
Laying of the Cables (and potentially burial)	Cable Laying Vessel	1
Boulder Clearance	Cable Laying Support Vessel	1
Support Main Vessel with Anchor Handling	Anchor Handling Tug Supply Vessel	1
Trenching Vessel	Purpose Built Offshore Construction/ROV/Survey Vessel	1
Crew Transfer	Crew Transfer Vessel	1
Place Rock or Concrete Mattresses	Rock/Mattress Placement Vessels	1
Dredging	Dredging Vessels	1
Inter-Array Cable Installation		
Pre-Lay Grapnel Run	Multipurpose Support Vessel	1
Pre-Installation Surveys	Multi-role survey vessel or Smaller Support Vessels	1
Laying of the Cables (and potentially burial)	Cable Laying Vessel	1
Burial Support Vessel	Cable Laying Support vessel	1
Crew Transfer	Crew Transfer Vessel	2

Cable Termination and Commissioning	Cable Laying Support vessel	1
Trenching Vessel	Purpose Built Offshore Construction/ROV/ Survey Vessel	1
Place Rock or Concrete Mattresses	Rock/Mattress Placement Vessels	1
WTG Installation		
Nacelle and Tower Transport	Heavy Lift Vessels	1-4
Blade Transport	Heavy Cargo Vessel	1-5
Feeding WTG Components from Harbor to WDA	Jack-up Vessels/Feeder Barges	2-6
Vessel and Feeder Concept Assistance	Harbor Tug	1-6
WTG Installation	Jack-up Crane Vessel	1-2
Crew Transfer	Crew Transfer Vessel	3
WTG Commissioning		
Crew Transfer	Crew Transfer Vessel	1-4
Main Commissioning Vessel	Service Operation Vessel	1
Miscellaneous Construction Activities		
Refueling Vessels	Crew Transfer Vessel or Multipurpose Support Vessel	1
Guard Vessels	Crew Transfer Vessel	1
Geophysical and Geotechnical Survey Operations	Multi-role survey vessel or Smaller Support Vessels	1

Overall construction vessel activity is described in Section 7.8.2.1 of the COP (Vineyard Wind 2020), Volume III, and the remaining vessel activity expected for the construction period is described here. Based on construction activities to date, Vineyard Wind expects an average of approximately 20 vessels operate during a typical work day; fewer vessels will transit to and from New Bedford Harbor or a secondary port each day. Many of these vessels would remain in the lease area for days or weeks at a time (e.g., HLV Orion), making only infrequent trips to port for bunkering and provisioning, as needed. Ports planned for use include Halifax (Canada), New London, CT, and New Bedford, MA. The types of vessels operating during a typical pile driving day as well as their estimated number of transits per month are shown in Table 3.2.

Table 3.2 Estimated number of vessels operating within the WDA during a typical pile driving day. (source: Table 2 in Vineyard Wind's MMPA IHA Application)

Maximum Number	Vessel Role	Activity Support	Estimated Transits/Month	Port
1	Pile Driving	Monopile Installation	2	Halifax, Canada
2	Bubble Curtain	Monopile Installation	4	New London, CT
2	PSO	Monopile	3	New

Maximum Number	Vessel Role	Activity Support	Estimated Transits/Month	Port
	Support Vessel	Installation		Bedford, MA
1	Service Operations Vessel	Monopile Installation	4	New Bedford, MA
2	Crew Transfer Vessel	Monopile Installation	12	New Bedford, MA
4	Safety Vessel	Monopile Installation	2	New Bedford, MA
2	Heavy Transport Vessel	Monopile Transport	2	Halifax, Canada

The 15 monopiles will be transported to the lease area in batches (monopile batches). The estimated number of vessel trips from the lease area and the staging area in Halifax per Monopile Batch during the 2024 construction is provided in Table 3.3. Each Batch will consist of approximately three to six monopiles, therefore, it is anticipated that a maximum of three MP Batches will be transported to the lease area from Halifax.

Table 3.3 Estimated maximum number of vessel trips per monopile batch during the remaining construction period (source: Table 3 in Vineyard Winds' 2023 MMPA IHA Application)

Origin or Destination	**Estimated Maximum Trips per Monopile Batch**
New Bedford, MA	2
Brayton Point, MA	1
Montaup, RI	1
Providence, RI	1
Quonset, RI	1
Canada (Sheet Harbor, St. John, or Halifax)	3

The majority of Project vessel traffic will occur within the Project area (WDA, OECC), and vessel transit corridors to New Bedford and Vineyard Haven. The New Bedford Marine Commerce Terminal (MCT) will be the primary port used to support construction and decommissioning. Other U.S. ports (e.g., Brayton Point and Quonset) may also be used. One-way distance from each of the potential ports to the WDA as delineated in Figure 3.5 are estimated as follows moving from west to east: New Bedford, westernmost route (61 miles [98 km]), New Bedford second route (50 miles [81 km]), New Bedford third route (45 miles [72 km]), New Bedford easternmost route (51 miles [82 km]), Brayton Point (69 miles [111 km]), Quonset (62 miles [99 km]), St. John, Canada (440 miles [708 km]), and Sheet Harbor, Canada (554 miles [891 km]).

Figure 3.5. Potential Vessel Routes between WDA and New Bedford

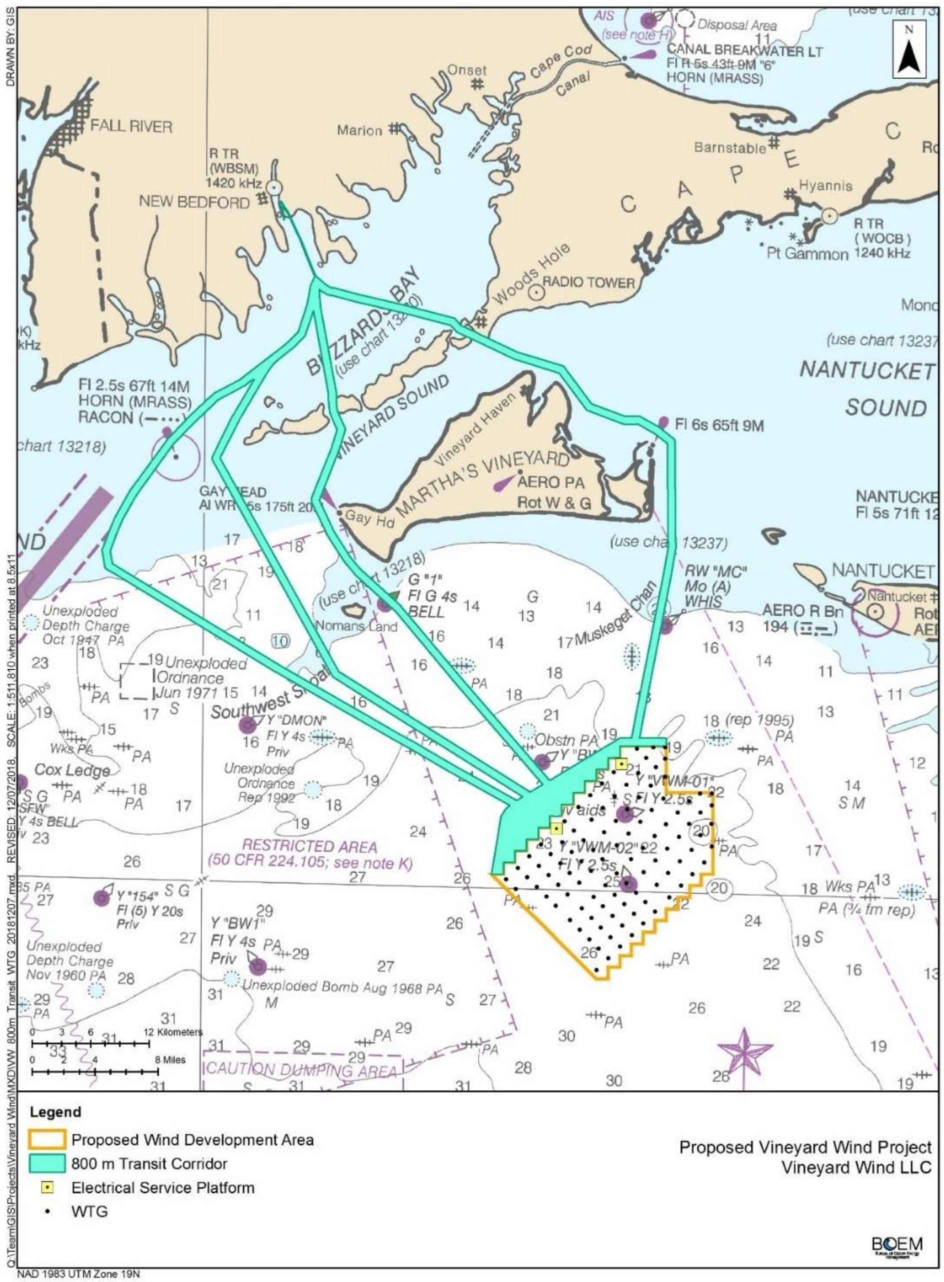
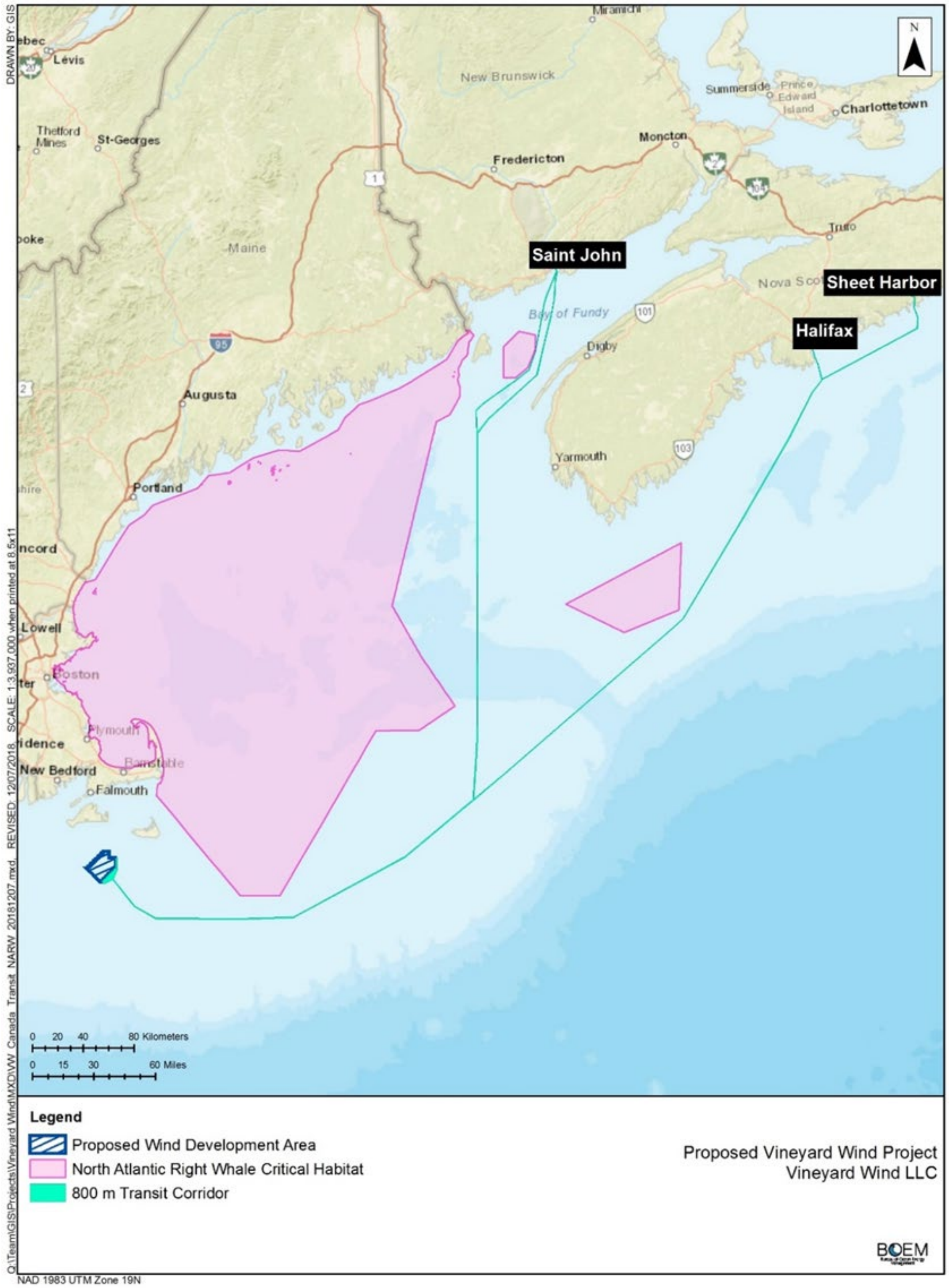


Figure 3.6. Vessel Traffic Routes from Canadian Ports



3.2.3 Operations and Maintenance

Operation and Maintenance activities are described in Section 4 of the COP. As described in BOEM's COP approval, the approval will remain effective until the termination of the Lease, which has an operations term of 33 years from the date of COP approval. Vineyard Wind would have to apply for an extension if it wished to operate the proposed Project for more than 30 years. This consultation does not consider operation of the proposed Project beyond the 30-year designed life span. The 33 year term is comprehensive of pre-construction, construction, operations and maintenance, and decommissioning activities.

During the operations period, Vineyard Wind would monitor operations primarily from the Operations and Maintenance Facilities in Vineyard Haven on Martha's Vineyard and a 24-hour a day / seven days a week control center on the mainland. Crew transfer vessels and helicopters would transport crews to the proposed offshore Project area during operations and maintenance. During the operations phase, there would be trips by crew transport vessels (CTV) (about 75 ft. [22.3 m] in length), multipurpose vessels, and service operations vessels (SOV) (260 to 300 ft. [79.2 to 91.4 m] in length), with larger vessels based at the MCT and smaller vessels based at Vineyard Haven. Vineyard Wind anticipates that on average fewer than three operations and maintenance vessels will operate in the WDA per day for regularly scheduled maintenance and inspections. In other maintenance or repair scenarios, additional vessels may be required, which could result in a maximum of three to four vessels per day operating within the WDA. Consequently, Vineyard Wind anticipates that there would be a maximum of three to four daily trips from New Bedford Marine Commerce Terminal and/or Vineyard Haven. This equates to a maximum of 124 vessel trips per month from either port. Helicopters may also be used for access and/or for visual inspections. The helicopters would be based at a general aviation airport near the Operations and Maintenance Facilities. As described in the COP (Table 4.3-2), 401-887 annual round trips are anticipated for operations and maintenance vessels, inclusive of up to 768 CTV trips annually.

WTG gearbox oil is anticipated to be changed after 5, 13, and 21 years of service. Additional operations and maintenance information can be found in COP Section 4.3. Operations and Maintenance activities and equipment are summarized in the following table (Source COP Table 4.3-1).

Activity Type	Equipment
Marine inspections and surveys: • Offshore and nearshore multi-beam echosounder inspections • Offshore and nearshore side scan sonar inspections • Offshore and nearshore magnetometer inspections • Offshore and nearshore depth of burial inspections • Other geophysical surveys • Geotechnical surveys	ROV or remotely-operated towed vessel ("ROTV") deployed from a survey vessel. For geotechnical surveys, sampling instrumentation deployed from a survey vessel with geotechnical spread. Cable toner survey.

Cathodic protection inspection and repair	ROV deployed from a survey vessel or divers
Hot work (welding) and ancillary equipment (including subsea)	Crew deployed to the WTG or divers deployed from diving vessel for subsea arc welding
Removal of marine growth and guano	Using a brush to break down the marine growth (where required) followed by high-pressure jet wash (sea water only). Technicians or deck hands will be deployed from crew transport vessels ("CTVs") or similar vessel.
External surface preparation and external protective coating repair	Technicians and equipment deployed from CTVs or similar vessel. Surface preparation to break down existing surface coating and any associated rust via blaster.
Grouted connections • Intrusive core samples • Re-grouting	Intrusive core samples: ROV deployed from a survey vessel or divers Re-grouting: Injected via one of several redundant grouting injection tubes from the TP
External component replacement or repair	Varies according to component in question, could be a crew mobilized to site in CTV, diving spread, construction support vessel (CSV), or jack-up barge.

3.2.4. Decommissioning

According to 30 CFR part 585 and other BOEM and/or BSEE requirements, Vineyard Wind would be required to remove or decommission all installations and clear the seabed of all obstructions created by the proposed Project. All facilities would need to be removed 15 feet (4.6 meters) below the mudline (30 CFR § 585.910(a)). Absent permission from BOEM and/or BSEE, Vineyard Wind would have to complete decommissioning within two years of termination of the lease and either reuse, recycle, or responsibly dispose of all materials removed. Conceptual decommissioning is describe in section 4.4 of the COP.

Offshore cables may be retired in place or removed. In consideration of mobile gear fisheries (i.e., dredge and bottom trawl gears), Vineyard Wind has stated that it is committed to removing scour protection during decommissioning.

Vineyard Wind would drain WTG and ESP fluids into vessels for disposal in onshore facilities before disassembling the structures and bringing them to port. Foundations would be temporarily emptied of sediment, cut 15 feet (4.6 meters) below the mudline in accordance with BOEM regulations (30 CFR § 585.910(a)), and removed. The portion buried below 15 feet (4.6 meters) would remain, and the depression would be refilled with the sediment that had been temporarily removed.

By maintaining an inventory list of all components of the proposed Project, the decommissioning team would be able to track each piece so that no component would be lost or forgotten. The above decommissioning plans are subject to a separate approval process under BOEM. BSEE will review decommissioning plans and provide recommendations to BOEM as part of the approval process. This process will include an opportunity for public comment and consultation with municipal, state, and federal management agencies. Vineyard Wind would require separate and subsequent approval from BOEM to retire any portion of the Proposed Action in place. Regulations default to complete site clearance.

During decommissioning, Vineyard Wind estimates the level of trips to be about 90 percent of those occurring during construction, or a maximum of approximately 990 trips per month from New Bedford, 90 trips per month from Brayton Point, Montaup, Providence, or Quonset, and 45 trips per month from Canada. Assuming that decommissioning is essentially the reverse of construction, except that offshore cables remain in place and Project components do not need to be transported overseas, Vineyard Wind anticipates decommissioning activities will require approximately 4,800 vessel trips (approximately 240 vessel trips may originate from Canada).

3.2.5 Ecological Surveys/Monitoring

BOEM is requiring that Vineyard Wind carry out a number of ecological surveys/monitoring activities as conditions of COP approval. These are summarized here.

Benthic Monitoring

Vineyard Wind will 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 wind turbine generator (WTG) scour protection, as well as the inter-array cabling and the offshore export cable corridor from the WDA to shore. The proposed plan will focus on seafloor habitat and benthic communities and make comparisons to areas unaffected by construction of the proposed Project. Proposed survey equipment and methods include the use of a grab sampler, a multibeam depth sounder, and underwater video. As described in the Benthic Monitoring Plan, surveys will occur based upon the project construction schedule, but will occur at roughly the same time of year in years 1, 3, and if necessary, year 5 post- construction. In addition to general benthic sampling, an additional 10 monitoring sites will be surveyed for sand lance using night-time benthic grabs. All survey years may not be completed if benthic community appear to have recovered and all stakeholders agree that monitoring may cease; however, we consider here that the benthic monitoring will occur for three years.

Bottom Profiling

Per the Nantucket Order of Conditions (Nantucket Conservation Commission 2019), prior to cable installation in Town of Nantucket waters, Vineyard Wind will provide updated bottom profiling detailing pre-construction bottom composition, sediment profiles, species composition, and topography of the area to be disturbed during cable installation, and shall include at a minimum high-resolution video monitoring. This is a onetime survey.

Post-Construction Cable Monitoring

In Federal waters, inter-array and export cable inspections will occur within 6 months following commissioning. Subsequent inspections will occur in years 1, 2, and every 3 years afterward (i.e., years 1, 2, 5, 8, 11, etc.). Additionally, cable inspection will occur after a major storm event as defined in Appendix D of the FEIS. The inspection is expected to include high resolution geophysical (HRG) methods to identify seabed features, man-made and natural hazards, and site conditions along Federal sections of the cable routing. The HRG surveys would use only electromechanical sources such as boomer, sparker, and chirp sub-bottom profilers, side-scan sonar, and multibeam depth sounders. A number of avoidance and minimization measures are incorporated into the HRG survey design as outlined in the conditions of COP approval.

Underwater Debris Surveys
Periodic surveys using remotely operated vehicles, divers, and/or video will be conducted to monitor indirect associated lost recreational fishing gear around WTG foundations. Surveys will inform frequency and locations of debris removal.

Benthic Invertebrate Optical Sampling
In collaboration with the University of Massachusetts Dartmouth School for Marine Science and Technology (SMAST), Vineyard Wind will conduct up to 3 years pre/during construction and 3 years post-construction drop camera surveys to examine the macroinvertebrate community and substrate habitat in the Vineyard Wind 1 WDA. The surveys will identify the distribution and abundance of the dominant benthic megafauna, classify the substrate, and compare the benthic communities and substrate types between the WDA, a control area, and the broader region of the U.S. Continental Shelf.

Surveys will be conducted in and near the Vineyard Wind WDA, with survey stations placed in a systematic grid design. A drop camera pyramid will be deployed four times at each pre-determined sampling station. The pyramid will be equipped with two downward-looking cameras, providing 2.3 m^2 and 2.5 m^2 quadrat samples of the seafloor for all stations. Following image collection, the pyramid will be raised, and the vessel allowed to drift 50 meters and the pyramid will be lowered to the seafloor again. This will be repeated for a total of four camera images at each station. Images will be reviewed within each quadrat for 50 taxa of epibenthic invertebrates that will be counted or noted as present and the substrate will be identified. A percent similarity index will be used to measure the similarity of benthic communities and substrates between the Vineyard Wind 1 WDA, control area, and the broader regions of the U.S. Continental Shelf.

Scour Protection Monitoring
In addition to post-construction monitoring of benthic habitat as described under the Benthic Monitoring Plan, Vineyard Wind will also inspect scour protection performance at 20 percent of WTG foundations every 3 years, starting in year 3 post-construction. This work will be carried out by underwater video.

Passive Acoustic Monitoring
Moored Passive Acoustic Monitoring (PAM) systems or autonomous PAM platforms such as gliders or autonomous surface vehicles will be used periodically over the lifetime of the project. PAM will be used to record ambient noise and marine mammal vocalizations in the lease area

before, during, and after (up to three years of operations) to monitor project impacts relating to vessel noise, pile driving noise, WTG operational noise, and to document whale detections in the WDA. In addition to specific requirements for Before after Control Impact Study (BACI) monitoring surrounding the construction period, periodic PAM deployments may occur periodically over the life of the project for other scientific monitoring needs.

Finfish and Squid Trawl Surveys
In collaboration with the University of Massachusetts Dartmouth SMAST, Vineyard Wind will conduct up to six years of post-ROD trawl surveys (three years pre/during construction and three years post-construction) to assess the finfish community in the Vineyard Wind WDA and adjacent control area (SMAST 2020). The pre-construction surveys have been completed. The surveys will be adapted to Northeast Area Monitoring and Assessment Program (NEAMAP) protocols. Twenty tows will be conducted in the Vineyard Wind 1 WDA and an additional 20 tows will occur in the control area. The 20 tows in the WDA will yield a sampling density of 1 station per 18.5 km^2. A systematic random sampling design will be used to ensure adequate spatial coverage of the WDA and control area. Tows will be conducted four times per year (spring, summer, fall, and winter) during daylight hours (after sunrise and before sunset) for 20 minutes each with a target speed of 3 knots (SMAST 2020b). Tows will be completed using a 400 x 12 centimeters (cm), three- bridle four-seam bottom trawl with a 12 cm cod end with a 2.54 cm knotless liner that is identical to those used in NEAMAP surveys. The net will also be paired with a three inch cookie-sweep and a set of Thyboron Type IV 66 inch doors.

Ventless Trap Surveys
In collaboration with the University of Massachusetts Dartmouth SMAST, Vineyard Wind will conduct ventless trap surveys to assess the American lobster (*Homarus americanus*), Jonah crab (*Cancer borealis*), and black sea bass (*Centropristis striata)* resources in the Vineyard Wind 1 WDA and control sites adjacent to the WDA and to evaluate the differences between pre (2 years)-, during (1 year), and post-construction (3 years) survey results. The pre-construction surveys have been completed. A total of 30 sampling stations will be selected and split evenly between the Vineyard Wind WDA and the control area (SMAST 2020). The strings in each area will use standardized protocols demonstrated in previous SMAST, Massachusetts Division of Marine Fisheries (MADMF), and coast wide ventless trap surveys. Each station will consist of a total of six pots, alternating between vented and ventless. The surveys will use standardized 40" x 21" x 16" traps and contain a single kitchen, parlor, and a rectangular $1^{15}/16$" x $5^{3}/4$" vent in the parlor of vented traps (SMAST 2020). Each sampling station/string will use two vertical lines marking each end of the string for a total 60 marking buoys/vertical lines. Trap deployment, maintenance, and hauling will be conducted between May 15 and October 31 by commercial lobstermen under the guidance of a SMAST researcher. To the greatest extent possible, gear will be hauled on a three-day soak time to standardize catchability among trips (SMAST 2020). To assess the black sea bass population, one un-baited fish pot will be deployed adjacent to each lobster string and allowed to naturally saturate over the soaking period. All gear used will be consistent with Federal regulations and use a 600 lb. breakaway swivel, then 120' of 3/8" 1,700lb breakaway sinking rope, connected to the next rope section by a "South Shore Sleeve."

Plankton Surveys

Plankton sampling will occur concurrent with the ventless trap surveys. The plankton surveys will determine the relative abundance and distribution of the larvae of commercially fished crustaceans. Results from this monitoring will provide data for a BACI study in the Vineyard Wind 1 WDA. The surveys will use a towed neuston net and sample the top 0.5 meters of the water column (SMAST 2020). At each ventless trap survey station, one ten-minute tow will be conducted at a target of four knots to assess pre-settlement and abundance of plankton resources in the Vineyard Wind WDA and the adjacent control area. The 2.4 x 0.6 x 6 meter sampling net made with 1320 microfiber mesh will be deployed off the stern of commercial fishing vessels from May to October on days set aside for baiting and setting gear for the ventless trap surveys described above (SMAST 2020).

Other Weather and Meteorological Buoys

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 (NMFS 2021a; Appendix A to this Opinion).

3.3 MMPA IHA

A complete description of the previously issued IHA is included in the 2021 Opinion. Here, we describe the new proposed IHA. More information on the IHA, including Vineyard Wind's application is available online (*https://www.fisheries.noaa.gov/action/incidental-take-authorization-vineyard-wind-llc-construction-vineyard-wind-offshore-wind*). As described in the Notice of Proposed IHA (89 FR 31008; April 23, 2024), take of marine mammals may occur due to in-water noise exposure resulting from pile driving activities associated with installation of 15 WTG foundations.

3.3.1. Amount and Type of Take Proposed for Authorization

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

Take Estimates

The methodology for estimating marine mammal exposure and incidental take is described fully in the Notice of Proposed IHA and discussed further in the *Effects of the Action*. NMFS OPR is proposing to authorize MMPA take of ESA listed marine mammals resulting from noise exposure from impact pile driving for foundation installation (see Table 3.4).

Table 3.4. Take of ESA Listed Species by Level A Harassment and Level B Harassment Proposed for Authorization, due to exposure to noise from installation of 15 Monopile Foundations

Species	Total	
	Level A	Level B
Fin Whale	1	6
North Atlantic Right Whale	0	7
Sei Whale	1	2
Sperm Whale	0	2

source: Table 11, 89 FR 31008

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

There are a number of measures designed to avoid, minimize, or monitor effects of the action that we consider part of the proposed action. BOEM has incorporated into the conditions of COP approval the measures that Vineyard Wind is proposing to take, the requirements of the 2021 IHA issued by NMFS, and the requirements of the Reasonable and Prudent Measures and Terms and Conditions of the Incidental Take Statement included with our 2021 Biological Opinion. There are a number of mitigation measures included in USACE's July 2021 permit authorization. NMFS OPR proposes additional measures in the 2024 Notice of Proposed IHA (see Appendix B of this Opinion). The measures considered as part of the proposed action, and thus mandatory for implementation, are described in the various permits and authorizations, including the Conditions of COP Approval and USACE's permit authorization (see Appendix C of this Opinion). As explained in this Opinion's ITS, compliance with the conditions of the final MMPA IHA is necessary for the ESA take exemption to apply to listed marine mammal species.

In January 2019, Vineyard Wind entered into an agreement with the Natural Resources Defense Council, the Conservation Law Foundation, and the National Wildlife Federation that outlined a number of commitments designed to minimize effects of the construction of the proposed project on North Atlantic Right Whales (Vineyard Wind NGO Agreement 2019). These commitments address seasonal restrictions on pile driving activities, clearance zone and monitoring measures for monitoring for right whales, limitations on the number of jacket foundations (to no more than two), measures for geophysical surveys during construction and post-construction, vessel speed restrictions and monitoring measures, and noise attenuation during pile driving. The agreement also identifies a $3 million “commitment to collaborative science.” To the extent that the measures in the agreement are reflected in Vineyard Wind’s COP, BOEM’s description of the proposed action and COP approval, and/or NMFS’ IHA, those measures are incorporated into the description of the proposed action as described herein. There is no information available on any activities that may be carried out as a result of the funding commitment in the NGO Agreement; as such, any effects resulting from this commitment are not reasonably certain to occur and are not effects of the action considered here.

BOEM, USACE, and NMFS OPR are requiring monitoring of clearance and shutdown zones before and during pile driving. More information is provided in the *Effects of the Action* section of this Opinion. These zones are summarized in tables 3.5 and 3.6. In addition to the clearance and shutdown zones, the MMPA IHA identifies minimum visibility zones for pile driving of WTG 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 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 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 cannot commence until all of these clearances (i.e. visual and PAM) are made. As described in the Notice of Proposed IHA, due to the increased density of North Atlantic right whales during the months of November and December, more stringent clearance and shutdown mitigation measures are proposed for these months.

Once pile driving begins, the shutdown zone applies. 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 Vineyard 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 Vineyard 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 by BOEM, there are two scenarios, approaching pile refusal and pile instability, where this imminent risk could be a factor; however, BOEM 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. This risk is reduced by having each pile 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. Vineyard 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 expected to be 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. For each 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, Vineyard 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 an appropriate period 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 the appropriate length, the likelihood is low for the pile to not achieve stability within the 6-hour window inclusive of stops and starts.

Table 3.5. Proposed and Required clearance and exclusion zones – Pile Driving
These are the PAM detection, minimal visibility, clearance, and shutdown zones incorporated into the proposed action; the zones for marine mammals reflect the revised conditions included in the 2024 proposed IHA, and the zones for sea turtles reflect the zone sizes included by BOEM as conditions of COP approval. Pile driving will not proceed unless the visual PSOs can effectively monitor the full extent of the minimum visibility zones. Detection of an animal

within the clearance zone triggers a delay of initiation of pile driving; detection of an animal in the shutdown zone triggers the identified shutdown requirements.

Species	Clearance Zone (m)	Shutdown Zone (m)
June – October		
Minimum visibility zone from each PSO platform (pile driving vessel and at least two PSO vessels): 4,000 m; PAM monitoring out to 10,000 m		
North Atlantic right whale – visual and PAM monitoring	At any distance (Minimum visibility zone plus any additional distance observable by the visual PSOs on all PSO platforms); At any distance within the 10 km zone monitored by PAM	At any distance (Minimum visibility zone plus any additional distance observable by the visual PSOs on all PSO platforms); At any distance within the 10 km zone monitored by PAM
Fin, sei, and sperm whale (visual and PAM monitoring) – WTG foundation	500	500
Sea Turtles	500 m (visual detection)	500 m (visual detection)
November and December		
Minimum visibility zone from each PSO platform (pile driving vessel and at least two PSO vessels): 4,000 m; vessel based surveys using two PSO support vessels to confirm that a 10-km (6.2-mi) clearance zone is clear of NARWs. If three or more NARWs are sighted in November or December, pile driving will be delayed for 24 hours; PAM monitoring out to 10,000 m		
North Atlantic right whale – visual and PAM monitoring	At any distance (Minimum visibility zone plus any additional distance observable by the visual PSOs on all PSO platforms); At any distance within the 10 km zone monitored by PAM and PSO support vessels	At any distance (Minimum visibility zone plus any additional distance observable by the visual PSOs on all PSO platforms); At any distance within the 10 km zone monitored by PAM
Fin, sei, and sperm whale (visual and PAM monitoring) – WTG foundation	500	500
Sea Turtles	500 m (visual detection)	500 m (visual detection)

Table 3.6 Required clearance and exclusion zones – HRG Surveys
These are the clearance and shutdown zones incorporated into the proposed action; the zones reflect the zone sizes included by BOEM as conditions of COP approval.

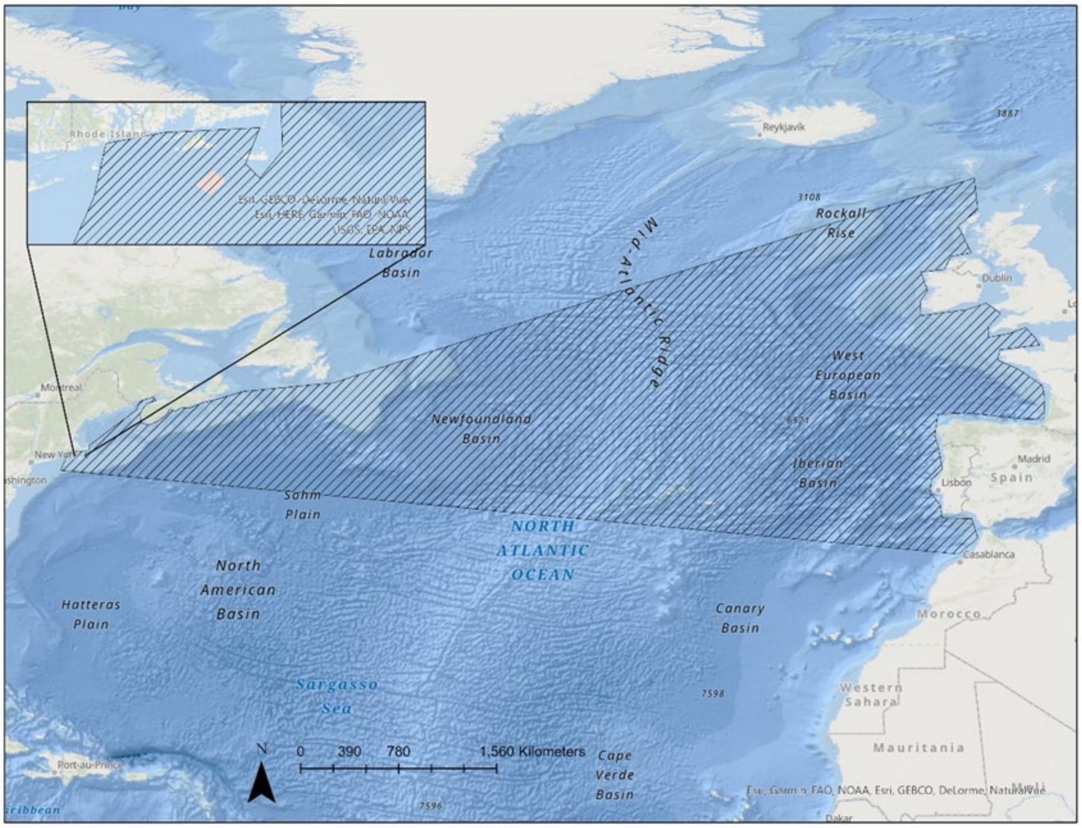
HRG Surveys		
North Atlantic right whale	500	500
Fin, sei, and sperm whale	200	200
Sea Turtles	200	50

3.4 Action Area

The action area is defined in 50 CFR 402.02 as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action." The action area includes the 75,614 acre WDA where project activities will occur and the surrounding areas ensonified by proposed Project noise; the OECC, which extends north through Muskeget Channel to landfall in south-central Cape Cod; the vessel transit areas between the WDA and ports in Massachusetts (New Bedford, Brayton Point, and Montaup), Rhode Island (Providence and Quonset Point, Rhode Island) and Canada (Sheets Port, St. John, and Halifax) and the routes used by vessels transporting manufactured components from Europe inclusive of the portion of the Atlantic Ocean that will be transited by those vessels and the territorial sea of nations along the European Atlantic coast from which those vessels will originate. The action area incorporates the area where survey and monitoring activities will occur.

As explained in the Effects of the Action section of this Opinion, the vessels transiting to the project area from Europe are trans-Atlantic cargo vessels that routinely travel between the U.S. and Europe. The exact vessel route from port facilities in Europe is unknown at this time and will depend on several factors including the origin and destination of particular trips. All trips originating from Europe will either travel directly to the project site within the WDA or to one of the ports in Canada, Massachusetts, or Rhode Island that were identified above. At this time, the port(s) of origin are unknown. Vessel routes will depend, on a trip-by-trip basis, on weather and sea-state conditions, other vessel traffic, and any maritime hazards. Based on a review of AIS data (see Figure 3.4.4), we expect vessels approaching the project area from Europe to have a track that eventually approaches the precautionary area at the intersection of the Boston Harbor Traffic Lanes and the Nantucket to Ambrose Traffic Lane and then tracks along the Nantucket to Ambrose Traffic Lane. At some point, the vessel will depart the Nantucket to Ambrose Traffic Lane and travel directly to the WDA or to the Narragansett Bay or Buzzards Bay traffic separation scheme. According to information provided by BOEM, vessels traveling to the WDA or to the MA or RI ports from Canada will travel along the route illustrated above i. We assume that vessels traveling from Europe to the WDA or the MA, RI, or Canadian ports will take the most direct route; thus, we consider the action area to include the portion of the North Atlantic Ocean as illustrated in Figure 3.7, where we assume that any project vessels transiting from Europe will operate.

Figure 3.7. Map representing the entirety of the action area (Note that given the scale of the map, this is meant only to serve as a general visual representation of the text description of the action area provided above - lease area (pink) is shown in inset map).



4.0 SPECIES AND CRITICAL HABITAT NOT CONSIDERED FURTHER IN THIS OPINION

In the BA, BOEM concludes that the proposed action is not likely to adversely affect blue whales, shortnose sturgeon, and giant manta rays and that hawksbill sea turtles and Atlantic salmon do not occur in the action area. BOEM also concludes that the proposed action will have no effect on critical habitat designated for North Atlantic right whales. We have also determined that the proposed action is not likely to adversely affect the oceanic white tip shark or the Northeast Atlantic DPS of loggerhead sea turtles. Here, we provide rationale to support these determinations. We note that the changes to the proposed action evaluated in this Opinion do not change these determinations from our 2021 Opinion. The ESA listed species and designated critical habitat occurring in the action area also remain unchanged from the 2021 Opinion. In a few instances, we have updated the text for clarity or to incorporate new information or citations that were not available at the time the 2021 Opinion was issued.

Blue whales (*Balaenoptera musculus*) – Endangered

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), 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). In the action area, blue whales are most frequently sighted in the waters off eastern Canada, with the majority of recent records in the Gulf of St. Lawrence (Hayes et al. 2020) which is outside the action area. The largest concentrations of blue whales are found in the lower St. Lawrence Estuary (LeSage et al. 2017, Comtois et al. 2010) which is outside of the action area. 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). We note that a blue whale was documented by whale watch vessels off the coast of Cape Ann, MA in July 2024; however, this is considered an unusual occurrence.

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).

Blue whales have not been documented in the WDA[7] and are not expected to occur in the WDA. Based on their distribution, blue whales could occur along a portion of the vessel transit routes between Canadian or European ports and the project site. There are recorded sightings of blue whales is the northern portion of the transit route from ports in Canada that may be used during the construction phase (see figure 2). There is an area off the coast of Nova Scotia (overlapping with the potential vessel transit route from Halifax and Sheet Harbor) with approximately 30 sightings of blue whales recorded; however, all of these sightings are from a three year period in the 1960s (1966-1968), despite sighting effort since then. The portion of the action area that overlaps with the vessel transit route from St. John has about seven sightings between 1975 and 2006. The rarity of observations in this area is consistent with the conclusion in Waring et al. (2010) that the blue whale is best considered as an occasional visitor in U.S. Atlantic EEZ waters and would be rare along the vessel transit route from Canada. In the BA, BOEM estimates a maximum of two vessels per day will travel between either St. John, Halifax, or Sheet Harbor, over the construction period for a total of no more than 265 trips. Given the rarity of blue whales in this area, it is extremely unlikely that any blue whales will co-occur in the area with these vessel trips. Similarly, given the rarity of blue whales along any transit routes from Europe, co-occurrence with any of those trips is not reasonably expected. However, even if co-occurrence did occur, any effects are extremely unlikely to occur. This is because the slow transit speed (not exceeding 10 knots) and the use of a dedicated lookout, will allow vessel operators to avoid interactions with any whales along the vessel transit route.). Traveling at speeds not exceeding 10 knots 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 (Laist et al., 2001; Jensen and Silber, 2003; Vanderlaan and Taggart, 2007). Therefore, based on the unexpected co-occurrence of blue whales and project vessels as well as the speed reductions and use of a lookout, any effects to blue whales are extremely unlikely to occur and therefore, discountable. The proposed action is not likely to adversely affect the blue whale. No take is anticipated.

Shortnose sturgeon (*Acipenser brevirostrum*) – Endangered
Shortnose sturgeon are benthic fish that mainly occupy the deep channel sections of large rivers. The population of shortnose sturgeon that is closest geographically to the lease area and cable corridor is the Connecticut River population (SSSRT 2010). However, shortnose sturgeon do not occur in the lease area or along the cable corridor. There are no records of shortnose sturgeon captures in state fisheries surveys or fisheries observer program records in the action area. Within the Gulf of Maine, some portion of the shortnose sturgeon population natal to the Kennebec River make nearshore coastal migrations north to at least the Penobscot River and south to the Merrimack River. Despite intense study of shortnose sturgeon in New England, there is only one recorded occurrence of a shortnose sturgeon making a coastal migration outside of the Gulf of Maine. In fall 2014, a shortnose sturgeon was caught in the Merrimack River (MA) carrying a tag that was implanted in the Connecticut River in 2001 (pers. comm. Kieffer and Savoy 2014). The genetic differentiation between the Connecticut and Merrimack River sturgeon populations is a reflection of the rarity of these types of movements. Based on the available information on coastal movements of shortnose sturgeon in the Gulf of Maine (Dionne et al. 2013, Zydlewski et al. 2011), we expect that the individual sturgeon that transited from the Connecticut to the Merrimack River would most likely have stayed in near shore waters with access to less saline waters, which do not overlap with the lease area or the cable corridor. Thus, even if these movements are more frequent than anticipated, we do not expect shortnose sturgeon to occur in the lease area, along the cable corridor, in ensonified areas, or where project-related vessels travel. Based on the information summarized here, we do not expect shortnose sturgeon to occur in the action area. Therefore, we conclude that the action will not affect any shortnose sturgeon. Nevertheless, even if some shortnose sturgeon move from one river to another and overlap with nearshore portions of the action area, any effects of the action on shortnose sturgeon would be extremely unlikely given the rarity of coastal movements in light of genetic differentiation, the paucity of tagged fish discovered outside their usual river systems, a physiology-based avoidance of marine waters (which are more saline than estuaries and rivers), and distance of nearshore waters from levels of noise that would be expected to disturb shortnose, and information that vessel strikes of shortnose sturgeon are most likely to occur in narrow, shallow rivers as opposed to open waters with depth, among other factors. Based on this information, any effects to shortnose sturgeon are extremely unlikely to occur and therefore, discountable. The proposed action is not likely to adversely affect shortnose sturgeon. No take is anticipated to occur.

Giant Manta Ray (*Mobula birostris)* – Threatened
In January 2023 (88 FR 81351), the scientific name of the species was revised to from *Manta birostris* to *Mobula birostris*; no other changes to the species' status accompanied this name

change. The giant manta inhabits temperate, tropical, and subtropical waters worldwide, between 35° N and 35° S latitudes. In the western Atlantic Ocean, this includes South Carolina south to Brazil and Bermuda. 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. Giant manta rays travel long distances during seasonal migrations and may be found in upwelling waters at the shelf break south of Long Island. Giant Manta Rays are not anticipated in the lease area. Farmer et al. (2021) summarized results of NYSERDA surveys carried out from nearshore to offshore marine environments of New York, with temporal coverage during the spring/summer of 2016–2019 and fall/winter of 2016–2018. Of the 21,539 rays identified in the surveys, 7 were manta rays. Farmer et al. (2021) reports that despite comprehensive coast to shelf survey coverage, manta ray sightings were exclusively in August on the continental shelf edge. We do not expect project vessels to be transiting offshore waters at the shelf break south of Long Island. Given the known distribution of this species, it is reasonable to conclude that the giant manta ray will not occur in the action area and, therefore, that the action will have no effect on 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 and that the action area does not overlap with the species normal range, we do not expect hawksbill sea turtles to occur in the action area. Therefore, we do not anticipate that any hawksbill sea turtles will be exposed to effects of the proposed action. As such, effects to hawksbill sea turtles from vessel operations are also extremely unlikely to occur. As all effects will be discountable, the proposed action is not likely to adversely affect the hawksbill sea turtle. No take is anticipated.

Gulf of Maine DPS of Atlantic salmon *(Salmo salar)* – Endangered

The only remaining populations of Gulf of Maine distinct population segment (GOM DPS) Atlantic salmon are in Maine. Smolts migrate from their natal rivers in Maine north to foraging grounds in the Western North Atlantic off Canada and Greenland (Fay et al. 2006). After one or more winters at sea, adults return to their natal river to spawn. Atlantic salmon do not occur in the lease area or along the cable corridor. The area that may be used by migrating GOM DPS Atlantic salmon overlaps with the route that BOEM has indicated will be used by barges transporting project components from Canada. However, even if migrating salmon occurred along the routes of vessels transiting to or from Europe or Canada, we do not anticipate any effects to Atlantic salmon. There is no evidence of interactions between vessels and Atlantic salmon. 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. 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 the identified ports in Canada. The proposed action will have no effect on the Gulf of Maine DPS of Atlantic salmon.

Oceanic White Tip Shark (*Carcharhinus longimanus*) – Threatened

The oceanic whitetip shark is usually found offshore in 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 that may be transited by vessels from Europe. Vessel strikes are not identified as a threat in the status review (Young et al., 2017), listing determination (83 FR 4153) or the recovery outline (NMFS 2018). We have no information to suggest that vessels in the ocean have any effects on oceanic white tip sharks. Considering the lack of any reported vessel strikes, their swim speed and maneuverability (Papastamatiou et al. 2018), and the slow speed of ocean-going vessels, vessel strikes are extremely unlikely even if migrating individuals occur along the vessel transit routes. The proposed action is not likely to adversely affect the oceanic white tip shark. No take is anticipated.

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 (NMFS and USFWS 2021). The only portion of the action area that loggerheads from the Northeast Atlantic DPS are present in is along the portion of any vessel transit routes from Europe that are east of 40° W. Long. In this portion of the action area, co-occurrence of project vessels and individual sea turtles is expected to be extremely unlikely; this is due to the dispersed nature of sea turtles in the open ocean and the only intermittent presence of project vessels. Together, this makes it extremely unlikely that any Northeast Atlantic DPS loggerheads will be struck by a project vessel. The proposed action is not likely to adversely affect the Northeast Atlantic DPS of loggerhead sea turtles. No take is anticipated of Northeast Atlantic DPS loggerhead sea turtles.

Critical Habitat Designated for North Atlantic Right Whales

On January 27, 2016, NMFS issued a final rule designating critical habitat for North Atlantic right whales (81 FR 4837). Critical habitat includes two areas (Units) located in the Gulf of Maine and Georges Bank Region (Unit 1) and off the coast of North Carolina, South Carolina, Georgia and Florida (Unit 2). The action area does not overlap with Unit 1 or Unit 2. In the BA, BOEM described the vessel transit routes to be used for project vessels traveling to or from Canada; based on our review of the information provided by BOEM in the BA, these vessels will not travel through Unit 1. No other effects of the project will extend to Unit 1 or Unit 2.

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 Vineyard Wind project would extend to Unit 1. The Vineyard 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 Vineyard 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 right whale critical habitat.

5.0 STATUS OF THE SPECIES

This section of the Opinion has been updated to incorporate relevant new information available since the issuance of the 2021 Opinion; however, there have been no new species listed that occur in the action area and no changes in the ESA listing status (i.e., threatened or endangered) of any of the species considered in the Opinion.

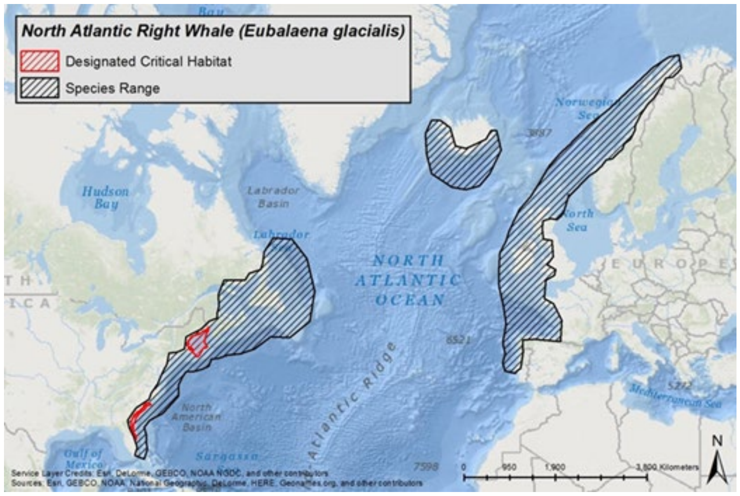
5.1 Marine Mammals

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 reports (Hayes et al. 2022 and Hayes et al. 2023), and the available 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 modelling efforts suggest that in 1980, females had a life expectancy of approximately 51.8 years of age, which was twice that of males at the time (Fujiwara and Caswell 2001); however, by 1995, female life expectancy was estimated to have declined to approximately 14.5 years (Fujiwara and Caswell 2001). Most recent estimates indicate that North Atlantic right whale females are only living to 45 and males to age 65 (https://www.fisheries.noaa.gov/species/north-atlantic-right-whale). Females, ages 5+, have reduced survival relative to males, ages 5+, resulting in a decrease in female abundance relative to male abundance (Pace et al. 2017). Specifically, state-space mark-recapture model estimates show that from 2010-2015, males declined just under 4.0%, and females declined approximately 7% (Pace et al. 2017).

Gestation is estimated to be between 12 and 14 months, after which calves typically nurse for around one year (Cole et al. 2013, Kenney 2009, Kraus and Hatch 2001, Lockyer 1984). After weaning a calf, females typically undergo a 'resting' period before becoming pregnant again, presumably because they need time to recover from the energy deficit experienced during lactation (Fortune et al. 2013, Fortune et al. 2012, Pettis et al. 2017). From 1983 to 2005, annual 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 2023 ranged from a low of 7 in 2019 to a high of 9.2 in 2021 (Pettis and Hamilton 2023).

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; from 2009 through 2023, the percentage of available females that had calves ranged from 0% (2018) to 44.9% (2011) and has ranged from 25-26.8% from 2021-2023 (Pettis and Hamilton 2023). 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 Hayes et al. 2023, 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 analysis, 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). Between 1990 and 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. 2023), 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 December 2021, and included photographic information up through November 2020. Using a 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% Credible Interval: 325–350). The minimum population estimate in the most recent SAR is 332 (Hayes et al. 2023). Linden 2023[8] updates the population size estimate of North Atlantic right whales at the beginning of 2022 using the most recent year of available sightings data (collected through December 2022) and the existing modeling approach. Using the established capture-recapture framework (Pace et al. 2017), the estimated population size in 2022 was 356 whales, with a 95% credible interval ranging from 346 to 363. Linden notes that given uncertainty in the accuracy of the terminal year estimate (Pace 2021), interpretations should focus on the multi-year population trend. The draft 2023 SAR is currently under review and revision. As reported in the publicly available draft (Hayes et al. 2024, DRAFT), a median abundance value (Nest) as of December 31, 2021, is 340 individuals (95% Credible Interval: 333-348). 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 sharp decrease observed from 2015-2020 appears to have slowed, though the right whale population continues to experience annual mortalities above recovery thresholds.

The annual calf count is highly variable; Pettis and Hamilton (2023) report a range of 5 (2017) to 39 (2009) calves from the 2009-2017 calving seasons. As noted above, no calves were observed in the 2018 season. Seven calves were born in 2019 and 10 in 2020 (not including a long calf observed in December 2020 off the Canary Islands). Fifteen mother calf pairs were sighted in 2022, down from 18 in 2021. There were no first time mothers sighted in 2022. Of the 15 calves born in 2022, one is known to have died and another is thought likely to have died. During the 2022-2023 season, there were 11 mothers with associated calves and one newborn documented alone that was later found dead. (Pettis and Hamilton 2023). Through July 15, 2024, 20 mother-calf pairs have been sighted in the 2023-2024 calving season which is

[8] Available at: https://www.fisheries.noaa.gov/s3/2023-10/TM314-508-0.pdf

considered a relatively productive year; of these, 4 are thought to be first time mothers. [9] One calf (mother Juno) had been sighted with injuries consistent with a vessel strike; while there were signs that the injuries were healing, the dead calf stranded in Georgia in early March. Additionally, three other calves are considered "missing" and are likely mortalities as the mothers have been seen alone after only a single sighting with their calves.

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 (Frasier et al. 2023). Additionally, there were no first-time mothers in 2022 (Pettis et al. 2022), and only two first-time mothers in 2023 (Pettis and Hamilton 2023), 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

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[9] https://mission.cmaquarium.org/2023-2024-right-whale-calving-season/ and https://www.fisheries.noaa.gov/national/endangered-species-conservation/north-atlantic-right-whale-calving-season-2024

[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).

mortalities for North Atlantic right whales have been provided by Hayes et al. (2023) and Pace et al. (2017); these estimates show that the total annual North Atlantic right whale mortality exceed or equal the number of detected serious injuries and mortalities.[11] 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 UME, as a result of elevated right whale mortalities along the Western North Atlantic Coast. 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 15, 2024, there are 142 individuals recorded as part of the UME. This includes 40 confirmed mortalities for the UME (with 1 pending), 35 serious injuries (including 1 dependent calve), and 66 sublethal injuries or illness (for more information on UMEs, see https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-unusual-mortality-events). Mortalities are recorded as vessel strike (15), entanglement (9), perinatal (2), unknown/undetermined (3), not examined (1), and pending (1).[12] These values include the dead female right whale documented off Virginia in April 2024 (whose calf is missing and was last spotted in February) and the dead calf of Juno (previously recorded with vessel strike injuries) observed in March 2024.

The North Atlantic right whale population continues to decline. As provided 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 2023 SAR reports an overall abundance decline between 2011 and 2020 of 23.5% (CI=21.4% to 26.0%) (Hayes et al. 2023). 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).

Long-term photographic identification data also indicate new calves rarely go undetected, so these years likely represent a continuation of low calving rates that began in 2012 (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 (Christiansen et al. 2020). North Atlantic right whale calves were in good condition. 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 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

[11] Currently, 72% of mortalities since 2000 are estimated to have been observed (Hayes et al. 2020).

[12] https://www.fisheries.noaa.gov/national/marine-life-distress/2017-2024-north-atlantic-right-whale-unusual-mortality-event; last accessed July 15, 2024

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/or serious injury occurred, the projected population in 2016 would be 12.2% higher (506 individuals). Furthermore, if the actual mortality resulting from fishing gear is double the observed rate (as estimated in Pace et al. 2017), eliminating all mortalities (observed and unobserved) could have resulted in a 2016 population increase of 24.6% (562 individuals) and possibly over 600 in 2018 (Kenney 2018).

Given the above information, North Atlantic right whales resilience to future perturbations 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 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). Using the refined methods of Pace et al. (2021), the estimated annual rate of total mortality for the period 2015–2019 was 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). The period 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 approach distance for threatened or endangered whales is 1312 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. 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

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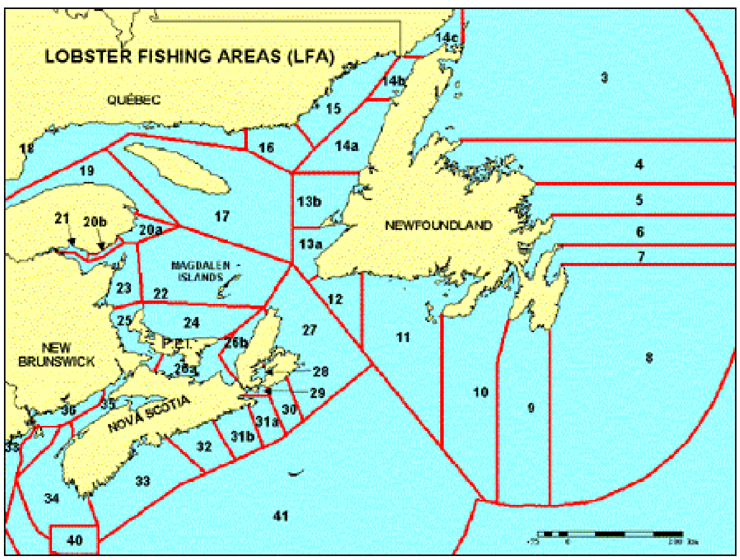
[13] Of the 41 Lobster Fisheries Areas, one is for the offshore fishery, and one is closed for conservation.

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

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



The snow crab fishery is DFO's second largest fishery, by landings. It is managed under regional management plans with approximately 60 Snow Crab Management Areas in Canada spanning four regions (Scotia-Fundy, Southern Gulf of St. Lawrence, Northern Gulf of St. Lawrence, and Newfoundland and Labrador). In 2010, 4,326 snow crab fishery licenses were issued. The DFO website indicated that 3,703 permits were issued in 2017[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

[14] (http://www.dfo-mpo.gc.ca/stats/commercial/licences-permis/species-especes/se17-eng.htm)

have been used since 2017 to minimize the impacts to North Atlantic right whales, as described below.

DFO manages the Atlantic mackerel fishery under one Atlantic management plan, established in 2007. Management measures include fishing seasons, total allowable catch, gear, Safety at Sea fishing areas, licensing, minimum size, fishing gear restrictions, and monitoring. The plan allows the use of the following gear: gillnet, handline, trap net, seine, and weir. When established, the DFO issued 17,182 licenses across four regions, with over 50% of these licenses using gillnet gear. In 2017, DFO issued 7,965 licenses (http://www.dfo-mpo.gc.ca/stats/commercial/licences-permis/species-especes/se17-eng.htm); 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. 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 measure 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 6400 commercial vessels transited the Cabot Strait and the Strait of Belle Isle annually. This represents a subset of the vessels in this area as it only includes commercial vessels (DFO 2013). To address vessel strikes in Canadian waters, the International Maritime Organization (IMO) amended the Traffic Separation Scheme in the Bay of Fundy to reroute vessels around high use areas. In 2007, IMO adopted and Canada implemented a voluntary seasonal Area to Be Avoided (ATBA) in Roseway Basin to further reduce the risk of vessel strike (DFO 2020). In addition, Canada has implemented seasonal speed restrictions and developed a proposed action plan to identify specific measures needed to address threats and achieve recovery (DFO 2020).

The Government of Canada has also implemented measures to mitigate vessel strikes in Canadian waters. Each year since August 2017, the Government has implemented seasonal speed restrictions (maximum 10 knots) for vessels 20 meters or longer in the western Gulf of St. Lawrence. In 2019, the area was adjusted and the restriction was expanded to apply to vessels greater than 13 m; smaller vessels are encouraged to respect the limit. Dynamic area management has also been used in recent years. Currently, there are two shipping lanes, south and north of Anticosti Island, where dynamic speed restrictions (mandatory slowdown to 10 knots) can be activated when right whales are present. In 2020 and 2021, the Government of Canada also implemented a trial voluntary speed restriction zone from Cabot Strait to the eastern edge of the dynamic shipping zone at the beginning and end of the season and a mandatory restricted area in or near Shediac Valley mid-season. 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. Since 2021, a variety of measures were in place to reduce the risk of vessel strike including vessel speed limits and restricted access areas. 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.

Critical Habitat

Critical habitat for North Atlantic right whales has been designated 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 goal is to reclassify the species from endangered to threaten. 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 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.

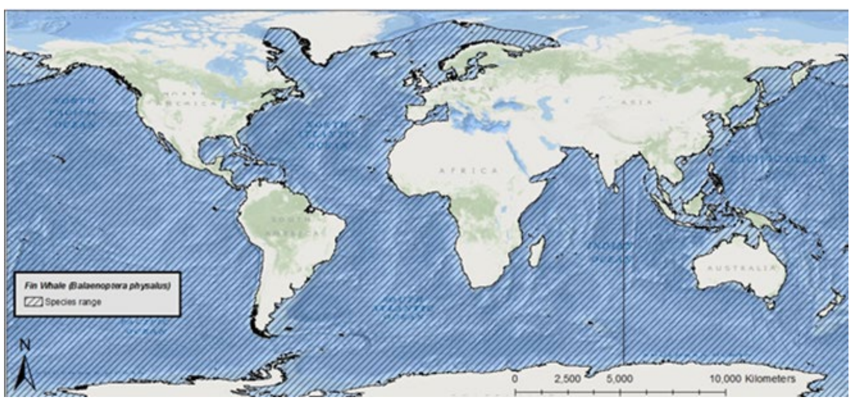
Specific criteria for delisting North Atlantic right whales are not included in the recovery plan; as described in the recovery plan, conditions related to delisting are too distant and hypothetical to realistically develop specific criteria. The current abundance of North Atlantic right whales is currently 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 review was for the status to remain as endangered. As described in the report, the North Atlantic right whale faces continued threat of human-caused mortality due to lethal interactions with commercial fisheries and vessel traffic. As stated in the 5-Year Review, there is also uncertainty regarding the effect of long-term sublethal entanglements, emerging environmental stressors including climate change, and the compounding effects of multiple continuous stressors that may be limiting North Atlantic right whale calving and recovery. In addition, the North Atlantic right whale population has been in a state of decline since 2010. Management measures in the United States have been in place for an extended period of time and continued modifications are underway/anticipated, and measures in Canada since 2017 also suggest continued progress toward implementing conservation regulations. Despite these efforts to reduce the decline and promote recovery, progress toward right whale recovery has continued to regress.

5.1.2 Fin Whale (Balaenoptera physalus)

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

Figure 5.1.3. Range of the fin whale



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

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

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

Population Dynamics
The pre-exploitation estimate for the fin whale population in the entire North Atlantic was approximately 30,000-50,000 animals (NMFS 2010a), and for the entire North Pacific Ocean, approximately 42,000 to 45,000 animals (Ohsumi and Wada 1974). In the Southern Hemisphere, prior to exploitation, the fin whale population was approximately 40,000 whales (Mizroch et al. 1984b). In the North Atlantic Ocean, fin whales were heavily exploited from 1864 to the 1980s; over this timeframe, approximately 98,000 to 115,000 fin whales were killed (IWC 2017). Between 1910 and 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, where 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 is available, the cetacean maximum theoretical net productivity rate of 4.0% will be used for the Western North Atlantic stock (Hayes et al. 2022). 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 is available, the cetacean maximum theoretical net productivity rate of 4.0% will be used for the Northeast Pacific stock (Muto et al. 2019b, NMFS 2016b). Overall population growth rates and total abundance estimates for the Hawaii stock of fin whales are not available at this time (Carretta et al. 2018). Based on line transect studies between 1991-2014, there was estimated a 7.5% increase in mean annual abundance in fin whales occurring in waters off California, Oregon, and Washington; to date, this represents the best available information on the current population trend for the overall California/Oregon/Washington stock of fin whales (Carretta et al. 2019a, Nadeem et al. 2016).[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 (minimum population size 65,573, Hayes et al. 2022) 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) (Hayes et al. 2022). Hayes et al. 2022 notes that these represent a minimum estimate of human-caused mortality, which is almost certainly biased low.

Critical Habitat

No critical habitat has been designated for the fin whale.

Recovery Goals

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[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).

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:

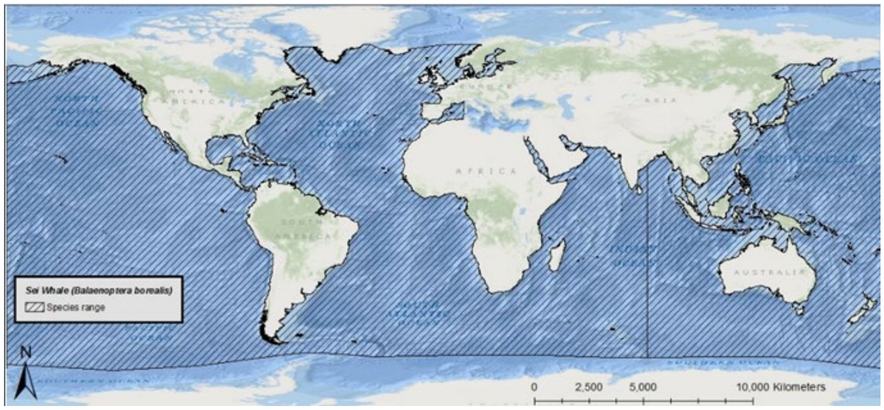
1. Coordinate state, federal, and international actions to implement recovery actions and maintain international regulation of whaling for fin whales;
2. Determine population discreteness and population structure of fin whales;
3. Develop and apply methods to estimate population size and monitor trends 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*. 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. 2020, Hayes et al. 2017), status review (NMFS 2012), 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 for the Nova Scotia stock (Hayes 2019). In the North Pacific, an abundance estimate for the entire North Pacific population of sei whales is not available. However, in the western North Pacific, it is estimated that there are 35,000 sei whales (Cooke 2018a). In the eastern North Pacific (considered east of longitude 180º), two stocks of sei whales occur in U.S. waters: Hawaii and Eastern North Pacific. Abundance estimates for the Hawaii stock are 391 sei whales (N_{min}=204), and for Eastern North Pacific stock, 519 sei whales (N_{min}=374) (Carretta et al. 2019a). In the Southern Hemisphere, recent abundance of sei whales is estimated at 9,800 to 12,000 whales. Population growth rates for sei whales are not available at this time as there are little to no systematic survey efforts to study sei whales; however, in U.S. waters, NMFS has determined that until additional data is available, the cetacean maximum theoretical net productivity rate of 4.0% will be used for the Hawaii, Eastern North Pacific, and Hawaii stocks of sei whales (Hayes 2019).

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

Status

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

Critical Habitat

No critical habitat has been designated for the sei whale.

Recovery Goals

The 2011 Recovery Plan for the sei whale (NMFS 2011b) indicates that, "because the current population status of sei whales is unknown, the primary purpose of this Recovery Plan is to provide a research strategy to obtain data necessary to estimate population abundance, trends, and structure and to identify factors that may be limiting sei whale recovery." The goal of the Recovery Plan is to promote the recovery of sei whales to the point at which they can be downlisted from Endangered to Threatened status, and ultimately to remove them from the list of

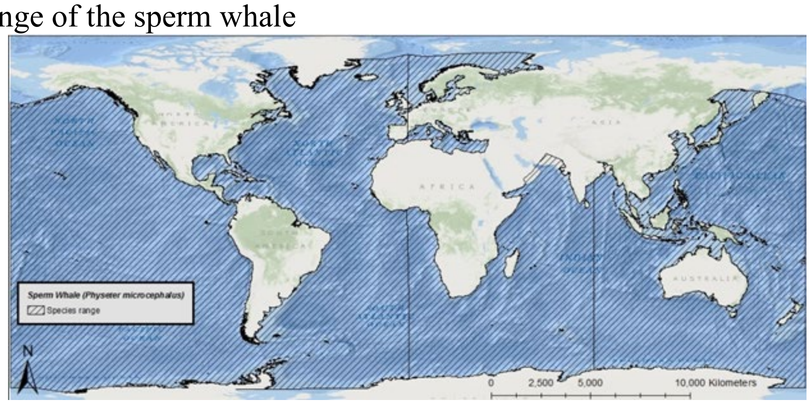
Endangered and Threatened Wildlife and Plants, under the provisions of the ESA. The intermediate goal is to reclassify the species from endangered to threatened. The recovery plan incorporates an adaptive management strategy that divides recovery actions into three tiers. Tier I involves: 1) continued international regulation of whaling (i.e., a moratorium on commercial sei whaling); 2) determining population size, trends, and structure using opportunistic data collection in conjunction with passive acoustic monitoring, if determined to be feasible; and 3) continued stranding response and associated data collection.

NMFS completed the most recent five-year review for sei whales in 2021 (NMFS 2021). In that review, NMFS concluded that the listing status should remain unchanged. They also concluded that recovery criteria outlined in the sei whale recovery plan (NMFS 2011) 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 (Physeter 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 and 2018b, Muto et al. 2018), status review (NMFS 2015b), as well as the recent IUCN sperm whale assessment (Taylor et al. 2019) were used to summarize the life history, population dynamics and status of the species as follows.

Life History
The average lifespan of sperm whales is estimated to be at least 50 years (Whitehead 2009). They have a gestation period of one to one and a half years, and calves nurse for approximately two years, though they may begin to forage for themselves within the first year of life (Tønnesen et al. 2018). Sexual maturity is reached between 7 and 13 years of age for females with an average calving interval of four to six years. Male sperm whales reach full sexual maturity in their 20s. Sperm whales mostly inhabit areas with a water depth of 1970 ft. (600 m) or more, and are uncommon in waters less than 985 ft. (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 et al. 2020). 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 (Hayes et al. 2020, Hayes et al. 2021).

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, population, 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 species' large population size shows that it is somewhat resilient to current threats. 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. During the 2013-2017 period, there were 12 sperm whale strandings documented along the U.S. Atlantic coast within the EEZ, none of these strandings were classified as human interactions (Hayes et al. 2020). 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 this 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/ productivity, and cite actions necessary to allow the populations to increase. The Recovery Plan includes downlisting and delisting criteria (NMFS 2010).

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

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

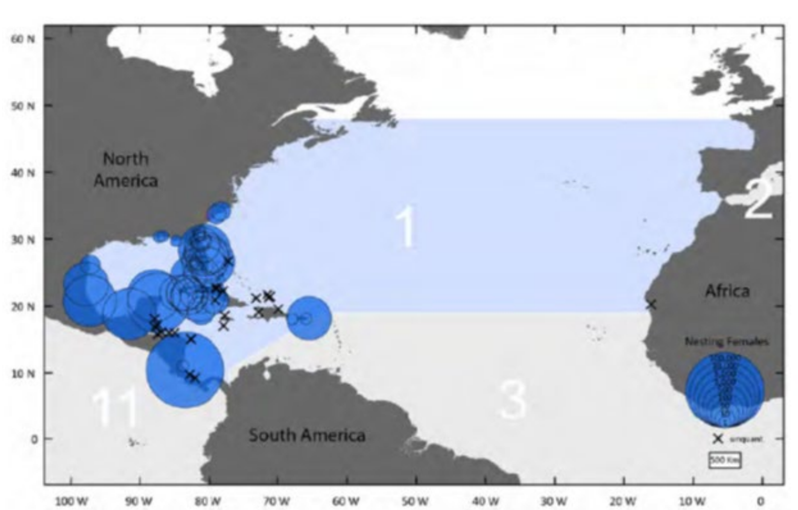
5.2 Sea Turtles

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 (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).

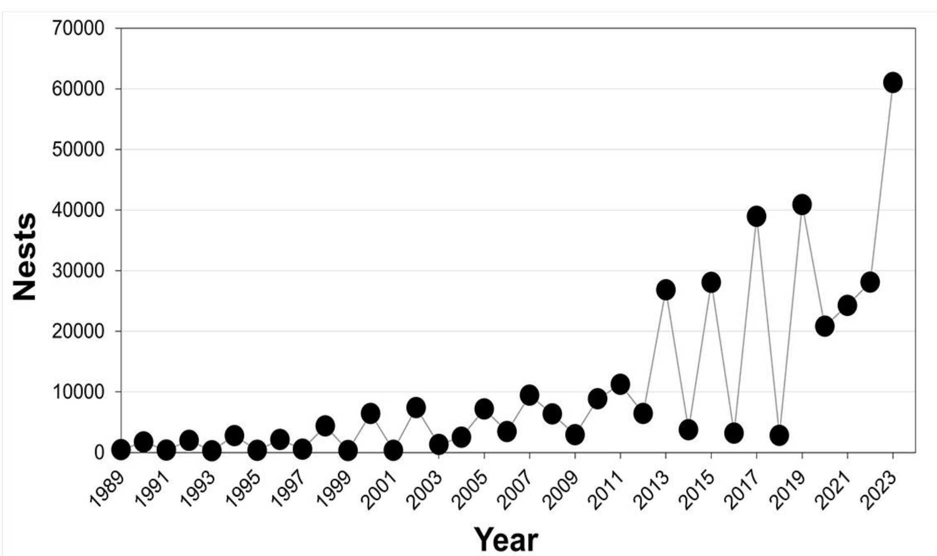
Compared to other DPSs, the North Atlantic DPS exhibits the highest nester abundance, with approximately 167,424 females at seventy-three nesting sites (using data through 2012), and available data indicated an increasing trend in nesting (Seminoff et al. 2015). Counts of nests and nesting females are 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 10 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 had 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 120-fold since standardized nest counts began in 1989 (less than 300 nests recorded in 1989). In 2023, green turtle nest counts on the 27-core index beaches reached more than 61,000 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, 2019, and 2023. Numbers show a mostly biennial pattern of fluctuation.

Figure 5.2.2. Number of green sea turtle nests counted on core index beaches in Florida from 1989-2023 (source: https://myfwc.com/media/sy5ey5jq/greenturtlenests.jpg)



Status
Historically, green sea turtles in the North Atlantic DPS were hunted for food, which was the principle 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 in effect 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. On July 19, 2023, NMFS published a proposed rule (88 FR 46572) to designate specific areas in the marine environment as critical habitat for six DPSs of the green sea turtle, including the North Atlantic DPS. The proposed critical habitat does not overlap with 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 for the U.S. population of green sea turtles is 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.

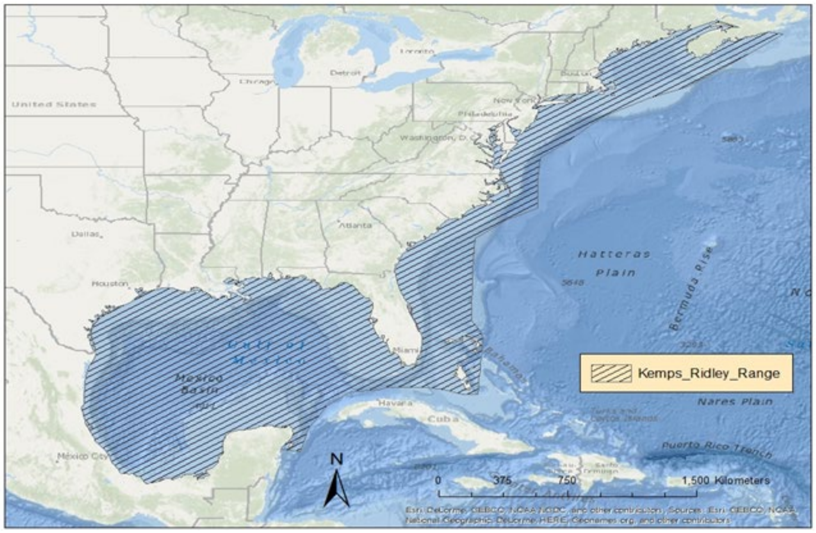
Priority actions to meet the recovery goals include:

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
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. 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). In the fall, most Kemp's ridleys migrate to deeper or more southern, warmer waters and remain there through the winter. As adults, many turtles remain in the Gulf of Mexico, with only occasional occurrence in the Atlantic Ocean (NMFS et al. 2011). Adult habitat largely consists of sandy and muddy areas in shallow, nearshore waters less than 120 feet (37 meters) deep (Seney and Landry 2008, Shaver et al. 2005, Shaver and Rubio 2008), although they can also be found in deeper offshore waters. As larger juveniles and adults, Kemp's ridleys forage on swimming crabs, fish, mollusks, and tunicates (NMFS et al. 2011).

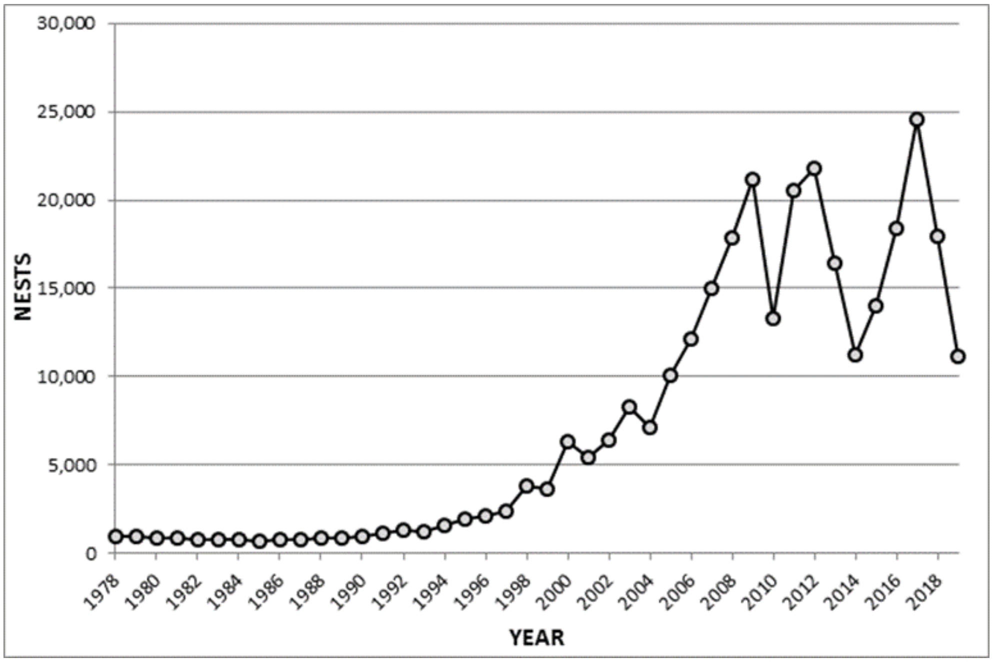
Population Dynamics
Of the sea turtles species in the world, the Kemp's ridley has declined to the lowest population level. Nesting aggregations at a single location (Rancho Nuevo, Mexico) were estimated at 40,000 females in 1947. By the mid-1980s, the population had declined to an estimated 300 nesting females. From 1980 to 2003, the number of nests at three primary nesting beaches (Rancho Nuevo, Tepehuajes, and Playa Dos) increased at 15% annually (Heppell et al. 2005). However, due to recent declines in nest counts, decreased survival of immature and adult sea turtles, and updated population modeling, this rate is not expected to continue and the overall trend is unclear (Caillouet et al. 2018, NMFS and USFWS 2015). In 2019, there were 11,090 nests, a 37.61% decrease from 2018, and a 54.89% decrease from 2017, which had the highest number (24,587) of nests (Figure 5.2.4; unpublished data). The reason for this recent decline is uncertain. In 2021, 198 Kemp's ridley nests were found in Texas – the largest number recorded in Texas since 1978 was in 2017, when 353 nests were documented.

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

Status
The Kemp's ridley was listed as endangered at the species level 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 is low.

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



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

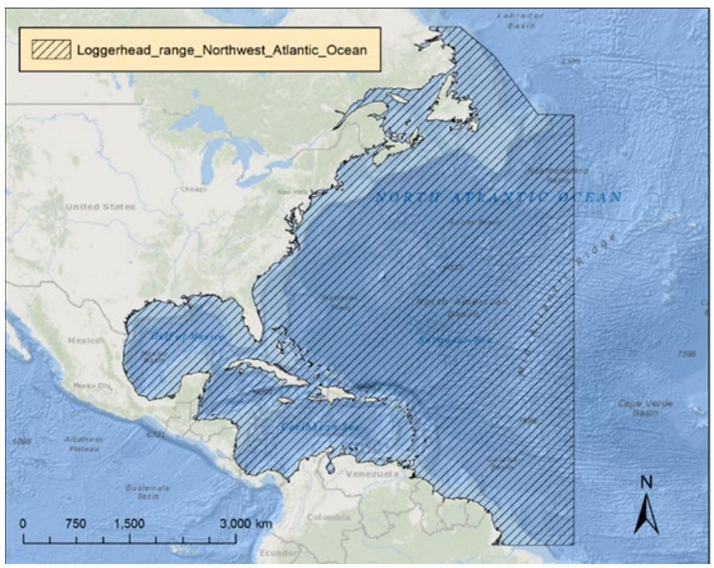
Recovery Goals
As with other recovery plans, the goal of the 2011 Kemp's ridley recovery plan (NMFS, USFWS, and SEMARNAT 2011) is to conserve and protect the species so that the listing is no longer necessary. The recovery criteria relate to the number of nesting females, hatchling recruitment, habitat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

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

5.2.3 Loggerhead Sea Turtle (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 (LaCasalla 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 (2007-2023) and an overall stable trend over the monitored time period (1989-2023). At core index beaches in Florida, nesting totaled a minimum of 28,876 nests in 2007 and a maximum of 70,945 nests in 2023 (https://myfwc.com/research/wildlife/sea-turtles/nesting/beach-survey-totals/). 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 and more recent years. 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, 1989-2023 (source: https://myfwc.com/media/wwded1gr/loggerheadnests.jpg)

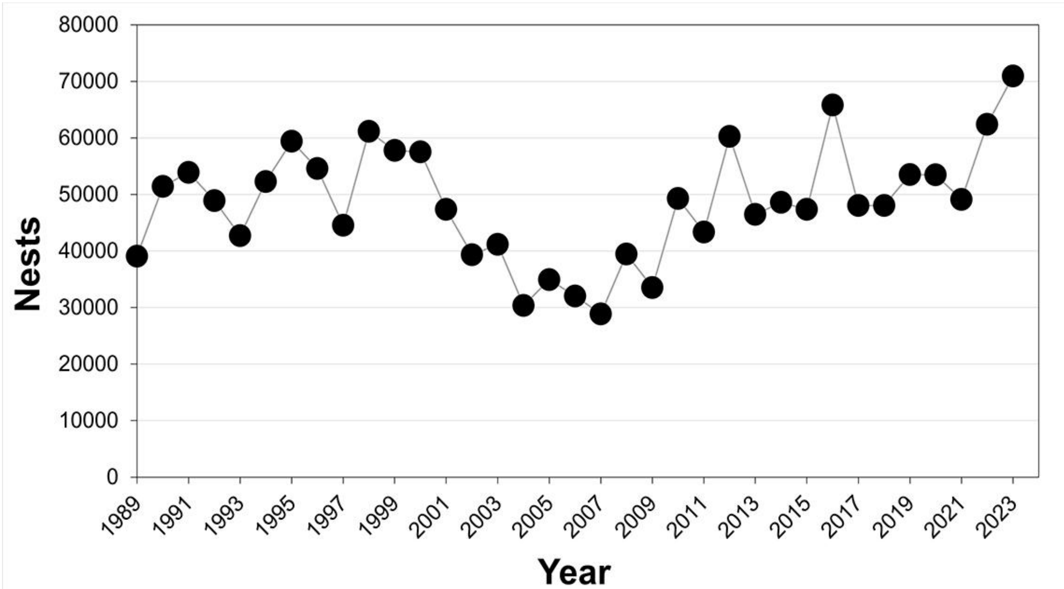
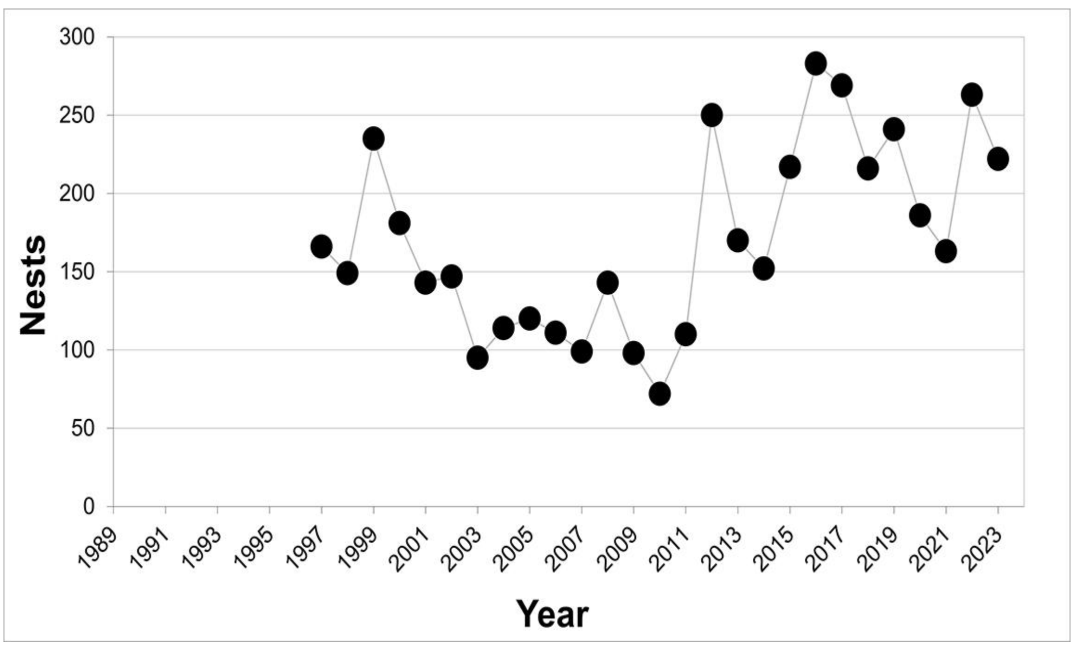


Figure 5.2.7. Annual nest counts of loggerhead sea turtles on index beaches in the Florida Panhandle, 1997-2023 (source: https://myfwc.com/media/ewydvgtl/loggerhead-nests-panhandle.jpg)



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 threatened 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 79 FR 39855); this critical habitat is outside the action area

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:

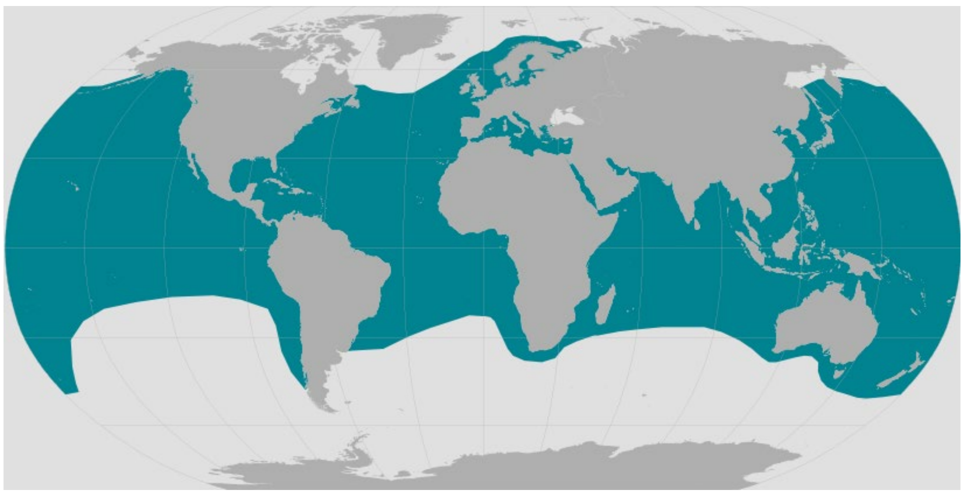
1. Ensure that the number of nests in each recovery unit is increasing and that this increase corresponds to an increase in the number of nesting females.
2. Ensure the in-water abundance of juveniles in both neritic and oceanic habitats is increasing and is increasing at a greater rate than strandings 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

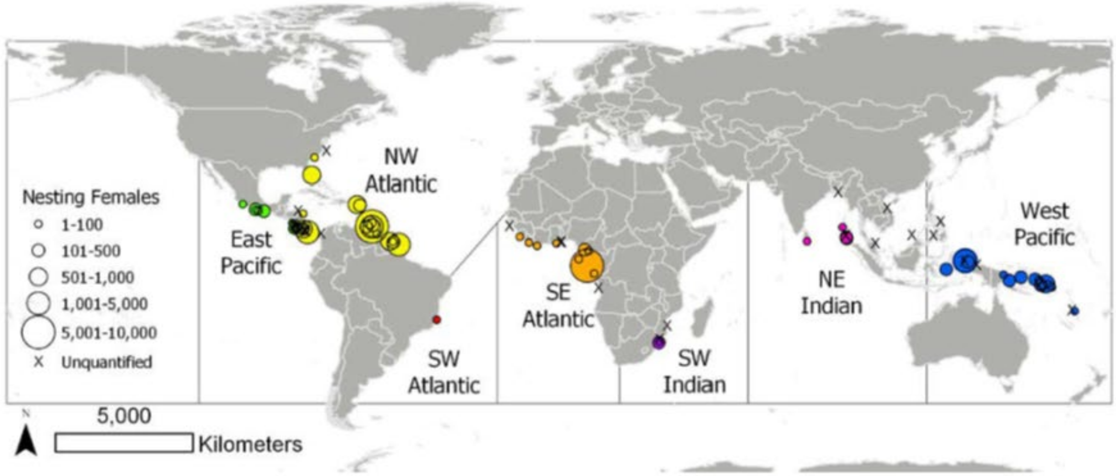
The leatherback sea turtle is unique among sea turtles for its large size, wide distribution (due to thermoregulatory systems and behavior), and lack of a hard, bony carapace. It ranges from tropical to subpolar latitudes, worldwide (Figure 5.2.8).

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 DPS were identified (NMFS and USFWS 2020). The population found within the action is area is the Northwest Atlantic DPS (NW Atlantic DPS) (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. NMFS and USFWS determined that the listing of DPSs was not warranted; leatherbacks continue to be listed as a species at the global level (85 FR 48332, August 10, 2020). Therefore, information is presented on the range-wide status of the species. We used information available in the five-year review (NMFS and USFWS 2013), the critical habitat designation (44 FR 17710, March 23, 1979), the 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).

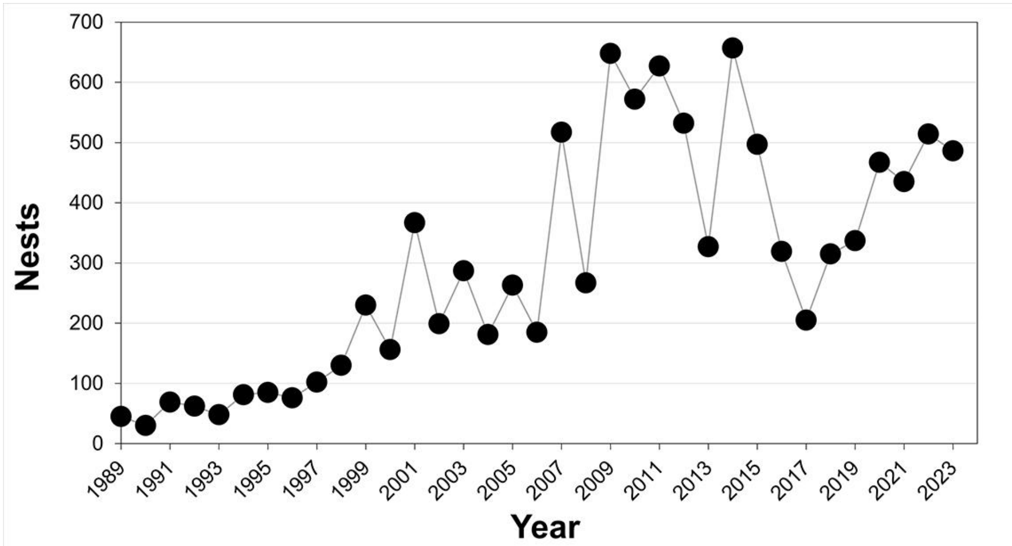
Several more recent assessments have been conducted. The Northwest Atlantic Leatherback Working Group was formed to compile nesting abundance data, analyze regional trends, and provide conservation recommendations. The most recent published IUCN Red List assessment for the NW Atlantic Ocean subpopulation 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 DPS, the leatherback status review estimated that the total index of nesting female abundance for the NW Atlantic DPS 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 a 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 vessels 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 nesting declined from 2014 to 2017 and then increased from 2018-2023. (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).

Figure 5.2.10. Number of leatherback sea turtle nests on core index beaches in Florida from 1989-2023 (source: https://myfwc.com/media/uxmp43et/leatherbacknests.jpg)



For the SW Atlantic population, 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 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 Atlantic population 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 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 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 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 DPS 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 population is limited, the DPS 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. While some populations show a stable or increasing nesting trend, there has been a global decline overall. For all populations, including the NW Atlantic, 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 2008 to 2017 (Northwest Atlantic Leatherback Working Group 2018). 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). We note that the Florida index beaches have demonstrated an increasing trend from 2018-2023. 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 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 includes 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:

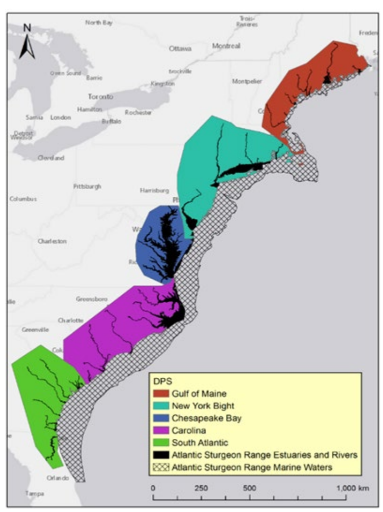
1. Protect and manage terrestrial and marine habitats.
2. Protect and manage the population.
3. Inform and educate the public.
4. Develop and implement international agreements.

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

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. 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. The conservation objective identified in the final rule is to increase the abundance of each DPS by facilitating increased successful reproduction and recruitment to the marine environment. The action area does not overlap with critical habitat designated for any of the five DPSs.

Figure 5.3.1.
Representative distribution of rivers of origin for ESA listed Atlantic sturgeon DPSs.



Information available from the 2007 Atlantic sturgeon status review (ASSRT 2007), 2017 ASMFC benchmark stock assessment (ASMFC 2017), final listing rules (77 FR 5880 and 77 FR 5914; February 6, 2012), material supporting the designation of Atlantic sturgeon critical habitat (NMFS 2017a), and Five-Year Reviews completed for the Gulf of Maine, New York Bight, and Chesapeake Bay DPSs (NMFS 2022a, b, c) and Carolina and South Atlantic DPSs (NMFS 2023a, 2023b) were used to summarize the life history, population dynamics, and status of the species.

Life History

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

Atlantic sturgeon spawn in freshwater (ASSRT 2007, NMFS 2017b) at sites with flowing water and hard bottom substrate (Bain et al. 2000, Balazik et al. 2012b, Gilbert 1989, Greene et al. 2009, Hatin et al. 2002, Mohler 2003, Smith and Clugston 1997, Vladykov and Greeley 1963). Water depths of spawning sites are highly variable, but may be up to 88.5 ft. (27 m) (Bain et al. 2000, Crance 1987, Leland 1968, Scott and Crossman 1973). Based on tagging records, Atlantic sturgeon return to their natal rivers to spawn (ASSRT 2007), with spawning intervals ranging from one to five years in males (Caron et al. 2002, Collins et al. 2000b, Smith 1985) and two to five years in females (Stevenson and Secor 1999, Van Eenennaam et al. 1996, Vladykov and Greeley 1963). Some Atlantic sturgeon river populations may have up to two spawning seasons comprised of different spawning adults (Balazik and Musick 2015, Collins et al. 2000b), although the majority likely have just one, either in the spring or fall.[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). Telemetry and empirical data suggest that there may be two potential spawning runs in the James River: 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, Balazik et al. 2017a).

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

[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).

deposition (Mohler 2003, Murawski and Pacheco 1977, Smith et al. 1980, Van Den Avyle 1984, Vladykov and Greeley 1963). Once the yolk sac is absorbed (eight to twelve days post-hatching), sturgeon are larvae. Shortly after, they become young of year and then juveniles. The juvenile stage can last months to years in the brackish waters of the natal estuary (ASSRT 2007, Calvo et al. 2010, Collins et al. 2000a, Dadswell 2006, Dovel and Berggren 1983b, Greene et al. 2009, Hatin et al. 2007, Holland and Yelverton 1973, Kynard and Horgan 2002, Mohler 2003, Schueller and Peterson 2010, Secor et al. 2000, Waldman et al. 1996). Upon reaching the sub-adult phase, individuals enter the marine environment, mixing with adults and sub-adults from other river systems (Bain 1997, Dovel and Berggren 1983a, Hatin et al. 2007, McCord et al. 2007) (NMFS 2017a). Once sub-adult Atlantic sturgeon have reached maturity/the adult stage, they will remain in marine or estuarine waters, only returning far upstream to the spawning areas when they are ready to spawn (ASSRT 2007, Bain 1997, Breece et al. 2016, Dunton et al. 2012, Dunton et al. 2015, Savoy and Pacileo 2003).

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

Table 5.3.1. General descriptions of Atlantic sturgeon life history stages

Age Class	Typical Size	General Duration	Representative Description
Egg	~2 mm – 3 mm diameter (Van Eenennaam et al. 1996)	Hatching occurs ~3-6 days after egg deposition and fertilization (ASSRT 2007)	Fertilized or unfertilized
Yolk-sac larvae (YSL)	~6mm – 14 mm (Bath et al. 1981)	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)	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
An index of population abundances for Atlantic sturgeon in oceanic waters off the Northeast coast of the U.S. during 2006-2011 was developed by Kocik et al. 2013. The report includes annual swept area abundance estimates of Atlantic sturgeon in nearshore areas derived from Northeast Area Monitoring and Assessment Program surveys conducted during 2007-2012.[18] For this Opinion, as we did in the prior 2021 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 at the time the population estimate was developed (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 that the NEAMAP-based estimates do not include young-of-the-year (YOY) fish and juveniles in the rivers; however, those segments of the Atlantic sturgeon populations are at minimal risk from the proposed actions since they are rare to absent within the action area. 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.

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

[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.

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** (outside of the 5 ESA listed DPSs)*	*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, Kazyak et al. 2021, White et al. 2021). 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 typically return to their natal river to spawn, despite extensive mixing in coastal waters.

The marine range of U.S. Atlantic sturgeon extends from Canada through Cape Canaveral, Florida. All five DPSs use the action area. Based on a recent genetic mixed stock analysis (Kazyak et al. 2021), the Vineyard Wind project area falls within the "MID Offshore" area described in that paper.), we expect Atlantic sturgeon throughout the action area 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 (Table 7.9.2). It is possible that a small fraction (0.7%) of Atlantic sturgeon in the action area may be Canadian origin (Kazyak et al. 2021); Canadian-origin Atlantic sturgeon are not listed under the ESA. This represents the best available information on the likely genetic makeup of individuals occurring throughout the action area.

Based on 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.

As described in the listing rules and in the 2022 and 2023 5-year reviews, 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 ASMFC 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 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-Year reviews for each DPS, completed by NMFS in 2022 and 2023, summarize information that has become available since the listing. No changes to the classification for any DPS is recommended in the 5-year reviews (NMFS 2022 a, b, and c, NMFS 2023 a, b).

Recovery Goals for All DPSs

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 Recovery 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

[19] https://media.fisheries.noaa.gov/dam-migration/ats_recovery_outline.pdf; last accessed July 26, 2024.

information through research and monitoring on current distribution and abundance; and addressing vessel strikes in rivers, the effects of climate change and bycatch.

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 and may also at least occasionally occur in the Androscoggin River below the Brunswick Dam (Wippelhauser et al. 2017). 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 FMPs. 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 percent (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. 2012).

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); the review includes a summary of additional information available since the listing determination, including information on life history and threats. 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. At this time, we are not able to conclude whether the juvenile sturgeon detected are indicative of sustained spawning in the river or whether they were the result of a single spawning event due to unique straying of the adults from the South Atlantic DPS's spawning rivers (see additional explanation in NMFS 2022b).

There are no abundance estimates for the entire New York Bight DPS or for the entirety of the (i.e., all age classes) Hudson River or Delaware River populations. 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. Recent analyses suggest that the abundance of juvenile Atlantic sturgeon belonging to the Hudson River spawning population has increased, with double the average catch rate for the period from 2012-2019 compared to the previous eight years, from 2004-2011 (Pendleton and Adams 2021).

There is limited new information on the spawning population abundance in the Hudson River since the time of listing; Kazyak et al. (2020) used side scan sonar technology in conjunction with detections of previously tagged Atlantic sturgeon to estimate a Hudson River spawning run size of 466 sturgeon (95% CRI = 310-745) in 2014. Another method for assessing the number of spawning adults is through determinations of effective population size (the number of individuals that effectively participates in producing the next generation, see NMFS 2022b for more information). The estimates of effective population size for the Hudson River spawning population from separate studies and based on different age classes are relatively similar to each other: 198 (95% CI=171.7-230.7) based on sampling of subadults captured off of Long Island across multiple years, 156 (95% CI=138.3-176.1) based on sampling of natal juveniles in multiple years (O'Leary et al. 2014; Waldman et al. 2019), and 144.2 (95% CI=82.9-286.6) based on samples from a combination of juveniles and adults (ASMFC 2017).

As described in the Status Review and listing rule, 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. Individuals are also exposed to effects of bridge construction (including the replacement of the Tappan Zee Bridge). Impingement at water intakes, including the Danskammer, Roseton, and Indian Point power plants has been documented in the past. 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 total 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. The Delaware Division of Fish and Wildlife (DFW) has conducted juvenile abundance surveys in the Delaware River in most years since 2010. The estimated abundance in 2014 was 3,656 (95% CI = 1,935–33,041) age 0-1 juvenile Atlantic (Hale et al. 2016). Estimates for the Delaware River spawning population by the same authors and using the same methods as described above for the Hudson River were: 108.7 (95% CI=74.7-186.1) and 40 (95% CI=34.7-46.2) for samples from subadults and natal juveniles, respectively (O'Leary et al. 2014; Waldman et al. 2019), and 56.7 (95% CI=42.5-77.0) based on samples from a combination of juveniles and adults (ASMFC 2017).

Some of the impacts 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 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. A summary of recently available information is included in NMFS 2022 b. NMFS has only minimum counts of the number of Atlantic sturgeon that are struck and killed by vessels because only sturgeon that are found dead with evidence of a vessel strike are counted. New research, including a study that intentionally placed Atlantic sturgeon carcasses along the Delaware River in areas used by the public, suggests that most Atlantic sturgeon carcasses are not found and, when found, many are not reported to NMFS or to our sturgeon salvage coinvestigators (Balazik et al. 2012b, Balazik, pers. comm. in ASMFC 2017; Fox et al. 2020). Based on the reporting rates in their study, Fox et al. estimated that a total of 199 and 213 carcasses were present along the Delaware Estuary shoreline in 2018 and 2019, respectively. 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); the review includes a summary of additional information available since the listing determination, including information on life history and threats. 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). I 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 the 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 effects 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); the review includes a summary of additional information available since the listing determination, including information on life history and threats. 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.).

In the 2023 5-year review for the Carolina DPS, NMFS SERO reviewed and considered new information for the DPS that has become available since this DPS was listed as endangered in February 2012. In the review, NMFS concluded that the Carolina DPS's demographic risk is "High" because of its productivity (i.e., relatively few adults compared to historical levels and irregular spawning success), abundance (i.e., riverine populations vary significantly and abundance is generally low in the DPS, overall), and spatial distribution (i.e., riverine populations and connectivity vary, creating inconsistent population coverage across the DPS and potentially limited ability to repopulate extirpated river populations). However, NMFS also concluded that the Carolina DPS' potential to recover is also "High" because man-made threats that have a major impact on the species' ability to persist have been identified (e.g., bycatch in federally-managed fisheries, dams blocking access to spawning habitat, dredging, vessel strikes), the DPS' response to those threats are well understood, management or protective actions to address major threats are primarily under U.S. jurisdiction or authority, and management or protective actions are technically feasible even if they require further testing (e.g., gear modifications to minimize dredge or fishing gear interactions).The review includes a summary of additional information available since the listing determination, including information on life history and threats. Based on the best scientific and commercial data available at the time of the review, the review concluded that no change to the listing status is warranted. (NMFS 2023a).

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.)

In the 2023 5-year review for the South Atlantic DPS, NMFS SERO reviewed and considered new information for the DPS that has become available since this DPS was listed as endangered in February 2012. In the review, NMFS concluded that the South Atlantic DPS' demographic risk is "High" because of its productivity (i.e., relatively few adults compared to historical levels and irregular spawning success), abundance (i.e., riverine populations vary significantly and abundance is generally low in the DPS, overall), and spatial distribution (i.e., riverine populations and connectivity vary, creating inconsistent population coverage across the DPS and potentially limited ability to repopulate extirpated river populations). However, NMFS also concluded that the South Atlantic DPS' potential to recover is also "High" because man-made threats that have a major impact on the species' ability to persist have been identified (e.g., bycatch in federally-managed fisheries, dams blocking access to spawning habitat, dredging, vessel strikes), the DPS' response to those threats are well understood, management or protective actions to address major threats are primarily under U.S. jurisdiction or authority, and management or protective actions are technically feasible even if they require further testing (e.g., gear modifications to minimize dredge or fishing gear interactions).The review includes a summary of additional information available since the listing determination, including information on life history and threats. Based on the best scientific and commercial data available at the time of the review, the review concluded that no change to the listing status is warranted. (NMFS 2023b).

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 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). "Early" consultation in this definition refers to "a process requested by a Federal agency on behalf of a prospective applicant under section 7(a)(3) of the Act" (50 CFR§§402.02, 402.11) which is governed by formalized procedures set forth in 50 CFR§402.11 that are separate and distinct from those set forth in 50 CFR§402.14 for formal consultations initiated under ESA Section 7(a)(2). "Early consultation" under 50 CFR §402.11 and ESA Section 7(a)(3) should not be confused with formal consultation initiated and in its early stages or planned for initiation under ESA Section 7(a)(2). Only projects that have completed "formal consultation" under ESA Section 7(a)(2) or completed "early consultation" under ESA Section 7(a)(3) are included in the environmental baseline for this Opinion. This section of the Opinion has been updated to incorporate relevant new information available since the issuance of the 2021 Opinion, including the completion of section 7 consultations for additional offshore wind projects.

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 more indirect or non-lethal impacts. 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 windfarms, as well as activities caused by aspects of their development and operation, that are not the subjects of a completed consultation are not in the *Environmental Baseline* for the Vineyard Wind 1 project. All planned and reasonably foreseeable offshore wind projects proposed for review and approval by BOEM will undergo a future formal ESA Section 7 consultation when initiation is requested. When an ESA 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. Thus, all offshore wind projects and associated activities that have undergone and completed the formal ESA Section 7 process that occur in the action area are included in the environmental baseline of this Opinion. The Vineyard Wind project will then be included in the environmental baseline for the ESA Section 7 reviews for future offshore wind projects to the extent its effects on listed species may occur in the action area for those future projects.

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 Atlantic Ocean, and the geographic extent of effects caused by project-related activities in those areas. The Vineyard 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 in the WDA range from 35-60m (Epsilon 2020), and sea surface water temperatures seasonally vary between approximately 37 °F (3 °C) in winter to 65 °F (18 °C) in summer (BOEM 2019). Benthic habitat in the WDA is predominantly flat with sand or sand-dominated substrate, with areas of mud to the south end and gravel to the northwest corner (BOEM 2019, Guida et al. 2017).

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).

Right whales predominantly occupy waters of the continental shelf, but tagging studies have documented some individuals visiting the deep basins of the Gulf of Maine and the Scotian Shelf (Baumgartner and Mate 2005, Mate et al. 1997). As described in Hayes et al. (2021), Mellinger et al. (2011) reported acoustic detections of right whales near the nineteenth-century whaling grounds east of southern Greenland, but the number of whales and their origin is unknown. Similarly, using passive acoustic monitoring, Davis et al. (2017) detected North Atlantic right whales near Iceland and Greenland from July-October. Sightings off of Europe remain limited to sporadic individuals. Knowlton et al. (1992) and Jacobsen et al. (2004) report eight individual sightings off Europe since 1964. Knowlton et al. (1992) reported several long-distance movements as far north as Newfoundland, the Labrador Basin, and southeast of Greenland. Resightings of photographically identified individuals have been made off Iceland, in the old Cape Farewell whaling ground east of Greenland (Hamilton et al. 2007), in northern Norway (Jacobsen et al. 2004), in the Azores (Silva et al. 2012), and off Brittany in northwestern France (New England Aquarium unpub. catalog record in Hayes et al. 2021). These long-range matches indicate an extended range for at least some individuals. However, visits to the eastern North Atlantic are rare.

In the late fall months (e.g., October and November), 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 also 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 of as migratory corridors (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. 2020, Leiter et al. 2017, Morano et al. 2012, Whitt et al. 2013).

Offshore of the Maine coast, the likelihood of a North Atlantic right whale being present increases with distance from shore (Roberts et al. 2016). Surveys have demonstrated the existence of 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, where they feed primarily on copepods (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 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 this 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 south of New England and Long Island in the fall and winter (NMFS NEFSC, unpublished data), including the area south of Nantucket (which partially overlaps with the action area) where right whales have been documented for the last several winters and are suspected to be foraging (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).

North Atlantic right whale Presence in the Vineyard 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 wind energy areas, including the Vineyard Wind lease area. 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. Socializing, including surface active groups, was only observed in winter and spring (defined in the paper as December – February and March – May, respectively). 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 the RI/MA and MA WEA, which includes the Vineyard Wind 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 general 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 whale sightings were recorded 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. In 2022, North Atlantic right whales were detected (acoustic or visual) in the shelf waters south of Martha's Vineyard and Nantucket, inshore of the Nantucket to Ambrose traffic lanes, in every month except May and June; in 2023 there was at least one right whale detected in that area in every month except for July, September, October. Similarly, at least one right whale was detected in that area from January – April 2024 (see https://whalemap.org/WhaleMap).

During aerial surveys conducted from 2011-2015 in the MA/RI WEA, including the proposed Project area, 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 North Atlantic right whales were most commonly present in and near the RI/MA WEA in the winter and spring and absent in the summer and fall. In contrast, Quintana 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 through 2015 (Kraus et al. 2016) and the 2017 and 2018 (Quintana 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).[20] These data suggest an increasing likelihood of species presence from September through June. North Atlantic right whale sightings per unit of effort (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 project area is provided by habitat-based density models produced by the Duke University Marine Geospatial Ecology Laboratory (Roberts et al., 2016, 2023).

Monthly density estimates used for modeling marine mammal exposures for monopile installation are presented in Table 6.1. These are the monthly average densities (individuals/100 km2) within a polygon extending 10 km around the remaining 15 monopile foundations to be installed (Table 9 in the 2023 MMPA IHA Application using data from Roberts et al. 2016 and 2023).

[20] 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.

Table 6.1 Estimated densities (animals/100km^2) of NARW used for modeling marine mammal exposures for monopile installation

Species	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec
North Atlantic right whale	0.77	0.88	0.85	0.84	0.51	0.09	0.04	0.03	0.05	0.09	0.14	0.43

Density estimates indicate that February is the month with the highest density of right whales in this area and that overall, North Atlantic right whales are most likely to occur in the lease area from December through May, with the highest densities extending from January through April.

Behavioral data associated with sightings within the lease portion of the action area and surrounding waters included surface active groups (SAG, defined as two or more whales rolling and touching at the surface) and feeding as well as adults traveling with calves (Leiter et al. 2017, Kraus et al. 2016). SAGs can be indicative of courtship (Kraus and Hatch 2001; Parks et al. 2007), and feeding. SAGs were observed primarily in March (Leiter et al. 2017). This is consistent with Quintana-Rizzo et al. (2021) who reported social behavior only in winter and spring. Although mating does not necessarily occur in SAGs (Kraus and Hatch 2001, Parks et al. 2007), Leiter et al. suggest that the regular observations of SAGs may indicate that animals are mating in this habitat; however, we are not aware of any confirmed mating activity in the MA/RI WEA or the Vineyard Wind 1 lease area. We note that mating for right whales occurs during the winter months. Feeding behavior was recorded for 39 of 117 (33 percent) sightings, in all years of the study period (2010 to 2015), and occurred exclusively during the months of March and April. North Atlantic right whales were observed skim feeding in the northern portion of the study area. However, the authors suggested that whales might also be feeding sub-surface; without visual detection this could not be confirmed (Leiter et al. 2017).

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. The presence of North Atlantic right whales along the vessel transit routes to Europe outside the Gulf of Maine and Scotian Shelf are expected to be rare and limited to occasional, sporadic individuals.

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 North 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). Based on the known

distribution of the species, sei whales may occur along the vessel transit routes used by project vessels transiting to and from ports in Canada and Europe.

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). NMFS aerial surveys found substantial numbers of sei whales in this region, in particular south of Nantucket, in the spring of 2001. The southern portion of the species' range during spring and summer includes the northern portions of the U.S. EEZ; the Gulf of Maine and Georges Bank (Hayes et al. 2017). Spring is the period of greatest sei whale abundance in New England waters, with sightings concentrated along the eastern margin of Georges Bank and into the Northeast Channel area, and along the southwestern edge of Georges Bank in the area of Hydrographer Canyon (CETAP 1982). NMFS aerial surveys in 1999, 2000, and 2001 found concentrations of sei and right whales along the northern edge of Georges Bank in the spring. In years of greater abundance of copepod prey sources, sei whales are reported in more inshore locations, such as the Great South Channel (in 1987 and 1989) and Stellwagen Bank (in 1986) (Waring et al. 2014).

Sei whales often occur along the shelf edge to feed, but also use shallower shelf waters. Although known to eat fish in other oceans, sei whales off the northeastern U.S. are largely planktivorous, feeding primarily on euphausiids and copepods (Flinn et al. 2002, Hayes et al. 2017). These aggregations of prey are largely influenced by the dynamic oceanographic processes in the region. 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 lease area.

Sei whales may be present in the general vicinity of the lease year-round but are most commonly present in the spring and early summer (Davis et al. 2020).[21] Kraus et al. (2016) and Quintana 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 Vineyard Wind 1 lease area. 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 et al. 2018). 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).

As described in BOEM's 2019 BA, sei whales were observed in the WEA from October 2011

[21] 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).

through June 2015 every year with enough sightings to estimate abundance (Stone et al. 2017). Sei whales were observed in the study area from March through June, with peaks in May and June, with mean abundances ranging from zero to 26 animals (Stone et al. 2017). The effort-weighted average sighting rate in the study area during the study period was highest in summer (0.78 animals per 621.4 miles [1,000 kilometers]) and second highest in spring (0.10 animals per 621.4 miles [1,000 kilometers]; Table 3.1-2; Kraus et al. 2016b). Over the same time period, sei whales were observed in the northern portion of the WDA during summer, with estimated SPUE ranging from 5 to 10 animals per 621.4 miles [1,000 kilometers] (Kraus et al. 2016b). Cow/calf pairs were observed in the study area on three occasions throughout the study period. Due to the uncertainty associated with sei whale vocalization, this species was not included in the acoustic surveys. Roberts et al. (2016, 2023) density data for the area where the remaining piles will be installed indicates that the maximum density month for sei whales is November (0.08 individuals/100km^2) (as reported in the 2023 IHA Application).

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 summer months. 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 common in the WDA but adult sei whales with calves have been observed during spring and summer months (Kraus et al. 2016).

Sperm whale (Physeter macrocephalus)
Sperm whales occurring in the North Atlantic belong to the North Atlantic stock (Hayes et al. 2020). 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.

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 (Westell et al. 2024). 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 the waters to the west, south, and southeast of the WDA during summer and fall 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.

The sightings in summer occurred north of OCS-A 0486 and OSC-A 0487, just southwest of Martha's Vineyard, in the southern portion of OCS-A 0500, 501, 520, 0521, and 0522, and just north of the WDA south of the Muskeget Channel (Figure 3.1-9; Stone et al. 2017). The sighting in the fall occurred immediately west of the WDA (Stone et al. 2017). Sperm whales acoustic presence was not reported in Kraus et al. (2016b) because their high-frequency clicks exceeded the maximum frequency of recording equipment settings used. Sperm whale sightings in the region during AMAPPS aerial surveys conducted from 2010 to 2013 do not indicate any observations within the lease area. Sperm whale sightings in the region during AMAPPS aerial surveys conducted from 2010 to 2013 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).

Westell et al. (2024) used passive acoustic recorders set at depths less than 60m in the vicinity of Nantucket Shoals and Cox's ledge to document sperm whale presence; sperm whales were detected year-round with the majority (78%) of detections between May and August. Predicted detection ranges were between 20 and 40 km; thus, it is difficult to determine the exact location of individuals in relation to the receivers. However, the authors conclude that sperm whales were present near the WEAs as well as at greater depths.

The density maps from Roberts *et al*. (2016, 2017, 2018, 2020) indicate that density of sperm whales in the lease area and along the cable corridor is low year-round, with a density of 0.0001/km^2 for all months (1 sperm whale/100,000 km^2). Denes et al. (2020a) compiled cetacean density data for the lease area from available data sources and developed composite monthly density values; the assembled data indicate that sperm whale density in and near the action area is generally low but with a distinct peak in July and August. The density data presented in the 2023 IHA Application (based on Roberts et al. 2016 and 2023) is similar; with low density year-round and the highest density months being July through September. Density models developed by Curtice et al. (2018) indicate this species is likely to occur in the lease area at low densities between June and November, with the highest probability of occurrence in July and August.

In summary, individual adult sperm whales are anticipated to occur infrequently in deeper, offshore waters 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 WEA as they make seasonal migrations, and to be foraging along the shelf break. No adults were observed foraging or with calves during the 2011-2015 aerial surveys (Kraus et al. 2016). As sperm whales typically forage at deep depths (500-1,000 m) (NMFS 2018), well beyond the depths of the lease area, foraging is not expected to occur in the lease area or along the cable corridor. Sperm whales may occur along the vessel transit routes from the project site to Europe and Canada year round.

Fin whales (Balaenoptera physalus)
Fin whale presence in the North Atlantic is limited to waters north of Cape Hatteras, NC. In general, fin whales in the central and eastern Atlantic tend to occur most abundantly over the continental slope and on the shelf seaward of the 200 m isobath (Rørvik et al. 1976 in NMFS 2010). In contrast, off the eastern United States they are centered along the 100-m isobath but with sightings well spread out over shallower and deeper water, including submarine canyons along the shelf break (Kenney and Winn 1987; Hain et al. 1992).

Fin whales occurring in the North Atlantic belong to the western North Atlantic stock (Hayes et al. 2019). They are typically found along the 328-foot (100-meter) isobath but also in shallower and deeper water, including submarine canyons along the shelf break (Kenney and Winn 1986). Fin whales are migratory, moving seasonally into and out of feeding areas, but the overall migration pattern is complex and specific routes are unknown (NMFS 2018a). The species occur year-round in a wide range of latitudes and longitudes, but the density of individuals in any one area changes seasonally. Thus, their movements overall are patterned and consistent, but distribution of individuals in a given year may vary according to their energetic and reproductive condition, and climatic factors (NMFS 2010). 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 et al. 1990).

Aerial survey observations collected by Kraus et al. (2016) from 2011 through 2015 and Quintana 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. Fin whales are the largest of the baleen whales observed in the proposed Project area. 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 is used extensively by feeding fin whales from March to October.

Fin whales are most likely to be present in the lease area during spring and summer, with fewer individuals from September through March (Kraus et al. 2016, Quintana et al. 2018). Regional PAM data indicate that this species is present in the region throughout the year with the lowest likelihood of occurrence in May and June (Davis et al. 2020).[22] Density data presented in the 2023 IHA Application (derived from Roberts et al. 2016 and 2023) is similar, with the highest densities from May through August.

In summary, we anticipate individual fin whales to occur in the action area year-round, with the highest numbers in the spring and summer. Adult fin whales are most common in the area but fin whales with calves have been observed during spring and summer months (Kraus et al. 2016). We expect these individuals to be moving through the project area as they make seasonal coastal migrations, and to be foraging when krill and schooling fish, particularly sand lance, are present. Fin whales will most commonly be foraging during spring and summer months, as they fast in the winter as they migrate to warmer waters (Kenney and Winn 1986; Payne et al. 1990). While migrating or foraging in the action area, fin whales are most commonly found in offshore waters (south of 40°50'0" N) of the proposed Project area during the spring months, and further inshore (south of 41°15'0" N) during the summer. In surveys of the area between 2011 and2015, no fin whales were observed north of 41°30'0" N, as the water depth is likely too shallow. The widespread distribution of fin whales in the area is likely tied to the occurrence of productive prey areas, as they move in and out of feeding areas.

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

Four ESA-listed species of sea turtles (Leatherback sea turtles, North Atlantic DPS of green sea turtles, Northwest Atlantic Ocean DPS of loggerhead sea turtles, Kemp's ridley sea turtles) make seasonal migrations into the proposed Project area including the coastal waters (Buzzards Bay, Vineyard Sound, and Nantucket Sound) and offshore waters (northern Mid-Atlantic Bight) south of Cape Cod that may be transited by project vessels. Sea turtles are less frequent in U.S. waters

[22] Based on frequency of acoustic detections of fin whales in Davis et al. (2020) designated monitoring region 7: Southern New England and New York Bight. This monitoring region encompasses the lease area.

north of Cape Cod. Along the vessel transit routes to Canadian ports, only leatherback and loggerheads are likely to occur. In the open ocean area where vessels from Europe will be transiting, all four species may be present.

The four species of sea turtles considered here are highly migratory. One of the main factors influencing sea turtle presence in mid-Atlantic waters and north is seasonal temperature patterns (Ruben and Morreale 1999) as waters in these areas are not warm enough to support sea turtle presence year round. In general, sea turtles move up the U.S. Atlantic coast from southern wintering areas to foraging grounds as water temperatures warm in the spring. The trend is reversed in the fall as water temperatures cool. By December, sea turtles have passed Cape Hatteras, returning to more southern waters for the winter (Braun-McNeill and Epperly 2002, Ceriani et al. 2012, Griffin et al. 2013, James et al. 2005b, Mansfield et al. 2009, Morreale and Standora 2005, Morreale and Standora 1998, NEFSC and SEFSC 2011, Shoop and Kenney 1992, TEWG 2009, Winton et al. 2018). Water temperatures too low or too high may affect feeding rates and physiological functioning (Milton and Lutz 2003); metabolic rates may be suppressed when a sea turtle is exposed for a prolonged period to temperatures below 8-10° C (George 1997, Milton and Lutz 2003, Morreale et al. 1992). That said, loggerhead sea turtles have been found in waters as low as 7.1-8 ° C (Braun-McNeill et al. 2008, Smolowitz et al. 2015, Weeks et al. 2010). However, in assessing critical habitat for loggerhead sea turtles, the review team considered the water-temperature habitat range for loggerheads to be above 10° C (NMFS 2013). Sea turtles are most likely to occur in the action area when water temperatures are above this temperature, although depending on seasonal weather patterns and prey availability, they could be also present in months when water temperatures are cooler (as evidenced by fall and winter cold stunning records as well as year round stranding records).

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. 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. Sea turtles in the action area are adults or juveniles; due to the distance from any nesting beaches, no hatchlings occur in the action area. Similarly, no reproductive behavior is known or suspected to occur in the action 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, Eckert et al. 2012, 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 WDA provide habitat for both the four species of sea turtles in the region as well as their prey.

In addition to the Kraus et al. (2016) survey referenced below, the North Atlantic Right Whale Consortium database also includes SPUE for unidentified sea turtles. Although speciation was not possible, likely due to weather or sea state conditions, the turtles should still be accounted for. From 1998 through 2017, turtles occurred in relatively high numbers (more than 80 turtles per 621.4 miles [1,000 kilometers]) along the OECC route southeast of Martha's Vineyard, and in moderate numbers in and surrounding the WLA in the summer and in relatively high numbers (15 to 80 turtles per 621.4 miles [1,000 kilometers]; North Atlantic Right Whale Consortium 2018) in the WDA in the fall.

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

Leatherback sea turtles
Leatherbacks are a predominantly pelagic species that ranges into cooler waters at higher latitudes than other sea turtles, and their large body size makes the species easier to observe in aerial and shipboard surveys. The CETAP regularly documented leatherback sea turtles on the OCS between Cape Hatteras and Nova Scotia during summer months in aerial and shipboard surveys conducted from 1978 through 1988. The greatest concentrations were observed between Long Island and the Gulf of Maine (Shoop and Kenney 1992). AMAPPS surveys conducted from 2010 through 2013 routinely documented leatherbacks in the MA/RI WEA and surrounding areas during summer months (NEFSC and SEFSC 2018, 2022: Palka 2021).

Leatherbacks were the most frequently sighted sea turtle species in monthly aerial surveys of the MA and RI/MA WEAs from October 2011 through June 2015. Kraus et al. (2016) recorded 153 observations (161 animals) in monthly aerial surveys, all between May and November, with a strong peak in August. (71 turtles) and the second highest number was recorded in September (33 turtles). Leatherbacks were sighted in the WDA and OECC area in the summer and fall with sightings per unit effort (SPUE) ranging from 10 to 20 turtles per 621.4 miles [1,000 kilometers] (Kraus et al. 2016b; COP Volume III, Figure 6.8.3; Epsilon 2020). From 1998 through 2017, SPUE of leatherback turtles were similar, with relatively high numbers (15 to more than 80 turtles per 621.4 miles [1,000 kilometers]) observed just west of the OECC to the southeast of Martha's Vineyard (North Atlantic Right Whale Consortium 2018). Leatherback turtles were observed over the same time period in the WDA in moderate numbers (15 to 40 turtles per 621.4 miles [1,000 kilometers], during fall; North Atlantic Right Whale Consortium 2018).

Satellite tagging studies have also been used to understand leatherback sea turtle behavior and movement in 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). 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 and Europe. 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 or 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. 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. 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).

Based on the information presented here, we anticipate leatherback sea turtles to occur in the project area (i.e., the lease area and cable corridors) during the warmer months, typically between June and November. Leatherbacks are also expected along the vessel transit routes to Europe and Canada, with seasonal presence dependent on latitude.

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 area of the North Atlantic that may be used by vessels transiting to and from Canada and Europe.

Extensive tagging results suggest that tagged loggerheads occur on the continental shelf along the United States Atlantic from Florida to North Carolina year-round but also highlight the importance of summer foraging areas on the Mid-Atlantic shelf which includes the 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). Loggerheads may also be present off the Canadian coast in the summer and fall and therefore, could also occur seasonally along the vessel transit route to Canada.

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 (NMFS 2011). 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 2011). 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).

Loggerhead sea turtles were the second most commonly sighted sea turtle species in the Kraus et al. (2016) study area from 2011 through 2015 (87 animals over 4 years). Loggerhead turtles were observed in the study area from April through September with peak occurrence during August and September, with a few sightings in May (Table 3.2-3; Kraus et al. 2016b). The highest number of loggerhead turtles occurred in September (45 turtles) and the second highest number was recorded in August (27 turtles; Kraus et al. 2016b). From October 2011 through June 2015, loggerhead turtle SPUE were relatively high in summer (5 to 30 animals per 621.4 miles [1,000 kilometers]) and fall (10 to 30 animals per 621.4 miles [1,000 kilometers]), and somewhat lower in the spring (5 to 10 animals per 621.4 miles [1,000 kilometers]; Kraus et al. 2016b). SPUE are likely to be underestimated for this species as a result of the relatively small size of the turtles and their long submergence time, which make visual detection difficult. From 1998 through 2017, loggerhead turtles were observed in relatively low numbers (0.1 to 15 turtles per 621.4 miles [1,000 kilometers] in the WDA and surrounding waters during the summer (June through August) and in moderate numbers (10 to 40 turtles per 621.4 miles [1,000 kilometers]; North Atlantic Right Whale Consortium 2018; Figure 3.2-1).

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).

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

Kemp's ridley sea turtles
Kemp's ridleys are distributed throughout U.S. Atlantic coastal waters, from Florida to New England. A few records exist for Kemp's ridleys near the Azores, waters off Morocco, and within the Mediterranean Sea and they are occasionally found in other areas around the Atlantic Basin.

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).

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.

Based on the information presented here, we anticipate Kemp's ridley sea turtles to occur in the project area (i.e., the lease area and cable corridors) during the warmer months, typically between June and November. Kemp's ridleys are also expected along the vessel transit routes to Europe, with seasonal presence dependent on latitude Kemp's ridleys are not expected to occur in Canadian waters.

North Atlantic DPS of Green sea turtles

Most green turtles spend the majority of their lives in coastal foraging grounds. These areas include fairly shallow waters both open coastline and protected bays and lagoons. In addition to coastal foraging areas, oceanic habitats are used by oceanic-stage juveniles, migrating adults, and, on some occasions, by green turtles that reside in the oceanic zone for foraging. While green sea turtles occur in the open Ocean, they are expected to be rare along the vessel transit routes from the project area to Europe due to their tendency to remain in coastal foraging grounds. Green sea turtles are not expected to occur in Canadian waters as they are rare north of Massachusetts.

Kenney and Vigness-Raposa (2010) recorded one confirmed sighting within the RI/MA WEA in 2005. Five green turtle sightings were recorded off the Long Island shoreline 10 to 30 miles southwest of the WEA in aerial surveys conducted from 2010 to 2013 (NEFSC and SEFSC 2018), but none were positively identified in multi-season aerial surveys of the RI/MA and MA WEAs 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 and do not cover the shallow nearshore habitats most commonly used by this species. Although green turtles are expected to be relatively uncommon, their occurrence is likely underestimated in the lease area and surrounding waters. Denes et al. (2019a) did not attempt to estimate green sea turtle density in the action area to support modeling of hydroacoustic impacts because no accurate estimate is available. As described in the 2019 BA, although green sea turtles were not observed in the Kraus et al. (2016b) surveys from October 2011 through June 2015 or identified in the North Atlantic Right Whale Consortium (2018) sightings data from 1998 through 2017, stranding records indicate the presence of green sea turtles in the area and they are expected to occur at least occasionally in the action area.

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 (Figure 8). 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.

Based on the information presented here, we anticipate green sea turtles to occur in the project area (i.e., the lease area and cable corridors) during the warmer months, typically between June and November. Green sea turtles are also expected along the vessel transit routes to Europe, with seasonal presence dependent on latitude. Green sea turtles are not expected to occur in Canadian waters.

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

Atlantic sturgeon (Acipenser oxyrinchus oxyrinchus)
Adult and subadult (less than 150cm in total length, not sexually mature, but have left their natal rivers) Atlantic sturgeon from all five DPSs undertake seasonal, nearshore (i.e., typically depths less than 50 meters), coastal marine migrations along the United States eastern coastline including in waters of southern New England (Dunton et al. 2010, Erickson et al. 2011). Given their anticipated distribution in depths primarily 50 m and less, Atlantic sturgeon are not expected to occur in the deep, open-ocean portion of the action area that will be transited by project vessels carrying turbine components.

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 (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; Kazyak et al. 2021), 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 New Jersey Coast; and the southwest shores of Long Island (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 project area. 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 action area 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. Marine and estuarine areas adjacent to spawning rivers are high use areas for Atlantic sturgeon; no such areas exist in the action area. 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. 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 action area, only 2 of the 173 Atlantic sturgeon observed by the observer program in this period were collected in the action area.

Dunton et al. (2015) caught sturgeon as bycatch in waters less than 50 feet deep during the New

York summer flounder fishery, and Atlantic sturgeon occurred along eastern Long Island in all seasons except for the winter, with the highest frequency in the spring and fall. The species migrates along coastal New York from April to June and from October to November (Dunton et al. 2015). Ingram et al. (2019) studied Atlantic sturgeon distribution using acoustic tags and determined peak seasonal occurrence in the offshore waters of the OCS from November through January, whereas tagged individuals were uncommon or absent from July to September. The authors reported that the transition from coastal to offshore areas, predictably associated with photoperiod and river temperature, typically occurred in the autumn and winter months.

Migratory adults and sub-adults have been collected in shallow nearshore areas of the continental shelf (32.9–164 feet [10–50 m]) on any variety of bottom types (silt, sand, gravel, or clay). Evidence suggests that Atlantic sturgeon orient to specific coastal features that provide foraging opportunities linked to depth-specific concentrations of fauna. Concentration areas of Atlantic sturgeon near Chesapeake Bay and North Carolina were strongly correlated with the coastal features formed by the bay mouth, inlets, and the physical and biological features produced by outflow plumes (Kingsford and Suthers 1994, as cited in Stein et al. 2004a). They are also known to commonly aggregate in areas that presumably provide optimal foraging opportunities, such as the Bay of Fundy, Massachusetts Bay, Rhode Island, New Jersey, and Delaware Bay (Dovel and Berggren 1983; Johnson et al. 1997; Rochard et al. 1997; Kynard et al. 2000; Eyler et al. 2004; Stein et al. 2004a; Dadswell 2006, as cited in ASSRT 2007).

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

None of the scientific literature that has examined the distribution of Atlantic sturgeon in the marine environment has identified the project area as a “hot spot” or an identified aggregation area (see above). However, given the depths (less than 50m) and the predominantly sandy substrate which are consistent habitat parameters with offshore areas where Atlantic sturgeon are known to occur, and the occasional collection of Atlantic sturgeon in this area in regional surveys and in commercial fisheries, at least some Atlantic sturgeon are likely to be present in the project area. Based on the location of spawning rivers both north and south of the project area and the general distribution of Atlantic sturgeon in the marine environment, we expect that individual Atlantic sturgeon will be moving through the project area 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.

In summary, Atlantic sturgeon occur in most of the action area; with the exception being waters transited by project vessels with depths greater than 50m. This means that 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 lease area and any ports. Spawning, juvenile growth and development, and overwintering are not known to occur in the action area. While individuals may be present year-round, we expect the majority of individual Atlantic sturgeon to be present from April to November. Given the known marine mixing of Atlantic sturgeon in waters south of Cape Cod, we expect that individuals from any of the five DPSs could be present in the action area (Kazyak et al. 2021).

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

Vineyard Wind Project to Date

As explained above, construction for the Vineyard Wind project is underway. Here, we present a summary of effects of the action to date on ESA listed species. In February 2024, Vineyard Wind submitted a summary report for the fisheries surveys (drop camera, trawl, and trap/pot) carried out from 2019-2022 (Vineyard Wind 2024). During this period there were no reported observations or interactions with ESA listed species during the drop camera surveys. Trawl surveys were carried out seasonally from June 2019 through February 2022; there were no reported observation or interactions with ESA listed species. Similarly, there were no reported observations or interactions with ESA listed species during the 2019-2021 ventless trap and larval surveys.

We have also reviewed the monthly project activity reports submitted by Vineyard Wind. While there are several reports of observations of ESA listed sea turtles and whales during various project activities (e.g., cable installation, vessel transits) there are no reported interactions with any ESA listed species and no reports of any suspected or confirmed vessel strikes. We have also reviewed the PSO reports submitted following the 2023 pile driving campaign (available at: https://s3.amazonaws.com/media.fisheries.noaa.gov/2024-05/VW1-2023IHA-MonRep-OPR1.pdf). No sea turtles were observed by PSOs during pile driving operations; a total of 89 whales (10 unidentified non-NARW, 53 humpback, 19 fin, 6 minke, 1 unidentified baleen) were detected, with 6 (2 humpback (non-ESA listed) and 4 fin) of those detected when the pile driving hammer was operational (Table 4 in PSO report). Additional detections were recorded by PAM buoys; a total of 253 acoustic detections were recorded. Of these, 18 percent (45 detection events) were of animals that were identified to the species level, all of which were fin whales, while the remaining animals (208 detection events) were identified to family level or a higher taxonomic level (classified as unidentified delphinids, and unidentified baleen whales) (Table 6 in PSO report). Table 8 in the PSO report describes the potential exposures of marine mammals to noise above the Level A and Level B harassment thresholds during pile driving. No ESA listed whales were observed inside the Level A harassment zone. Two fin whales were observed inside the Level B harassment zone. More information regarding the 2023 pile driving campaign is presented in Section 7.1.

Vineyard Wind Blade Failure and Emergency Response Actions

On July 13, 2024, during commissioning of one of the Vineyard Wind WTGs, a single turbine blade broke. This resulted in the immediate release of a portion of the blade into the ocean; additional debris fell into the water over the following weeks. At the time this Opinion was being written, emergency response activities, including clean-up of blade debris was ongoing.

In response to a July 31, 2024 request from BOEM, an emergency ESA section 7 consultation has been initiated and is ongoing regarding the effects of emergency response activities being carried out in response to the July 13 blade failure. We have provided recommendations to minimize effects to ESA-listed species during the response action through that consultation process. Once the emergency response actions are complete, that consultation will be completed. At this time we are not aware of any take of any ESA listed species that has occurred as a result of the blade failure or any associated emergency response activities.

Fishing Activity in the Action Area

Commercial and recreational fishing occurs throughout the action area. Excluding the vessel routes to Canada, the action area overlaps with a portion of NMFS statistical areas 537, 538, and 539. The WDA occupies a small portion (<1%) of area 537. The vessel routes to Canadian ports and the area that may be transited by vessels from Europe overlap with a number of offshore statistical areas. Commercial fishing in the action area is regulated in state waters out to 3nm offshore by the individual states or in the U.S. EEZ portion of the action area by NMFS under the Magnuson-Stevens Fishery Conservation and Management Act and other fishery management laws and regulations. Fisheries that operate pursuant to Federal statutes and regulations 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). The accompanying Incidental Take Statements, which describe the amount or extent of incidental take anticipated to occur in these fisheries, are included with each opinion.

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. Entangled whales may swim significant distances, and dead entangled whales may drift long distances as well. Given that fisheries occur in the action area that are known to interact with large whales, we consider that there is a past and ongoing risk of entanglement in the action area; the degree of risk in the future may change in association with fishing practices and accompanying regulations. 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. 2023, 2022, 2021, and 2020 and Henry et al. 2022 and 2023). As reported in Hayes et al. 2022, for the most recent 5-year period of review for fin and sei whales (2015-2019) in the U.S. Atlantic, the minimum rate of serious injury or mortality resulting from fishery interactions as 1.45/year for fin whales, and 0.4 for sei whales. For the period 2016-2020, the annual detected (observed) human-caused mortality and serious injury for right whales averaged 5.7 entanglements per year (Hayes et al. 2023). The minimum rate of serious injury or mortality resulting from fishery interaction is zero for sperm whales as reported in the most recent SAR for sperm whales in the North Atlantic (Hayes et al. 2020). In all cases, the authors note that this is a minimum estimate of the amount of entanglement and resultant serious injury or mortality. These data represent only known mortalities and serious injuries; more, undocumented mortalities and serious injuries have likely occurred and gone undetected due to the offshore habitats where large whales occur. Hayes et al. (2020) notes that no confirmed fishery-related mortalities or serious injuries of sei whales have been reported in the NMFS Sea Sampling bycatch database and that a review of the records of stranded, floating, or injured sei whales for the period 2013 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 2013 through 2019 on file at NMFS found no records classified as human interactions (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[23]. Of the 142 right whales in the UME, 9 mortalities are attributed to entanglement as well as 31 serious injuries and 50 sublethal injuries. We note that 1 mortality is listed as "pending"; this is the female stranded on Martha's Vineyard in January 2024. While no cause of death has been determined, preliminary indications are that there was no sign of vessel strike and that the individual had previously been documented with an entanglement. None of the whales recorded as part of the UME were first documented in the WDA[24]. We reviewed information on serious injury and mortalities reported in Henry et al. 2022 and 2023 (for the period 2016-2022, the most recent reporting periods). Several live right whales have been 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. On February 24, 2020, right whale 3180 was observed in poor condition with a buoy lodged in its mouth approximately 28 nm SE of Nantucket. It is unknown where these entanglements actually occurred. Henry et al. 2022 and Henry et al. 2023 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 near Martha's Vineyard, MA. The whale found on August 6, 2017 had no gear present, but showed signs of constriction associated with gear and evidence of subsequent hemorrhaging, and similarly the whale found on August 25, 2018 had no gear

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[23] 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, 2024

[24] https://noaa.maps.arcgis.com/apps/webappviewer/index.html?id=e502f7daf4af43ffa9776c17c2aff3ea; last accessed July 17, 2024

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, we assume 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 and that new efforts to revise the regulations under the Atlantic Large Whale Take Reduction Plan are ongoing. 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 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). We queried the most recent five years of data in the NMFS NEFOP and ASM database for the number of reports of Atlantic sturgeon bycatch in the three statistical areas that overlap with the action area (537, 538, and 539[25]) where we expect Atlantic sturgeon to occur. 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 (2014-2018), a total of 74 Atlantic sturgeon were reported as bycatch in bottom otter trawls and gillnets in these three statistical areas that overlap the action area, this represents approximately 5% of the total bycatch of Atlantic sturgeon in the Maine to Cape Hatteras area where the NEFOP, and Maine to New York area where the ASM program, operates. Note that the action area occupies only a portion of area 538 and 539 and a very small percentage of area 537. We expect that incidental capture of Atlantic sturgeon will continue in the action area at a similar rate over the life of the proposed action. While the rate of encounter is low and survival is relatively high (96% in otter trawls and 70% in gillnets), bycatch is expected to be the primary source of mortality of Atlantic sturgeon in the action area.

Sea turtles are vulnerable to capture in trawls as well as entanglement in gillnets and vertical

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

lines. Using the same data source as for Atlantic sturgeon, there were a total of 25 incidents of observed sea turtle bycatch in gillnet, trap/pot, and bottom otter trawl fisheries in areas 537, 538, and 539 (1 green, 2 Kemp's ridley, 3 leatherback, 15 loggerhead and 4 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. We expect that incidental capture and entanglement of sea turtles will 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 also expected to continue over the life of the project.

Vessel Operations
All portions of the action area are 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. In the COP, Vineyard Wind reports on vessel traffic in the WDA based on AIS data from 2016 and 2017. Based on this data, the most common type of vessels transiting in the WDA are commercial fishing vessels. Commercial vessel traffic in the region is variable depending on location and vessel type. The Northeast Regional Ocean Council (NROC) assessed AIS data in the project area from 2011-2013 and established relative densities of various vessel types. Commercial vessel types and relative density in the area during 2011-2013 included cargo (low), passenger (high), tug-tow (high), and tanker (low) (COP Volume III; Epsilon 2020). As described in Appendix III-I of the COP, commercial vessel traffic in the vicinity of the WDA is heaviest in four primary areas: 1) vessels approaching, entering, and exiting Narragansett Bay; 2) vessels entering and exiting Buzzards Bay; 3) vessels traveling from Hyannis to Nantucket; and 4), vessels traveling from Woods Hole to Vineyard Haven. A high volume of passenger ferry traffic occurs between Cape Cod and Nantucket and Martha's Vineyard. These vessels typically stay within 9.6 km (6 mi) of the shoreline while transporting passengers throughout Rhode Island and Massachusetts, but must cross Nantucket Sound and the proposed cable corridor when transporting passengers to Martha's Vineyard and Nantucket. Both seasonal and year-round service is provided by several ferry companies, with more than twenty-four daily trips between Hyannis and Nantucket during the peak of the summer season.

In addition to commercial fishing activity, recreational boating, including paddle sports, sport fishing, and diving occur in the action area. Recreational boating activity varies seasonally, with peak boating season occurring between May and September. Other boat-based recreational activities, including canoeing, kayaking, and paddle boarding take place close to shore, in sheltered waters, and predominantly within one mile of the coastline. Recreational fishing vessels operate from nearly every harbor in Massachusetts and Rhode Island; in addition, ramp-launched vessels are brought to the action area from other parts of New England. BOEM estimates that, of the nearly two million angler trips occurring in Massachusetts between 2007 and 2012, approximately 4.4% of those angler trips occurred within one mile of the Massachusetts Wind Energy Area (MA WEA) (Kirkpatrick et al., 2017). Substantially fewer numbers of angler trips originating in New York and Rhode Islands occurred within one mile of the MA WEA. During that same time period, recreational angler trips occurring within one mile of the MA WEA most frequently originated from Tisbury, Nantucket, and Falmouth Harbors; while fewer than 600 angler trips originated from Rhode Island (Kirkpatrick et al., 2017).

Information from a number of sources including the DEIS, Navigational Risk Assessment (NRA) prepared to support the COP (Epsilon 2020), and the United States Coast Guard's Areas Offshore of Massachusetts and Rhode Island Port Access Route Study (MARIPARS) (USCG 2020) helps to establish the baseline vessel traffic in the WDA and surrounding area. Section 4 of the NRA characterizes the baseline vessel traffic within the Project region according to identified vessel types, their characteristics, operating areas/routes, separation zones, traffic density, and seasonal traffic variability over a 24-month period. The vessels operating within the WDA most frequently are commercial fishing vessels, followed by recreational vessels such as pleasure boats, charter fishing vessels, and sailboats. Research and underwater operations vessels, cargo vessels, tugboats and tankers, and military vessels/SAR vessels were also observed in the WDA, but less frequently. The OECC is mostly trafficked by pleasure craft, passenger ferries, high-speed craft, and commercial fishing vessels, in order of frequency. The WDA and OECC receive increased vessel traffic during the summer months. Overall, the WDA experiences moderate levels of commercial traffic, with approximately 1,300 unique trips recorded annually in 2016-2018 (Epsilon 2020). Commercial fishing vessels transit the WDA, primarily in the northern most portion with most traffic traveling in a northwest to southeast direction; some vessels also actively fish in the WDA. Vessel traffic between southern New England and the ports in Canada mainly consists of fishing vessels, tankers, container ships, and passenger vessels, and exhibits similar seasonal increases in vessel traffic to the Project Area. Trans-Atlantic vessel traffic mainly consists of tankers, container ships, and passenger vessels.

Table 3.4.7-1 in the COP Section 4.3, Appendix III-I (portions of which are replicated below in Table 7.2.2) summarizes the type and number of unique vessel counts recorded within 10 miles (16 kilometers) of the WDA based on AIS data from 2016 and 2017 (Epsilon 2020). Commercial fishing vessels and recreational vessels (pleasure craft and sailing vessels) comprised more than 70 percent all of the AIS tracks within 10 miles of the WDA recorded in 2016 and 2017. It is important to note that AIS is only required on commercial vessels with a length of 65 feet (19.8 meters) or longer, it is likely that vessel traffic is significantly more than described as many recreational vessels, as well as some fishing vessels are below the required length to have AIS. As reflected in the table, some smaller recreational and fishing vessels carry an AIS; however, the data likely excludes most vessels less than 65 feet (19.8 meters) long that traverse the WDA. Vessel Monitoring System reports collected by NMFS from 2011 to 2016 and recreational boating data surveys from 2010 and 2012 (Starbuck and Lipsky 2013) were used to supplement the AIS data.

This table also does not reflect AIS crossings of the OECC (including Lewis Bay); however Figure 4.0-4 in the Navigational Risk Assessment shows AIS vessel tracks across the

OECC. About 15 nautical miles offshore, the OECC route would cross a navigation route for tug-and-barge (shown as "towing"), tanker, and fishing vessels have also been commonly recorded throughout this area (COP Figure 4.0-4, -I; Epsilon 2020). The heaviest vessel traffic in the vicinity of the WDA occurs in four primary areas: Narragansett Bay, Buzzards Bay, Nantucket Sound, and the area between Woods Hole and Vineyard Haven. Additionally, high-volume passenger ferry traffic occurs between Hyannis and Nantucket and Martha's Vineyard. This ferry traffic is a significant source of existing vessel traffic in the action area. Between Hyannis and Nantucket there are 7-12 roundtrips per day; approximately 6 round trips each day between Hyannis and Martha's Vineyard, 14-19 round trips between Woods Hole and Martha's Vineyard, and approximately 9 trips a day between Falmouth and Martha's Vineyard. Additionally, the ferry between New Bedford and Martha's Vineyard runs 7 roundtrips per day and the ferry between New Bedford and Nantucket runs 3 roundtrips per day. There were about 2,200 commercial cargo trips to the Port of New Bedford in 2016 and approximately 1,300 commercial cargo trips to the Port of Providence in 2015 (USACE 2015); all of these vessels would transit through a portion of the action area. The USCG's Port Access Study for Nantucket Sound indicates that there are 1,000s of trips through Nantucket Sound each year, including 22,000 annual ferry trips and 7-9,000 fishing vessel transits (USCG 2016). A portion of these trips occur in the action area. As part of the MARIPARS, the USCG examined vessel traffic AIS density data for years 2015, 2016, 2017, and 2018 to identify current traffic characteristics, drawn from the USCG Navigation Center. Based on this data, annual vessel transits through the MA/RI WEA range from 13,000 to 46,900 transits (USCG 2020). AIS annual vessel traffic data shows that vessel activity and vessel density quadruples during the summer months compared to the colder months of January and February (USCG 2020).

Table 6.2. 2016 and 2017 AIS Vessel Traffic Data within the WDA 10-mile Analysis Area

Vessel Type [a]	Vessel Dimensions (maximum-minimum)					Number of Unique Vessels	
	Length	Beam	Draft	DWT [b]	Speed (knots)	2016	2017
Research Vessels	108–236 ft. (33–72 m)	23–46 ft. (7–14 m)	7–20 ft. (2–6 m)	97–2,328 t (88–2,112 MT)	<1–19	1	1
Passenger Cruise Ships/Ferries	Na	na	Na	Na	na	0	7
Commercial Fishing	36–197 ft. (11–60 m)	13–49 ft. (4–15 m)	13–16 ft. (4–5 m)	453 t (411 MT)	<1–18	198	314
Dredging/Underwater/ Diving Operations	112–341 ft. (34–104 m)	39–66 ft. (12–20 m)	9–22 ft. (3–7 m)	4,400 t (3,992 MT)	<1–22	2	1
Military or Military Training	141–269 ft. (43–82 m)	39–43 ft. (12–13 m)	11 ft. (3 m)	1,820–2,250 t (1,651–2,041 MT)	3–9	4	8

Recreational (Pleasure, Sailing, Charter Fishing, High Speed Craft)	36–184 ft. (11–56 m)	13–33 ft. (4–10 m)	7–38 ft. (2–12 m)	499 t (452 MT)	<1–58	143	178
Cargo	551–656 ft. (168–200 m)	56–108 ft. (17–33 m)	23–36 ft. (7–11 m)	22,563 t 20,469 MT	2–8	5	13
Tug-and-barge	118–492 ft. (36–150 m)	36–76 ft. (11–23 m)	17–23 ft. (5–7 m)	637 t (578 MT)	10–21	2	14
Other/Unspecified	Na	na	Na	Na	na	76	147
Total						431	683

Source: Table 3.4.7-1 COP Section 4.3, Appendix III-I (Epsilon 2020)
AIS = Automatic Identification System; ft. = feet; m = meter; na = data not available
[a] Includes only vessels equipped with AIS (required for commercial vessels >65 ft. in length)
[b] Displacement based on example vessels

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. Vessel strike is a significant and widespread concern for the recovery of the listed species that occur in the action area. Atlantic sturgeon are struck and killed by vessels in at least some portions of their range. There are no records of vessel strike in the Atlantic Ocean, with all records within rivers and estuaries. Risk is thought to be highest in areas with higher densities of sturgeon (i.e., within rivers and estuaries adjacent to spawning rivers), geography that presents reduced opportunity for escape, and from vessels operating at a high rate of speed or with propellers large enough to entrain sturgeon. We do not expect Atlantic sturgeon to be struck by vessels in the action area.

As reported in Hayes et al. 2021, for the most recent 5-year period of review (2014-2018) in the North Atlantic, the minimum rate of serious injury or mortality resulting from vessel interactions is 1.3/year for right whales, 0.80/year for fin whales, 0.8 for sei whales, and 0 for sperm whales. 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 in the vicinity of 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 (Hayes et al. 2021 and 2020, Henry et al. 2020, UME website as cited above), includes three records of fin whales and two records of right whales presumed to have been killed by vessel strike that were first detected in the action area. 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 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 below, 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.

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). One such SMA, the Block Island SMA, overlaps with a portion of the action area. 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 Seasonal Management Areas along the U.S. East Coast during times when right whales are likely to be present. 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.

Seasonal Management Areas 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 mariner's route around these zones or transit through them at 10 knots or less. In 2021, NMFS supplemented the DMA program with a new Slow Zone program which identifies areas for recommended 10 knot speed reductions based on acoustic detection of right whales. Together, these zones are established around areas where right whales have been recently seen or heard, and the program provides maps and coordinates to vessel operators indicating areas where they have been detected. Compliance with these zones is voluntary.

Atlantic sturgeon, sea turtles, and ESA listed whales are all vulnerable to vessel strike, although the risk factors and areas of concern are different. Vessels have the potential to affect animals through strikes, sound, and disturbance by their physical presence.

As reported in Hayes et al. 2022, for the most recent 5-year period of review (2015-2019) in the North Atlantic, the minimum rate of serious injury or mortality resulting from vessel interactions is 0.40/year for fin whales, and 0.2 for sei whales. As reported in Hayes et al. 2023, for the most recent 5-year period of review (2016-2020) in the North Atlantic, the minimum rate of serious injury or mortality resulting from vessel interactions is 2.4/year for right whales. No vessel strikes for sperm whales have been documented (Hayes et al. 2020). A review of available data on serious injury and mortality determinations for sei, fin, and sperm whales for 2000-2020 and right whales for 2000-2023 (Henry et al. 2022, UME website as cited above), includes no records of whales that were first detected in the WDA. The nearest records identified in the UME are three right whales documented in 2017 and 2018 in moderate to advanced decomposition off the southern coast of Martha's Vineyard[26]. Hayes et al. (2021) reports three vessel struck sei whales first documented in the U.S. Northeast – all three were discovered on the bow of vessels entering port (two in the Hudson River and one in the Delaware River); no information on where the whales were hit is available. Hayes et al. (2020) reports only four recorded ship strikes of sperm whales. In May 1994, a ship-struck sperm whale was observed south of Nova Scotia (Reeves and Whitehead 1997), in May 2000, a merchant ship reported a strike in Block Canyon and in 2001, and the U.S. Navy reported a ship strike within the EEZ (NMFS, unpublished data). In 2006, a sperm whale was found dead from ship-strike wounds off Portland, Maine. A similar rate of strike is expected to continue in the action area over the life of the project and we expect vessel strike will continue to be a source of mortality for right, sei, fin, and sperm whales in the action area. As outlined above, there are a number of measures that are in place to reduce the risk of vessel strikes to large whales that apply to vessels that operate in the action area.

NMFS' Sea Turtle Stranding and Salvage Network (STSSN) database provides information on records of stranded sea turtles in the region. The STSSN database was queried for records of stranded sea turtles with evidence of vessel strike throughout the waters of 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 for which data was available (2020-2022), there were 33 recorded sea turtle vessel strikes, primarily between the months of August

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[26] https://noaa.maps.arcgis.com/apps/webappviewer/index.html?id=e502f7daf4af43ffa9776c17c2aff3ea; last accessed 1/22/24

and November. The majority of strikes were of leatherbacks with a smaller number of loggerhead and green; there are no records 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.

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), the construction of the South Fork project as well as ongoing effects of construction of the Revolution Wind project.

To date, we have completed section 7 consultation to consider the effects of construction, operation, and decommissioning of multiple commercial scale offshore wind project along the U.S. Atlantic coast (South Fork Wind, Ocean Wind 1, Sunrise Wind, CVOW, Empire Wind, Atlantic Shores South, New England Wind, Maryland Wind); at this time, construction of the South Fork Wind project has been completed and construction of the CVOW and Revolution Wind projects is ongoing. 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. There are no offshore wind projects or associated activities (i.e. site characterization, site assessment) in the action area for which "early consultation" has been initiated or completed pursuant to 50 CFR §402.11.

The offshore wind projects that we have completed consultation on that are within the action area defined in section 3.4 of this Opinion are South Fork Wind, Revolution Wind, Sunrise Wind, and New England Wind. The other projects are south of the action area.

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, Appendix A to this Opinion). 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 may affect but are not likely to adversely affect any ESA listed species if implemented in accordance with the applicable BMPs and PDCs. 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 ESA incidental take, including harassment, injury (e.g., permanent hearing impairment or non-auditory injury), 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; effects of various surveys were considered in the Biological Opinions issued for offshore wind projects in the action area. 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 a number of OSW projects to date. Complete information on the assessment of effects of these 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, CVOW – NMFS 2023b, Empire Wind – NMFS 2023c, Revolution Wind – NMFS 2024, Sunrise Wind – NMFS 2023e, Atlantic Shores South – NMFS 2023f, New England Wind – NMFS 2023g, Maryland Wind – NMFS 2024b). The South Fork, Block Island, and CVOW (demo) projects have been constructed and turbines are operational. As noted above, only the South Fork, Revolution Wind, Sunrise Wind, and New England Wind projects are in the Vineyard Wind action area. Construction of the Revolution Wind project is ongoing and foundation installation is expected to be completed in 2024.

Given numerous project delays, it is difficult to predict which, if any, projects may be undergoing construction during the period when pile driving for the remaining Vineyard Wind foundations may occur. However, based on available information, we expect that foundation installation for Revolution Wind, scheduled for 2024 (and possibly 2025), may occur during the same period. However, given the geographic separation between the projects, no additive effects are anticipated (i.e., the sound fields would not overlap in space or time). We provide more information below on the projects in the action area.

In the Biological Opinions prepared for these projects, we anticipated temporary loss of hearing sensitivity (TTS) and/or short term behavioral disturbance of ESA listed sea turtles and whales exposed to pile driving noise or UXO detonations resulting in take that meets the ESA definition of harassment and, in a few cases, anticipated permanent loss of hearing sensitivity (PTS) resulting in take that meets the definition of harm. The amount of incidental take exempted through project Biological Opinions is included below for the projects that occur in the New England Wind action area (Tables 6.2 and 6.3). In the Biological Opinions prepared for the offshore wind projects considered to date, 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 South Fork, Sunrise Wind, New England Wind, and Revolution Wind projects.

Table 6.3. Summary of available Incidental Take Statements (ITS) regarding project noise (pile driving and/or UXO detonations) for the following completed offshore wind consultations. Note that not all construction periods overlap. Source: Revolution Wind – NMFS 2024, Sunrise Wind – 2023e, South Fork Wind - NMFS 2021a, and New England Wind – NMFS 2024.

South Fork Wind - Amount and Extent of Take Identified in the BiOp's ITS due to Noise Exposure (Impact and Vibratory Pile Driving)		
Species	**Harm (Auditory Injury -PTS)**	**Harassment (TTS/Behavior)**
North Atlantic right whale	None	10
Fin Whale	1	15
Sei Whale	1	2
Sperm whale	None	3
NA DPS green sea turtle	None	6
Kemp's ridley sea turtle	None	6
Leatherback sea turtle	None	8
NWA DPS Loggerhead sea turtle	None	6
New England Wind - Amount and Extent of Take Identified in the BiOp's ITS due to Exposure to Noise (UXO Detonation and Impact Pile Driving – Schedule B)		
Species	**Harm (Auditory Injury -PTS)**	**Harassment (TTS/Behavior)**
North Atlantic right whale	None	101
Fin whale	33	368
Sei Whale	6	58
Sperm whale	None	96
Blue whale	2	100
NA DPS green sea turtle	1	1
Kemp's ridley sea turtle	None	1

Leatherback sea turtle	5	8
NWA DPS Loggerhead sea turtle	2	11
Sunrise Wind - Amount and Extent of Take Identified in the BiOp's ITS due to Noise Exposure (Impact Pile Driving Only)		
Species	**Harm (Auditory Injury -PTS)**	**Harassment (TTS/Behavior)**
North Atlantic right whale	None	23
Fin whale	4	55
Sei Whale	2	22
Sperm whale	None	10
Blue whale	None	2
NA DPS green sea turtle	None	1
Kemp's ridley sea turtle	None	1
Leatherback sea turtle	4	9
NWA DPS Loggerhead sea turtle	None	7
Revolution Wind - Amount and Extent of Take Identified in the BiOp's ITS due to Noise Exposure (Impact Pile Driving, UXO Detonation)		
Species	**Harm (Auditory Injury -PTS)**	**Harassment (TTS/Behavior)**
North Atlantic right whale	None	34
Fin whale	2	35
Sei Whale	3	18
Sperm whale	None	5
Blue whale	None	2
NA DPS green sea turtle	1	8
Kemp's ridley sea turtle	1	7
Leatherback sea turtle	1	7
NWA DPS Loggerhead sea turtle	1	15

Table 6.4. Summary of available Incidental Take Statements (ITS) regarding vessel strikes for the following completed offshore wind consultations. The amount of take identified is over the life of the project (construction, operations, and decommissioning). Source: Revolution Wind – NMFS 2024, Sunrise Wind – 2023e, South Fork Wind - NMFS 2021a, and New England Wind - NMFS 2024.

South Fork Wind - Amount and Extent of Take Identified in the BiOp's ITS due to Vessel Strike	
Species	**Serious Injury or Mortality**
NA DPS green sea turtle	1
Kemp's ridley sea turtle	1
Leatherback sea turtle	7
NWA DPS Loggerhead sea turtle	3
New England Wind -Amount and Extent of Take Identified in the BiOp's ITS due to Vessel Strike	
Species	**Serious Injury or Mortality**
North Atlantic DPS green sea turtle	2
Kemp's ridley sea turtle	2
Leatherback sea turtle	22
Northwest Act DPS Loggerhead sea turtle	28
Sunrise Wind - Amount and Extent of Take Identified in the BiOp's ITS due to Vessel Strike	
Species	**Serious Injury or Mortality**
North Atlantic DPS green sea turtle	1
Kemp's ridley sea turtle	1
Leatherback sea turtle	5
Northwest Atlantic DPS Loggerhead sea turtle	6
Revolution Wind - Amount and Extent of Take Identified in the BiOp's ITS due to Vessel Strike	
Species	**Serious Injury or Mortality**
North Atlantic DPS green sea turtle	1
Kemp's ridley sea turtle	1
Leatherback sea turtle	5
Northwest Atlantic DPS Loggerhead sea turtle	6

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; a programmatic ESA Section 7 consultation was issued in 2017 that identifies a limit on lethal take for each river population (NMFS OPR 2017); depending on the identified health of the river population, the allowable mortality limit, across all issued permits, ranges from 0.4 to 0.8%. In that Opinion, NMFS determined this was not likely to jeopardize the continued existence of any DPS.

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 WDA, 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 Vineyard Wind lease area lies within a dynamic ambient noise environment, with natural background noise contributed by natural wind and wave action, a diverse community of vocalizing cetaceans, and other organisms. Anthropogenic noise sources, including commercial shipping traffic in high-use shipping lanes in proximity to the action area, also contributed ambient sound.

As 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.

Ambient noise within the Lease Area was measured as, on average, between 76.4 and 78.3 decibels (dB) re 1 µPa2 /Hz (Alpine Ocean Seismic Surveying Inc., 2017 in COP Volume III, section 6); no effects to listed species are anticipated on exposure to noise at these levels. Short term increases in noise in the action area associated with vessel traffic and other activities, including geotechnical and geophysical surveys that have taken place in the past and will continue in the future in the portions of the action area that overlap with other offshore wind lease areas and/or potential cable routes. Exposure to these noise sources can result in temporary masking or temporary behavioral disturbance; however, in all cases, these effects are expected to be temporary and short term (e.g., the seconds to minutes it takes for a vessel to pass by) and not result in any injury or mortality in the action area. No acoustic surveys using seismic equipment or airguns have been proposed in the action area and none are anticipated to take place in the future, as that equipment is not necessary to support siting of future offshore wind development that is anticipated to occur in the action area.

Other Factors

Whales, sea turtles, and Atlantic sturgeon are exposed to a number of other stressors in the action area that are widespread and not unique to the action area which makes it difficult to determine to what extent these species may be affected by past, present, and future exposure within the action area. These stressors include water quality and marine debris. Marine debris in some form is present in nearly all parts of the world's oceans, including the action area. While the action area is not known to aggregate marine debris as occurs in some parts of the world (e.g., The Great Pacific garbage patch, also described as the Pacific trash vortex, a gyre of marine debris particles in the north central Pacific Ocean), marine debris, including plastics that can be ingested and cause health problems in whales and sea turtles is expected to occur in the action area.

The Vineyard Wind lease area and cable corridor are located in offshore marine waters where available water quality data are limited. Broadly speaking, ambient water quality in these areas is expected to be generally representative of the regional ocean environment and subject to constant oceanic circulation that disperses, dilutes, and biodegrades anthropogenic pollutants from upland and shoreline sources (BOEM 2013). 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 Vineyard Wind lease area, 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.

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, water quality is not anticipated to negatively affect 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 ESA-listed threatened or endangered species and critical habitat. 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 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).

Here, we examine the activities associated with the proposed action and determine what the consequences of the action are to listed species in the action area. Effects to critical habitat were addressed in section 4 of this Opinion. 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)).

The main element of the action considered here is BOEM's approval of Vineyard Wind's COP with conditions; 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 IHA proposed for issuance by NMFS OPR to authorize incidental take of ESA-listed marine mammals under the MMPA and other permits issued by USACE and EPA are considered effects of the action as they are consequences of BOEM's approval of Vineyard Wind's COP with conditions. In addition, the IHA to be issued by NMFS OPR, as well as permits issued 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 IHA, as well as with other Federal action agencies aside from BOEM , and we have analyzed the effects of those actions along with the effects of BOEM's 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.

When the 2021 Opinion was written, the Vineyard Wind project was proposed in only a portion of what was a larger lease area. We explained why future development in the western portion of that larger lease area was not an effect of the Vineyard Wind project. In June 2021, BOEM segregated lease OCS-A 0501 such that Vineyard Wind retained the original lease number and the remainder of the lease was designated as lease OCS-A 0534, which is now the site of the New England Wind Project (see: https://www.boem.gov/sites/default/files/documents/renewable-energy/OCS-A-0534_OCS-A-0501-Lease-Segregation.pdf). ESA section 7 consultation for development in Lease OCS-A 0534 (New England Wind Project) is addressed in the *Environmental Baseline* of this Opinion.

The purpose of the Vineyard Wind project is to generate electricity. Electricity will travel from the WTGs to the ESP and then by submarine cable to on-land cables in Massachusetts. From this point, electricity generated at the WTGs would be distributed to the New England Power Grid, which is managed by ISO New England, and pools electricity from numerous sources. Power from the project is expected to displace electricity generated by existing fossil-fuel fired plants (Epsilon 2020). Electricity will then be used to support existing uses. Even if we assume the Vineyard 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 Vineyard Wind project specifically. Because the electricity generated by Vineyard 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 Vineyard Wind's contribution to the grid and, therefore, we cannot identify any impacts, positive or negative, that would occur because of the Vineyard 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 Vineyard Wind's production of electricity and are reasonably certain to occur.

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. The analysis here has been updated to reflect the changes in the proposed action described in section 3 as well as new information on effects that has become available since the 2021 consultation was completed (e.g., regarding operational noise). Note that the analysis of noise during the construction phase is now limited to the activities that are ongoing or remain to be completed; for example, the consideration of pile driving only addresses the effects of pile driving for the remaining 15 monopile foundations. Effects of pile driving already completed are considered in the *Environmental Baseline*. For ease of reference, we also summarize it here.

Vineyard Wind submitted a report of all detections of protected species by all protected species observers during the 2023 pile driving[27]. The report notes that no sea turtles were observed by the PSOs. The only ESA listed whales observed by PSOs during active pile driving (i.e., hammer "on") were four fin whales. An additional 9 fin whales were detected on the passive acoustic recorders (PAM) during active pile driving. Vineyard Wind reports that none of the fin whales were within the range of the pile where they would have experienced permanent threshold shift (PTS, MMPA Level A harassment). One fin whale was detected acoustically within the Level B harassment zone and two fin whales were observed by PSOs within the Level B harassment zone. Thus, we consider that the incidental take, by harassment, of 3 individual fin whales occurred during the 2023 pile driving. No reports of right whales, or suspected right whales, were recorded by the PSOs or PAM operators. We recognize that given the distance to the Level B harassment threshold (up to 5.7 km), not all exposures of whales may have been observed by the PSOs; however, we do expect that any exposure to noise that could result in acoustic injury (PTS) would have been observed. Sea turtles may be difficult to detect at distances beyond 500 m from the PSO platform or vessel; however, we expect that any sea turtles close enough to the pile to experience auditory injury (within 487 m for an extended period of time) would have been documented by the PSOs. It is possible that some sea turtles were exposed to noise that resulted in behavioral disturbance and that they were outside the area readily observable by the PSOs. However, given the absence of any observations of sea turtles before or during pile driving, we have no information to suggest that there was exposure of more sea turtles than expected. Atlantic sturgeon remain submerged and are not expected to be observed by PSOs. No take of Atlantic sturgeon due to exposure to pile driving noise was anticipated or exempted in the 2021 Opinion; we have no information to suggest that any unanticipated take occurred during the 2023 pile driving.

7.1.1 Background on Noise

This section contains a brief technical background on sound, the characteristics of certain sound types, and metrics used in this consultation inasmuch as the information is relevant to the specified activity and to consideration of the potential effects of the specified activity on listed species found later in this document.

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[27] https://s3.amazonaws.com/media.fisheries.noaa.gov/2024-05/VW1-2023IHA-MonRep-OPR1.pdf

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. 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*. As noted in the *Environmental Baseline*, ambient noise within the Lease Area was measured as, on average, between 76.4 and 78.3 decibels (dB) re 1 μPa^2 /Hz (with measurements ranging from 67.2 to 88.09 dB) re 1 μPa^2 /Hz (Alpine Ocean Seismic Surveying Inc., 2017 in COP Volume III, section 6).

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 (e.g., cable laying). During the operations and maintenance phase of the project, sources of increased underwater noise are largely limited to WTG operations, vessel and aircraft operations, and maintenance activities. During decommissioning, sources of increased underwater noise include removal of project components and associated surveys, as well as vessel and aircraft 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 (COP Appendix III-M), Vineyard Wind's applications for an MMPA IHA (LGL 2024, JASCO and LGL 2019), the Underwater Sound Field Verification Report (Küsel et al. 2024), the Federal Register notice prepared for the proposed IHA (89 FR 31008, April 23, 2024), the Federal Register notices for the previous IHA (86 FR 33810, June 25, 2021; 84 FR 18346, April 30, 2019), and BOEM's BA.

Impact Pile Driving for Foundations

In the 2021 Opinion we considered the effects of the installation of up to 102 foundations (with up to 12 of those being jacket foundations) installed on up to 102 days of pile driving between May 1 and December 31 of a single year. As explained in section 3, the Vineyard Wind project is now proposed to consist of up to 62 WTGs and one ESP. The ESP was constructed on a jacket foundation that was installed in 2023. Forty-seven of the 62 WTG monopile foundations were installed in 2023. As such, this analysis is limited to considering the installation of the 15 monopile foundations that remain to be installed. That installation is subject to the conditions of COP approval, the USACE permit, and the IHA proposed for issuance in 2024 (as described in 89 FR 31008, referred to here as the 2024 proposed IHA). Effects of pile driving that occurred in 2023 are addressed in the *Environmental Baseline*.

No more than one foundation will be installed per day; therefore, pile driving would occur on 15 days. Consistent with the conditions of the 2024 proposed IHA, no pile driving activities would occur from January 1 through May 31. Given the anticipated issuance of the IHA in late summer 2024, it is expected that pile driving would occur between September 1 and December 31, 2024 and/or June 1 – August 31, 2025 (or possibly into Fall 2025 depending on the effective dates of the IHA). The conditions of COP approval and the 2024 proposed IHA do not allow the initiation of pile driving after dark (i.e., Vineyard Wind must not initiate pile driving earlier than 1 hour after civil sunrise or later than 1.5 hours prior to civil sunset). Therefore, no pile driving initiated outside of this period is considered in this Opinion.

The monopile foundations are up to 9.6 m in diameter (31.5 ft), 312 feet (95 meters) in length and would be driven to a penetration depth of 66 to 148 feet (20 to 45 meters). The anticipated pile driving schedule for a single monopile is presented in Table 7.1.1; as explained in the Notice of Proposed IHA, this is based on the information from 2023 pile installation.

Table 7.1.1 Impact Pile Driving Schedule for Remaining Monopile Foundations

Max Hammer Size (kJ)	Number of Hammer Strikes	Max Piling Time Duration (minutes/pile)	Number of Piles/Day	Total Piles to be Installed
4,000 kJ	2,884	117	1	15

source: Table 1, 89 FR 31008

Acoustic modeling was carried out to support the COP, BA, and original IHA application. Pyć et al. (COP Appendix III-M) utilized the following assumptions: an IHC S-4000 hammer for driving the monopile foundations and a total number of strikes to drive the monopile foundations was 5,500. At full energy for the monopile, the strike rate was approximately 36 strikes per minute and the analysis assumed a slower strike rate of approximately 30 strikes per minute for the monopile installation resulting in a duration of approximately 11,000 seconds (3.05 hours) for continuous pile driving. Pile driving in 2023 for individual piles progressed more quickly than expected, with pile driving occurring for about 2 hours per pile.

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. For the monopile models, the piles were assumed to be vertical and driven to a penetration depth of 30 m. While pile penetrations across the site would vary, these values were chosen as reasonable penetration depths. The estimated number of strikes required to drive piles to completion were obtained from drivability studies provided by Vineyard Wind. All acoustic modeling was performed assuming that only one pile is driven at a time. No concurrent pile driving is planned and it is not considered in this Opinion.

Additional modeling assumptions for the monopiles were as follows:

- 1,030 cm steel cylindrical piling with wall thickness of 10 cm.
- Impact pile driver: IHC S-4000 (4000 kJ rated energy; 1977 kN ram weight).
- Helmet weight: 3234 kN.

While the 2021 Opinion noted that rotary drilling or vibratory hammer may be used to assist in some foundation installations, no such installation is considered in the 2023 proposed IHA. No drilling or vibratory hammering was used in 2023 and none is planned for the remaining foundation; as such, these methods are not considered in this Opinion.

BOEM required, through conditions of COP approval, the use of a noise attenuation system designed to minimize the sound radiated from piles by 6 dB. This requirement will be in place for all remaining piles to be installed. The 2024 proposed IHA also includes a requirement for Vineyard Wind to "deploy, at minimum, a functionally optimized double bubble curtain (DBBC) and hydro-sound damper (HSD) during all foundation impact pile driving that are capable of reducing distances to harassment thresholds to those modeled (assuming 6 dB-attenuation for Level A harassment) and measured (Level B harassment)." Sound field verification (SFV) will be required through conditions of the 2024 proposed IHA. SFV involves monitoring underwater noise levels during pile driving to determine the actual distances to isopleths of concern (e.g., the distances to the noise levels equated to Level A and Level B harassment for marine mammals). Requirements will be in place through the MMPA IHA to implement adjustments to pile driving and/or additional or alternative sound attenuation measures for subsequent piles if any distances to any thresholds are exceeded. The goal of the SFV and associated requirements is to ensure that the actual distances to isopleths of concern do not exceed the noise levels/distances considered in the proposed IHA (for Level A harassment, distances to the Level A harassment threshold modeled assuming 6 dB-attenuation and for Level B harassment, those distances measured during 2023 SFV) that are the foundation of the effects analysis carried out in this Opinion and the exposure analysis and take estimates in the proposed MMPA IHA. Failure to demonstrate that distances to these thresholds of concern as modeled/measured can be met through SFV could lead to the need for reinitiation of consultation.

Noise attenuation systems, such as bubble curtains, are designed to decrease the sound levels radiated from a source. Bubbles create a local impedance change that acts as a barrier to sound transmission. The size of the bubbles determines their effective frequency band, with larger bubbles needed for lower frequencies. There are a variety of bubble curtain systems, confined or unconfined bubbles, and some with encapsulated bubbles or panels. Attenuation levels also vary by type of system, frequency band, and location. Small bubble curtains have been measured to reduce sound levels, but effective attenuation is highly dependent on depth of water, current, and configuration and operation of the curtain (Austin *et al.,* 2016; Koschinski and Lüdemann, 2013). Bubble curtains vary in terms of the sizes of the bubbles; those with larger bubbles tend to perform a bit better and more reliably, particularly when deployed with two separate rings (Bellmann, 2014; Koschinski and Lüdemann, 2013; Nehls *et al.,* 2016). Encapsulated bubble systems (i.e*.,* HSDs) can be effective within their targeted frequency ranges (e.g*.,* 100-800 Hz) and when used in conjunction with a bubble curtain appear to create the greatest attenuation. The literature presents a wide array of observed attenuation results for bubble curtains. The variability in attenuation levels is the result of variation in design as well as differences in site conditions and difficulty in properly installing and operating in-water attenuation devices. For example, Dähne *et al.* (2017) found that single bubble curtains that reduce sound levels by 7 to 10 dB reduced the overall sound level by approximately 12 dB when combined as a double bubble curtain for 6-m steel monopiles in the North Sea. During installation of monopiles (consisting of approximately 8-m in diameter) for more than 150 WTGs in comparable water depths (>25 m) and conditions in Europe indicate that attenuation of 10 dB is readily achieved (Bellmann, 2019; Bellmann *et al.,* 2020) using single BBCs for noise attenuation.

Encapsulated bubble systems (*e.g.,* Hydro Sound Dampers (HSDs)), can be effective within their targeted frequency ranges, *e.g.,* 100-800 Hz, and when used in conjunction with a bubble curtain appear to create the greatest attenuation. The literature presents a wide array of observed attenuation results for bubble curtains. The variability in attenuation levels is the result of variation in design, as well as differences in site conditions and difficulty in properly installing and operating in-water attenuation devices. A California Department of Transportation (CalTrans) study tested several systems and found that the best attenuation systems resulted in 10-15 dB of attenuation (Buehler *et al.,* 2015). Similarly, Dähne et al. (2017) found that single bubble curtains that reduced sound levels by 7 to 10 dB reduced the overall sound level by ~12 dB when combined as a double bubble curtain for 6 m steel monopiles in the North Sea. Bellmann et al. (2020) provide a review of the efficacy of using bubble curtains (both single and double) as noise abatement systems in the German EEZ of the North and Baltic Seas. For 8 m diameter monopiles, single bubble curtains achieved an average of 11 dB broadband noise reduction (Bellmann et al., 2020). Caltrans (2020) reports on attenuation achieved at a number of pile driving projects with confined and unconfined bubble systems; reported attenuation ranged from 5 dB to 30 dB. In modeling the sound fields for the proposed project, hypothetical broadband attenuation levels of 6 dB and 12 dB were modeled to gauge the effects on the ranges to thresholds given these levels of attenuation.

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 (HDR 2020). 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. Towed hydrophone array recordings also indicated that the noise mitigation system was more effective at reducing sound levels at higher frequencies, and the largest differences in received SPLs were seen above 200 Hz; towed array results showed differences of up to 10 dB in recorded sound levels (Lpk and Lpk-pk metrics) for the mitigated versus unmitigated pile. Results from the long-range measurements conducted using a dipped hydrophone indicated that the bubble curtain reduced noise levels by between 11 dB and 23 dB depending on distance from the sound source, sensor depth, and noise metric. Attenuation was present at all frequencies where significant energy existed in the pulse, from 80 Hz up to 4 kHz, at 20 km. At frequencies above 4 kHz the noise reduced to near background levels in the unmitigated pulse, although this is relative to the ambient noise in that specific location and time. 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, in addition to the SFV results for 12 Vineyard Wind monopile foundations, we have received sound field verification reports for monopiles installed for the South Fork, Revolution Wind, and CVOW projects; these results indicate that the required sound attenuation systems are capable of reducing noise levels to the distances predicted by modeling assuming 10 dB attenuation when properly and effectively deployed and when maintenance is carried out between deployments to optimize effectiveness. We note that South Fork deployed a double bubble curtain and a near field noise attenuation device, Revolution Wind is operating with a double bubble curtain and an AdBm near field attenuation device, and CVOW is operating with a double big bubble curtain. These results indicate that the required sound attenuation devices are capable of reducing noise levels to the distances predicted by modeling. Results from these projects have indicated that actual noise can be inconsistent between piles installed with similar methodology and location, and the importance of proper deployment and maintenance of the bubble curtains in obtaining expected sound attenuation results. These results also suggest that given variability, it may not be reasonable to expect that sound field verification results from a small subset of piles will be truly representative of noise produced during all subsequent piles due to differences in noise source and attenuation, at least in part related to functionality of the noise attenuation system.

For the remaining pile driving, Vineyard Wind proposes and NMFS OPR is proposing to require (through conditions of the proposed IHA) Vineyard Wind to use a double bubble curtain (DBBC) and Hydro Sound damper (HSD) in addition to an enhanced big bubble curtain (BBC) maintenance schedule. This is consistent with the refined noise attenuation system design and operations (DBBC + HSD + enhanced bubble curtain maintenance schedule) used during the 2023 pile driving (following deployment of the second bubble curtain and identification of enhanced maintenance activities) and would be used on the 15 remaining piles to minimize noise levels. The conditions of the 2024 proposed IHA require that:

> The double 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. In the unforeseen event of a single compressor malfunction, the offshore personnel operating the bubble curtain(s) must adjust the air supply and operating pressure such that the maximum possible sound attenuation performance of the bubble curtain(s) is achieved. 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. Construction contractors must train personnel in the proper balancing of airflow to the bubble ring, and Vineyard Wind must submit an inspection/performance report within 72 hours. Additionally, a full maintenance check (e.g., manually clearing holes) must occur prior to each pile being installed; and corrections to the attenuation device to meet the performance standards must occur prior to impact driving of monopiles. Vineyard Wind must also inspect and carry out appropriate maintenance on the noise attenuation system and ensure the system

is functioning properly prior to every pile driving event. A DBBC inspection report must be submitted to NMFS.

The HSD system Vineyard Wind proposes to use would be employed, in coordination with the DBBC, as a near-field attenuation device close to the monopiles (Küsel *et al.,* 2024). Should SFV identify that distances to the Level A and/or Level B harassment isopleths are louder than expected, Vineyard Wind would be required to adjust the NAS, or conduct other measures to reduce noise levels, such that distances to thresholds are not exceeded. Through the conditions of the proposed IHA, Vineyard Wind would be required to maintain numerous operational performance standards, including the enhanced BBC maintenance protocol (Vineyard Wind Enhanced BBC Technical Memo, 2023). These standards are defined in the proposed IHA and include, but are not limited to, the measures identified above. The DBBC enhanced maintenance protocol includes an adjustment from typical bubble curtain operations to drill hoses after every deployment to maximize performance in siltier sediments. The DBBC enhanced maintenance protocol also includes DBBC hose inspection and clearance, pressure testing of DBBC hoses, visual inspection of DBBC performance, and minimizing disturbance of the DBBC hoses on the seafloor.

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.

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 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 vessels used during 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). Ship types also have unique acoustic signatures characterized by differences in dominant frequencies. 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).

Project vessels will either have ducted propellers, blade propellers, or use jet drive propulsion. Ducted propellers are shrouded in an assembly fitted with a non-rotating nozzle that provides higher efficiency at lower speeds, course stability, and decreased vulnerability to debris. Vineyard Wind would use vessels with ducted propellers during construction and installation activities. Sound-source levels for ducted propeller thrusters were modeled for a project offshore of Virginia (BOEM 2015) and measured during the installation of the Block Island Wind Farm transmission cable. For both projects, the sound-source level was 177 dB (RMS) at 3 feet (1 meter). Blade propeller systems are typical of small craft such as fishing vessels; therefore, the estimates for noise associated with fishing vessels (source level of 158 dB re 1 µPa) referenced above are expected. As most vessel noise is associated with propeller cavitation and a jet propulsion system has no external propeller, vessels with jet propulsion systems are quieter than similar vessels with propellers. Rudd et al. (2015) reports a maximum source level noise of 175 dB re 1uPa for a 117m jet propelled fast ferry traveling at a speed of 24 knots.

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 meter length 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 Vineyard Wind project are expected to be similar in frequency and source level. The median rms sound pressure level (SPL) measured at a range of 750 m from the Vineyard Wind pile installation vessel (the Orion), and support vessels prior to pile driving (median calculated from SFV data for the first 13 piles from the Vineyard Wind 2023 construction activities) measured approximately 134 dB (Küsel *et al.,* 2024).

Aircraft Operation Noise
During the Project, helicopters may be used when rough weather limits or precludes the use of

crew transport vessels (CTVs) as well as for fast response visual inspections and repair activities, as needed to support operations and maintenance activities. Helicopters would be able to land on helipads, which some of the larger support vessels have. BOEM expects that helicopters transiting to the Project area would fly at altitudes above those that would cause behavioral responses from whales except when flying low to inspect WTGs or take off and land on the service operations vessel (SOV). Aircraft operation may ensonify areas, albeit for short periods at any one location while in transit. Helicopters produce sounds (resulting from rotors) generally below 500 Hz with estimated source levels for a Bell 212 helicopter of 149 to 151 dB re 1 μPa-m (Richardson et al. 1995). At incident angles greater than 13° from the vertical, much of the incident noise from passing aircraft is reflected and does not penetrate the water (Urick 1972). Patenaude et al. (2002) included an analysis of the underwater noise that from two aircraft recorded at 9.8 and 59 feet (3 and 18 meters) depth, a Bell 212 helicopter and a fixed-wing De Havilland Twin Otter. The helicopter was 7 to 17.5 dB louder than the fixed-wing aircraft, with a peak received level of approximately 126 dB re 1 μPa. Sound levels decreased considerably with flight altitude.

North Atlantic right whale approach regulations (50 CFR 222.32) prohibit approaches within 500 yards. BOEM will require all aircraft operations to comply with current approach regulations for any sighted North Atlantic right whales or unidentified large whales.

Cable Installation

In the BA, BOEM indicates that noise produced during cable laying includes dynamic positioning (DP) thruster use. The sound source-level assumption employed in the underwater acoustic analysis was 177 dB re 1 μPa at 1 meter and a vessel draft of 8 feet (2.5 meters) for placing source depth. 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

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. BOEM notes that much 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). These 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). Recent publications have provided more information on operational noise including from larger, direct drive turbines (HDR 2023, Bellman et al. 2023, Holme et al. 2023). Our analysis of operational noise has been updated to reflect this more recently available literature. Consistently, the available scientific literature concludes that, regardless of turbine or foundation type, 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 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 Vineyard Wind project and its 13 MW direct-drive GE Haliade-X WTGs. Further, as noted by Tougaard et al. (2020), as the turbines also become higher with larger capacity (i.e. they are further above the water), 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. Comparison of in-situ measurements of operational noise to predicted outcomes from these models (see Bellman et al. 2023, Holme et al. 2023, both described further below), indicates that the Stober and Thomsen 2021 modeling significantly overestimates actually measured operational noise of turbines. Therefore, consistent with the determination made in our 2021 Opinion, Stober and Thomsen (2021) is not considered the best available scientific information for estimating operational noise levels of the Vineyard Wind turbines. We also note that Tougaard et al. (2020) and Stober and Thomsen (2021) both note that operational noise is less than shipping (i.e., vessel) noise; this suggests that in areas with consistent vessel traffic, such as the Vineyard Wind lease area, operational noise may not be detectable above ambient noise.

Elliot et al. (2019)[28] 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 30 km west of the proposed SFWF. 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); this is consistent with findings reported in Bellman et al. 2023. However, we note that HDR 2023 (see below) found differences in operational noise from the BIWF and CVOW turbines that could be related to differences in foundation types. Thus, the extent to which foundation types may influence of underwater noise from operations is at least partially unresolved. However, we note that, across foundation types, underwater operational noise levels are largely consistent and that most studies have not found meaningful differences in underwater operational noise across foundation types.

For the BIWF, 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 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.

Elliot et al. (2019) presented a representative high operational noise scenario at an observed wind speed of 15 m/s (approximately 54 kmh), 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.

[28] Also cited elsewhere as HDR 2019 or BOEM OCS Study 2019-028. Available online at: https://espis.boem.gov/final%20reports/BOEM_2019-028.pdf

Table 7.1.2. Frequency weighted underwater noise levels, based on NMFS 2018, at 50 m from an operational 6-MW WTG at the Block Island Wind Farm

Species Hearing Group	Instantaneous dB SEL*		Cumulative dB SEL†	
	10 Hz to 8 kHz	10 Hz to 20 kHz	10 Hz to 8 kHz	10 Hz to 20 kHz
Unweighted	121.2	127.1	170.6	176.5
LFC (North Atlantic right whale, fin whale, sei whale)	103.0	122.5	152.4	171.9
MFC (sperm whale)	79.0	123.3	128.4	172.7

Source: Elliot et al. (2019) in BOEM's January 2021 BA.
* 1-second SEL re 1 μPaS2 at 15 m/s (33 mph) wind speed. 1sec SEL = RMS
† Cumulative SEL re 1 μPaS2 assuming continuous 24 exposure at 50 m from WTG foundation operating at 15 m/s.

Elliot et al. (2019) also summarizes sound levels sampled over the full survey duration. These averages used data sampled between 10 PM and 10 AM each day to reduce the risk of sound contamination from passing vessels. The loudest noise recorded was 126 dB re 1uPa at 50 m from the turbine when wind speeds exceeded 56 km/h; at wind speeds of 43.2 km/h and less, measured noise did not exceed 120 dB re 1uPa at 50 m from the turbine. As summarized in the COP Appendix III-I, average wind speeds in the lease area (based on a 10-year query of historical weather data from NOAA Nantucket Shoals Monitoring Station 44008), are 19.2 km/h (6.1 m/s or 11.9 knots). The maximum observed wind speed from 2007 to 2017 occurred during Extratropical storm Noel in November in 2007 (94.27 km/h or 50.9 knots). A recent query of the data indicates that wind speed exceed 43 km/h 9% of the time during 2023 and wind speed exceeding 56 km/h 1% of the time during 2023. Similar results were observed in 2022 and 2021 (all data available at: https://www.ndbc.noaa.gov/histsearch.php?station=44008). These winds were experienced at Station 44008 November 3-4 during; N between 17.5 and 35 km/h and exceed 54 km/h less than 5% of the time.

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

Underwater acoustic monitoring was conducted under BOEM's Real-Time Opportunity for Development Environmental Observations (RODEO) Program after CVOW's two turbines became operational off the coast of Virginia (HDR 2023). As described in the report, the objective of the monitoring was to measure and analyze underwater sound levels within the water column and seafloor sediment vibrations generated by the operating monopile turbines. The two operating WTGs are Siemens Gamesa's 6 MW SWT-6.0-154 direct drive turbines with 154 m rotors installed on 7.8 m diameter monopile foundations. Underwater noise data were collected using one Geosled and two Ocean Bottom Seismometers; one RBRconcerto conductivity, temperature, and depth logger was also deployed approximately 1.3 km from Turbine A01 and 352 meters (m) from Turbine A02. The unattended systems collected data over approximately 40 days from December 13, 2021 to January 24, 2022 (HDR 2023). Analyses of operational phase underwater acoustic monitoring data indicated that noise levels recorded during turbine operations ranged from 120 to 130 dB re 1 µPa except during storms, when the received levels increased to 145 dB re 1 µPa. Recorded particle acceleration levels were compared to published behavioral audiograms of selected fish species and were found to be below the respective hearing thresholds for these species. Additionally, all recorded measurements were below the NMFS criteria for TTS and PTS for marine mammals. Results also indicated that operational phase sound levels recorded at CVOW were higher (10 to 30 dB) than those previously recorded at the BIWF at frequencies below approximately 120 Hz. At frequencies above 120 Hz, CVOW operational phase monitoring results were broadly consistent with operational phase acoustic monitoring previously conducted at BIWF and wind farms in Europe. The report indicates that these differences may be attributable to the differences in foundation types and the vibrations in the monopile structures but that this requires further investigation (monopiles at CVOW, lattice jacket at BIWF); we also note that while the WTGs at both projects are 6 MW direct drive turbines they have different manufacturers. (HDR 2023).

Holme et al. 2023 examined underwater noise measurements recorded within and outside operating offshore wind farms consisting of 6.3 MW (direct-drive) and 8.3 MW (planetary gear) turbines, considering data collected over a 5 week period from multiple hydrophones located between 70 m and 5 km from operating WTGs. All three wind projects (Gode Wind 1 and 2, Borkum Riffgrund 2, all in the North Sea, Germany) monitored have depths of approximately 30 m. Data were collected to facilitate a statistical examination of how the magnitude of underwater noise changes with turbine activity (power production data) and natural fluctuations (e.g., tides and wind). Additionally, the authors compared recorded noise levels to simulated noise levels from a published empirical model (Tougaard et al. 2020, Stober and Thomsen 2021, both described above), showing that the model's extrapolated noise levels greatly exceeded that of the in-situ recordings. The data reported by Holme et al. showed no noticeable differences on the broadband SPL between the two foundation types assessed in the study (monopiles and suction bucket jackets). The authors found no changes to the ambient broadband SPL from either 6.3 or 8.3 MW operating wind turbines. While this partly was attributed to the high ambient noise levels of the German Bight, the authors concluded that natural effects (e.g., wind speed and tidal changes) were the dominating forces behind changes to the ambient noise levels.

Bellman et al. 2023 evaluated data from all German offshore wind farms included in the MarinEARS database (MarinEARS - Marine Explorer and Registry of Sound; specialist information system for underwater noise and national noise registry for noise events (continuous and impulsive noise) in the German EEZ of the North- and Baltic Sea to the EU in accordance with the MSFD (https://marinears.bsh.de). This database includes data for 27 operational and 12 background noise measurements in 24 wind farms with 16 different WTG-types from seven different manufacturers and nominal power between 2.3 and 8.0 MW, installed on five different foundation structures; there were three measurement positions per wind farm, each with three defined operating states of the turbines. The authors concluded that the evaluation of noise conditions during the operation of offshore wind farms inside and outside wind farms is extremely complex, as noise input from wind turbines in operation and from wind farm-related service traffic do not differ significantly in time or space from background noise already present in the surroundings. Specific findings include: Noise input from operating offshore wind turbines is basically characterized by low frequencies; these low-frequency noise inputs into the water are only dominating the broadband Sound Pressure Level in the immediate vicinity of the turbines (~ 100 m) and when the turbines are operating close to their nominal power. The mean (broadband) total Sound Pressure Level (SPL50 or L50) at nominal power of the turbines varies between 112 and 131 dB (median and mean value 120 dB). The mean Sound Pressure Level (L50) from the 1/3-octave-band with the dominant component of the natural frequency of the system varies between 102 and 126 dB (median and mean value 114 dB); no evaluation-relevant differences based on water depths (20 to 40 m); The natural frequencies of the turbines tend to be lower-frequency (≤ 80 Hz) for direct-drive resp. gearless turbines and are also "quieter" than turbines with gearboxes; and, a significant correlation between the noise and foundation structure could not be determined.

Importantly, the authors concluded that a strong correlation between the noise inputs and the nominal power of the turbines (between 2.3 and 8.0 MW) could not be found. They noted turbines with a higher nominal power to be slightly quieter than turbines with a lower nominal power (on average ≤ 5 MW 122.8 dB, > 5 MW 120.0 dB); however, they note that this may also be due to larger, newer turbines mostly being direct drive rather than gearbox. The tonal, low-frequency components of the turbines in operation can usually still be measured outside the wind farms up to distances of a few kilometers, but with increasing distance, they mix with the general background noise level, so that the emitted noise is no longer dominating the broadband Sound Pressure Level (signal-to noise-ratio < 6 dB). The authors conclude that low-frequency noise input from the wind turbine is no longer audible to individual marine mammals at distances of 100 m from the turbine. The background noise level outside the wind farms is mostly dominated by non-wind farm-related shipping traffic outside the wind farms and varies strongly in different directions to a wind farm. (Bellman et al. 2023).

Like Holme et al. (2023), Bellman et al. (2023) evaluated in-situ measurements in comparison to the predictions made by modeling approaches (Tougaard et al. 2020, Stober and Thomsen 2021). Consistent with the findings of Holme et al. 2023, the authors concluded that these modeled predictions lead to considerable overestimations of the actually measured operational noise of turbines of up to 8 dB and that other modeling components could not be validated.

The WTGs being installed at Vineyard Wind (GE Haliade-X 13 MW) use the newer, direct-drive technology. The results from the available in-situ operational noise measurements (Elliot et al. 2019, HDR 2023, Holme 2023, Bellman et al. 2023) all have consistent findings across a range of turbine sizes, geographic areas, water depths, and foundation types. As such, and given the issues with modeled predictions outlined above including the findings of Bellman et al. 2023 and Holme 2023 that the modeled predictions significantly overestimate underwater noise from operational turbines, we consider the published in-situ measurements cited herein to represent the best available data on operational noise that can be expected from the operation of the Vineyard Wind turbines. We acknowledge that as the Vineyard Wind turbines will have a greater capacity (13 MW) than the turbines reported in these papers there is some uncertainty in operational noise levels. However, we note that Bellman et al. (2023) did not identify a strong correlation between noise and the nominal power of the turbines (between 2.3 and 8.0 MW) and that even the papers that predict greater operational noise note that operational noise is less than shipping noise. In consideration of the literature cited here, we expect that operational noise will typically be 130 dB or less and be detectable above ambient by any listed species at only short distances from any foundation (less than 100 m).

HRG Surveys
As part of the proposed action for consultation in this opinion described in Section 3, Vineyard Wind will carry out high-resolution geophysical (HRG) surveys to complete required monitoring of the cabling over the life of the project and for site clearance activities during decommissioning. The HRG surveys would use only electromechanical sources such as boomer, sparker, and chirp subbottom profilers; side-scan sonar; and multibeam depth sounders. No air guns are proposed for use. The 2024 proposed IHA does not address HRG surveys as no HRG surveys that would be expected to result in any MMPA take of marine mammals are anticipated during the effective period of the IHA. The information in this section has been reorganized for clarity.

A number of measures to minimize effects to ESA listed species during HRG operations are required by BOEM as conditions of COP approval (see part 5.8). Through conditions of COP approval, BOEM requires Vineyard Wind to comply with clearance and shutdown zones for all equipment operating below 180 kHz, implement vessel strike avoidance and equipment shutdown and restart protocols, utilize trained third party PSOs, and carry out reporting.

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. Anticipated distances from the HRG sound sources to noise thresholds of concern are presented in the species specific analyses below.

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.

The table below (7.1.4) identifies all the representative survey equipment described in BOEM's BA (and therefore considered part of the proposed action) that operate below 180 kilohertz (kHz) (*i.e.,* at frequencies that may be audible to the different ESA listed species in the action area) that is proposed for use in planned geophysical survey activities. Equipment with operating frequencies above 180 kHz and equipment that does not have an acoustic output (*e.g.,* magnetometers) may also be used but are not discussed further because they are outside the general hearing range of ESA listed species in the action area or do not produce noise and thus will have no effect on such species.

Table 7.1.4: Acoustic Characteristics of Representative HRG Survey Equipment

HRG Source	Source Level (dB re 1 μPa at 1m)			Main Pulse Frequency (kHz)	Pulse Duration (seconds)	Pulses per Second (PPS)
	PK-PK	RMS	SEL			
Boomers	219	207	176	4.3	.0008	1
S-Boom	213	203	172	3.8	.0009	3
Bubble Gun	207	198	173	1.1	.0033	8
Sparkers	229	214	188	2.7	.0022	6
EdgeTech Sub-bottom Profiler	191	180	159	6.3	.0087	8
Knudsen 3202 Sub-bottom Profiler	220	209	193	3.3	.0217	4
Acoustic Corer Sub-bottom Profiler	-	190	-	6	481.5	16.6
Reson Seabat 7111 Multibeam Echosounder	233	224	185	100	.00015	20
Reson Seabat T20P Multibeam Echosounder	226	218	182	>200	.00025	50
Echotrac CV100 Single-Beam Echosounder	202	193	159	>200	.00036	20
Klein 3900 Side-Scan Sonar	232	220	179	>200	.000084	unreported

Source: BOEM's BA. Highest reported source levels reported in Crocker and Fratantonio (2016).

The boomer and sparker, as well as some of the sub-bottom profilers, operate at a frequency that is detectable by the ESA listed whales, sea turtles, and Atlantic sturgeon in the action area. Assessments of exposure by these species to the noise sources is addressed in the species group sections below.

7.1.2 Effects of Project Noise on ESA Listed Whales

Background Information – Acoustics and Whales

The *Federal Register* notice prepared for the Proposed IHA (84 FR 18346; April 30, 2019) 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 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, 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 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 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.

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. 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. 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.

Criteria Used for Assessing Effects of Noise Exposure to Sei, Fin, Sperm, and Right 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[29]). 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).

Table 7.1.5. 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[30]	Permanent Threshold Shift Onset[31]	Temporary Threshold Shift Onset
Low-Frequency Cetaceans (LF: baleen whales)	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

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

[30] 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).

[31] $L_{pk,flat}$: 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 ($_{24h}$)

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. 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 B harassment. The 160 dB re 1uPa rms value 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. 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. In the context of MMPA ITAs, among Level B exposures, NMFS OPR's Permits and Conservation Division does not distinguish between those individuals that are expected to experience TTS and those that would only exhibit a behavioral response.

Effects of Project Noise on ESA Listed Whales
Fin, sei, sperm, and right whales may be exposed to increased underwater noise during construction, operation, and decommissioning of the Vineyard Wind project. As explained above in section 3, NMFS OPR is proposing to authorize take by Level B harassment of a number of fin, sei, sperm, and right whales, and take by Level A harassment of fin and sei whales as a result of exposure to noise from pile driving for the installation of the remaining 15 monopile foundations. Vineyard Wind did not apply for an IHA 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 noise. No serious injury or mortality is expected to result from exposure to any project noise sources and none is proposed to be authorized through the MMPA ITA. As described below, NMFS GARFO has carried out our own independent analysis of these noise sources in the context of the ESA definition of take.

Here, we consider the effects of exposure and response to underwater noise during construction, operations, and decommissioning in the context of the ESA. Information on the relevant acoustic thresholds and a summary of the best available information on likely responses of whales to underwater noise is presented above.

More information on Vineyard Wind's IHA application and details of the acoustic modeling is available in the *Federal Register* notice of the proposed IHA (89 FR 31008; April 23, 2024), the IHA application (available at: https://www.fisheries.noaa.gov/action/incidental-take-authorization-vineyard-wind-1-llc-construction-vineyard-wind-offshore-wind), Pyc et al. 2018, and the 2023 SFV Report (Küsel et al. 2024).

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 and authorized 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[32]). We have independently evaluated and adopted OPR's analysis of the number of fin, right, sei, and sperm whales expected to be exposed to foundation installation 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.

Foundation Pile Driving

As noted above, the updated acoustic thresholds for impulsive sounds (such as impact pile driving) contained in the NMFS Technical Guidance (NMFS, 2018) are dual metric acoustic thresholds using both SEL_{cum} and peak sound pressure level metrics (Table 7.1.5). 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. Considering acoustic range, 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 three hours of pile driving to install a monopile); this contrasts to exposure range which models the "closest point of approach" (exposure ranges are not used in this analysis). Acoustic ranges ($R_{95\%}$) to the Level A harassment SELcum metric thresholds are generally considered to be conservative as the accumulation of acoustic energy does not account for animal movement and behavior and therefore assumes that animals are essentially stationary at that distance for the entire duration of the pile installation, a scenario that does not reflect realistic animal behavior. Because NMFS Level A peak and Level B harassment thresholds are an instantaneous exposure, acoustic ranges are typically used in that context, and are in this analysis.

As described in the 2021 Opinion, modeling was carried out to determine distances to the onset of injury and behavioral disruption thresholds for marine mammals exposed to pile driving sound

[32] Available at: https://www.fisheries.noaa.gov/national/laws-and-policies/protected-resources-policy-directives. Last accessed June 26, 2024.

for installation of monopile and jacket foundations installed with an impact hammer (Pyc et al. 2018). During the 2023 Vineyard Wind pile driving, Vineyard Wind conducted the required SFV (Küsel *et al.,* 2024) to compare in-situ pile driving noise with the results of the 2018 modeling. SFV was carried out for pile driving of the first 12 monopile foundations, which were installed from June 6 through September 7, 2023. Vineyard Wind and NMFS OPR determined that 5 of the 12 acoustically monitored monopiles were determined to be representative of the noise attenuation system (NAS) configuration and maintenance schedule that would be used for the remaining 15 monopile foundations. These five representative monopiles (piles 7, 8, 10, 11, and 12 in the Vineyard Wind SFV Monitoring Report) were installed with a DBBC and Hydrosound Damper System (HSD) and with the enhanced bubble curtain maintenance (see above). Peak (pk), SEL, and RMS SPL received distances for each of these five piles are reported in the VW1 SFV Final Report Appendix A (Küsel *et al.,* 2024). For additional details on how acoustic ranges were derived from SFV measurements, see the VW1 SFV Final Report sections 2.3 and 3.3 (Küsel *et al.,* 2024).

Table 7.1.6 describes the key piling assumptions and proposed impact pile driving schedule for the remaining 15 foundations. These assumptions and schedule are based upon the 2023 piling and hammer energy schedule for installing monopiles; Vineyard Wind expects installation of the 15 remaining piles will be comparable. Further, as described in detail in section 6.1 of Vineyard Wind's IHA application, the water depth and bottom type are similar throughout the Lease Area and therefore sound propagation for these 15 piles is not expected to differ from where the SFV data were collected in 2023.

Table 7.1.6—Key Piling Assumptions and Hammer Energy Schedule for Monopile Installation

Pile type	Project component	Max hammer energy (kJ)	Number of hammer strikes	Max piling time duration per pile (min)	Number piles/day
9.6-m monopile	WTG	4,000	2,884-4,329 (average 3,463) [a]	117	1

[a] The number of hammer strikes represent the range of strikes needed to install the 12 monopiles for which SFV was conducted in 2023.

As part of their new IHA application, Vineyard Wind compared the acoustic ranges to the Level A harassment and Level B harassment thresholds derived from the 2018 acoustic modeling (Pyć *et al.,* 2018) to the maximum ranges (measured with absorption) for the five representative monopiles. For low and mid frequency cetaceans (i.e., right, fin, sei, and sperm whales), the maximum measured range to the peak and cumulative Level A thresholds for the five representative monopiles was less than the maximum 2018 modeled ranges, assuming 6 dB of attenuation (table 7.1.7). To avoid underestimating estimated take, Vineyard Wind used the modeled ranges (rather than the smaller measured distances) to estimate expected distance to the Level A harassment threshold in their estimated take analysis; NMFS OPR adopted that approach in the proposed IHA. We agree that this is a reasonable approach given the inherent variability in pile installation noise. For monopile foundations, the 2018 modeling predicted the distance to the peak Level A threshold for low frequency cetaceans would be 17m and for mid-frequency cetaceans would be 5 m. There were no indications from the 2023 SFV reports that noise above the peak Level A threshold exceeded the modeled distances.

Table 7.1.7—Modeled and Measured Ranges to SEL $_{cum}$ PTS Thresholds for Marine Mammal Hearing Groups

Marine mammal hearing group	Modeled range to SEL $_{cum}$ PTS threshold (km) [a]	Measured maximum range to SEL $_{cum}$ PTS threshold (km) [b]
Low-frequency cetaceans (fin, sei, right)	3.191	2.37
Mid-frequency cetaceans (sperm whales)	0.043	0.01

[a] Based upon modeling conducted for the 2023 IHA (Pyć *et al.,* 2018)
[b] Based upon the five representative monopiles from the Vineyard Wind 2023 construction campaign (Küsel *et al.,* 2024).

The maximum range with absorption to the Level B harassment threshold for the five representative piles was 5.72 km (3.6 mi) (pile 13, AU-38; Küsel *et al.,* 2024), which was greater than the 2018 modeled distance to the Level B harassment threshold of 4.1 km (2.5 mi) (Pyć *et al.,* 2018). In their 2023 IHA application, Vineyard Wind based the expected distance to the Level B harassment threshold and associated estimates of exposure on the 5.72-km distance. NMFS OPR adopted this approach in the proposed IHA and used this 5.72 km distance to develop the amount of take proposed for authorization through the IHA. We agree that this is a reasonable approach as it reflects the real world conditions monitored during 2023 and using the modeled results could result in underestimating distances and associated exposure of ESA listed whales.

To calculate the number of each ESA listed species that may be exposed to noise above the Level A harassment thresholds, Vineyard Wind first used animat modeling to estimate the number of each marine mammal species that would be expected to be exposed to noise above the Level A harassment threshold (and therefore, would be expected to experience PTS), during pile driving. Please see the notice of proposed IHA and Vineyard Wind's IHA application for a complete description of the modeling approach including a description of JASCO's Animal Simulation Model Including Noise Exposure (JASMINE) animal movement modeling. As described therein, sound exposure models like JASMINE use simulated animals (also known as "animats") to forecast behaviors of animals in new situations and locations based upon previously documented behaviors of those animals. The predicted 3D sound fields (i.e., the output of the acoustic model, in this case, the distance to the Level A cumulative harassment threshold) are sampled by animats using movement rules derived from animal observations. The output of the simulation is the exposure history for each animat within the simulation. The precise location of animats and their pathways are not known prior to a project; therefore, a repeated random sampling technique (i.e., Monte Carlo) is used to estimate exposure probability with many animats and randomized starting positions. The combined exposure history of all animats gives a probability density function of exposure.

As described in the notice of proposed IHA, since the time that the JASMINE animal movement modeling was conducted for the 2023 IHA (86 FR 33810, June 25, 2021), no new behavior data is available that would have changed how animats move in time and space in that model and, therefore, NMFS OPR determined that the JASMINE outputs from the 2018 modeling effort are reasonable for use in the 2024 proposed IHA. However, as explained in the notice of proposed IHA, more recent density data is available (Roberts et al. 2023), which has been used to calculate the number of expected exposures.

For each of the ESA listed whale species, the mean number of modeled animats predicted to be exposed to noise above the Level A cumulative threshold per day (using the modeled distance to the Level A threshold as described above, 3.19 km), were scaled by the maximum monthly density for the area where pile driving would occur (Roberts et al. 2023). This results in an estimate of the number of individuals predicted to be exposed to noise above this threshold for a single pile driving event. This number of animals was then multiplied by the expected number of days of pile installation (15 days) to derive a total number of individuals predicted to be exposed to noise above the cumulative Level A harassment threshold for each species. Because we do not know which of the months in the pile driving window that pile driving will occur, this results in a reasonable prediction of the upper limit of likely exposures and avoids underestimating exposure which could occur in the mean density across the June – December was used.

To estimate the amount of take by Level B harassment incidental to installing the remaining 15 piles, Vineyard Wind applied a static method (*i.e.,* did not conduct animal movement modeling). Vineyard Wind calculated the Level B harassment ensonified area using the following equation:

$A = 3.14 \times r^2$,

where A is equal to the ensonified area and r is equal to the radial distance to the Level B harassment threshold from the pile driving source ($r\text{Level}_{\text{B harassment}}$ = 5.72 km).

The ensonified area (102.7 km^2) was multiplied by the mean maximum monthly density for each species (table 7.1.8) and the expected number of days of pile driving (15 days) to provide a density-based estimate for the number of individuals of each species predicted to be exposed to noise above the Level B harassment threshold. The number of potential exposures by Level B harassment was estimated for each species using the following equation:

Density-based exposure estimate of Level B harassment = ensonified area (km^2) × maximum mean monthly density estimate (animals/km^2) × number of days (15).

It is important to note that none of these estimates incorporated any aversion behavior nor did they incorporate any anticipated reductions in exposure that would result from following the required clearance and shutdown measures.

As noted above, Vineyard Wind applied the 2022 Duke University Marine Geospatial Ecology Laboratory Habitat-based Marine Mammal Density Models for the U.S. Atlantic (Duke Model-Roberts *et al.,* 2016, 2023) to estimate take from foundation installation. The models estimate absolute density (individuals/km^2) by statistically correlating sightings reported on shipboard and aerial surveys with oceanographic conditions. For most marine mammal species, densities are provided on a monthly basis. The Duke habitat-based density models delineate species' density into 5 × 5 km (3.1 × 3.1 mi) grid cells. Vineyard Wind calculated mean monthly densities by using a 10-km buffered polygon around the remaining WTG foundations to be installed and overlaying this buffered polygon on the density maps. The 10-km buffer defines the area around the area used to calculate mean species density. Mean monthly density for each species was determined by calculating the unweighted mean of all 5 × 5 km grid cells (partially or fully) within the buffered polygon. The unweighted mean refers to using the entire 5 × 5 km (3.1 × 3.1 mi) grid cell for each cell used in the analysis, and was not weighted by the proportion of the cell overlapping with the density perimeter if the entire grid cell was not entirely within the buffer zone polygon. Vineyard Wind calculated densities for each month. Vineyard Wind used maximum monthly density from June to December for density-based calculations as this is the period when pile driving could occur.

Table 7.1.8—Maximum Mean Monthly Marine Mammal Density Estimates (Animals per km^2) Considering a 10- km Buffer Around the Limited Installation Area

Species	Maximum mean density	Maximum density month
NARW	0.0043	December.
Fin whale	0.0036	July.
Sei whale	0.0008	November.
Sperm whale	0.0008	September.

As described in the notice of proposed IHA, Vineyard Wind and OPR also considered observations recorded by protected species observers (PSO) during surveys and construction for southern New England (ESS Group, 2016; Vineyard Wind, 2018, 2019, 2023a-f) as well as information on mean group size data compiled from the Atlantic Marine Assessment Program for Protected Species (AMAPPS) (Palka *et al.,* 2017, 2021) to determine if the density-based exposure estimates may be insufficient to account for the number of individuals of a species that may be encountered during the planned activities. However, for each ESA listed species, the PSO data-based exposure estimate was less than the density-based exposure estimate (see table 14 in the ITA application) and, therefore, for these species, density-based exposure estimates were not adjusted according to PSO data-based exposure estimates. In cases where the density-based Level B harassment exposure estimate for a species was less than the mean group size-based exposure estimate, the amount of take proposed for authorization was increased to the mean group size and rounded to the nearest whole number (table 7.1.9).

Table 7.1.9—Mean Marine Mammal Group Sizes Used in Take Estimate Calculations

Species	Mean group size	Source
NARW *	2	Table 6-5 of Palka *et al.,* 2021.
Fin whale *	1.2	Palka *et al.,* 2021.
Sei whale *	1	Palka *et al.,* 2021.
Sperm whale *	2	Palka *et al.,* 2021.

Here we present the amount of take requested by Vineyard Wind and proposed to be authorized by NMFS OPR. We have reviewed the methods (described above) to estimate take and agree that the approach used by NMFS OPR is based on the best available scientific information and is a reasonable approach to predicting exposures to noise above the identified thresholds and agree with NMFS OPR's determination that the amount of take proposed for authorization, appropriately consider SFV measurements collected in 2023 and represent the maximum amount of take that is reasonably expected to occur.

Table 7.1.10 Number of individuals predicted to be exposed to noise above the Level A and Level B Harassment Thresholds

Species	Density-based exposure estimates	
	Level A Harassment	**Level B Harassment**
NARW	0.503	6.6
Fin whale	0.598	5.5
Sei whale	0.144	1.2
Sperm whale	0	1.2

Table 7.1.11 Amount of take by Level A and Level B harassment proposed for authorization in OPR's proposed IHA

Species	Amount of Take Proposed for Authorization in the MMPA IHA	
	Level A Harassment	**Level B Harassment**
NARW	0	7
Fin whale	1	6
Sei whale	1	2
Sperm whale	0	2

Due to the enhanced mitigation measures for North Atlantic right whales, Vineyard Wind did not request any Level A take of right whales. NMFS OPR determined that with the implementation of the mitigation measures required by the proposed MMPA IHA, no Level A takes of North Atlantic right whales are expected. As described in section 3, these measures are considered part of the proposed action we are consulting on.

Consideration of Measures to Minimize Exposure of ESA Listed Whales to Pile Driving Noise

Here, we consider the measures that are part of the proposed action, either because they are required by BOEM as conditions of COP approval, or are required by NMFS OPR as conditions of the proposed IHA, and how those measures will serve to minimize exposure of ESA listed whales to pile driving noise during the installation of the remaining 15 foundations. Details of these measures are included in the Description of the Action section above and Appendix A and B.

Seasonal Restriction on Pile Driving
As required by the proposed IHA, no pile driving activities would occur between January 1 and May 31 to avoid the time of year with the highest densities of right whales in the project area. Note that this is a broader time of year restriction than what is considered in our 2021 Opinion as it now excludes the potential for pile driving in May. The January 1 to May 31 seasonal restriction is factored into the acoustic modeling that supported the development of the amount of MMPA take proposed to be authorized through the IHA. That is, the modeling does not consider any pile driving in the January 1 – May 31 period. Thus, the take estimates do not need to be adjusted to account for this seasonal restriction.

Sound Attenuation Devices and Sound Field Verification
As required by BOEM's conditions of COP approval, for all impact pile driving, Vineyard Wind is required to implement sound attenuation technology that would target at least a 12 dB reduction in pile driving noise, and that must achieve at least a 6 dB reduction in pile driving noise, as described above. The proposed IHA includes requirements for sound attenuation as well as sound field verification. Together, the purpose of the requirements to utilize sound attenuation devices (also referred to as noise or sound mitigation measures) and sound field verification (i.e., in situ noise monitoring during pile installation) are to ensure that Vineyard Wind does not exceed the distances to the Level A and Level B harassment thresholds for ESA listed marine mammals that underpin the analysis in the proposed IHA and this Opinion. The sound field verification related measures are based on the expectation that Vineyard Wind's initial pile driving methodology and sound attenuation measures (inclusive of the required enhanced maintenance) will result in noise levels that do not exceed the identified distances but, if that is not the case, provide a step-wise approach for modifying or adding sound attenuation measures that can reasonably be expected to achieve those metrics prior to the next pile being installed.

As explained above, the distances to the Level A and Level B harassment thresholds used to develop the amount of take proposed for authorization are based on modeling that incorporates a 6 dB reduction in pile driving noise (Level A cumulative) or are based on in-situ measurements of pile driving noise with the required noise attenuation measures in place. Thus, the take estimates do not need to be adjusted to account for the use of sound attenuation. If a reduction greater than 6 dB is achieved, the actual amount of take could 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 the required sound attenuation for impact pile driving can be achieved assuming proper deployment and maintenance of devices. This was achieved during the 2023 Vineyard Wind pile driving when there was proper deployment and continuous maintenance of a dBBC plus a nearfield attenuation device as will be required for the remaining pile driving.

As required by the proposed IHA, Vineyard Wind will conduct thorough sound field verification for at least the first monopile and abbreviated SFV on all piles for which thorough SFV is not carried out. Additional details of the required sound field verification are included in the notice of proposed IHA.

The required sound field verification will provide information necessary to confirm that the sound source characteristics predicted are reflective of actual sound source characteristics in the field. As described in the conditions of the proposed IHA, if sound field verification measurements on any of the monopiles indicate that the ranges to Level A harassment or Level B harassment isopleths are larger than those expected and used in the analysis, Vineyard 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. There are also provisions to expand the clearance and shutdown zones based on the sound field verification measurements. In the event that noise attenuation measures and/or adjustments to pile driving cannot reduce the distances to less than or equal to those considered in the take analysis, this may indicate that the amount or extent of taking specified in the incidental take statement has been exceeded or 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 is expected to be necessary. (50 CFR 402.16).

Clearance and Shutdown Zones
As described in Section 3, conditions of COP approval and the proposed IHA require monitoring of clearance and shutdown zones before and during impact pile driving. In addition to the clearance and shutdown zones, the proposed IHA identifies required minimum visibility zones for pile driving of the remaining 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 the remaining foundations, the minimum visibility distance is 4,000 m. As explained in the notice of proposed IHA, this value corresponds to the modeled Level A harassment distance for low-frequency cetaceans plus twenty percent, and rounded up to the nearest 0.5 km.

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. For example, if a right whale is observed at a distance of 6 km from a monopile that is ready to be installed, pile driving would be delayed. 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. The conditions of the proposed IHA require that the PAM monitoring system be capable of detecting vocalizing North Atlantic right whales within 10 km of the pile. Pile driving cannot commence until all visual and PAM these clearances are made.

As required by conditions of the proposed IHA, from November 1 to December 31, if pile driving has been delayed or stopped due to the observation of a right whale (at any distance) or acoustic detection within 10 km of the pile being driven, pile driving may not resume until the following day or until the animal is confirmed to have exited the 10 km zone by additional vessel surveys.

Once pile driving begins, the shutdown zone applies. If a marine mammal is observed by a PSO entering or within the respective shutdown zones after pile driving has commenced, an immediate shutdown of pile driving will be implemented unless Vineyard 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: a PSO observing a right whale at any distance (i.e., even if it is outside the shutdown zone identified for other whale species); or, a detection by the PAM operator of a vocalizing right whale at a distance determined to be within the identified PAM shutdown zone (10 km from the pile).

For sei and fin whales, the clearance and shutdown zone (extending 500 m from the pile) is smaller than the distance to the Level A cumulative threshold (3.19 km). For sperm whales, the clearance and shutdown zone (500 m) is larger than the distance to the Level A cumulative threshold (43 m, which is within the bubble curtains). For fin, sei, and sperm whales, the clearance and shutdown zone is smaller than the expected distance to the Level B threshold (5.72 km). For right whales, considering just the minimum visibility distance (4,000 m), this minimum clearance and shutdown zone is about 800 m larger than the expected distance to the Level A cumulative threshold.

Table 7.1.12. Required Clearance and Shutdown Zones for Foundation Pile Driving. These are the PAM detection, minimal visibility, and clearance and shutdown zones incorporated into the proposed action. Pile driving will not proceed unless the visual PSOs can effectively monitor the full extent of the minimum visibility zones. Detection (visual or PAM) of an animal within the clearance zone triggers a delay of initiation of pile driving; detection (visual or PAM) of an animal in the shutdown zone triggers the identified shutdown requirements.

Species	Clearance Zone (m)	Shutdown Zone (m)
Remaining Monopile Foundation Installation - Impact pile driving, visual PSOs and PAM		
Minimum visibility zone from each PSO platform (pile driving vessel and at least two PSO vessels): 4,000 m; PAM monitoring out to 10,000 m for all monopile foundations		
North Atlantic right whale – visual PSO and PAM monitoring	At any distance (minimum visibility zone plus any additional distance observable by the visual PSOs on all PSO platforms); At any distance within the 10 km zone monitored by PAM	At any distance (Applicable minimum visibility zone plus any additional distance observable by the visual PSOs on all PSO platforms); At any distance within the 10 km zone monitored by PAM
Fin, sei, and sperm whale –	500 m	500 m

source: Table 13 in 89 FR 731008

For impact pile driving, clearance zones will be monitored by at least three PSOs at the pile driving platform and at least three PSOs on each of at least two dedicated PSO vessels located at a distance to ensure effective monitoring of the clearance zone (for a total of at least 9 dedicated, third-party PSOs on duty at all times during pile driving). All distances to the edge of clearance zones are the radius from the center of the pile. The dedicated PSO vessels would be located at a distance determined to provide optimal coverage of the clearance and shutdown zones. The 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 detections 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 PSOs 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 fin, sei, and sperm whales, this means that the PSOs have not seen any individuals within the 500 m clearance zone. For right whales, this means that the PSOs have not seen any right whales in the minimum visibility zone (extending 4 km from the PSO platform) plus any additional distance that they can see beyond those areas and, during November and December, that pile driving is delayed until the following day following the observation or detection of a right whale (unless the 10 km clearance zone has been determined to be clear of right whales via vessel based survey). Similarly, the PAM operator must confirm that there have been no detections of vocalizing right whales in the PAM clearance zone (extending 10 km from the pile) for the preceding 60 minutes. If any 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 distance (4 km) for at least 30 minutes (i.e., clearance zone is fully visible for at least 30 minutes). As required by the conditions of COP approval and the proposed IHA, 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.

The requirement for the minimum visibility zones for foundation pile driving and the requirement that at least 9 PSOs be working from at least three platforms (3 PSOs at the pile driving platform, 3 on each of two dedicated-PSO vessels located at a distance from the pile), make it reasonable to expect that the full extent of the clearance zones will be effectively monitored and that large whales within this area will be detected by at least one of the PSOs. 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 and the PAM operator has made the required clearances based on detection of vocalizing whales.

The time of day when pile driving can begin is limited to daytime, which is defined as being between one hour after civil sunrise and 1.5 hours before civil sunset. 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. Pile driving may continue after dark only when: the driving of the same foundation began during the day when clearance zones were fully visible; it was anticipated that foundation installation could be completed before sundown; and, foundation installation must proceed for human safety or installation feasibility reasons (e.g., stopping would result in pile refusal or pile instability that would risk human life or safety). In such cases, monitoring must be carried out consistent with an approved monitoring plan for low visibility conditions. Given that the time to install the pile is expected to be predictable, we expect these instances of pile installation 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 vessels 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 a larger area can be monitored (in this case, extending 10 km from the pile being driven). 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 must be designed and established in a manner that will meet all the requirements of the proposed IHA. NMFS OPR is requiring that Vineyard Wind submit a PAM plan that must include a description of all proposed PAM equipment, address how the proposed passive acoustic monitoring will follow standardized measurement, processing methods, reporting metrics, and metadata standards for offshore wind as described in *NOAA and BOEM Minimum Recommendations for Use of Passive Acoustic Listening Systems in Offshore Wind Energy Development Monitoring and Mitigation Programs* (Van Parijs *et al.,* 2021). We note that a PAM plan was approved for the 2023 pile driving; NMFS OPR is requiring the plan be resubmitted for a subsequent review and approval to ensure it is compliant with the new IHA. With these requirements in place, we anticipate that use of PAM will be highly effective at detecting vocalizing marine mammals within the identified PAM monitoring zone (10 km), which will enhance the detection capabilities of the PSOs and increase the effectiveness of the clearance and shutdown requirements. If the PAM operator detects a right whale vocalization confirmed or suspected to be within the PAM clearance zone (10 km; the area that the PAM system will need to be able to effectively monitor for vocalizing right whales), the associated clearance or shutdown procedures must be implemented (i.e., delay or stop pile driving). As required by the conditions of COP approval and the proposed IHA, in the event that a large whale is acoustically detected that cannot be confirmed as a non-North Atlantic right whale, it must be treated as if it were a right whale for purposes of mitigation. More details on PAM operator training and PAM protocols are included in the proposed IHA.

If an ESA listed whale is observed entering or within the identified shutdown zone (see Table 7.1.12) 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 PAM detection of a North Atlantic right whale within 10 km of the pile. 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 Vineyard 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.

Additional clearance requirements are included in the proposed IHA for any pile driving in November and December. For foundation installation activities between November 1 - December 31, if a North Atlantic right whale is observed at any distance or acoustically detected with 10 km of the pile being driven, pile driving must be delayed or stopped and may not resume until the following day or until the animal is confirmed to have exited the zone via additional vessel surveys. If 3 or more North Atlantic right whales are observed at any distance, pile driving must be delayed until the following day.

As required by the proposed IHA, Vineyard Wind must conduct PAM for at least 24 hours immediately prior to foundation pile driving activities. The PAM operator must review all detections from the previous 24-hour period immediately prior to foundation pile driving activities. PAM operator(s), using a NMFS-approved PAM system, must monitor for marine mammals 60 minutes prior to, during, and 30 minutes following all pile driving activities. The real-time PAM system would be designed and established such that detection capability extends to 10 km from the pile driving location. The PAM operator must be trained in identification of mysticete vocalizations. Any detection of a right whale vocalization within 10 km of the pile or a vocalization that cannot be identified as non-right whale will trigger the clearance and/or shutdown requirements.

Consideration of the Effectiveness of Clearance and Shutdown Requirements
As explained above, noise above the Level A peak harassment threshold is not anticipated to exceed the modeled distances (17 m for LFC, 5 m for MFC). The bubble curtains will extend to approximately 150 m from the pile. Given these very small distances, we do not anticipate any exposure of any ESA listed whales to noise that could result in PTS due to a single pile strike. This is the same conclusion reached in our 2021 Opinion.

Modeling predicted the exposure of a small number of right, sei, and fin whales to noise above the cumulative Level A harassment threshold (see Table 7.1.10). No exposure of sperm whales that could result in PTS is expected based on the distance to the Level A harassment threshold for mid-frequency cetaceans being exceeded only at a distance less than 50 m from the pile. Given how close a sperm whale would need to be to the pile, and that the bubble curtains would extend beyond this distance, and that the clearance and shutdown zone is 10x larger than this distance, we consider that pile driving occurring when a sperm whale is that close to the pile to be extremely unlikely to occur; as such, PTS of sperm whales is discountable. This is the same conclusion reached in our 2021 Opinion.

As explained above, modeling predicts the exposure of less than 1 fin and less than 1 sei whale to noise above the Level A harassment threshold for the 15 remaining monopile foundations total (i.e., for all 15, not for a single foundation). For fin and sei whales, the clearance and shutdown zone is smaller than the range to the Level A cumulative threshold (500 m vs. 3,191 m). As such, while we expect that the PSOs will be able to detect fin and sei whales within the area where exposure to noise above the Level A cumulative threshold would occur, there would be no requirement to delay or stop pile driving upon detection unless the animal was within 500 m of the pile. Therefore, the clearance and shutdown requirements are not expected to reduce potential exposure of fin or sei whales to noise above the Level A cumulative threshold or reduce the risk of exposure to noise that could result in PTS; this is the same conclusion reached in our 2021 Opinion.

Right Whales

As explained above, modeling predicts the exposure of 0.503 right whales to noise above the Level A harassment threshold for the 15 remaining monopile foundations total (i.e., for all 15, not for a single foundation). Given that noise above the Level A peak threshold is not expected beyond 17 m and that the bubble curtains will extend to 150 m from the pile; exposure of any right whales to noise above the peak Level A threshold is extremely unlikely to occur.

The area with noise that would exceed the cumulative Level A threshold is expected to extend 3,191 m from a monopile foundation during active pile driving. Pile driving cannot commence unless the PSOs determine there is adequate visibility to monitor an area extending 4,000 m. Three sets of three PSOs will be deployed on three platforms, including three PSOs on an elevated location on the pile driving platform. PSOs will call for a delay of pile driving on the visual detection of a right whale at any distance (i.e., even if beyond the 4,000 m minimum visibility distance). 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 and will be deployed to detect vocalizations from right whales within 10 km of the pile. Detection of a vocalizing NARW by PAM within 10 km of the pile would trigger a delay. Additionally, as described in the proposed IHA, for any pile driving carried out in November and December, if a North Atlantic right whale is observed at any distance or acoustically detected with 10 km of the pile being driven, pile driving must be delayed and may not resume until the following day or until the animal is confirmed to have exited the zone via additional vessel surveys. The detection of three or more NARWs would delay pile driving until the next day. 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 lower 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 cannot be detected to species. Additionally, shutdown is required if a right whale is detected via PAM within 10 km 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 combined with the requirement for at least 9 visual PSOs stationed at three locations to be able to effectively monitor the clearance zone before pile driving and the shutdown zone during pile driving in a way that is expected to prevent pile driving from occurring if a right whale is close enough to pile driving such that exposure to noise above the Level A harassment threshold would occur (i.e., within 3.19 km of the pile). In the unanticipated event that a right whale swims towards a pile during pile driving, it is expected that it would be detected prior to getting close enough to be exposed to noise above the Level A harassment threshold; it is expected that pile driving will be stopped upon that detection 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. The slow swim speed of right whales makes it extremely unlikely that lower hammer energy could not be enacted before the whale was exposed to pile driving noise that could result in PTS (noting that as these are acoustic ranges, the modeling considers that a right whale would need to remain within 3.19 km of the pile for the entire duration of pile driving). 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. We expect that these measures in combination with the requirements for monitoring North Atlantic right whale sightings reports for surrounding areas daily, 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 any of the modeled exposure to noise above the Level A threshold, which already was small (fewer than 1 individual over the entirety of pile driving), will occur. 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, it is extremely unlikely that any right whales will experience permanent threshold shift or any other injury as a result of exposure to pile driving noise. This is the same conclusion we reached in our 2021 Opinion.

Given that the size of the area with noise above the Level B harassment threshold (up to approximately 5.72 km) is larger than the clearance and shutdown zone for fin, sei, and sperm whales (500 m), the exclusion and shutdown procedures may limit the duration of exposure of fin, sei, and sperm 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 or shutdown zone. We also note that while the enhanced measures for right whales, including clearance and shutdown that extends to a sighting at any distance, and the use of PAM which may detect vocalizing whales that are not detected by the visual observers, these measures are also likely to limit the duration of exposure of right whales to noise above the Level B harassment thresholds.

Soft Start

As described in the Notice of Proposed IHA, the use of a soft start procedure is expected 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. Conditions of the proposed IHA require Vineyard Wind to utilize soft start techniques for impact pile driving to include an initial set of four to six single hammer strikes at less than 40 percent of the maximum hammer energy from the impact hammer followed by at least a one-minute delay before the subsequent hammer strikes. This process (e.g., 4-6 single strikes, delay) must be repeated at least three times prior to initiation of pile driving 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. Through use of soft start, marine mammals are expected to move away from a sound source that is annoying, thereby avoiding exposure resulting in a serious injury and avoiding sound sources at levels that would cause hearing loss (Southall et al. 2007, Southall et al. 2016). It is possible that some whales may swim out of the noisy area before full force pile driving begins; in this case, the number of whales exposed to noise that exceeds the cumulative Level A harassment threshold would be reduced. It is likely that by eliciting avoidance behavior prior to full power pile driving, the soft start will reduce the duration of exposure to noise that could result in Level A or Level B harassment. However, we are not able to predict the extent to which the soft start will reduce the number of whales exposed to pile driving noise or the extent to which it will reduce the duration of exposure. Therefore, while the soft start is expected to reduce effects of pile driving, we are not able to modify the estimated take numbers to account for any benefit provided by the soft start.

Summary of Noise Exposure Anticipated as a Result of Foundation Pile Driving

In summary, we expect that no ESA listed whales will be exposed to noise above the peak Level A harassment threshold; up to 1 fin and 1 sei whale will be exposed to noise above the cumulative Level A threshold during impact pile driving; and up to 6 fin, 7 right, 2 sei, and 2 sperm whales will be exposed to noise above the Level B threshold but below the Level A harassment threshold during all remaining foundation pile driving. Below, we consider the effects of these noise exposures.

Effects to ESA Listed Whales from Exposure to Pile Driving Noise

Effects of Exposure to Noise above the Level A Harassment Threshold
As explained above, no more than one fin whale and one sei whale are expected to be exposed to pile driving noise that is loud enough to result in Level A harassment in the form of permanent threshold shift (PTS). Consistent with OPR's determination in the notice of issued IHA, in consideration of the duration and intensity of noise exposure we expect that the consequences of exposures above the Level A harassment threshold would be in the form of slight PTS. PTS would consist of permanent minor degradation of hearing capabilities occurring predominantly at frequencies one-half to one octave above the frequency of the energy produced by pile driving (i.e. the low-frequency region below 2 kHz) (Cody and Johnstone, 1981; McFadden, 1986; Finneran, 2015), not severe hearing impairment. If hearing impairment occurs, 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 perform essential behavioral functions, such as foraging, socializing, migrating, and communicating with conspecifics, or detecting environmental cues. No severe hearing impairment or serious injury is expected because of the received levels of noise anticipated and the short duration of exposure. 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). The PTS anticipated is considered a minor but permanent auditory injury and is considered harm in the context of the ESA definition of take.

The measures designed to minimize exposure, or effects of exposure, that will be required by NMFS OPR through the terms of the IHA and by BOEM through the conditions of COP approval and implemented by Vineyard Wind – all of which are considered part of the proposed action - make it extremely unlikely that any whale will be exposed to pile driving noise that would result in severe hearing impairment or serious injury. Severe hearing impairment or serious injury would require both greater received levels of noise and longer duration of exposure than are anticipated to result from the Vineyard Wind pile driving. While we anticipate minor injury and corresponding hearing loss due to PTS, the sound attenuation measures, clearance and shutdown requirements, and soft start all effectively limit the potential for exposure to noise that could result in severe hearing impairment or serious injury: those measures make necessary noise exposure at that level and duration extremely unlikely to occur.

PTS is permanent, meaning the effects of PTS last well beyond the duration of the proposed action and outside of the action area as animals migrate. As such, PTS has the potential to affect aspects of the affected animal's life functions that do not overlap in time and space with the proposed action. The PTS anticipated is considered a minor auditory injury. With this minor degree of PTS, we do not expect it to affect any of any individuals' overall health, reproductive capacity, or survival. The up to 1 fin and 1 sei whale that experience PTS could be less efficient at locating conspecifics and/or have decreased ability to detect threats at long distances, but these animals are still expected to be able to locate conspecifics to socialize, forage and reproduce, and are expected to be able to detect threats with enough time to avoid injury or mortality resulting from those threats. While PTS may affect the ability of an individual to use acoustic cues to respond to threats or stressors, the effects are not expected to be so severe to actually increase the risk that a fin or sei whale will be injured. That is, while PTS may affect the behavior of an affected fin or sei whale in a way that affects its ability to use acoustic cues to detect and respond to threats, we do not expect this response will be so impacted that it would actually result in a whale being hit by a vessel or becoming entangled in fishing gear or otherwise resulting in non-auditory injury or mortality. For this reason, we do not anticipate that the instances of PTS will result in any other injuries or any impacts on foraging or reproductive success, inclusive of mating, gestation, and nursing, or survival of any of the fin or sei whales that experience PTS.

Effects of Exposure to Noise above the Level B Harassment Threshold
Potential impacts associated with noise above the Level B harassment threshold but below the Level A harassment threshold 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. The up to 6 fin, 7 right, 3 sei, and 2 sperm whales exposed to noise above the Level B harassment threshold but below the Level A harassment threshold are expected to experience TTS, behavioral disturbance, and masking.

An extensive discussion of TTS is presented in the proposed MMPA IHA 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, alone, 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, thus, is a temporary hearing impairment and 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 Vineyard Wind's pile driving activities would not be expected to 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 will last for up to 3 hours at a time, it is unlikely that ESA listed whales would stay in the close proximity to the source long enough to incur more severe TTS (see additional explanation below regarding anticipated duration of exposure). Overall, given that we do not expect an individual to experience TTS from pile driving on more than one day, the low degree of TTS, and the short anticipated duration of exposure (no more than a few hours), and that it is extremely unlikely that any TTS will overlap 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 minutes to hours from the time of exposure. Effects of TTS resulting from exposure to Vineyard Wind project noise are addressed more fully below.

In order to evaluate whether or not individual behavioral responses, in combination with other stressors, impact animal populations, scientists have developed theoretical frameworks that can then be applied to particular case studies when the supporting data are available. One such framework is the population consequences of disturbance model (PCoD), which attempts to assess the combined effects of individual animal exposures to stressors at the population level (NAS 2017). Nearly all PCoD studies and experts agree that infrequent exposures of a single day or less are unlikely to impact individual fitness, let alone lead to population level effects (Booth et al. 2016; Booth et al. 2017; Christiansen and Lusseau 2015; Farmer et al. 2018; Harris et al. 2017; Harwood and Booth 2016; King et al. 2015; McHuron et al. 2018; NAS 2017; New et al. 2014; Pirotta et al. 2018; Southall et al. 2007; Villegas-Amtmann et al. 2015).

Since we expect that any exposures would be 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 the up to three hours of pile driving for a single foundation), and repeat exposures to the same individuals are unlikely (based on abundance, distribution and sightings data), 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 7 North Atlantic right whales may experience TTS and/or behavioral disturbance from exposure to pile driving noise during the installation of the remaining 15 monopile foundations. We expect that this will be up to 7 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 and transient nature of right whales in the area during the June – December period when pile driving would occur. That is, because right whales are not expected to stay in the limited area where pile driving will occur for any extended period of time (regardless of pile driving activity) we do not expect an individual to be persist in a single area for multiple days such that it could be exposed to multiple pile driving events.

When in the WDA where noise exposure would occur, one of the primary activities North Atlantic right whales are expected to be engaged in is migration. However, we also expect the animals to perform other behaviors, including opportunistic foraging, resting, and socialization (Quintana-Rizzo et al. 2021). If a North Atlantic right whale exhibited a behavioral response to the pile driving noise, the normal activity of the animals 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; these effects are addressed below. However, as noted previously, responses to pile driving noise are anticipated to be short-term (no more than about three hours).

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. Of the months defined in that paper as winter (December – February) and spring (March – May), pile driving could only occur in December. Given that the only overlap between observed social behavior and the pile driving window is 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 three 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 for the remaining 15 foundations, the area with noise above the Level B harassment threshold is expected to extend 5.72 km from the pile being driven. As such, a right whale that was at the pile driving location when pile driving starts (i.e., at the center of the area with a 5.72 km radius that will experience noise above the 160 dB re 1uPa threshold), we would expect a right whale swimming at maximum speed (9 kph) would escape from the area with noise above 160 dB re 1uPa the noise in about 30 minutes, but at the median speed observed in Hatin et al. (1.3 kph, 2013), it would take the animal approximately 4 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 (4 km, with a 10 km area required for clearance in December). 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 (three hours a day).

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 up to 7 individuals exposed to noise above the Level B harassment threshold will return to normal behavioral patterns (primarily migrating, but also resting, socialization, and opportunistic 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 less than 6 km out of their way. This is far less than the distance normally traveled 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.

While right whales may be present throughout the year, right whales predominantly use the WDA from November through April, with the highest densities in January – April. While opportunistic foraging may occur in the WDA if prey is available in suitable densities to trigger foraging behavior, the WDA is not an area where right whales are known to aggregate for foraging, and it is not known to support regular or sustained foraging during the time of year when pile driving will occur. The up to 7 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. The up to 7 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. However, given the opportunistic nature of foraging in the WDA during the months when pile driving could occur combined with the limited duration of pile driving (2-3 hours for 15 piles, with each pile installed on a different day), we consider this to be a very low probability of occurrence. As explained above, given that the duration of pile driving is short (up to 3 hours for a single pile, with exposure expected to be less than that period), 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. As explained above, given that the duration of pile driving is short (up to 3 hours), and we expect an individual to only be exposed to noise from a single pile driving event, we expect that disruption of foraging for a single animal would 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 habitat 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 Vineyard Wind project.

Stress responses are also anticipated in the up to 7 right whales experiencing temporary behavioral disruption due to exposure to noise during pile driving for foundation installation. 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 anticipated minutes to up to 3 hours that the individual right whales are expected to be exposed to disturbing levels of noise during impact pile driving. These stress responses are expected to be in contrast 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 no more than 3 hours and will not recur on subsequent days. Because we expect these 7 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 7 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).

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 three 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 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 June 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 7 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 3 hours) and none are expected to be repeated. The effects of this temporary exposure and associated behavioral response, including the potential loss of a single foraging opportunity during a short period of time on a single day, 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 Vineyard 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 longterm health or any fitness consequences to 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 Vineyard 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. Masking may also make it more difficult for the individual to hear other animals or to detect auditory cues; however, masking resolves as soon as the animal moves sufficiently far from the source. As such, while TTS and masking may temporarily 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, we do not expect these effects to be so severe that they would prevent the affected individual from communicating or limit their response to acoustic cues such that it would prevent them from responding to a threat. For example, to the extent that a right whale relies on acoustic cues to detect and move away from nearby vessels, which is largely unknown, TTS, and/or masking could slow the animal's response time. However, these risks are lowered by the limited nature of the TTS, the short duration of TTS (likely minutes to hours and in all cases less than a week) and masking (limited only to the time that the whale is exposed to the pile driving noise, so from a few minutes up to approximately three hours). As such, while TTS and masking may increase the likelihood of injury by temporarily affecting the ability of an individual to use acoustic cues to respond to threats or stressors, the effects are not expected to be so severe to actually increase the risk that a right whale will be injured. That is, while TTS and masking may temporarily effect the behavior of a right whale in a way that affects its ability to use acoustic cues to detect and respond to threats, we do not expect this response will be so impacted that it would actually result in a whale being hit by a vessel or becoming entangled in fishing gear or otherwise resulting in injury or mortality.

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 of whales, is illustrated in the Navigational Risk Assessment prepared for the Vineyard Wind Project (Clarendon Hill 2018 - Vineyard Wind NRA, COP Appendix III-I). Based on the available information, we do not expect avoidance of pile driving noise to result 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 6 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 6 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[33] provides for a four-step process to determine if a response meets the definition of harassment. The Interim Guidance defines harassment as to "[c]reate the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering." The guidance states that NMFS will consider the following steps in an assessment of whether proposed activities are likely to harass: 1) Whether an animal

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

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 7 individual right whales expected to be exposed to noise above the Level B harassment threshold meet the definition of harassment. We have established that up to 7 individual right whales will be exposed to levels of noise above the threshold at which we expect TTS and behavioral response to occur, we also expect exposure to noise will result in masking (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 3 hours) with TTS lasting for as long as a week; 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 approximately 6 km). As explained above, these individuals are expected to experience TTS (temporary hearing impairment due to loss of hearing sensitivity), masking, stress, disruptions to behaviors including foraging, resting, socializing, and migrating, and energetic consequences of moving away from the pile driving noise and potentially needing to seek out alternative patches of copepod prey (step 3). As explained above, breeding and calving do not occur in the action area or do not occur at the time of year when exposure to pile driving could occur. Together, these effects will significantly disrupt a right whale's normal behavior for the period that the exposure occurs, additionally TTS is expected to affect the animal's behavior, including limited impacts on its ability to communicate and use acoustic cues to detect and respond to threats for the period before TTS resolves (up to a week); 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 right whales expected to be exposed to pile driving noise louder than 160 dB re 1uPa rms are likely to be adversely affected and that effect amounts to harassment. As such, we expect the harassment of 7 right whales as a result of pile driving for the remaining 15 monopile foundations.

NMFS defines "harm" in the definition of "take" as "an act which actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding or sheltering" (50 CFR §222.102). No right whales will be injured or killed due to exposure to pile driving noise. Further, while exposure to pile driving noise will significantly disrupt behaviors of individual right whales on the day that the whale is exposed to the pile driving noise as well as for the period before TTS resolves (i.e., when hearing sensitivity returns to normal) 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 behavioral disturbance, displacement, potential loss of foraging opportunities, and expending additional injury, will be limited to that short period of time 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." This is consistent with the conclusions we reached in our 2021 Opinion.

Fin, Sei and Sperm Whales
Behavioral responses may impact health through a variety of different mechanisms, but most Population Consequences of Disturbance (PCodD) 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 are not expected to 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 direct 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 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 fin, sei, or sperm whales exhibited a behavioral response to pile driving noise, these activities would be disrupted and it may pose some energetic cost. However, as noted previously, responses to pile driving noise are anticipated to be short term (less than three hours) 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. 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. During impact pile driving for the remaining monopile foundations, the area with noise above the Level B harassment threshold will extend approximately 5.7 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 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 5.72 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 a little more than an hour, even at a slow speed of 5 kmh. However, given the requirements for ensuring an area extending 500 m from the pile is clear of fin, sei, and sperm whales before pile driving begins, such a scenario is unlikely to occur. Rather, it is far more likely that any exposure and associated disturbance would be for a significantly shorter period of time. In any event, it would not exceed the period of pile driving (three hours).

Considering the density and distribution of fin, sei, and sperm whales in the WDA and their known prey, disruptions of foraging activity are most likely for individual fin whales. 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 is the case, 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 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 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 or not 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 sei or fin whales exposed to pile driving noise are mother-calf pairs. Absent data on fin and sei whale mother-calf communication 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 fin or sei whales. Based on this analysis, we expect that any effects of TTS and/or masking on communication or nursing by 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 any 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 any 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 Vineyard 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. Masking may also make it more difficult for the individual to hear other animals or to detect auditory cues; however, masking resolves as soon as the animal moves sufficiently far from the source. As such, while TTS and masking may temporarily affect the ability of a whale to communicate with other whales or to detect audio cues to the extent they rely on audio cues to avoid vessels or other threats, we do not expect these effects to be so severe that they would prevent the affected individual from communicating or limit their response to acoustic cues such that it would prevent them from responding to a threat. For example, to the extent that an individual whale relies on acoustic cues to detect and move away from nearby vessels, which is largely unknown, TTS and/or masking could slow the animal’s response time. However, these risks are lowered even further by the short duration of TTS (likely minutes to hours but less than a week) and masking (limited only to the time that the whale is exposed to the pile driving noise, so less than three hours). As such, while TTS and masking may increase the likelihood of injury by temporarily affecting the ability of an individual to use acoustic cues to respond to threats or stressors, the effects are not expected to be so severe to actually increase the risk that a sperm, fin, or sei whale will not be able to avoid detection of a threat that would result in injury or mortality.

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 any fin, sei, or sperm 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 of any of these species, is illustrated in the Navigational Risk Assessment prepared for the Vineyard Wind Project (Clarendon Hill 2018 - Vineyard Wind NRA, COP Appendix III-I). 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 whale is expected to avoid (no more than 6 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 6 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 6 fin, 3 sei, and 2 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 6 fin, 3 sei, and 2 sperm whales will be exposed to levels of noise above the threshold at which we expect TTS and behavioral response to occur; we also expect exposure to noise will result in masking (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 3 hours), with TTS lasting for as long as a week; 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 approximately 6 km). As explained above, these individuals are expected to experience TTS (temporary hearing impairment due to a temporary reduction in hearing sensitivity), masking, stress, disruptions to behaviors including foraging, resting, socializing, and migrating, and energetic consequences of moving away from the pile driving noise and potentially needing to seek out alternative locations to forage (step 3). As explained above, breeding and calving do not occur in the action area or do not occur at the time of year when exposure to pile driving could occur. Together, these effects will significantly disrupt an individual fin, sei, or sperm whale's normal behavior for that period that the exposure occurs, additionally TTS is expected to affect the animal's behavior, including limited impacts on its ability to communicate and use acoustic cues to detect and respond to threats for the period before TTS resolves (up to a week); 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 6 fin, 3 sei, and 2 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 6 fin, 3 sei, and 2 sperm whales as a result of exposure to pile driving noise above the Level B harassment threshold but below the Level A harassment threshold. As such, we expect the harassment of 6 fin, 3 sei, and 2 sperm whales as a result of exposure to pile driving noise above the Level B harassment threshold but below the Level A harassment threshold during the installation of the remaining 15 foundations .

As noted, NMFS defines "harm" 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 fin, sei, or sperm whales will be injured or killed due to exposure to pile driving noise above the Level B harassment threshold but below the Level A harassment threshold. 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 as well as for the period before TTS resolves (i.e., when hearing sensitivity returns to normal) 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 fin, sei, or sperm whales to pile driving noise above the Level B harassment threshold but below the Level A harassment threshold does not meet the definition of "harm." This is consistent with the conclusions reached in our 2021 Opinion.

Vessel Noise and Cable Installation

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. 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 when exposed to vessel noise, including DP thrusters. 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.

In addition to 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. 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, inclusive of DP thrusters, or are not likely to measurably respond in ways that would disrupt normal behavior patterns that include, but are not limited to, breeding, feeding or sheltering. This conclusion is based in part on considering that exposure to vessel noise, including DP thrusters, is expected to be intermittent and limited to the period when an individual whale is in close enough proximity to detect and potentially react to the noise and considering that consequences, including evasive behavior or abandoning or avoiding foraging, socializing, or other behaviors are extremely unlikely to occur. Therefore, the effects of exposure to Vineyard Wind project 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

This section has been extensively updated to reflect information and publications that post-dates the 2021 Opinion; however, we reach the same conclusions here as we reached in our 2021 Opinion.

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. Van Parijs et al. (2023) used PAM to document ambient noise near the southern New England wind lease areas; median broadband SPLs of all available data at each site ranged from 105 to 112 dB (re 1 μPa) with some variability among sites and years. Daily median broadband SPLs were variable within and among sites, ranging from 96 to 129 dB (re 1 μPa). 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.

As described above, many of the published measurements of underwater noise levels produced by operating WTGs range are from older geared WTGs and may not be representative of newer direct-drive WTGs, like those that are being installed for the Vineyard Wind project. Elliot et al. (2019) reports underwater noise monitoring at the BIWF, which has direct-drive GE Haliade 150-6 MW turbines; 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. The loudest noise recorded by Elliot et al. (2019) was 126 dB re 1uPa at 50 m from the turbine when wind speeds exceeded 56 kmh; at wind speeds of 43.2 km/h and less, measured noise did not exceed 120 dB re 1uPa at 50 m from the turbine. Based on data from the Nantucket Sound Buoy[34] from April 2010-July 2024, the average wind speed is less than 32 kph and exceeds 40 km/h from 0-3% of the time depending on the month. In a review of data from 27 operational wind farms in the North Sea (turbines between 2.3 and 8 MW), the mean (broadband) total SPL (SPL50 or L50) at nominal power of

[34] https://www.windfinder.com/windstatistics/nantucket_sound_buoy; last accessed August 2024.

the turbines varied between 112 and 131 dB (median and mean value 120 dB) (Bellman et al. 2023). Bellman et al. (2023) also found that the low-frequency noise input from the wind turbine is no longer audible to individual marine mammals at distances of 100 m from the turbine. HDR 2023 found that noise levels recorded during the 6 MW CVOW turbine operations ranged from 120 to 130 dB re 1 µPa except during storms, when the received levels increased to 145 dB re 1 µPa. All recorded measurements were below the NMFS criteria for TTS and PTS for marine mammals. As described above these recent publications (Elliott et al. 2019, HDR 2023, Holme et al. 2023, and Bellman et al. 2023) are the best available data for estimating operational noise of the Vineyard Wind turbines.

Given that conditions necessary to result in noise above 120 dB re 1uPa are expected to be rare (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 50 – 100 m 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 being installed at the Vineyard Wind project. We also recognize the literature that has predicted larger sound fields for larger turbines. However, we note that Bellman et al. (2023) did not identify a strong correlation between noise and the nominal power of the turbines (between 2.3 and 8.0 MW) and that even the papers that predict greater operational noise (Tougaard et al. (2020) and Stober and Thomsen (2021)) note that operational noise is less than shipping noise. The available information suggests that in areas with consistent vessel traffic, such as the Vineyard Wind WDA, operational noise is not expected to be detectable above ambient noise at a distance more than 50 – 100 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.

Aircraft Noise

Whales at the surface may be exposed to noise from helicopters. North Atlantic right whale approach regulations (50 CFR 222.32) prohibit approaches to within 500 yards of a right whale with an aircraft. BOEM will require all aircraft operations to comply with current approach regulations for any sighted North Atlantic right whales or unidentified large whale. As noted above, source levels are expected between 149 to 151 dB re 1 µPa at 1 m (Richardson et al. 1995), with a received level of approximately 126 dB re 1 µPa (Patenaude et al. 2002). Any exposure of whales to aircraft noise will be brief and limited to the time of overflight (seconds). Due to the short-term nature of any exposures to aircraft and the brief responses that could follow such exposure, the effects of aircraft overflight noise on ESA-listed marine mammals are insignificant (i.e., so minor that the effects cannot be meaningfully evaluated or detected).

HRG Survey Equipment
HRG surveys are planned within the lease area and cable routes at various points in the life of the project and are elements of the action under consultation in this Opinion.
A number of minimization measures for HRG surveys are included as part of the proposed action. This includes maintenance of a 500 m clearance and shutdown zone for North Atlantic right whales and 200 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). There is no new information on the proposed sound sources or effects of the noise since our 2021 Opinion; the text below has been reorganized for clarity but contains the same analysis and conclusions reached in our 2021 Opinion.

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, we have determined that exposure of any ESA listed whales to noise above ESA behavioral harassment thresholds or at levels anticipated to cause take by harassment is extremely unlikely to occur. Further, if any exposure to noise resulting from HRG surveys were to occur, we expect the effects to be of very brief duration and marginal intensity causing only minor behavioral reactions and not TTS (i.e. so minor that they could not be detected, measured or evaluated: insignificant). We do not expect any effects to any ESA-listed whale's hearing to result from exposure to HRG noise sources. Based on these considerations, we have determined that all effects of exposure to HRG survey noise to be either insignificant or discountable. The basis for this conclusion is set forth below.

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 which we consider the best available science and information on these effects. We summarize the relevant conclusions here.

Table 7.1.13. Distances To Injury and Behavioral Disturbance Thresholds For Each HRG Representative Sound Source Category

Equipment Type	Distance to PTS threshold (peak)	Level B (m)
		All (SPL_{rms})
Sub-bottom Profiler	<5 m	10
Sparker	<15 m	502
Boomer	<5 m	224

Based on the characteristics of the noise sources, no ESA listed whales are anticipated to be exposed to noise above the Level A harassment thresholds (peak or cumulative). It is extremely unlikely that a whale would be close enough (within 15 m) to the sound source to experience any exposure at all, and even less likely that it would experience sustained exposure. This is due to both the very small distance from the source that noise above the threshold extends (less than 15 m) and because the sound source is being towed behind a vessel and therefore is moving. 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 200 m for an identified sei, fin, or sperm whale (see section 3). 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. 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. Based on this, any effects of masking on ESA-listed whales will be insignificant.

Considering the sources that would be used for the surveys, the distance to the Level B harassment threshold extends out to approximately 500 m from the source. Given the very small area ensonified and considering the source is moving, any exposure of ESA listed whales to noise above the Level B harassment threshold is extremely unlikely to occur. The use of PSOs to monitor a clearance and shutdown zone (500 m for right whales and 200 m for other ESA listed whales) makes exposure even less likely to occur.

In the unlikely event that a whale did get within 501 m of the source (the maximum distance from the source where noise is above the Level B harassment threshold), 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., Southall et al. 2007). The noise source itself will be moving. This means that any co-occurrence between a whale, even if stationary, and the noise source 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), 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 measurable 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. Thus, while we anticipate effects to be discountable as explained above, even in the extremely unlikely event that such effects were to occur, we anticipate the effects of these temporary behavioral changes to be so minor as to be insignificant. Insignificant and discountable effects are not adverse effects and thus cannot result in ESA take by harassment or otherwise.

7.1.3 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 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 breeding females do not occur in the action area.

Due to the limited information about acoustically induced stress responses in sea turtles, we assume physiological stress responses would occur concurrently with any other response such as hearing impairment or behavioral disruptions. However, we expect such responses to be brief, with animals returning to a baseline state once exposure to the acoustic source ceases. As with cetaceans, such a short, low level stress response may in fact be adaptive and beneficial as it may result in sea turtles exhibiting avoidance behavior, thereby minimizing their exposure duration and risk from more deleterious, high sound levels.

Effects to Hearing

Interference, or masking, occurs when a sound is a similar frequency and similar to or louder than the sound an animal is trying to hear (Clark et al. 2009b; Erbe et al. 2016). Masking can interfere with an individual's ability to gather acoustic information about its environment, such as predators, prey, conspecifics, and other environmental cues (Richardson 1995). This can result in loss of environmental cues of predatory risk, mating opportunity, or foraging options. Compared to other marine animals, such as marine mammals which are highly adapted to use sound in the marine environment, sea turtle hearing is limited to lower frequencies and is less sensitive. Because sea turtles likely use their hearing to detect broadband low-frequency sounds in their environment, the potential for masking would be limited to certain sound exposures. Only continuous anthropogenic sounds that have a significant low-frequency component, are not of brief duration, and are of sufficient received level could create a meaningful masking situation (e.g., long-duration vibratory pile extraction or long term exposure to vessel noise affecting natural background and ambient sounds); this type of noise exposure is not anticipated based on the characteristics of the sound sources considered here.

There is evidence that sea turtles may rely primarily on senses other than hearing for interacting with their environment, such as vision (Narazaki et al. 2013), magnetic orientation (Avens and Lohmann 2003; Putman et al. 2015), and scent (Shine et al. 2004). Thus, any effect of masking on sea turtles could be mediated by their normal reliance on other environmental cues.

Behavioral Responses

To date, very little research has been done regarding sea turtle behavioral responses relative to underwater noise. Popper et al. (2014) describes relative risk (high, moderate, low) for sea turtles exposed to pile driving noise and concludes that risk of a behavioral response decreases with distance from the pile being driven. O'Hara and Wilcox (1990) and McCauley et al. (2000b), who experimentally examined behavioral responses of sea turtles in response to seismic airguns. O'Hara and Wilcox (1990) found that loggerhead turtles exhibited avoidance behavior at estimated sound levels of 175 to 176 dB re: 1 μPa (rms) (or slightly less) in a shallow canal. Mccauley et al. (2000a) experimentally examined behavioral responses of sea turtles in response to seismic air guns. The authors found that loggerhead turtles exhibited avoidance behavior at estimated sound levels of 175 to 176 dB rms (re: 1 μPa), or slightly less, in a shallow canal. Mccauley et al. (2000a) reported a noticeable increase in swimming behavior for both green and loggerhead turtles at received levels of 166 dB rms (re: 1 μPa). At 175 dB rms (re: one μPa), both green and loggerhead turtles displayed increased swimming speed and increasingly erratic behavior (Mccauley et al. 2000a). Based on these data, NMFS assumes that sea turtles would exhibit a significant behavioral response in a manner that constitutes harassment or other adverse behavioral effects, 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.

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). . At the time of this consultation, we consider the 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), 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 7.1.14). The cumulative metric accumulates all sound exposure within a 24-hour period and is therefore different from a peak, or single exposure, metric.

Table 7.1.14. Acoustic thresholds identifying the onset of permanent threshold shift and temporary threshold shift for sea turtles exposed to impulsive sounds (U.S. Navy 2017a)

Hearing Group	Generalized Hearing Range	Permanent Threshold Shift Onset	Temporary Threshold Shift Onset
Sea Turtles	30 Hz to 2 kHz	204 dB re: 1 $Pa^2 \cdot s$ SEL_{cum} 232 dB re: 1 µPa SPL (0-pk)	189 dB re: 1 $\mu Pa^2 \cdot s$ SEL_{cum} 226 dB re: 1 µPa SPL (0-pk)

Criteria for Considering Behavioral Effects

For assessing behavioral effects, NMFS recommends using the 175 dB re 1uPa RMS criteria based on McCauley et al. (2000b). 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 expects 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.

Effects of Project Noise on Sea Turtles

Here, we consider the effects of the noise producing activities of the Vineyard Wind project in the context of the noise thresholds presented above. The pile driving analysis has been updated to reflect the limited work remaining (15 foundations) and to incorporate SFV results from the 2023 pile driving.

Impact Pile Driving for WTG Foundation Installation

As described in the 2021 Opinion, modeling was carried out to determine distances to the onset of injury and behavioral disruption thresholds for sea turtles exposed to pile driving sound for the different pile types during impact pile driving (Pyc et al. 2018). Pyc et al. (2018) modeled radial distances to 207 dB peak and 210 dB SELcum for considering injury (based on Popper et al. 2014) and 166 dB re 1 uPa rms for behavioral disturbance (based on McCauley et al. 2000a). In 2023, Vineyard Wind determined the predicted ranges to the Navy 2017 injury thresholds and the NMFS recommended 175 dB re 1uPa RMS threshold for behavioral disturbance. The table below demonstrates the differences in the predicted distances to the predicted thresholds. As explained in the 2021 Opinion, the use of the Popper et al. 2014 injury thresholds was expected to overestimate the number of sea turtles exposed to noise that could result in injury and is expected to predict responses of exposed sea turtles that exceed actual responses.

Table 7.1.15. Radial distance (meters) to acoustic thresholds resulting from modeling of 10.3 m monopile with 6 dB attenuation. The values are calculated using the most conservative hammer energy radii, averaged over both modeling sites. (source: Pyc et al. (2018) and Küsel et al. 2024).

	Threshold	Predicted Distance to Threshold (with 6 dB attenuation)
Peak Injury Threshold	207 dB (Popper et al. 2014)	67 m
	232 dB re: 1 µPa SPL (0-pk) (Navy 2017)	Not Expected
Cumulative Injury Threshold	210 dB SPL	487 m
	204 dB re: 1 $Pa^2 \cdot s$ SEL_{cum} (Navy 2017)	161 m
Behavioral Disturbance	166 dB re 1uPa rms	2,944 m
	175 dB re 1uPa rms	1,400 m

In addition to the modeling results, SFV results from the five representative piles provide information on the in-situ distances to these thresholds. We note that the closest hydrophone was at 750 m from the pile; this can result in overestimates of near-field noise given the need for extrapolation. SFV results indicate that for the five representative piles, the distance to the 204 dB cumulative injury threshold ranged from 10 m to 180 m (mean 78 m) and the distance to the 175 dB threshold ranged from 130 to 480 m. As predicted by modeling, pile driving noise did not exceed the peak injury threshold (232 dB).

In the 2021 Opinion, we used the best available sea turtle density data to predict the number of sea turtles likely to be exposed to noise above the identified thresholds. For the "maximum impact scenario" considered in the 2021 Opinion (90 monopiles, 12 jacket foundations), we expected that no sea turtles would be exposed to noise above the injury threshold and 3 loggerhead, 1 green, 1 Kemp's ridley, and 7 leatherbacks would be exposed to noise above the behavioral disturbance threshold.

New exposure modeling was not carried out by Vineyard Wind or the action agencies as part of this reinitiation. However, we can adjust the exposure estimates from the 2021 Opinion to account for the new predictions on distances to thresholds of concern based on in-situ SFV monitoring and the updated sea turtle thresholds and in consideration of the number of remaining pile driving events (15). The expected distance to the cumulative injury threshold based on modeling is 161 m, with the maximum distance from the 2023 SFV results being 180 m (area = 0.1 km^2), this is approximately 13% of the distance used in the exposure estimates in the 2021

Opinion (487 m, area = 0.75 km^2). For the behavioral threshold, and a measured maximum range (from the 5 most representative piles) of 0.480 km (pile AT-39), the area ensonified above the behavioral threshold would be π × 0.4802 = 0.72 km^2 based on the in situ measurements. Considering the distance predicted by modeling (1,400 m), the ensonified area is 6.16 km^2. This is approximately 2.7% - 22.7% of the modeled ensonified area used in the 2021 Biological Opinion to inform estimates of sea turtle exposures to noise above the behavioral threshold (distance = 2.94 km, area = 27.15 km^2).

As noted above, peak noise is not expected to exceed 232 dB; therefore, no exposure of any sea turtle to noise above that threshold is expected. The previous modeling did not predict the exposure of any sea turtles to noise above the 210 dB cumulative injury threshold; considering the 204 dB threshold that is considered the best available scientific information and the even smaller distances to that threshold, no exposure of any sea turtles to noise above the cumulative injury threshold is expected. Even by just scaling the numbers of sea turtles predicted to be exposed to noise above the behavioral disturbance threshold by the number of remaining piles (from 102 foundations to 15), we would predict small fractions (0.15) of Kemp's ridley and green sea turtles, less than one loggerhead (0.44), and 1 leatherback to be exposed to noise above the cumulative injury threshold. These values are reduced even further when considering that the distance to the behavioral disturbance threshold (1.4 km, based on modeling, even smaller based on SFV results from the representative piles) is no more than 27% of the area considered in those predictions. Scaling those estimates to 27% results in a prediction of the following exposure above the 175 dB threshold: 0.04 Kemp's ridley, 0.04 green, 0.12 loggerhead, and 0.28 leatherbacks. In the table below we present these predicted exposures as whole numbers. No predictions were made for the number of sea turtles that may be exposed to the TTS thresholds (189 dB re: 1 $\mu Pa^2 \cdot s$ $SEL_{cum;}$ 226 dB re: 1 μPa SPL (0-pk). However, noise is not expected to exceed the peak TTS threshold. It is reasonable to assume that some of the sea turtles exposed to noise above the 175 dB threshold but below the PTS threshold would also be exposed to noise above the cumulative TTS threshold. As we have no means of estimating the proportion of these turtles that would experience TTS, we have reasonably considered that all of these turtles may also experience TTS; this is consistent with the analysis in our 2021 Opinion. We have rounded up fractions to whole animals with the exception that fractions 0.1 or less have been rounded down to zero as we consider predicted exposures at that level extremely unlikely to occur. No sea turtles are expected to be exposed to noise above the peak PTS threshold in any scenario. These estimates do not account for any aversion behavior (i.e., avoidance of pile driving noise) and they do not incorporate the clearance or shutdown zones. These estimates consider the area ensonified above the identified threshold, the number of foundations, and the density estimates outlined above.

Table 7.1.16. Predicted exposure for each sea turtle species - Impact Pile Driving all 15 remaining WTG foundation monopiles, with 6-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 Disturbance)
Green	0	0
Kemp's ridley	0	0
Leatherback	0	1
Loggerhead	0	1

Proposed Measures to Minimize Exposure of Sea Turtles to Pile Driving Noise
Here, we consider the measures that are part of the proposed action, either because they are included as conditions of the COP approval or are proposed to be required through the IHA, and how those measures will serve to minimize exposure of ESA listed sea turtles to pile driving noise. Details of these measures are included in the Description of the Action section above and/or Appendix A and B. We do not consider 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 pile driving activities would occur between January 1 and May 31 to avoid the time of year with the highest densities of right whales in the project area. The January 1 – May 31 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 exposure estimates above. That is, the modeling does not consider any pile driving in the January 1 – May 31 period. Thus, the exposure estimates do not need to be adjusted to account for this seasonal restriction.

Sound Attenuation Devices
Vineyard Wind would implement sound attenuation technology that would target at least a 12 dB reduction in pile driving noise, and that must achieve at least a 6 dB reduction in pile driving noise, as described above. The attainment of a 6 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 6 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 and Shutdown Zones
The proposed action we consulted on in 2021 included a 500 m clearance and shutdown zone for sea turtles that would need to be monitored prior to and during pile driving, with steps outlined for delay and shutdown of pile driving; this requirement will be in place for the remaining pile driving. As required by conditions of COP approval, Vineyard Wind would use trained third-

party PSOs to establish a clearance zone of 500 m around the pile being installed to ensure the area is clear of any sea turtles at the surface 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.

Pile driving would only commence once PSOs have declared the clearance zone clear of sea turtles for at least 30 minutes. Sea turtles observed within a clearance zone will be allowed to remain in the clearance zone (*i.e.*, must leave of their own volition), and their behavior will be monitored and documented. The clearance zones may only be declared clear, and pile driving started, when the entire clearance zones are visible (*i.e.*, when not obscured by dark, rain, fog, etc.) for a full 30 minutes prior to pile driving. As required by conditions of the proposed IHA, a zone of at least 4,000 m must be fully visible to the PSOs (i.e., not obscured by fog, rain, sea state, or other conditions) for a full 30 minutes before pile driving can begin. Time of day restrictions in the conditions of COP approval require Vineyard Wind to not commence pile driving until at least 1 hour after civil sunrise and they must not commence pile driving within 1.5 hours of civil sunset to minimize the potential for pile driving to continue after civil sunset when visibility would be impaired. If a sea turtle is observed entering or within the clearance zone after pile driving has begun, the PSO will request a temporary cessation of pile driving as explained for marine mammals above.

As described above and required in the conditions of the proposed IHA, there will be at least three PSOs stationed at an elevated position on the pile driving platform and a minimum of two additional PSO support vessels each with three active on-duty PSOs monitoring the clearance and shutdown zone. Given that pile driving will only be initiated during day light hours when PSOs have a minimum visibility of 4,000 meters, we expect that PSOs will be able to detect sea turtles at a distance of 500 m from their station; therefore, we expect that the PSOs will be able to effectively monitor the clearance zone which extends 500 m from the pile.

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/shutdown zone for long enough to be exposed to a single pile strike.

As noted above, the distance to the cumulative injury (PTS) threshold may extend up to 180 m from the pile. Modeling does not predict the exposure of any sea turtles above this threshold. Because this is a cumulative threshold, in order to accumulate enough energy to experience PTS, a sea turtle would need to remain within that area for the duration of pile driving. We expect this to be extremely unlikely to occur given that this is within the clearance/shutdown period and given the duration of pile driving (up to 3 hours). 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 reduced hammer energy for 20 minutes. 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 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 Field Verification
As described above, Vineyard Wind will conduct thorough sound field verification for at least the first monopile installed in 2024 and abbreviated sound field verification for all monopiles installed without thorough SFV. If foundation installation occurs in December, thorough SFV measurements must be conducted on, at minimum, the first monopile installed in December. Additional details of the required sound field verification are included in the proposed IHA (see Appendix B of this Opinion).

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 conditions of the proposed IHA, if sound field verification measurements on any of the monopiles indicate that the ranges to the MMPA Level A harassment or Level B harassment isopleths are larger than those modeled, assuming 6-dB attenuation, Vineyard 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. There are also provisions for expanding the shutdown and clearance zones. In the event that noise attenuation measures and/or adjustments to pile driving cannot reduce the distances to less than or equal to those considered in the marine mammal take estimates, this may indicate that the amount or extent of taking specified in the incidental take statement included in this Opinion has been exceeded or 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 is expected to be necessary. (50 CFR 402.16).

Effects to Sea Turtles Exposed to Impact Pile Driving Noise for Foundation Installation s

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 180 m or less during installation of the WTG monopiles (Table 7.1.15); this requires a turtle to remain within that distance of the pile for the entire duration of pile driving. Modeling does not predict any sea turtles will be exposed to noise above the PTS threshold and based on the small distance to the threshold and the duration of pile driving, we consider that exposure of a sea turtle to noise above the PTS threshold would be extremely unlikely to occur. The clearance and shutdown requirements reduce this potential even further. Therefore, we do not expect any sea turtles to be exposed to noise that could result in PTS or any other injury.

The exposure analysis also predicts exposure of sea turtles to noise expected to result in a behavioral response (Tables 7.1.16). It predicts the exposure of up to 1 loggerhead and 1 leatherback. Given the small size of the area where noise above the behavioral disturbance threshold will be experienced (up to 1.44 km from the pile being installed), the limited number of piles to be installed (15), the duration of pile driving (up to 3 hours/day for 15 days), and the low density of Kemp's ridley and green sea turtles in the area, exposure of green or Kemp's ridley sea turtles to noise above the behavioral harassment threshold is extremely unlikely to occur; therefore, we do not expect any Kemp's ridley or green sea turtles to experience TTS or behavioral disturbance due to exposure to pile driving noise. We predict that no more than 1 leatherback and no more than 1 loggerhead sea turtle will be exposed to noise above the behavioral impacts threshold. Neither Vineyard Wind nor any of the action agencies modeled the number of sea turtles expected to be exposed to noise above the TTS threshold. It is reasonable to assume that some of the sea turtles exposed to noise above the 175 dB threshold but below the PTS threshold would also be exposed to noise above the cumulative TTS threshold (189 dB cSEL). As we have no means of estimating the proportion of these turtles that would experience TTS, we have reasonably considered that all of these turtles may also experience TTS; this is consistent with BOEM's analysis presented in the BA and our 2021 Opinion.

Any sea turtles that experienced 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 expect 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, while TTS may impact the ability of affected individuals to avoid threats during the few days that TTS is experienced, we do not anticipate that single TTSs would have any long-term impacts on the health or reproductive capacity or success of individual sea turtles; TTS is considered in the context of the ESA definition 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 (3 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 disrupt migration, feeding, or resting. However, that disruption will last for no longer than it takes the sea turtle to swim away from the area where noise is above 175 dB re 1uPa RMS (up to 1.4 km from the pile being installed) or, at the longest, the duration of pile driving (up to three hours). There is no evidence to suggest that any behavioral response would persist beyond the duration of the sound exposure which in this case is the time it takes the turtle to swim 1.4 km or to drive a pile, up to three hours. For migrating sea turtles, it is unlikely that this temporary disturbance, which would result in a change in swimming direction for a short distance, 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 is a small portion of the coastal area used for north-south and south-north migrations and is only a fraction of the project area used by foraging sea turtles. We have no information to indicate that any particular portion of the 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 project area or that any area is better suited for these activities than any other area. A disruption in migration, feeding, or resting for no more than three hours and likely even less given the short distance a sea turtle would need to swim to avoid the noise (less than 1.5 km, which would only take a few minutes), 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 Vineyard 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 also experience a stress response, such responses are expected to be short-term in nature given the duration of pile driving (three 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 15 days, 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 due to avoidance or displacement resulting from exposure to pile driving noise.

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. Based on a review of AIS data for 2020 and 2019 (using the Northeast Ocean Data Explorer[35]), the only areas outside of the lease with higher vessel traffic than within the lease area are commercial traffic routes ("shipping lanes"). The nearest "shipping lanes" are the Nantucket to Ambrose Traffic Separation Scheme and the Rhode Island Sound Traffic Separation Zones. At their closest distances to the lease area they are 48 and 33 kms away, respectively. As described above, we expect that sea turtles may avoid the area with noise above 175 dB re 1uPa rms). Based on the modeled size of the area that will have noise above this level (up to 1.4 km meters from the pile being driven), a sea turtles only needs to swim less than 1.5 km to avoid the noise. As such, it is not reasonable to expect that any sea turtle will swim into either traffic lane as a result of avoiding pile driving noise. Information on patterns and distribution of fishing activity, including fishing gear that may result in the entanglement or capture of sea turtles, is illustrated in the Navigational Risk Assessment prepared for the Vineyard Wind Project (Clarendon Hill 2018 - Vineyard Wind NRA, COP Appendix III-I). Based on the available information, we do not expect avoidance of pile driving noise resulting in an increased risk of entanglement or capture 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 1.4 km from the pile being installed), the short term nature of

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[35] https://www.northeastoceandata.org/data-explorer/; last accessed October 15, 2021.

any disturbance, the limited number of sea turtles impacted, and the lack of any significant differences in fishing activity in that 1.4 km area that would put a sea turtle at greater risk of 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 1 leatherback and 1 loggerhead sea turtles expected to be exposed to noise above the 175 dB threshold but below the injury threshold meet the definition of harassment.
We have established that no more than 1 leatherback and 1 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 3 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 1.4 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 resting, 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 at a level that creates the likelihood of injury for the duration of exposure to pile driving and the period before TTS resolves (i.e., when hearing sensitivity returns to normal); 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 leatherback and 1 loggerhead sea turtle exposed to pile driving noise louder than 175 dB re 1uPa rms and experience TTS are likely to be adversely affected and that effect amounts to harassment as defined in the context of take under the ESA. As such, we expect the harassment of 1 leatherback, and 1 loggerhead sea turtle as a result of exposure to pile driving noise.

NMFS defines "harm" in the definition of "take" as "an act which actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding or sheltering" (50 CFR §222.102). Here, we consider if the sea turtles that will experience TTS and behavioral disruption that meet the definition of harassment will also be harmed. 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 for the period that the sea turtle experiences exposure to pile driving noise and any longer period for which it experiences TTS creating the likelihood of injury, it will not actually kill or injure any sea turtles directly or 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.

Due to the short term, localized nature of the effects and because we expect these behaviors to resume once the sea turtle is no longer exposed to the noise. The energetic consequences of the evasive behavior and delay in resting or foraging are not expected 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 . TTS will resolve within no more than a week of exposure and is not expected to affect the health of any sea turtle or its ability to migrate, forage, breed, or nest. 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."

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, including DP thrusters, 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 range are from older geared WTGs and may not be representative of newer direct-drive WTGs, like the GE-Haliade X turbines being installed for the Vineyard Wind project. Elliot et al. (2019) reports underwater noise monitoring at the Block Island Wind Farm, which has direct-drive GE Haliade 150-6W 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. Based on data from the Nantucket Sound Buoy[36] from April 2010-July 2024, the average wind speed in the Vineyard Wind lease area is less than 32 km/h and exceeds 40 km/h from 0-3% of the time depending on the month.

Elliot et al. (2019) conclude that based on monitoring of underwater noise at the Block Island site, under worst-case assumptions, no risk of temporary or permanent hearing damage (PTS or TTS) could be projected even if an animal remained in the water at 50 m (164 ft.) from the turbine for a full 24-hour period. Similarly, in a review of data from 27 operational wind farms in the North Sea (turbines between 2.3 and 8 MW), the mean (broadband) total SPL (SPL50 or L50) at nominal power of the turbines varied between 112 and 131 dB (median and mean value 120 dB). HDR 2023 found that noise levels recorded during the 6 MW CVOW turbine operations ranged from 120 to 130 dB re 1 μPa except during storms, when the received levels increased to 145 dB re 1 μPa. Together, these publications are the best available data for estimating operational noise of the Vineyard Wind turbines. As underwater noise associated with the operation of the WTGs is below the thresholds for considering behavioral disturbance for sea turtles, 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.

Aircraft Noise

As with vessel disturbance above, little information is available on how ESA-listed sea turtles may respond to aircraft. For the purposes of this consultation, we assume all ESA-listed sea turtles may exhibit similar short-term behavioral responses such as diving, changes in swimming, etc., which is also consistent with those behaviors observed during aerial research surveys of sea turtles. We are unaware of any data on the physiological responses sea turtles exhibit to aircraft, but we conservatively assume a low-level, short-term stress response is possible.

The working group that developed the 2014 *ANSI Guidelines* for fishes and sea turtles did not consider this specific acoustic stressor for sea turtles in part because it is not considered to pose a great risk (Popper et al. 2014). Any low-flying altitude aircraft would only likely transmit low levels of sound within one meter into the water column. Sea turtles located at or near the water surface may exhibit startle reactions to certain aircraft overflights if the aircraft is flying at a low

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[36] https://www.windfinder.com/windstatistics/nantucket_sound_buoy; last accessed August 9, 2024.

altitude and the turtle can see it or detect it through sound or water motion generated from wind currents on the surface. This would most likely occur when helicopters are hovering and might be visually detected by a sea turtle. The currents and waves the helicopter produces on the water's surface may also cause sea turtles to respond to the disturbance along with the sound. Aircraft overflight is brief, and does not persist in the action area for significant periods of time (not longer than a few hours), nor is the sound expected to be transmitted well into the water column. Thus, the risk of masking any biologically relevant sound to sea turtles is extremely low. Any startle reactions that occur, if any, are expected to be brief, with sea turtles resuming normal behaviors once the aircraft is no longer detectable or leaves the area. Due to the short-term nature of any exposures to aircrafts and the brief responses expected to the noise or visual disturbance produced, the effects of aircraft overflight noise on ESA-listed sea turtles is considered temporary and insignificant (i.e., so minor that the effect cannot be meaningfully evaluated).

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 sub-bottom profilers including boomers and sparkers. 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. We summarize the relevant conclusions here. 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 7.1.17).

Table 7.1.17 Largest PTS Exposure Distances from mobile HRG Sources at Speeds of 4.5 knots –Sea Turtles

HRG Source	Highest Source Level (dB re 1 µPa)	Sea Turtle Onset of Injury Threshold		Sea Turtle Behavior (175 dB re 1uPa rms)
		Peak	*SEL*	*RMS*
SBP: Boomers	176 dB SEL 207 dB RMS 216 PEAK	0	0	40
SBP: Sparkers	188 dB SEL 214 dB RMS 225 PEAK	0	0	90
Multi-beam echosounder (100 kHz)	185 dB SEL 224 dB RMS 228 PEAK	NA	NA	NA
	182 dB SEL	NA	NA	NA

Multi-beam echosounder (>200 kHz) (mobile, non-impulsive, intermittent)	218 dB RMS 223 PEAK			
Side-scan sonar (>200 kHz) (mobile, non-impulsive, intermittent)	184 dB SEL 220 dB RMS 226 PEAK	NA	NA	NA

Sea turtle PTS distances were calculated for 203 cSEL and 230 dB peak criteria from Navy (2017).
NA = not applicable due to the sound source being out of the hearing range for the group.

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. 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 7.1.7). Thus, a sea turtle would need to be within 90 m of the HRG 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. BOEM's conditions of COP approval require that a clearance zone (200 m in all directions) for sea turtles 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.

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.

7.1.4 Effects of Noise on Atlantic sturgeon

Background Information – Atlantic sturgeon and Noise
Impulsive sounds such as those produced by impact pile driving are known to affect fishes in a variety of ways, and have been shown to cause mortality, auditory injury, barotrauma, and behavioral changes. Impulsive sound sources produce brief, broadband signals that are atonal transients (e.g., high amplitude, short-duration sound at the beginning of a waveform; not a continuous waveform). They are generally characterized by a rapid rise from ambient sound pressures to a maximal pressure followed by a rapid decay period that may include a period of diminishing, oscillating maximal and minimal pressures. For these reasons, they generally have an increased capacity to induce physical injuries in fishes, especially those with swim bladders (Casper et al. 2013a; Halvorsen et al. 2012b; Popper et al. 2014). These types of sound pressures cause the swim bladder in a fish to rapidly and repeatedly expand and contract, and pound against the internal organs. This pneumatic pounding may result in hemorrhage and rupture of blood vessels and internal organs, including the swim bladder, spleen, liver, and kidneys. External damage has also been documented, evident with loss of scales, hematomas in the eyes, base of fins, etc. (e.g., Casper et al. 2012c; Gisiner 1998; Halvorsen et al. 2012b; Wiley et al. 1981; Yelverton et al. 1975a). Fishes can survive and recover from some injuries, but in other cases, death can be instantaneous, occur within minutes after exposure, or occur several days later.

Hearing impairment
Research is limited on the effects of impulsive noise on the hearing of fishes, however some research on seismic air gun exposure has demonstrated mortality and potential damage to the lateral line cells in fish larvae, fry, and embryos after exposure to single shots from a seismic air gun near the source (0.01 to 6 m; Booman et al. 1996; Cox et al. 2012). Popper et al. (2005a) examined the effects of a seismic air gun array on a fish with hearing specializations, the lake chub (*Couesius plumbeus*), and two species that lack notable hearing specializations, the northern pike (*Esox lucius*) and the broad whitefish (*Coregonus nasus*), a salmonid species. In this study, the average received exposure levels were a mean peak pressure level of 207 dB re 1 μPa; sound pressure level of 197 dB re 1 μPa; and single-shot sound exposure level of 177 dB re 1 μPa^2-s. The results showed temporary hearing loss for both lake chub and northern pike to both 5 and 20 air gun shots, but not for the broad whitefish. Hearing loss was approximately 20 to 25 dB at some frequencies for both the northern pike and lake chub, and full recovery of hearing took place within 18-24 hours after sound exposure. Examination of the sensory surfaces of the 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 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.

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 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 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, 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 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 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.

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.

Effects of Project Noise on Atlantic sturgeon

Foundation Pile Driving

This analysis has been updated to reflect the limited pile driving remaining and to incorporate SFV results from 2023. Here we consider the effects of installation of the remaining 15 monopile foundations. As explained above, SFV results are available for a subset of foundations installed in 2023, with five of those piles determined to be representative of the installation methods and noise attenuation system deployment planned for the remaining foundations. The table below includes the modeled (Pyc et al. 2018) and measured (Küsel et al. 2024) ranges to the injury and behavioral disturbance thresholds for Atlantic sturgeon.

Table 7.1.18. Radial distance (meters) to acoustic thresholds

Threshold		Modeled Results	SFV results	
			maximum	mean
Injury	206 peak	78 (note: modeled at 207 pk)	30	18
	187 SELcum	6,894	4,860	4,324
Behavioral Disturbance	150 dB RMS	9,229	12,130	11,270

As illustrated in the table, the distances to the injury thresholds from the representative SFV data are within the distances considered in the 2021 Opinion. However, the measured ranges to the SPLrms behavioral threshold for Atlantic sturgeon for the five most representative piles are all longer than the expected range of 9,229 m based on the 2018 acoustic modeling.

No density estimates 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 like was done for marine mammals and sea turtles.

Consideration of Mitigation Measures
Here, we consider the measures that are part of the proposed action, either because they are proposed by Vineyard Wind and reflected in the proposed action as described to us by BOEM in the BA, are conditions of COP approval, or are proposed to be required through the IHA (recognizing that the IHA conditions are related to marine mammals only but may provide some benefit to other species). Specifically, we consider how those measures may minimize exposure of Atlantic sturgeon to pile driving noise. Details of these measures are included in section 3 and the Appendixes.

Atlantic sturgeon are not visible to PSOs because they occur near the bottom and depths in the WDA 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 pile driving activities would occur between January 1 and May 31 to avoid the time of year with the highest densities of right whales in the project area. Information from Ingram et al. (2019) indicates that abundance of Atlantic sturgeon in the New York Wind Energy Area peaked from November through January. If seasonal patterns are similar in the Vineyard Wind WDA, the seasonal restriction would reduce the number of Atlantic sturgeon that would otherwise have been exposed to foundation pile driving noise; however, absent a similar study in the Vineyard Wind lease area, it is not possible to determine if there would be any reduction in exposure. 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.

Sound Attenuation Devices
Vineyard Wind would implement sound attenuation technology that would target at least a 12 dB reduction in pile driving noise, and that must achieve at least a 6 dB reduction in pile driving noise, as described above. The attainment of a 6 dB reduction in pile driving noise was incorporated into the estimates of the area where injury or behavioral disruption may occur as presented above. If a reduction greater than 6 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
Soft start procedure 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, before full energy pile driving begins, three sets of three strikes, separated by a minute each, will occur at less than 40 percent of total hammer energy, for at least 20 minutes. 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 noise levels that would result in behavioral disturbance of Atlantic sturgeon (i.e., louder than 150 dB rms) but not exceed the threshold for injury. We expect that any Atlantic sturgeon close enough to the pile to be exposed to noise above 150 dB re 1uPa rms would exhibit evasive behaviors and swim away from the noise source. 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.

Sound Source Verification
As described above, Vineyard Wind will conduct hydroacoustic monitoring for all remaining 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.

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, we expect Atlantic sturgeon to at least occasionally occur in the area where pile driving noise will be experienced. 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 expected 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).

Based on the modeling and SFV data outlined above, in order to be exposed to pile driving noise that could result in injury, an Atlantic sturgeon would need to be within 80 m of a pile being installed for a single strike (based on the 206 dB 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 80 m from the pile). We also expect that the bubble curtain(s) deployed as part of the noise attenuation system will extend out to approximately 150 m from the pile, this is likely to further deter Atlantic sturgeon from being closer than that to the pile. This risk is further reduced by the small amount of time that pile driving will occur (up to three hours at a time for 15 piles) which limits the potential opportunities for co-occurrence. 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. Given these considerations, we do not anticipate any Atlantic sturgeon to be exposed to noise above the peak injury threshold during monopile installation. This is the same conclusion reached in our 2021 Opinion.

Considering the modeled distance to the 187 dB SELcum threshold, an Atlantic sturgeon would need to remain within approximately 7 km of a monopile for the full duration of pile driving during a 24-hour period (approximately three hours for a monopile). Results from the SFV for the five representative piles suggest that the range to this threshold may be smaller (up to approximately 5 km). Considering the anticipated behavioral reaction of sturgeon to avoid pile driving noise above 150 dB re 1 uPa RMS and the swimming abilities of Atlantic sturgeon, this is extremely unlikely to occur. Downie and Kieffer (2017) reviewed available information on maximum sustained swimming ability (Ucrit) for a number of sturgeon species. No information was presented on Atlantic sturgeon. Kieffer and May (2020) report that swimming speed of sturgeons is consistent at approximately 2 body lengths/second. Considering that the smallest Atlantic sturgeon in the ocean environment where piles will be driven will be migratory subadults (at least 75 cm length), we can assume a minimum swim speed of 150 cm/second (equivalent to 5.4 km/hour) for Atlantic sturgeon in the lease area. Assuming a straight line escape and the slowest anticipated swim speed (5.4 km/h), even a sturgeon that was close by the pile at the start of pile driving would be able to swim away from the noisy area 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 3 hours it takes to install a monopile is 16.2 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 take by harm (i.e., injury) of any Atlantic sturgeon is expected to occur. This is the same conclusion reached in our 2021 Opinion.

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. This response could range from a startle with immediate resumption of normal behaviors to complete avoidance of the area. The area where pile driving 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. Based on the SFV results from 2023, during pile driving, the area that will have underwater noise above the 150 dB re 1uPa RMS threshold will extend approximately 12.1 km from the pile being installed; we note that this is larger than the 9.3 km distance considered in our 2021 Opinion. 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. In the worst case, Atlantic sturgeon would avoid that entire area. The consequences for an individual sturgeon would be alteration of movements to avoid the noise and temporary cessation of opportunistic foraging. Considering the minimum swimming speeds noted above, we expect a sturgeon actively avoiding this area could swim out of it in less than 2 hours.

While in some instances temporary displacement from an area may have significant consequences to individuals or populations, this is not the case here. For example, if individual Atlantic sturgeon were prevented or delayed from accessing spawning or overwintering grounds or were precluded from a foraging area for an extensive period, there could be impacts to reproduction and the health of individuals, respectively. However, as explained above the area where noise may be at disturbing levels is used only for movement between other more highly used portions of the coastal Atlantic Ocean and is used only for opportunistic, occasional foraging. Displacement from, of avoidance of, any area ensonified during impact pile driving for the WTG 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 up to three hours each day for a period of 15 non-consecutive days, this exposure and displacement will be temporary and not chronic. Therefore, any interruptions in behavior and associated metabolic or energetic consequences will similarly be temporary. Thus, we do not anticipate any impairment of the health, survivability, or reproduction of any individual 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 approximately 12 km to swim outside the area where noise is above the threshold where behavioral disturbance is expected; this distance would result from a sturgeon being very near the source when pile driving started, it is more likely that the distance traveled would be smaller. As we do not expect vessel strike to occur in the open ocean, regardless of traffic levels, we do not expect any increase in risk of vessel strike even if a sturgeon was displaced into an area with higher vessel traffic. Based on the available information on the distribution of fishing activities that may interact with sturgeon (i.e., gillnets, trawl), it is extremely unlikely that a sturgeon avoiding pile driving noise would be more at risk of entanglement or capture than had it not been exposed to the noise source. This is because the distance that a sturgeon would need to move to avoid potentially disturbing level of noise would not put the individual in areas with higher levels of trawl or gillnet fishing than in the WDA (see Vineyard Wind NSA).

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 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 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. 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, 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 of Atlantic sturgeon in the action area. Therefore, the effects of vessel noise on Atlantic sturgeon is considered insignificant (i.e., so minor that the effect cannot be meaningfully evaluated).

Operation of WTGs

As described above, many of the published measurements of underwater noise levels produced by operating WTGs range are from older geared WTGs and may not be representative of newer direct-drive WTGs, like those that will be installed for the Vineyard Wind project. Elliot et al. (2019) reports underwater noise monitoring at the Block Island Wind Farm, which has direct-drive GE Haliade turbines. The loudest noise recorded was 126 dB re 1uPa at a distance of 50 m when wind speeds exceeded 56 kmh. Based on data from the Nantucket Sound Buoy from April 2010-July 2024, the average wind speed in the Vineyard Wind lease area is less than 32 km/h and exceeds 40 km/h from 0-3% of the time depending on the month.

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. Similarly, in a review of data from 27 operational wind farms in the North Sea (turbines between 2.3 and 8 MW), the mean (broadband) total SPL (SPL50 or L50) at nominal power of the turbines varied between 112 and 131 dB (median and mean value 120 dB). HDR 2023 found that noise levels recorded during the 6 MW CVOW turbine operations ranged from 120 to 130 dB re 1 µPa except during storms, when the received levels increased to 145 dB re 1 µPa. Recorded particle acceleration levels were compared to published behavioral audiograms of selected fish species and were found to be below the respective hearing thresholds for these species. Together, these publications are the best available data for estimating operational noise of the Vineyard Wind turbines. 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. Based on these considerations, effects of operational noise on Atlantic sturgeon are extremely unlikely to occur and are discountable.

Aircraft Noise

Exposure of Atlantic sturgeon to aircraft noise is extremely unlikely given that any sound that transmits into the water column, would likely only be to a shallow depth and sound transmission into deep depths of the water column where Atlantic sturgeon occur is not likely. As only fish located at or near the surface of the water and within the limited area where transmission of aircraft noise is expected to occur have the potential to detect any noise produced from low-flying aircraft, and we do not expect Atlantic sturgeon in the action area to be at or near the surface, exposure of any Atlantic sturgeon to aircraft noise that could be potentially disturbing is extremely unlikely to occur.

HRG Surveys

Some of the equipment that is described by BOEM for use for high resolution geophysical surveys produces underwater noise that can be perceived by Atlantic sturgeon. This is limited to boomers, sparkers, and some sub-bottom profilers. 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. We summarize the relevant conclusions here. For the equipment proposed for use, the maximum distance to the injury threshold (peak) 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).

Table 7.1.19 Largest PTS Exposure Distances from mobile HRG Sources at Speeds of 4.5 knots – Fish

HRG Source	Highest Source Level (dB re 1 µPa)	Distance to Fish Thresholds in m (FHWG 2008)		
		Peak	*SEL*	*Behavior (150 dB re 1uPa rms)*
Boomers	176 dB SEL 207 dB RMS 216 PEAK	3.2	0	708
Sparkers	188 dB SEL 214 dB RMS 225 PEAK	9	0	1,996[a]
Multi-beam echosounder (100 kHz)	185 dB SEL	NA	NA	NA
Multi-beam echosounder (>200 kHz) (mobile, non-impulsive, intermittent)	182 dB SEL	NA	NA	NA
Side-scan sonar (>200 kHz) (mobile, non-impulsive, intermittent)	184 dB SEL	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
NA = not applicable due to the sound source being out of the hearing range for the group.

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/sub-bottom profilers 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 Atlantic sturgeon in the action area, the use of a ramp up procedure where possible, 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. We consider the potential for effects on behavior below.

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 7.1.19). 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 (seconds). 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 sturgeon 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
For completeness, we have added an analysis of the effects of project noise on prey species to this Opinion. 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 (i.e., some displacement/avoidance but no injury or mortality). 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 to be so small that they cannot be meaningfully measured, detected, or evaluated and are therefore insignificant. No take is anticipated as a consequence of disturbance to prey.

We are not aware of any information on the effects of pile driving 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 Vineyard Wind project. 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. 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 Vineyard Wind project. Elliot et al. (2019) reports underwater noise monitoring at the Block Island Wind Farm, which has direct-drive GE Haliade turbines the loudest noise recorded was 126 dB re 1uPa at a distance of 50 m when wind speeds exceeded 56 kmh. Based on data from the Nantucket Sound Buoy from April 2010-July 2024, the average wind speed in the Vineyard Wind lease area is less than 32 km/h and exceeds 40 km/h from 0-3% of the time depending on the month. 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. Similarly, in a review of data from 27 operational wind farms in the North Sea (turbines between 2.3 and 8 MW), the mean (broadband) total SPL (SPL50 or L50) at nominal power of the turbines varied between 112 and 131 dB (median and mean value 120 dB). HDR 2023 found that noise levels recorded during the 6 MW CVOW turbine operations ranged from 120 to 130 dB re 1 μPa except during storms, when the received levels increased to 145 dB re 1 μPa. Recorded particle acceleration levels were compared to published behavioral audiograms of selected fish species and were found to be below the respective hearing thresholds for these species. Together, these publications are the best available data for estimating operational noise of the Vineyard Wind turbines. 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, summarizing the anticipated increase in vessels associated with construction, operations, and decommissioning of the project, and then determining likely effects to sea turtles, whales, and Atlantic sturgeon. We also consider impacts to air quality from vessel emissions. Effects of vessel noise were considered in section 7.1, above, and are not repeated here. There are no changes to planned vessel use or ports since the issuance of the 2021 Opinion; while ESA listed species have been observed during vessel operations and vessel strike avoidance measures have been implemented, no take of any ESA listed species due to vessel strike has been observed or reported as a result of these activities to date (Vineyard Wind monthly reports, through June 2024). The analysis here is updated to improve clarity through reorganization of some text and to incorporate any new relevant background information (e.g., more recent non-project related vessel strikes of right whales), status of remaining construction vessel traffic, and the conditions of the 2024 proposed IHA that will be in effect during the remaining construction period. We have also moved information on existing (non-project) vessel traffic in the action area to the *Environmental Baseline* section of the Opinion.

7.2.1 Project Vessel Descriptions and Increase in Vessel Traffic from the Vineyard Wind Project

Descriptions of project vessel use and traffic are described in Section 3 of this Opinion and summarized here for reference.

There are a number of distinct areas that will be transited by project vessels. During the construction, operations, and decommissioning periods there will be vessel trips between a number of ports in Massachusetts (New Bedford and Brayton Point) and Rhode Island (Montaup, Providence, and Quonset) and the WDA. There will be a limited amount of project related traffic between the WDA and three ports in Canada (Halifax, St. John, and Sheets Harbor) during the construction and decommissioning periods. Vineyard Wind has indicated that up to three round-trips will occur during the remaining foundation installation period to transport monopile foundations in batches from Canadian ports to the project site.

The 2021 consultation addressed the anticipated maximum of five trips per day (maximum of 50 trips per month) over a two-year construction schedule of relatively slow moving (13-18 knots) construction/installation vessels and cargo vessels transporting project components (Epsilon 2020, Volume 1, Table 4.2-1) as well as the use of European-origin construction/installation vessels over the course of the Project's offshore construction period. These vessels are expected to remain on site for the duration of the work that they are contracted to perform, which could range from two to twelve months. WTG components were also expected to be shipped to the WDA from one or more ports in Europe. The BA and 2021 Opinion considered up to approximately 122 round trips from Europe, based on the maximum design envelope installation of 100 WTGs. On average, vessels transporting components from Europe were expected to make approximately five round trips per month over a two-year offshore construction schedule. The information presented by Vineyard Wind associated with the 2023 IHA application indicates that no additional trips from Europe are anticipated during the remaining construction period (Table 7.2.2); therefore, consideration of trips to/from Europe have been removed from this analysis. Table 7.2.2 describes the number of vessel trips anticipated for the remaining monopile foundation installation activities.

It should be noted that the trips for the activities the vessels will be conducting in the Project Area might not necessarily occur within the same timeframe. The peak of vessel traffic will occur during the construction period and will consist of a mix of slower moving, larger construction and cargo vessels, and smaller, faster crew transport vessels. Once in the WDA, vessels may remain on station for weeks or months or remain for only a day.

Table 7.2.1. Estimated maximum daily trips and trips per month during two-year project construction schedule, based on installation of 100 WTGs (note that the project will now consist of 62 WTGs).

Origin or Destination	Est. Max. Daily Trips	Est. Max Trips/Month
New Bedford (MA)	46	1,100
Brayton Point (MA)	4	100
Montaup (RI)	4	100
Providence (RI)	4	100
Quonset (RI)	4	100
Canada (either Sheet Harbor, St. John, or Halifax)	5	50
Europe (ports unknown)	NA	5

Source: Table 5.1-6 in Vineyard Wind BA, Vineyard Wind RFI

Table 7.2.2. Estimated maximum number of vessel trips per MP Batch and overall (3 MP batches) during the 2024 construction.

Origin or Destination	Estimated Maximum Trips per MP Batch	Total for 2024 Monopile Construction
New Bedford (MA)	2	6
Brayton Point (MA)	1	3
Montaup (RI)	1	3
Providence (RI)	1	3
Quonset (RI)	1	3

Origin or Destination	Estimated Maximum Trips per MP Batch	Total for 2024 Monopile Construction
Canada (either Sheet Harbor, St. John, or Halifax)	3	9
Europe (ports unknown)	0	0

source: 2023 IHA Application

To help assess the potential increase in risk of vessel strike on listed species that may result from an increase in vessel traffic in the action area, we calculated the percent increase of vessel traffic due to the project above baseline vessel traffic in the WDA and along the OECC by considering the available information on annual vessel transits in the WDA and across the OECC (without Vineyard Wind project vessels). We were not able to generate an accurate estimate of total annual non-Project transits of the action area as a whole. However, as project vessel traffic will be concentrated in the WDA and along the OECC, we determined this was a reasonable approach; nonetheless, as explained below, this results in an underestimate of total baseline vessel activity for the entire action area, but captures where all project vessels will be operating during construction, operations and maintenance, and decommissioning. An underestimate of baseline (non-project) vessel traffic in the area means that any calculation of the increase in vessel traffic attributable to the project is likely to be an overestimate. However, at this time, this is the best available information and we do not have any information on how much of an underestimate the determination of baseline traffic may be so we are not able to make any adjustments to that number.

According to section 4.3 of the Navigational Risk Assessment, the traffic within the OECC analysis area (analysis area of the Offshore Export Cable Corridor including a 500-m zone around it) accounts for 19-22% of the overall traffic in Nantucket Sound. On average, 145 - 156 vessels are traversing this area daily, or approximately 52,925 annually. The Supplementary Analysis for Navigational Risk Assessment (COP Volume III, Appendix III-I, Table 2.2; Epsilon 2020) provides a summary of AIS data from vessel traffic transiting the Vineyard Wind WDA from 2016-2018. For this three-year period there were 591 unique vessels, and 4,139 unique vessel tracks recorded, or approximately 1,380 unique tracks a year. For the purposes of this section, a unique vessel track is assumed to be equivalent to a vessel trip. To determine the total annual vessel trips through the OECC and WDA, we added the two annual trip estimates to get a total of 54,305 annual trips. Through the rest of this section, 54,305 annual vessel trips will be used as the baseline of vessel activity in the OECC and WDA (i.e., anticipated vessel trips in this area without the addition of Vineyard Wind project vessels). However, as explained above, the data collected to inform this estimate underrepresents smaller (less than 65 feet) vessels using the area, and also does not include traffic in the Ambrose-Nantucket TSS (unless those vessels crossed the WDA or OECC) and does not account for all vessels transiting along all routes that will be used by project vessels and thus, is an underestimate of the total baseline vessel traffic in the area.

The DEIS, BA, and COP prepared for the Vineyard Wind project all present various statistics on the vessel traffic related to the project activities during construction, operation, and decommissioning (BOEM 2018, 2019, Epsilon 2020). The trips listed in these documents (COP Volume I – Section 4.2.4, Volume III – Section 7.8, and Navigational Risk Assessment in Appendix III-I; Epsilon 2020) include vessel activity occurring in the Project Area, and describe vessel operations for all phases of the project. For all three phases of the project an average and maximum count of vessel trips over various temporal domains is listed. As the maximum is for an extreme case and does not represent vessel traffic during all times, the average for each phase was determined to better represent a reasonable estimate of the sustained increase in vessel traffic over the life of the project. To determine the percent increase in annual vessel traffic due to the project we divided the annual project-related vessel trips by phase by the baseline annual vessel trips (54,305 trips) (Table 7.2.3). Note that the percent increase in annual vessel traffic due to the project is just calculated for the OECC and the WDA, which are the two areas vessels will be transiting to/from during construction, operation, and decommissioning. As explained above, existing vessel traffic in the greater southern New England area is currently very high, for a review of vessel characteristics in the area see the Navigational Risk Assessment (COP Volume III, Appendix III-I; Epsilon 2020) and the USCG MARIPARS (USCG 2020).

As described in the COP (Appendix III-I), the most intense period of vessel traffic would occur during the construction phase when wind turbine foundations, inter-array cables, and WTGs are installed in parallel. BOEM has estimated that a maximum of 46 vessels could be on-site (at the WDA or along the OECC) at any given time. Many of these vessels will remain in the WDA or OECC for days or weeks at a time, potentially making only infrequent trips to port for bunkering and provisioning, if needed. Therefore, although an average of 25 vessels will be involved in construction activities on any given day, on average only 7 vessels will transit to and from ports each day. However, the maximum number of vessels involved in the Project at one time is highly dependent on the Project's final schedule, the final design of the Project's components, and the logistics solution used to achieve compliance with the Jones Act. The peak level of construction is expected to occur during pile driving activities from May through December. However, mobilization to and from the WDA would occur before and after this period (COP Volume III Section 7.8.2.1). New Bedford Harbor is expected to be the primary port used to support construction activities. Because established shipping lanes into New Bedford Harbor are located to the southwest of New Bedford Harbor (see Figure 3.5 in COP Volume III, Appendix III-I) and the WDA is located southeast of New Bedford Harbor, it is assumed that Project vessels will not use the shipping lanes, but instead will take the most direct route to the WDA. The most direct route would be to travel around the Elizabeth Islands and the west coast of Martha's Vineyard, and then head southeast to the WDA.

During operations and maintenance, and as described in Section 7.8.2.2 of Volume III of the COP (Epsilon 2020), it is anticipated that on average one CTV or survey/inspection vessel will operate in the WDA per day for regularly scheduled maintenance and inspections. In other maintenance or repair scenarios, additional vessels may be required, which could result in a maximum of three to four vessels per day operating within the WDA, on average we expect there to be ~2.5 daily trips during the operational phase (~30 years) of the project (Vineyard Wind COP; Volume I, Section 4.3.4; Epsilon 2020). CTVs will be homeported in New Bedford, or other southern New England ports, however additional vessels used for maintenance may have to travel to the project area from domestic and international ports.

During decommissioning, the level of trips is estimated to be about 90 percent of those occurring during construction, or a maximum of 990 trips per month from New Bedford, 90 trips per month from Brayton Point or Quonset, and 45 trips per month from Canada. Assuming that decommissioning is essentially the reverse of construction, except that offshore cables remain in place and Project components do not need to be transported overseas, decommissioning activities will require approximately 2,190 trips per year. Assuming that decommissioning also lasts two years, this equates to approximately six vessel trips per day. Vessels used during the decommissioning phase are expected to be similar to the vessels used during construction. As these vessels are not all currently in the southern New England area, they will have to travel to the project area from domestic and international ports. While most of the vessels operating during construction and decommissioning will travel at relatively low speeds (i.e., 12 knots or less), some vessels are capable of transiting at up to 30 knots. There are a number of measures designed to decrease the risk of interactions between project vessels and listed species that are part of the proposed action, as highlighted below. In addition to these measures, all vessel operators are required to abide by the right whale ship strike reduction rule (78 FR 73726) and the right whale approach regulations (62 FR 6729).

As explained above, the best available information indicates there are approximately 54,305 vessel transits annually in the general area that the majority of Revolution Wind vessel transits will overlap. Table 7.2.3 below describes the calculated increase in traffic attributable to Vineyard Wind project vessels during each project phase.

Table 7.2.3. Percent Increase Above Baseline Vessel Traffic in the WDA and OECC Due to Project Vessels, inclusive of survey vessels

Phase	Phase Duration	Annual Project-Related Vessel Trips (average daily trips x 365 days)	% Increase in Annual Vessel Trips in the OECC and WDA
Construction (remaining)	1 year	2,555 [a]	+ 4.7%
Operation	27 of 30 years	887 [b]	+ 1.6%
Operation (with fisheries surveys)	3 of 30 years	959	+1.8%
Decommissioning	2 years	2,190 [c]	+ 4.0%

[a] Source: Vineyard Wind Biological Assessment, 2019, pg. 81
[b] Source: Vineyard Wind COP Volume I Table 4.3-2, Epsilon 2020
[c] Source: Vineyard Wind Biological Assessment, 2019, pg. 80

7.2.2 Avoidance, Minimization, and Monitoring Measures for Vessel Operations

There are a number of measures included as conditions of COP approval that are designed to avoid and minimize the risk of vessel strike. NMFS OPR's proposed IHA also contains requirements for vessel strike avoidance measures for marine mammals; these measures will be required for vessels operating during the one-year effective period of the IHA. The complete list of required measures is referenced in section 3 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). Neither the conditions of COP approval or the proposed IHA provide any exemption from the existing vessel speed regulations which require all vessels 65-feet in length or greater to operate at speeds of 10 knots or less in all identified Seasonal Management Areas. However, both the conditions of COP approval and the proposed IHA provide exceptions to other project vessel speed restrictions to protect vessel and crew safety.

Specific measures related to vessel speed reduction that are required as conditions of COP approval, and thus apply for the life of the Vineyard Wind project include:

- 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. Lookouts/visual observers must be equipped with alternative monitoring technology (e.g., night vision devices, infrared cameras) for periods of low visibility (e.g., darkness, rain, fog, etc.).
- 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.
- Year round, all vessels of all sizes will operate at 10 knots or less in any DMA unless they are traveling in a transit corridor monitored by real-time PAM (see below).
- Between November 1 and May 14, with the exception of crew transfer vessels operating in a transit corridor monitored by real-time PAM (see below), vessels of all sizes will operate at 10 knots or less when transiting to, from, or within the WDA. This speed restriction does not apply to vessels transiting in Nantucket Sound, unless an active DMA is in place that overlaps Nantucket Sound, as right whales generally do not occur in the shallow waters of Nantucket Sound.
- For crew transfer vessels operating in a transit corridor monitored by real-time PAM, vessel speeds must be limited to 10 knots upon the detection of a right whale via visual observation or PAM within or approaching the transit route; all CTVs must travel at 10 knots (18.5 kilometers per hour) or less for the remainder of that day.
- Any use of PAM to monitor a transit corridor (and the associated exception to 10 knot speed restriction) is subject to review and approval of a PAM plan by NMFS and BOEM.
- 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. If a sea turtle is sighted within 328 feet (100 meters) of the operating vessels' forward path, the vessel operator must safely slow down to 4 knots (7.4 kilometers per hour) and may resume normal vessel operations once the vessel has passed the sea turtle.

During the effective period of the IHA, the following measures are proposed related to vessel speed:

- From November 1 to April 30, all vessels, regardless of size, must travel at 10 knots or less. (Note: The proposed IHA provides no exception to the 10 knot speed restriction for CTVs operating in a PAM-monitored transit corridor.)

- Vessels, regardless of size, must travel 10 knots or less in any Seasonal Management Area (SMA) or active Slow Zones (i.e., DMAs or acoustically-triggered slow zone);
- All vessel operators must immediately reduce speed to 10 knots or less for at least 24 hours when a North Atlantic right whale is sighted, at any distance, by any project-related personnel or acoustically detected by any project-related PAM system. Each subsequent observation or acoustic detection in the Project area shall trigger an additional 24-hour period. A slowdown in the transit corridor expires when there has been no further North Atlantic right whale visual or acoustic detection in the transit corridor in the past 24 hours;
- From May 1 to October 31, project vessels may travel at speeds above 10 knots only when there is no other speed restriction in place (e.g., the vessel is outside a DMA/Slow Zone) and is operating in a transit corridor monitored by real-time PAM (in accordance with a NMFS approved plan). This does not apply in Narragansett Bay or Long Island Sound;
- All vessel operators, regardless of their vessel's size, must immediately reduce speed to 10 knots or less when any large whale, (other than a North Atlantic right whale), mother/calf pairs, or large assemblages of cetaceans are sighted within 500 m of a transiting vessel;

Vineyard Wind is required to prepare and then operate their vessels pursuant to a NMFS and BOEM approved Vessel Strike Avoidance Plan that includes identification of any "transit corridor" and plans for conducting PAM in that area, including information to support the effectiveness of the proposed PAM in detecting right whales. This plan must be approved by BOEM, BSEE, NMFS OPR, and NMFS GARFO before any PAM in transit corridors can be used to alleviate any 10 knot speed restriction that would otherwise be in place (noting, as above, this cannot provide an exemption to the 10 knot speed restriction for vessels 65' or greater in SMAs). Vineyard Wind has submitted such a plan and it was approved by the agencies. The conditions of the proposed IHA require Vineyard Wind to submit an updated plan for agency approval. Without an approved updated plan, the conditions of the proposed IHA restrict all project vessels to speeds of 10 knots or less at all times during the effective period of the IHA, with the only exceptions being for safety.

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, conditions of COP approval require that 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 from Vineyard Wind project vessels. This assessment incorporates the strike avoidance measures identified as part of the proposed action or that are otherwise required by regulation. This analysis is organized by species group (i.e., whales, sea turtles, Atlantic sturgeon) 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). Thus, Atlantic sturgeon only occur along a portion of the vessel routes described above and are absent from much of the deep-water offshore vessel routes.

While Atlantic sturgeon are known to be struck and killed by vessels in rivers and estuaries located adjacent to spawning rivers (e.g., Delaware Bay), we have no reports of vessel strikes in the marine environment.

We have considered whether Atlantic sturgeon are likely to be struck by project vessels or if the increase in vessel traffic is likely to otherwise increase the risk of strike for Atlantic sturgeon in the action area. As established elsewhere in this Opinion, Atlantic sturgeon use of the action area is intermittent and disperse; there are no aggregation areas in the WDA, the cable corridors or along the vessel transit routes to any of the ports in MA, RI, or Canada. The dispersed and transient 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 action area (with the exception of near shore areas where vessels will dock and where Atlantic sturgeon are not expected to occur) and that sturgeon occur at or near the bottom while in the action area, the potential for co-occurrence of a vessel and a sturgeon in the water column is extremely low even if a sturgeon and vessel co-occurred generally. The areas to be transited by project vessels are free flowing with no obstructions; therefore, even in the event that a sturgeon was up in the water column such that it could be vulnerable to strike, there is ample room for a sturgeon swim deeper to avoid a vessel or to swim away from it which further reduces the potential for strike. None of the nearshore port areas where vessels will potentially enter shallower water and dock, including New Bedford, are known to be used by Atlantic sturgeon; as such, co-occurrence between any Atlantic sturgeon and any project vessels in areas with shallow water or constricted waterways where the risk of vessel strike is theoretically higher, is extremely unlikely to occur. Considering this analysis, it is extremely unlikely that any project vessels will strike an Atlantic sturgeon during any phase of the proposed project. We have also considered whether avoiding these project vessels increases the risk of being struck by non-project vessels operating in the action area. In order for this to occur, another vessel would have to be close enough to the project vessel such that the animal's evasive movements made it such that it was less likely to avoid the nearby vessel. Given common navigational safety practices (i.e., not traveling too close to other vessels to minimize the risk of collisions), it is extremely unlikely that another vessel would be close enough such that a sturgeon avoiding a project vessel would not be able to avoid another non-project vessel or that the risk of being struck by another non-project vessel would otherwise increase. Based on this analysis, it is extremely unlikely that any Atlantic sturgeon will be struck by project vessels and therefore, effects are discountable.

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 considered to be those that spend extended periods of time at the surface feeding or in order to restore oxygen levels within their tissues after deep dives. Mother/calf pairs are at high risk of vessel strike because they frequently rest and nurse in nearshore habitats at or near the water surface, particularly in the Southeast calving area (Cusano et al. 2018; Dombroski et al. 2021; note that the action area does not overlap with the Southeast calving area). A summary of information on the risk of vessel strike to right whales is found in Garrison et al. 2022. 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). Numerous studies have indicated that slowing the speed of vessels reduces the risk of lethal vessel collisions, particularly in areas where right whales are abundant and vessel traffic is common and otherwise traveling at high speeds (Vanderlaan and Taggart 2007; Conn and Silber 2013; Van der Hoop et al. 2014; Martin et al. 2016; Crum et al. 2019). 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). NMFS' data on documented vessel strike events continues to affirm the role of high vessel speeds (> 10 knots (5.1 m/s)) in lethal collision events and supports existing studies implicating speed as a factor in lethal strikes events (87 FR 46921). While it remains unclear how whales generally, and right whales in particular, respond to close approaches by vessels (<460 m) and the extent to which this allows them to avoid being struck, Conn and Silber (2013) indicated that encounter rates were higher with fast-moving vessels than expected, which may be consistent with successful avoidance of slower vessels by whales.

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. NMFS' data on documented vessel strike events continues to affirm the role of high vessel speeds (>10 knots (5.1 m/s)) in lethal collision events and supports existing studies implicating speed as a factor in lethal strikes events. Growing evidence shows that vessel speed, rather than size, is the greater determining factor in the severity of vessel strikes on large whales; vessels less than 65 ft. in length accounted for 5 of the 12 documented lethal strike events of North Atlantic right whales in U.S. waters since 2008 (87 FR 46921). Of the six lethal vessel strike cases documented in U.S. waters and involving right whales since 1999 where vessel speed is known, only one involved a vessel transiting at under 10 knots (5.1 m/s) (87 FR 46921).

Reducing vessel speed is one of the most effective, feasible options available to reduce the likelihood of lethal outcomes from vessel collisions with right whales (87 FR 46921). 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 and the potential effects of those regulations are not evaluated in this Opinion.

In the 2008 regulations, NMFS also established a Dynamic Management Area (DMA) program whereby vessels are requested, but not required, to either travel at 10 knots or less or route around locations when certain aggregations of right whales are detected outside SMAs. These temporary protection zones are triggered when three or more whales are visually sighted within 2-3 miles of each other outside of active SMAs. The size of a DMA is larger if more whales are present. A DMA is a rectangular area centered over whale sighting locations and encompasses a 15-nautical mile buffer surrounding the sightings' core area to accommodate the whales' movements over the DMA's 15-day lifespan. The DMA lifespan is extended if three or more whales are sighted within 2-3 miles of each other within its bounds during the second week the DMA is active. Only verified sightings are used to trigger or extend DMAs; however DMAs can be triggered by a variety of sources, including dedicated surveys, or reports from mariners. Acoustically triggered Slow Zones were implemented in 2020 to complement the visually triggered DMAs. The protocol for the current acoustic platforms that are implemented in the

Slow Zone program specify that 3 upcalls must be detected (and verified by an analyst) to consider right whales as “present” or “detected” during a specific time period. Acknowledging that visual data and acoustic data differ, experts from NMFS’ right whale Northeast Implementation Team, including NEFSC and Woods Hole Oceanographic Institute staff, developed criteria for accepting detection information from acoustic platforms. To indicate right whale presence acoustically (and be used for triggering notifications), the system must meet the following criteria: (1) evaluation has been published in the peer-reviewed literature, (2) false detection rate is 10% or lower over daily time scales and (3) missed detection rate is 50% or lower over daily time scales. For consistency, acoustically triggered Slow Zones are active for 15 days when right whales are detected and can be extended with additional detections. However, acoustic areas are established by rectangular areas encompassing a circle with a radius of 20 nautical miles around the location of the passive acoustic monitoring system.

In an analytical assessment of when the vessel restrictions were and were not in effect, Conn and Silber (2013) estimated that 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).

In the Vineyard Wind action area, the Block Island SMA, which is in effect from November 1 - April 30 each year, overlaps with a portion of the Vineyard Wind Lease block (MA Lease OCS-A 0501) (Figure 7.2.1), the Great South Channel SMA, in effect April 1 – July 31 each year also overlaps the action area. Many DMAs have been established in response to aggregations of right whales in the waters of southern New England; as such, we expect these may occur throughout the year in various portions of the action area. For example, in 2022, NMFS declared a total of 77[37] 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,

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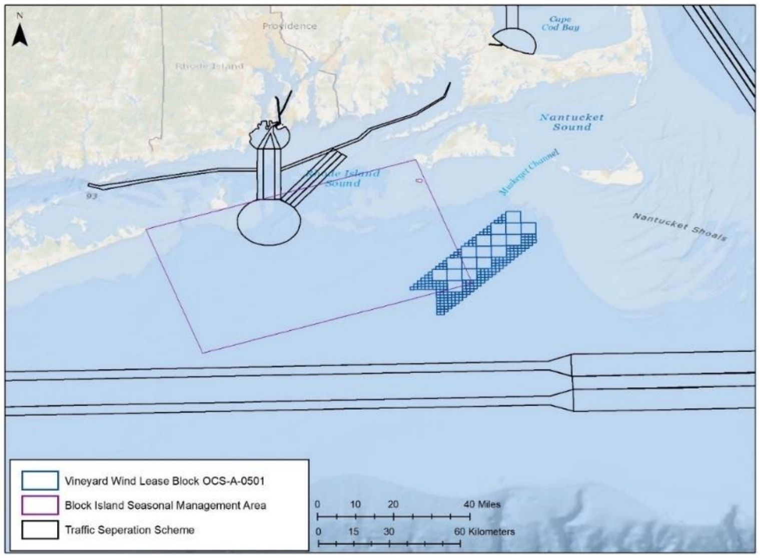
[37] https://www.fisheries.noaa.gov/s3/2023-01/2022_DMAs_and_Right_Whale_Slow_Zones_508.pdf; last accessed June 27, 2023.

New York Bight, NY, Atlantic City, NJ and Cape Cod Bay, MA) and in one location in the Southeast U.S. (Ocracoke, NC).

Figure 7.2.1. Traffic Separation Schemes (TSSs), Seasonal Management Areas (SMAs), Vineyard Wind Lease block (MA Lease OCS-A 0501) in the Project Area in southern New England



We consider vessel strike of ESA-listed large whales in context of specific project phases, as well as in the context of the different parts of the action area where project vessels will operate. This is because the characteristics and volume of vessel traffic is distinctly different during the three phases of the project and there are differences in the distribution of large whales in the different parts of the action area. We have reorganized the text in this section for clarity and have also updated information on remaining construction vessel trips and to reflect the conditions of the new proposed IHA. While we have updated our analysis, the conclusions reached in this analysis are the same as those reached in our 2021 Opinion.

Effects of Vessel Transits in the Vineyard Wind WDA and to/from Ports in RI and MA (west of Monomoy, MA)

To assess risk of vessel strike in the area where the majority of vessel traffic will occur (i.e., the lease area, the cable corridor, and the area between ports used in RI and MA and the WDA) 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, and sperm whales struck annually in that geographic area. 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 Vineyard Wind on the number of anticipated vessel transits in that area by Vineyard Wind project vessels to determine to what extent vessel traffic would increase in this geographic area during each of the three phases of the Vineyard Wind project. For example, if baseline traffic was 100 trips per year and the Vineyard 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 considered how an increase in vessel traffic may increase the risk of vessel strikes in the area. For example, if in the baseline condition, we expect a whale to be struck and the project doubled traffic, we would consider that a doubling of traffic may double the risk of vessel strike in that area. It is important to note that these steps were carried out without consideration of any measures designed to reduce vessel strike and with 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 of an ESA listed whale by a Vineyard Wind project vessel 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 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 Vineyard Wind vessels to the baseline than could have been carried out using vessel miles and we consider it the best available information for conducting the vessel strike risk analysis.

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 Vineyard Wind WDA and identified ports in MA and RI (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 and RI accounts for nearly all of the anticipated vessel traffic during all phases of the proposed project, with a limited number of trips anticipated between the WDA and ports in Canada and Europe.

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 for 2016-2020 data, Henry et al. 2023 for 2017-2021 data; these are the most recent reports available). From the marine mammal stock assessment reports and serious injury and mortality reports produced by NMFS, for the period of 2009-2021 (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 Rhode Island or Massachusetts, south of Cape

Cod and west of Monomoy, which is the best representation of the geographic area representing the Vineyard Wind WDA, and the area where vessels will transit between these areas and the identified ports in Massachusetts and Rhode Island. We also reviewed older marine mammal stock assessment reports and serious injury and mortality reports produced by NMFS, for the period of 2000-2008. We did not identify any records of fin, sei, sperm, or right whales with vessel strike injuries that were first reported in this geographic area or that were recorded as having vessel strikes suspected to have occurred in this area. As noted above, this area accounts for where nearly all of the vessel traffic associated with the Vineyard Wind project will occur. We also reviewed NMFS records post-dating 2021, including information from the right whale UME (as posted through August 10, 2024)[38], and did not identify any records of vessel strikes in this area. However, we note that there are multiple reports of sei, fin, and right whales with evidence of vessel strike observed in waters outside the geographic area considered here. 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. We also recognize that not all carcasses of vessel struck animals are detected. For example, a time series of observed annual total mortality and serious injury of North Atlantic right whales versus estimated total mortalities is included in the 2020 North Atlantic right whale Stock Assessment Report (see Figure 5 in Hayes 2021). Additionally, depending on cetacean species, carcasses may be more likely to float or sink, they may be carried from where they were struck on the bow of a vessel and only noticed in port, or carried away from the ship strike location by wind, currents, and waves. All of these factors contribute to the difficulty in detecting carcasses, in particular from ship strike (Rockwood et al. 2017).

A number of studies have estimated carcass recovery rates for different cetacean species, including 17% for right whales, 6.5% for killer whales, <5% for grey whales, and 3.4% for sperm whales (Kraus et al. 2005). Pace et al. (2021) used an abundance estimation model to derive estimates of cryptic mortality for North Atlantic right whales and found that observed carcasses accounted for 36% of all estimated deaths during 1990–2017 (Pace et al. 2021). Given these factors, it is difficult to identify a number of strikes of any of these species that has occurred in the geographic area of interest in the past. We note that there are no indications or reports of any strikes of any whales by Vineyard Wind vessels to date.

Absent any mitigation measures we would expect an increase in risk of vessel strike in a given area to be proportional to the increase in vessel traffic. As such, this would result in an increase in risk during the construction period of 4.7-4.8%, during the operational period by 1.6-1.8%, and 4% during the decommissioning period. As noted above, there are no records of right, fin, sei, or sperm whales with evidence of vessel strike where the first observation was in waters where the majority of Vineyard Wind vessel traffic will occur (between the ports in RI and MA and the OECC and WDA). This suggests that baseline risk of vessel strike in this area may be lower compared to other areas along the Atlantic coast; any reduced risk is likely due to the nearshore environment where large whales typically are not as common as further offshore areas.

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[38] https://www.fisheries.noaa.gov/national/marine-life-distress/2017-2024-north-atlantic-right-whale-unusual-mortality-event; last accessed 8/15/2024; note that of the 5 NARW deaths mapped in this area, 4 are identified as entanglement or probable entanglement and 1 was unknown due to state of decomposition.

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 in areas and at times of year when risk of strike is considered highest, monitoring via dedicated visual observers during vessel transits, PAM, and alternative monitoring technologies to be used at night or in other low visibility conditions to improve detection of whales in time to slow down and avoid a strike.

The vessel speed limit requirements that will be implemented by Vineyard Wind as required by 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. As described above and in Appendices A-D of this Opinion, specific measures related to vessel speed reduction include limiting speeds to 10 knots or less in areas where right whales are expected to occur, specifically SMAs and DMAs/Slow Zones and limiting vessels that operate at speeds greater than 10 knots to operating within an area being monitored by 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 24 hours, with any subsequent detection triggering a 24-hour reset. 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 and being equipped with technology to improve visibility/detection in low light conditions.

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 (2007) 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 (of which only the Block Island SMA overlaps with the action area), 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 can 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/lighting conditions, that if whale is in the vicinity of a project vessel, 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 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 increases time available to avoid a strike. Awareness of any whales in the area will also be enhanced through monitoring of reports on USCG Channel 16, communication between multiple project vessel operators or any sightings, and monitoring of the NMFS Right Whale Sightings Advisory System.

Here, we explain how these measures support our determination that any potential vessel strike due to increases in project vessel traffic caused by the proposed action is extremely unlikely to 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; alternatively, the animal needs to detect the vessel and move out of the way of the vessel. The speed limits and monitoring measures that are part of the proposed action maximize the opportunity for detection and avoidance.

Vessel speed restrictions:

By reducing speeds below 10 knots, the probability of a lethal 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. Some project vessels are expected to never, or rarely, operate at speeds over 10 knots including during HRG survey activities, cable laying, and survey vessels trawling or hauling gear, these vessels are expected to normally operate at speeds less than 5 knots. Vessel speed restrictions are summarized above and are designed to limit vessel speeds during times of year and in locations when right whales are most likely to occur.

Exceptions to 10 knot speed restriction:
As explained above, project vessels may travel at speeds greater than 10 knots at certain times of the year and in certain geographic areas or when an area is being monitored by PAM and no vocalizing NARWs have been detected for an identified period of time. 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 24 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.

PSOs/Lookouts and Increased right whale awareness:
A number of measures will be required by BOEM and/or NMFS OPR to increase awareness and detectability of whales. Vessel operators and crews will receive protected species identification training that covers species identification as well as making observations in good and bad weather. All vessel operators and crews must maintain a vigilant watch for all marine mammals and slow down, stop their vessel, or alter course (as appropriate) and regardless of vessel size, to avoid striking any marine mammal. All vessels must have a dedicated lookout to monitor a vessel strike avoidance zone around the vessel. When vessels are traveling over 10 knots, these observers will have no other duty than to monitor for listed species and if one is sighted communicate to the vessel captain to slow down and take measures to avoid the sighted animal. These observers are required to monitor for daily information of right whale sightings to inform situational awareness. Visual observers will also be equipped with alternative monitoring technology for periods of low visibility (e.g., darkness, rain, fog, etc.). At all times the lookout will be monitoring for presence of whales and ensuring that the vessel stays at least 500 m away from any right whale or unidentified large whale. If any whale is detected within 500 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 must check for information regarding mandatory or voluntary ship strike avoidance (DMAs/Slow Zones and SMAs) and daily information regarding right whale sighting locations through project specific communications channels, WhaleAlert, US Coast Guard Channel 16, and the Right Whale Sighting Advisory System. Vineyard Wind is required to ensure that whenever multiple Project vessels are operating, any visual detections of ESA-listed species (marine mammals and sea turtles) are communicated, in near real time, to a third-party Protected Species Observer (hereafter, PSO) and/or vessel captains associated with other Project vessels. Active monitoring and communications of whale sightings information provides situational awareness for monitoring of whales in the area of vessel activities.

Passive Acoustic Monitoring:
As explained above, during some periods, crew transfer vessels may travel greater than 10 knots (18.5 kilometers per hour) when operating in a transit corridor being monitored by a real-time PAM system and when the lead PSO confirms that NARWs are clear of the transit route,

consistent with the protocols in a NMFS and BOEM approved plan. In this scenario the PAM system will be used for situational awareness when crew transfer vessels request to travel greater than 10 knots, if whale vocalizations are detected, vessels may not travel over 10 knots for the remainder of the day (or until the transit route is clear of NARWs for two consecutive days when the transit route overlaps a DMA). 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 the WDA, OECC, and to/from ports in MA and RI
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 vessel operations 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 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 Vineyard Wind vessel operating in this area is extremely unlikely. The required mitigation measures outlined above further reduce this risk. As such, effects to sei, and sperm whales from the operation of Vineyard Wind vessels in this area are discountable.

Given the location of the Vineyard Wind WFA and the area where vessel transits will occur to/from ports in MA and RI and the WDA, vessels will be transiting in areas where right whale sightings and predicted density are low. 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 Vineyard Wind vessels in this area are discountable. Similarly, given the areas where Project vessels will be transiting, fin whale predicted density is low, thus there is not a high likelihood for co-occurrence. 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 Vineyard Wind vessels in this area are discountable.

Effects of Vessel Transits between Canada and/or Europe and the WDA
During the remainder of the construction period, three additional round trips between Halifax, Canada, and the WDA are expected to transport the 15 remaining WTG foundations to the project site. At this point it is unknown if project vessels will travel to and from Canada during the operations phase; however, the available information indicates that this would be limited to occasional special purpose vessels to carry out non-routine maintenance. During decommissioning, a similar amount of transits from Europe or Canada to the constructions phase could occur. Given this, we expect a limited amount of vessel trips between the project area and ports in eastern Canada and Europe over the remaining life of the project.
These vessel trips would be limited to slow moving barges and/or cargo ships that travel at speeds at 10 knots or less.

The Port of Halifax receives approximately 1,500 cargo vessels a year while the Port of St. John receives approximately 950. Vessels traveling to and from these ports travel to several ports in the United States as well as Europe and Asia. Project vessels will represent an extremely small portion of the vessel traffic traveling to and from these ports in Canada. Given that these vessels will be in compliance with measures that NMFS has determined minimize the potential for ship strike (i.e., traveling at speeds of 10 knots or less) and given the extremely small increase in vessel traffic in this portion of the action area that these vessels will represent, it is extremely unlikely that one of these ships will strike an ESA-listed whale.

Similarly, any vessels that transit between the WDA and Europe are expected to be large slow moving construction/installation or cargo vessels, which travel at slow speeds of approximately 10 knots. Current vessel traffic between the U.S. and Europe is predominantly tankers, container ships, and passenger vessels, which are similar ships in size and speed to the ones that will be used during the construction phase of the project. In this portion of the action area, co-occurrence of project vessels and individual whales is expected to be extremely unlikely; this is due to the dispersed nature of whales in the open ocean and the only intermittent presence of project vessels. Given vessel speeds and given the extremely small increase in vessel traffic in this portion of the action area that these vessels will represent make it extremely unlikely that any ESA-listed whales will be struck by a project vessel.

In summary, while there is a hypothetical increase in risk of vessel strike during all phases of the proposed project due to the increase in vessel traffic, the measures that will be in place, particularly the reduction in speed to 10 knots or less, and use of enhanced monitoring measures for any vessels larger than 65 feet that may operate at speeds above 10 knots, we do not expect that this hypothetical increase in risk will be realized. 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, or sperm whale during any phase of the proposed project.

7.2.3.3 Sea Turtles

Updates to this section are limited to organizational changes to improve clarity and changes to reflect updated estimates of the remaining vessel trips during the construction phase. No strikes of sea turtles by Vineyard Wind project vessels have been reported to date.

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 often congregate close to shorelines during the breeding season, where boat traffic is denser (Schofield et al. 2007; Schofield et al. 2010); however, the lack of nesting beaches in the action area makes this factor irrelevant for this analysis. 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 thought to be based primarily on the animal's ability to see the oncoming vessel, which would provide less time to react as vessel speed increases (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 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 (NMFS and USFWS 2008). 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, which are all outside the action area. 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); none of the areas documented as highest risk for sea turtle vessel strikes occur in the action area.

We consider vessel strike of ESA-listed sea turtles in context of specific project phases, because the characteristics and volume of vessel traffic is distinctly different during the three phases of the project, as well as in the context of the geographic areas where vessels will operate.

Effects of Vessel Transits in the Vineyard Wind WDA and to/from Ports in Southern New England

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. As described in the 2021 Opinion, we queried the NMFS' Sea Turtle and Stranding and Salvage Network (STSSN) database for records of stranded sea turtles with evidence of vessel strike throughout the waters of Rhode Island and Massachusetts (west of Monomoy, MA)from 2016-2018. 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 identified MA and RI ports (transits from Canada are addressed below). 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). 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). Out of the 118 recovered stranded sea turtles in the southern New England region during the three year time period of data, there were a total of 33 records of sea turtles recovered with evidence of vessel strikes (Table 7.2.4). Recovered sea turtles included 18 leatherbacks, 14 loggerheads, and one green sea turtle, and primarily occurred between the months of August and November, which is consistent with the time period when sea turtle abundance is greatest in the region. Though no Kemp's ridley sea turtles were recovered with evidence of vessel strike injuries in this time period, they are generally in the same size class as green sea turtles in this area and occur in the area at the same time. For this analysis, we determined it was reasonable to expect that Kemp's ridley sea turtles are at a similar risk of vessel strike as green turtles in the area.

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 took 93% of the strandings where the animal was dead and had evidence of propeller strike or probable vessel collision to estimate the number of interactions where vessel strike was the cause of death ("Total Presumed Vessel Mortalities" column in Table 7.2.4).

Table 7.2.4. Preliminary STSSN cases from July 2016 to October 2018 with evidence of propeller strike or probable vessel collision in RI and MA (west of Monomoy, MA)

Sea Turtles	Total Records – Definitive Vessel or Blunt Force Trauma	Total Presumed Vessel Mortalities*
Loggerhead	14	13.02
Green	1	0.93
Leatherback	16	14.88
Kemp's ridley	0	-

* 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 gases causes 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 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 may represent as low as five percent of total mortalities in some areas (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 occurred on 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 estimate with the detection value of 17%. The resulting, adjusted number of vessel strike mortalities of each species in RI and MA (west of Monomoy, MA), are presented in the "annual total presumed vessel mortalities" column in Table 7.2.5 below. In using the 17 percent correction factor, we assume that all sea turtle species and at-sea mortalities are equally likely to be represented in the STSSN dataset. That is, sea turtles killed by vessel strikes are just as likely to strand and be recorded in the STSSN database (i.e., 17 percent) as those killed by other activities, such as interactions with fisheries, and the likelihood of stranding once injured or killed does not vary by species.

Table 7.2.5. Estimated Annual Vessel Strike Mortalities (baseline) Adjusted for Unobserved Vessel Strike Mortalities in RI and MA (west of Monomoy, MA)**, based on July 2016 – October 2018 STSSN data**

Sea Turtles	Presumed Vessel Mortalities* Over 3 years	Total Over 3 Years (17% Detection Rate)	Annual Total Presumed Vessel Mortalities
Loggerhead	13	76.5	25.49
Green	1	5.88	1.96
Leatherback	15	88.24	29.41

* 93% of the total of "definitive vessel" plus "blunt force trauma" (see Table 7.2.4), rounded to nearest whole number

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 Vineyard Wind project the vast majority of vessel traffic will occur between the WDA and ports in MA ((west of Monomoy, MA) and RI. 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). Note that given the status of construction at the time this Opinion was written, only one year of construction traffic is expected.

Table 7.2.6. Estimated Vessel Strikes, by sea turtle species, for (remaining) construction, operations, and decommissioning of the Vineyard Wind project.

Remaining Construction

Species	Increase in Vessel Traffic	Baseline strikes/year (rounded to whole number)	Length of phase	estimated vessel strikes
Leatherback	0.047	30	1	1.41
Loggerhead	0.047	26	1	1.22
Green	0.047	2	1	0.094

Operation (27 years without post-construction fisheries surveys):

Species	Increase in Vessel Traffic	Baseline strikes/year (rounded to whole number)	Length of phase	estimated vessel strikes
Leatherback	0.016	30	27	12.96
Loggerhead	0.016	26	27	11.23
Green	0.016	2	27	0.86

Operation, with fisheries surveys (3 of 30 years of operations phase):

Species	Increase in Vessel Traffic	Baseline strikes/year	Length of phase	estimated vessel strikes
Leatherback	0.018	30	3	1.62
Loggerhead	0.018	26	3	1.4
Green	0.018	2	3	0.11

Decommissioning = 4.0% increase in traffic for 2 years:

Species	Increase in Vessel Traffic	Baseline strikes/year	Length of phase	estimated vessel strikes
Leatherback	0.04	30	2	2.4
Loggerhead	0.04	26	2	2.08
Green	0.04	2	2	0.16

As explained above in section 7.2.2, Vineyard 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 right whales, vessel operators must reduce vessel speed to 10 knots or less when sea turtles are observed in the path of an underway vessel, and to use lookouts to spot protected species and direct vessel captains to slow down or alter course to avoid strike (BA Section 5.2.1.2). 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. We also expect that waiting until a turtle is within 50 m to take steps to avoid a strike would limit the opportunity to act in time to avoid a collision. Further, the available information indicates that the speed necessary to avoid a strike is below 4 knots. It is not clear that a vessel detecting a turtle at a distance of 50 m could slow down to below 4 knots in time to avoid collision. Also, even vessels transiting at speeds of 10 knots are likely not traveling slow enough to avoid all collisions. 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 rounded up to whole animals the numbers calculated above. 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 7.2.7 below.

No estimate was calculated for Kemp's ridley sea turtles as none were documented in the three-year period of STSSN data used to generate the estimates; however, as explained above, for the purposes of this analysis we have determined it is reasonable to expect that their risk to vessel strike is no greater than green sea turtles.

Table 7.2.7. Total Estimate of Sea Turtle Vessel Strikes as a Result of the Proposed Action.

Species	Maximum Vessel Strike Anticipated
NWA DPS Loggerhead sea turtle	16
NA DPS Green sea turtle	2
Leatherback sea turtle	19
Kemp's ridley sea turtle	2

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. These estimates are consistent with the estimates of vessel strike mortality included in the 2021 Opinion (with a slight reduction for loggerhead and leatherback sea turtles that is accounted for by the status of construction vessel traffic).

Effects of Vessel Transits between Canada and/or Europe and the WDA

During the remainder of the construction period, three additional round trips between Halifax, Canada, and the WDA are expected to transport the 15 remaining WTG foundations to the project site. At this point it is unknown if project vessels will travel to and from Canada during the operations phase; however, the available information indicates that this would be limited to occasional special purpose vessels to carry out non-routine maintenance. During decommissioning, a similar amount of transits from Europe or Canada to the constructions phase could occur. Given this, we expect a limited amount of vessel trips between the project area and ports in eastern Canada and Europe over the remaining life of the project.

These vessel trips would be limited to slow moving barges and/or cargo ships that travel at speeds at 10 knots or less. In this portion of the action area, co-occurrence of project vessels and individual sea turtles is expected to be extremely unlikely; this is due to the dispersed nature of sea turtles in the open ocean and the only intermittent presence of project vessels. Together, this makes it extremely unlikely that any ESA-listed sea turtles will be struck by a project vessel transiting in the U.S. EEZ or foreign waters as it moves between foreign ports and the WDA. Therefore, effects of vessel transits 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 remaining life of the proposed action will result in the strike and mortality of up to 16 loggerhead, 2 green, 19 leatherback, and 2 Kemp's ridley sea turtles.

7.2.4 Consideration of Potential Shifts in Vessel Traffic
Here, we consider how the proposed project may result in shifts or displacement of existing vessel traffic. Any shifts or displacement of vessel traffic are expected to primarily occur in the WDA due to the presence of the WTGs and ESPs during the operational phase of the proposed Project. However, as stated in the Navigational Risk Assessment (COP Volume III; Epsilon 2020), 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 WDA is a matter of risk tolerance, and up to the individual vessel operators. Therefore, while the presence of the WTGs and ESP is not expected to result in any required re-routing or other shift or displacement in vessel traffic it is possible that it will result in changes to vessel operator preferences and habitats. Currently, vessel traffic in the WDA is primarily fishing vessels which transit the northern portion of the lease area. Larger vessels such as cargo, tug, or cruise vessels transit the WDA very infrequently as these larger vessels primarily transit the Nantucket to Ambrose TSS and TSS routes into New Bedford and Buzzards Bay. Existing vessel traffic may transit within the turbines in the WDA, or operators may avoid the 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 WDA such that risk of vessel 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.

7.2.5 Air Emissions Regulated by the OCS Air Permit

The OCS Air Permit considers effects of air emissions from sources that meet the definitions for coverage under the permit as described in the Fact Sheet (EPA 2021). As noted in section 3, the OCS Air Permit was issued by EPA in 2021 with modifications issued in 2022. We have no new information on the effects of air emissions and there are no updates to this analysis from our 2021 Opinion.

As described by EPA, the "potential to emit" for this OCS source includes emissions from vessels installing the WTGs and the Electrical Service Platform (ESP), engines on the WTGs and ESP, as well as vessels that are at and are traveling within 25 miles to-and-from the windfarm during construction, operations and maintenance of the windfarm. Criteria air pollutant emissions and their precursors generated from the construction and operation of the windfarm include nitrogen oxides, carbon monoxide, sulfur dioxide, particulate matter, and volatile organic compounds. These air pollutants are associated with the combustion of diesel fuel in a vessel's propulsion and auxiliary engines and the engine(s) located on WTGs and ESP.

In the Fact Sheet, EPA notes that the pollutant-emitting activities within the work area (WA) are part of a single plan to construct and operate an offshore windfarm. They also note that it is appropriate and reasonable to aggregate the estimated 106 WTGs, ESP, and OCS source vessels, operating within the WDA as a single OCS facility for purposes of applying the part 55 OCS permitting regulations and a single stationary source for purposes of applying the prevention of significant deterioration (PSD) and nonattainment new source review (NNSR) permit program elements. They also note that once the facility meets the definition of an OCS source, emissions from vessels servicing or associated with any part of the OCS facility are included in the potential emissions from the facility while traveling to and from any part of the OCS facility when within 25 miles of the centroid of the facility. The proposed OCS Air Permit considers emissions only during the construction and operations/maintenance phases of the project. As explained in the Fact Sheet, EPA states, "due to the fact that the decommissioning phase of the windfarm will occur well into the future, the EPA is unable to determine best available control technology (BACT) and lowest achievable emissions rate (LAER) for the decommissioning phase and will not be permitting this phase at this time." Below, we address air quality effects and decommissioning, given decommissioning is part of BOEM's COP approval/disapproval. However, the effects of air emissions during decommissioning are not considered in this consultation with regard to EPA's action because EPA did not include it in its permit. Reinitiation may be necessary in the future to consider these effects once there is sufficient information to determine what the Best Available Control Technology will be during the decommissioning phase and what effects to listed species and/or critical habitat are reasonably certain to occur.

As described in the Fact Sheet developed by EPA to support permit issuance, EPA has determined that the ambient air impact analysis done in support of the proposed OCS Air Permit shows that the impact from the OCS facility operation 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. The analysis also shows that construction phase emissions for both the facility and OECLA will not cause significant impacts for the PSD increments at any Class I area (national parks and wilderness areas). In addition, the air quality impact analysis demonstrated that operation of the facility will not adversely cause impairment to soils, vegetation, or visibility at Class I areas.

Based on the analysis presented by EPA in the Fact Sheet, any effects to air quality from the construction and operations phases of the proposed action are likely to be very small. Given the types of activities and vessels needed for construction and decommissioning (e.g., driving/removing piles, laying/removing cable, etc.) are similar, we assume the effects to air quality from decommissioning are similar to those of construction such that the air quality effects from the proposed action as a whole are still likely to be minor. 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 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.

7.3 Effects to Habitat and Environmental Conditions 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 activities including dredging, cable installation, foundation installation, and installation of scour protection, and project lighting during construction. The effects of noise caused by these activities are discussed in Section 7.1; the effects of associated vessel activities are discussed in Section 7.2. Information has been added to this section to identify which activities have been completed and to provide any available information on any observed or reported effects to ESA listed species.

7.3.1 Cable Installation

Two offshore export cables in one cable corridor have been installed to connect the offshore components to the onshore electrical grid. Each offshore export cable consists of three-core 220-kV alternating current (AC) cables that would deliver power from the ESPs to the onshore facilities. A single primary offshore export cable corridor (OECC) with two potential routes through Muskeget Channel was analyzed in the BA. The OECC from the WDA could pass through the deepest part of Muskeget Channel proper, or it could pass atop the shoals to the east of the deepest area (see Figure 2.1-3). Two potential landfall sites were considered in the BA, Covell's Beach in Barnstable, Massachusetts, and New Hampshire Avenue in Yarmouth, Massachusetts. In June 2020, Vineyard Wind notified BOEM that the New Hampshire Avenue route was no longer being considered; in July 2020 BOEM requested that we remove consideration of the New Hampshire Avenue route from consideration in the consultation, as it is no longer part of the proposed action. As the offshore export cable approaches Cape Cod, the final route would be contingent on the choice of landfall site. Detailed specifications of offshore export cables and inter-array cables are provided in the COP Volume I, Sections 3.1.5 and 3.1.6, respectively (Epsilon 2020). Installation of the export cable has been completed; installation of the inter-array cable is ongoing as of July 2024. While ESA listed species have been observed from vessels supporting cable installation there are no reported interactions with any ESA listed species during cable installation activities.

Vineyard Wind is proposing to lay most of the inter-array cable and offshore export cable using simultaneous lay and bury via jet embedment. Cable burial would likely use a tool that slides along the seafloor on skids or tracks (up to 3.3 to 6.6 feet [1 to 2 meters] wide), which would not dig into the seafloor but would still cause temporary disturbance. The installation methodologies are described in detail in COP Volume I, Section 4.2.3 (Volume I; Epsilon 2020). Prior to installation of the cables, a pre-lay grapnel run would be performed in all instances to locate and clear obstructions such as abandoned fishing gear and other marine debris. Following the pre-grapnel run, dredging within the OECC would occur (where necessary) to allow for effective cable laying through any sand waves. More information on dredging methodology is presented below.

Protection conduits installed at the approach to each WTG and ESP foundation would protect all offshore export cables and inter-array cables. In the event that cables cannot achieve proper burial depths or where the proposed offshore export cable crosses existing infrastructure, Vineyard Wind could use the following protection methods: (1) rock placement, (2) concrete mattresses, or (3) half-shell pipes or similar product made from composite materials (e.g., Subsea Product from Trelleborg Offshore) or cast iron with suitable corrosion protection.[39] Vineyard Wind has conservatively estimated up to 10 percent of the inter-array and offshore export cables would require one of these protective measures.

7.3.1.1 Pre-lay Grapnel Run

Prior to installation of the cables, a pre-lay grapnel run would be performed to locate and clear obstructions such as abandoned fishing gear and other marine debris. 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 device and avoid an interaction. Additionally, as the cable of the grapnel run 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 and listed species is extremely unlikely to occur. No interactions with ESA listed species have been reported during any pre-lay grapnel runs completed to date.

7.3.1.2 Dredging

The 2021 Opinion contained an analysis of anticipated effects from dredging that may be required in association with installation of the OECC. In the 2021 Opinion we concluded that effects to ESA listed species from dredging would be insignificant or discountable; no take was

[39] Half-shell pipes come in two halves and are fixed around the cable to provide mechanical protection. Half-shell pipes or similar solutions are generally used for short spans, at crossings or near offshore structures, where there is a high risk from falling objects. The pipes do not provide protection from damage due to fishing trawls or anchor drags (COP Volume I, Section 3.1.5.3; Epsilon 2020)

anticipated. No dredging was carried out; therefore, there were no effects to any ESA listed species and effects are thus not assessed in this Opinion.

7.3.1.3 Turbidity from Cable Installation

Installation of the OECC and inter-array cables would disrupt bottom habitat and suspend sediment in the water column. BOEM indicates in the BA that a maximum impact assessment includes 171 miles (275 kilometers) of 66 kV inter-array cable at the WDA and 98 miles (158 kilometers) of 220 kV export and inter-array cables in the WDA and OECC. The greatest potential impact of turbidity from cable laying would occur if Vineyard Wind uses pre-cable installation dredging during the cable-laying process. Modeling of sediment and transport potential (COP Volume III, Appendix III-A; Pyć et al. 2018, Epsilon 2020) was completed for typical and maximum impact installation of inter-array cables in the WDA and for dredging and installation of the OECC. This would result in about 214,500 cubic yards (164,000 m^3) of dredged material that would be sidecast along the seafloor (COP Volume I, Section 4.2.3.3.2; Epsilon 2020). As noted above, installation of the OECC has been completed while installation of the inter-array cables is ongoing.

Dredging will only occur along a portion of the route (no more than 10%) and only in areas with sand waves that would disrupt the ability to successfully lay the cable. As described in the BA, modeling indicates that the sediment plume associated with dredging would be mostly confined to the bottom 1 foot (3 meters) of the water column. Model results of simulations of the OECC show that the use of the trailing suction hopper dredger for pre-cable installation dredging has the potential to generate temporary turbidity plumes throughout the entire water column of TSS at 10 milligrams per liter (mg/L) extending up to 9.9 miles (16 kilometers) and 750 mg/L extending up to 3.1 miles (5 kilometers) from the OECC centerline for 2 to 3 hours respectively, though this may be less extensive at varying locations along the route (Crowley et al. 2018). Because the dredge will be moving along the cable route, the plume will be temporary and localized.

Simulation of the typical (non-dredging) cable installation for the OECC suggest plumes of greater than 10 mg/L total suspended solids (TSS) above ambient levels would occur up to 1.9 miles (3.1 kilometers) from the centerline with higher concentrations of 50 mg/L constrained to 525 feet (160 meters) from the centerline. Maximum impact installation indicates the 10 mg/L plume could extend up to 4.6 miles (7.5 kilometers) from the centerline while plumes at 50 mg/L and 100 mg/L would extend up to 1.2 miles (2.0 kilometers) and 0.53 miles (0.86 kilometers) from the centerline, respectively. According to modeling presented in the BA, the sediment plume is confined to the bottom 9.8 feet (3 meters) of the water column. As the cable laying will be moving along the cable route, the associated turbidity plume will also be transient and will not last in any particular area for more than a few hours.

Atlantic sturgeon

Atlantic sturgeon are adapted to natural fluctuations in water turbidity through repeated exposure (e.g., high water runoff in riverine habitat, storm events) and are adapted to living in turbid environments (Hastings 1983, ECOPR Consulting 2009). Atlantic sturgeon forage at the bottom by rooting in soft sediments meaning that they are routinely exposed to high levels of suspended sediments. Few data have been published reporting the effects of suspended sediment on sturgeon. Garakouei et al. (2009) calculated Maximum Allowable Concentrations (MAC) for total suspended solids in a laboratory study with *Acipenser stellatus* and *A. persicus* fingerlings (7-10 cm TL). The MAC value for suspended sediments was calculated as 853.9 mg/L for *A. stellatus* and 1,536.7 mg/L for *A. persicus*. All stellate sturgeon exposed to 1,000 and 2,320 mg/L TSS for 48 hours survived. All Persian sturgeon exposed to TSS of 5,000, 7,440, and 11,310 mg/L for 48 hours survived. Given that Atlantic sturgeon occupy similar habitats as these sturgeon species we expect them to be a reasonable surrogate for Atlantic sturgeon. Wilkens et al. (2015) contained young of the year Atlantic sturgeon (100-175 mm TL) for a 3-day period in flow-through aquaria, with limited opportunity for movement, in sediment of varying concentrations (100, 250 and 500 mg L−1 total suspended solids [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 5 km of the operating dredge would be exposed to TSS of up to 750 mg/L; an Atlantic sturgeon within 2 km of the cable laying operation would be exposed to TSS of up to 100 mg/L. These elevated TSS levels are not expected to persist for more than 3 hours in any particular location. 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.

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 whale to find copepod aggregations, particularly if they locate prey concentrations by looking upwards. However, Fasick et al. (2017) indicate that North Atlantic right whales certainly must rely on other sensory systems (e.g. vibrissae on the snout) to detect dense patches of prey in very dim light (at depths >160 meters or at night). Because ESA listed whales often forage at depths deeper than light penetration (i.e., it is dark), which suggests that vision is not relied on exclusively for foraging, TSS that reduces visibility would not be expected to affect foraging ability. Data are not available regarding whales avoidance of localized turbidity plumes; however, Todd et al. (2015) conclude that since marine mammals often live in turbid waters and frequently occur at depths without light penetration, impacts from turbidity are not anticipated to occur. As such, any effects to ESA listed whales from exposure to increased turbidity during dredging or 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 on 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 cannot be meaningfully measured, evaluated, or detected and would therefore be insignificant. Effects on prey are considered below.

7.3.1.4 Potential for Entanglement during Cable Laying
The jet plow uses jets of water to liquefy the sediment, creating a trench in which the cable is laid. Cable laying operations proceed at speeds of <1 knot. At these speeds, any sturgeon, sea turtle, or whale is expected to be able to avoid any interactions with the cable laying operation. Additionally, as the cable will be taut as it is unrolled and laid in the trench, there is no risk of entanglement. Based on this information, entanglement of any species during the cable laying operation is extremely unlikely to occur. No interactions with any ESA listed species have been observed or reported during any cable installation activities to date.

7.3.1.5 Impacts of Cable Installation on Prey
Cable installation could affect prey of Atlantic sturgeon, sea turtles, and whales due to impacts of sediment disturbance during dredging or cable laying; exposure to increased TSS; burial during dredged material disposition; or direct removal during dredging. Here, we provide a brief summary of the prey that the various listed species forage on and then consider the effects of cable installation on prey, with the analysis organized by prey type.

Summary of Information on Feeding of 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 finmarchicus*, 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.

Green sea turtles
Green sea turtles feed primarily on sea grasses and may feed on algae. The cable route is designed to avoid areas with sea grasses; therefore, no effects to sea turtle forage are anticipated.

Loggerhead and Kemp's ridley sea turtles
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
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).

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.

<u>Effects of Cable Installation on the Prey Base of ESA Listed Species in the Action Area</u>

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). Baumgartner 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 expect any entrainment of copepods as a result of dredging and do not anticipate any burial or loss of copepods during dredged material placement or installation of the cable. We were unable to identify any scientific literature that evaluated the effects to marine copepods of exposure to TSS. Based on what we know about effects of TSS on other aquatic life, it is possible that high concentrations of TSS could negatively affect copepods. However, given that: the expected TSS levels are below those that are expected to result in effects to even the most sensitive species evaluated; the sediment plume will be transient and temporary (i.e., persisting in any one area for no more than three hours); elevated TSS is limited to the bottom 3 meters of the water column; and will occupy only a small portion of the WDA 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
Of the fish species that fin and sei whales and Atlantic sturgeon may feed on in the action area, only sand lance are expected to be vulnerable to entrainment and mortality in the hopper dredge (Michel et al. 2013); their vulnerability is due to their behavior of burrowing into the sand. Sand lance are strongly associated with bottom habitats comprised of clean sandy sediments located in relatively shallow water depths of less than 100 m. This suggests that sand lance may be present in the sand waves where dredging will occur. As described in Reine and Clarke (1998), not all fish entrained in a hydraulic dredge are expected to die. Studies summarized in Reine and Clarke (1998) indicate a mortality rate of 37.6% for entrained fish. We expect that dredging in sand waves to allow for cable installation will result in the entrainment and mortality of some sand lance. However, given the size of the area where dredging will occur, the short duration of dredging, and the expectation that most entrained sand lance will survive, and that sand lance are only one of several species available for fin and sei whales and Atlantic sturgeon to forage on while in the action area, we expect any impact of the loss of sand lance on these species to be so small that it cannot be meaningfully measured, evaluated, or detected.

As explained above, elevated TSS will be experienced along the cable corridor during cable installation. Anticipated TSS levels are below the levels expected to result in the mortality of fish that are preyed upon by fin or sei whales or Atlantic sturgeon. In general, fish can tolerate at least short term exposure to high levels of TSS. Wilber and Clarke (2001) reviews available information on the effects of exposure of estuarine fish and shellfish to suspended sediment. In an assessment of available information on sublethal effects to non-salmonids, they report that the lowest observed concentration–duration combination eliciting a sublethal response in white perch was 650 mg/L for 5 d, which increased blood hematocrit (Sherk et al. 1974 in Wilber and Clarke 2001). Regarding lethal effects, Atlantic silversides and white perch were among the estuarine fish with the most sensitive lethal responses to suspended sediment exposures, exhibiting 10% mortality at sediment concentrations less than 1,000 mg/L for durations of 1 and 2 days, respectively (Wilber and Clarke 2001). Forage fish in the action area will be exposed to maximum TSS concentration-duration combinations far less than those demonstrated to result in sublethal or lethal effects of the most sensitive non-salmonids for which information is available. Based on this, we do not anticipate the mortality of any forage fish; therefore we do not anticipate any reduction in fish as prey for fin or sei whales or Atlantic sturgeon.

Dredged material will be sidecast. This could result in the burial of sand lance in areas where dredged material is deposited. However, sand lance routinely bury themselves several inches into the substrate so we do not expect any loss of sand lance due to sidecast disposal. Modeling presented in the BA indicates that as suspended sediment settles out of the water column following cable installation, maximum deposition will be less than 0.2 inches (5 mm) of sediment with deposition greater than 0.04 inch (1 millimeter) only within 328 feet to 492 feet (100 meters to 150 meters) of the trench centerline. Given the thin layer of deposition we do not anticipate any effects to sand lance.

Benthic Invertebrates
Benthic invertebrates that are present within the sand being dredged, including polychaete worms that Atlantic sturgeon forage on would be removed along with the sand. These organisms may survive entrainment and if so would be deposited alive adjacent the areas being dredged. Some motile organisms, such as crabs, may avoid the dredge. However, entrainment of crabs does occur (Reine et al. 1998) and we expect that most small benthic invertebrates in the path of the dredge would be entrained. We do not have any information to base a mortality rate on. We expect that dredging in sand waves to allow for cable installation will result in the entrainment and mortality of some benthic invertebrates. However, given the size of the area where dredging will occur and the short duration of dredging, the loss of benthic invertebrates will be small, temporary, and localized. Similarly, the burial and mortality of any benthic invertebrates during dredge material deposition will be small, temporary, and localized. In the BA, BOEM indicates that an area approximately 6-feet wide will be disturbed during cable installation; this is likely to result in the mortality of some benthic invertebrates in the path of the jet plow. Immediately following cable installation, this area will likely be devoid of any benthic invertebrates. However, given the narrow area, we expect recolonization to occur from adjacent areas that were not disturbed; therefore, this reduction in potential forage will be temporary.

As explained above, elevated TSS will be experienced along the cable corridor during cable installation. Because polychaete worms live in the sediment, we do not expect any effects due to exposure to elevated TSS in the water column. Wilbur and Clarke (2001) reviewed available information on effects of TSS exposure on crustacean and report that in experiments shorter than 2 weeks, nearly all mortality of crustaceans occurred with exposure to concentrations of suspended sediments exceeding 10,000 mg/L and that the majority of these mortality levels were less than 25%, even at very high concentrations. Wilbur and Clarke (2001) also noted that none of the crustaceans tested exhibited detrimental responses at dosages within the realm of TSS exposure anticipated in association with dredging. Based on this information, we do not anticipate any effects to crustaceans resulting from exposure to TSS associated with cable installation. Given the thin layer of deposition associated with the settling of TSS out of the water column following cable installation we do not anticipate any effects to benthic invertebrates. Based on this analysis, we expect any impact of the loss of benthic invertebrates to foraging Kemp's ridley and loggerhead sea turtles and Atlantic sturgeon due to cable installation to be so small that they cannot be meaningfully measured, evaluated, or detected and therefore, are insignificant.

Jellyfish

Jellyfish occur in the water column and therefore are not vulnerable to entrainment in the hopper dredge. Therefore, we do not expect any loss of jellyfish due to dredging. We also do not expect the deposition of dredged material or the settling of sediment onto the bottom to affect 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.

7.3.1.6 Onshore Cable Connections

Work at the landfall location at Covell's Beach in Barnstable, MA has been completed. As explained in the 2021 Opinion, the only in-water work would be at the transition site where a temporary cofferdam will be installed. Given the shallow, nearshore location of the transition site, we did not expect any whales, sea turtles, or Atlantic sturgeon to be exposed to any effects of the cofferdam installation or cable pull-in. No ESA listed species were observed during cofferdam installation or cable pull-in.

As noted in Section 3.1, Vineyard Wind has filed a Notice of Intent to obtain authorization under EPA's NPDES General Permit for Stormwater Discharges from Construction Activity. This requires development of a Stormwater Pollution Prevention Plan in accordance with EPA regulations. With this plan in place, any effects to listed species that may be exposed to discharge from the construction activity will be extremely unlikely to occur or so small that they cannot be meaningfully measured, detected, or evaluated, and are therefore insignificant.

7.3.2 Turbidity Associated with WTG and ESP Installation

Pile driving 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.

7.3.3 Lighting

Most construction activities (pile driving, WTG assembly) will be limited to daylight hours. However, cable laying operations would take place 24 hours per day, 7 days a week during installation. 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 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. 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 WDA is more than 600 km), there is no potential for project lighting to impact the orientation of any sea turtle hatchlings.

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. Some analysis in this section of the Opinion has been revised to incorporate scientific literature that was not available when the 2021 Opinion was issued; there are no changes to the conclusions reached on the effects of project operations on ESA listed species.

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 grounded metallic shielding to prevent detectable direct electric fields. Vineyard Wind would also bury cables to a target burial depth of approximately 6.6 feet (2 meters) below the surface or utilize cable protection (e.g., rock or concrete mattresses). The metallic shielding and sediments used for burial are expected to completely contain the electrical field (Bevelhimer et al. 2013). 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 Vineyard Wind (i.e., 66 kV and 220 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). These findings are consistent with the modeling analysis for the Vineyard Wind cables; modeling was carried out to model magnetic fields at the sea floor for two representative submarine cable cross sections, at 1m and 2m burial depths (Gradient 2018). The modeling shows that the highest modeled magnetic fields occur directly above the 400-MW submarine cable with a 1-meter burial depth. The seafloor magnetic field levels fall sharply under the 2-meter burial depth assumption. The target burial depth for the Project's submarine cables is 1.5 to 2.5 meters, thus as noted in the modeling report, the 1-meter and 2-meter assumption for magnetic field modeling is conservative. Further, the modeling does not account for any reduction in transmission of EMF that is expected to be provided by the metallic shielding. The modeling report shows that magnetic fields diminish very rapidly with distance away from the conductors for each of the cross sections; the analysis shows 97% and 89% reductions in MF levels at lateral distances of ±20 feet from conductor centerlines for the 1-meter and 2-meter burial depths, respectively. The report concludes that as the peak AC magnetic fields (~160 mG at the shallowest burial depth) are weaker than the earth's magnetic field (~550 mG) the magnetic fields are not expected to adversely impact marine organisms, including benthic organisms.

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 impacting 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 Vineyard Wind cables, 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). The anticipated maximum exposure of an Atlantic sturgeon to the proposed cable 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 (Normandeau 2011).

Wyman et al. (2023) investigated the migration behaviors of adult green sturgeon in relation to the cable energization status (off/on) for a ±200 kilovolt direct current (DC) transmission line buried through a portion of the green sturgeon's spawning migration pathway in San Francisco Bay. Detection data collected along the migration route when the transmission line was energized and not energized allowed the authors to assess whether the energized cable - and by inference the magnetic field from its load - may have affected the green sturgeon's migratory behavior. Study results provided varied evidence for an association between cable status and migration behavior. For example, a higher percentage of inbound fish were able to successfully transit inbound after the cable was energized, but this effect did not reach the level of significance. Outbound fish took longer to transit when the cable was energized. Additionally, fish transiting along both inbound and outbound migration paths were not significantly influenced by the cable's energization status, but results suggest a potential subtle relationship between cable energization and the location of inbound and outbound fish migration paths. We note that the findings of Wyman et al. (2023) are not transferable to the proposed AC cables for the Vineyard Wind project. This is because of differences in EMF fields generated by DC cable systems compared to EMF fields generated by AC cable systems. DC cable systems such as the one described in Wyman et al. (2023) generate static EMF fields in the vicinity of the cable route, while AC systems like the proposed cable cause time-varying elliptic EMF fields (Lesur and Deschamps 2012). As a result, we expect biological responses to static (DC) or elliptic (AC) fields to be distinct.

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 Vineyard 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 Vineyard Wind cable's would range from 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 (Normandeau 2011). This is several orders of magnitude below the levels that elicited a behavioral response in the Bevelhimer et al. (2013) study. 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 magnetic field from the proposed cable; therefore, effects are discountable.

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). Information presented in the BA describes modeled and measured magnetic field levels from various existing submarine power cables indicating that AC cables buried to a depth of 3 feet (1 meter) would emit field intensities less than 0.05 μT to 82 feet (25 meters) above the cable, and 79 feet (24 meters) along the sea floor. Given that the cables will be buried at depths of 3 to 8 feet this represents a "worst case" scenario for exposure and establishes that ESA listed whales may detect the magnetic field associated with the cables at a distance of 25 m above the cable and within 24 meters horizontally from the cable.

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 48m wide corridor along the cable route that 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 Vineyard Wind cables are expected to be so small that they cannot be measured or detected and are, therefore, insignificant.

Effects to Prey

Magnetic fields associated with the operation of the transmission line could impact benthic organisms that serve as sturgeon and sea turtle prey. Effects to forage fish, jellyfish, copepods, and krill are extremely unlikely to occur given the limited distance into the water column that any magnetic field associated with the transmission line is detectable. Information presented in the BA summarizes a number of studies on the effects of exposure of benthic resources to magnetic fields. According to these studies, the survival and reproduction of benthic organisms are not thought to be affected by long-term exposure to static magnetic fields (Bochert and Zettler 2004, Normandeau *et al*. 2011). Results from the 30-month post-installation monitoring for the Cross Sound Cable Project in Long Island Sound indicated that the benthos within the transmission line corridor for this project continues to return to pre-installation conditions. The presence of amphipod and worm tube mats at a number of stations within the transmission line corridor suggest construction and operation of the transmission line did not have a long-term negative effect on the potential for benthic recruitment to surface sediments (Ocean Surveys 2005). Therefore, no impacts (short-term or long-term) of magnetic fields on sturgeon or sea turtle prey are expected.

7.4.2 Lighting and Marking of Structures

To comply with FAA and USCG regulations, the WTGs and ESP will be marked with distinct lettering/numbering scheme and with lighting. The USCG requires that offshore wind lessees obtain permits for private aids to navigation (PATON, see 33 CFR part 67) for all structures located in or near navigable waters of the United States (see 33 CFR part 66) and on the OCS. PATON regulations require that individuals or organizations mark privately owned marine obstructions or other similar hazards. No additional buoys or markers will be installed in association with the PATON.

In general, lights will be required on offshore platforms and structures, vessels, and construction equipment during O&M and decommissioning of Vineyard Wind 1. O&M and support vessels would be required to display lights when operating at night and deck lights would be required to illuminate work areas. However, lights would be down shielded to illuminate the deck, and would not intentionally illuminate surrounding waters. If sea turtles, Atlantic sturgeon, whales, or their prey are attracted to the lights, it could increase the potential for interaction with equipment or associated turbidity. However, due to the nature of project activities and associated seafloor disturbance, turbidity, and noise, listed species and their prey are not likely to be attracted by lighting because they are disturbed by these other factors. As such, we have determined that any effects of project lighting on sea turtles, sturgeon, or whales are extremely unlikely.

In addition to vessel lighting, the WTGs will be lit for navigational and aeronautical safety. Lighting may also be required at on shore areas, such as where the cables will make landfall. Many of the onshore areas used for staging will be part of an industrial port where artificial lighting already exists. Sea turtle hatchlings are known to be attracted to lights and artificial beach lighting is known to disrupt proper orientation towards the sea. However, due to the distance from the nearest nesting beach to the project area (the straight line distance through the Atlantic Ocean from Virginia Beach, VA, the northernmost area where successful nesting has occurred, and the WDA is more than 600 km), there is no potential for project lighting to impact the orientation of any sea turtle hatchlings.

7.4.3 Effects of the Physical Presence of the WTG and ESP Foundations on Listed Species

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 Vineyard Wind project; this analysis has been updated to reflect information that has become available since the issuance of the 2021 Opinion including updates to reflect the planned installation of only 62 WTGs on monopile foundations (rather than 100) and the installation of only 1 jacket foundation (for 1 ESP).

7.4.3.1 Consideration of the Physical Presence of Structures on the Movements of Listed Species

There are a limited number of offshore wind turbines currently in operation in U.S. waters, including the five WTGs that make up the Block Island Wind Farm, the two WTGs that are part of the Coastal Virginia Offshore Wind pilot project, the 12 South Fork WTGs, and approximately 10 operational WTGs at Vineyard Wind. We have not identified any reports or publications that have examined or documented any changes in listed species distribution or abundance at these 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 (e.g., AKRF 2012). As such, we do not anticipate that the presence of the WTGs or the ESP 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 use 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 (up to 11 m diameter) and presence above and below water, we expect that whales and sea turtles will be able to visually detect the structures and, as a result, we do not expect whales or sea turtles to collide with the stationary foundations. Listed whales are the largest species that may encounter the foundations in the water column, all other listed species (sea turtles and sturgeon) in the WDA are smaller. Of the listed whales, fin whales are the largest species at 75-85 ft. Based on the spacing of the foundations (1 x 1 nm grid) relative to the sizes of the listed species that may be present in the WFA, we anticipate that ESA-listed whales, sea turtles, and Atlantic sturgeon would move freely through the area and that the foundations would not create a barrier or restrict the movement of any listed species from moving 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 turbine spacing is closer together (0.5 km compared to at least 1.4 km) than the Vineyard Wind project. 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 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. 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 lease area that uses echolocation is the sperm whale. Baleen whales, which includes North Atlantic right whales, fin, and sei whales do not echolocate. Sperm whales use echolocation primarily for foraging (NMFS 2010, NMFS 2015, Miller et al. 2004, Watwood et al. 2006); sperm whale foraging is not expected 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 impact echolocation, it is extremely unlikely that this would have any effect on sperm whales. 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, and given the conflicting results from studies of harbor porpoises, it is difficult to predict how listed whales and sea turtles will respond to the presence of the foundations in the water column. However, 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 ESP foundations, as well as cable protection along any portions of the inter-array and export cables that could not be buried to depth. The footprint of 62 monopile foundation and 1 jacket foundation and associated scour protection would amount to a total of less than 53 acres (0.21 km^2) in the WDA. Placement of the inter-array cable protection (e.g., concrete mattresses, rock placement, and/or half-shell) would alter up to an additional 63 acres (0.26 km^2) of bottom habitat. Long-term habitat alteration may occur from the placement of scour protection along the OECC in areas where the cable cannot be buried to the acceptable depth is 35 acres (0.14 km^2). The addition of the WTGs and ESPs, 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 WTGs, ESPs, and scour protection would transform approximately 152 acres (0.61 km^2) of soft bottom habitat into coarse, hard bottom habitat. 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 (Taormina et al. 2018) which may provide a potential increase in available forage items for sea turtles compared to the surrounding soft-bottoms. In the North Sea, Coolen et al. (2018) sampled epifouling organisms at offshore oil and gas platforms and compared data to samples from the Princess Amalia Wind Farm (PAWF) and natural rocky reef areas. The 60 PAWF monopile turbine foundations with rock scour protection were deployed between November 2006 and March 2007 and surveys were carried out in October 2011 and July 2013. This study demonstrated that the WTG foundations and rocky scour protection acted as artificial reef with a rich abundance and diversity of epibenthic species, comparable to that of a natural rocky reef.

Stenburg et al. (2015) studied the long-term effects of the Horns Rev 1 offshore wind farm (North Sea) on fish abundance, diversity, and spatial distribution. Gillnet surveys were conducted in September 2001, before the WTGs were installed, and again in September 2009, 7 years post-construction at the wind farm site and at a control site 6 km away. The three most abundant species in the surveys were whiting (*Merlangius merlangus*), dab (*Limanda limanda*), and sand lance (*Ammodytidae spp*.). Overall fish abundance increased slightly in the area where the wind farm was established but declined in the control area 6 km away. None of the key fish species or functional fish groups showed signs of negative long-term effects due to the wind farm. Whiting and the fish group associated with rocky habitats showed different distributions relative to the distance to the artificial reef structures introduced by the turbines. Rocky habitat fishes were most abundant close to the turbines while whiting was most abundant away from them. The authors also note that the wind farm development did not appear to affect the sand-dwelling species dab and sand lance, suggesting that 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.

Methartta and Dardick (2019) carried out a meta-analysis of studies that examined finfish abundance inside windfarms compared to nearby reference sites. The overall effect size was positive and significantly different from zero, indicating greater abundance of fish inside of wind farms 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 Vineyard Wind 1 project, effects to listed species from the loss of soft bottom habitat and conversion of soft bottom habitat to hard bottom habitat may occur if this habitat shift resulted in changes in use of the area (considered below) by listed species or resulted in changes in the availability, abundance, or distribution of forage species.

The only forage fish species we expect to be impacted by these habitat alterations would be sand lance (*Ammodytes spp.)*. 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 WDA, which is dominated by sandy substrate, the loss or conversion of soft bottom habitat is very small, approximately 0.2% of the WDA (calculated as 112 acres of 75,614 acre size of the WDA), and an even smaller portion of the action area as a whole. 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 in the action area is directly proportional to the amount of soft substrate lost, we would expect a 0.2%

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 infanual benthic organisms in the action area is directly proportional to the amount of soft substrate lost, we would expect a 0.2% reduction in the abundance of these species as forage for Atlantic sturgeon in the action area. Given this small, localized, patchy reduction in infaunal benthic organisms, and that the action area 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 WDA due to the reef effect of the foundations 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 foundations and 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 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.

None of the available studies examined distribution or abundance of copepods in association with wind farms built to date. In section 7.4.3.3 below, we explain how the physical presence of the foundations may affect 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 Vineyard Wind 1 WFA is located within multiple defined marine areas. Here, we consider the best available information on how the presence and operation of the up to 63 foundations with 62 WTGs and one ESP proposed for the Vineyard Wind 1 project may affect the oceanographic and atmospheric conditions in the action area and whether there will be any consequences to listed species.

A number of theoretical, model-based, and observational studies have been conducted that help inform the potential effects offshore wind facilities may have on the oceanic and atmospheric environment; summaries of several of these studies, which 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 wind facility) and were carried out in Europe, specifically the North Sea, where commercial-scale offshore wind facilities 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 (HDR 2020); however, no additional reports or literature about oceanographic or atmospheric impacts during operation has been published. 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 CVOW-C project and the Revolution Wind projects, the latter located nearby the Vineyard Wind 1 WFA began in the summer of 2024 and is ongoing; as neither of these projects are fully operational yet, there are not yet any available studies about the effects of either project on oceanographic or atmospheric conditions. The construction of the South Fork Wind project was completed in the spring of 2024, however, we are not aware of any available information on the effects of the project on oceanographic or atmospheric conditions.

Background Information on Oceanic and Atmospheric Conditions in the Project Area

At the broadest scale, the proposed Vineyard Wind 1 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 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 temperature, chlorophyll, and salinity at a range of depths. Additionally, long-term shelf-wide surveys 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, and insight to detect changes in the environment.

In the waters of the Vineyard Wind 1 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 flowing 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 Vineyard Wind 1 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 for a number of 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 are mobile, 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 RI/MA WEA and MA WEA) primarily feed on five prey resources - zooplankton, pelagic fish, gelatinous organisms/cephalopods, marine vegetation, and benthic invertebrates. Of the listed species in the area, North Atlantic right whales are the only obligate zooplanktivores. Blue whales, which occur primarily along the shelf break rather than on the shelf where the Vineyard Wind 1 WFA is located, feed primarily on krill but also feed on fish and zooplankton. 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 Vineyard Wind 1 project is being 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 Vineyard Wind 1 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 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 forage 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. However, while forage fish species do move independent of ocean currents, many of these species prey on plankton.

Since around 2010, North Atlantic right whales have been sighted more frequently in southern New England waters than in previous time periods (Meyer-Gutbrod et al. 2022, O'Brien et al. 2022). The southern New England region is generally defined as 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 to right whale habitat use in this area, with some inter-annual variability. Right whales predominantly occupy Nantucket Shoals and the western and southern edges of the Shoals during the fall (September – November), remain in this general 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 Vineyard Wind 1 WFA (Stone et al. 2017, Quintana-Rizzo et al. 2021). Summer (June – August) is when right whale density is lowest in the southern New England region generally, and in the Vineyard Wind 1 WFA specifically. However, right whales have been both sighted and detected year-round throughout the entire southern New England region (Estabrook et al. 2022, O'Brien et al. 2022, Van Parijs et al. 2023). North Atlantic right whales use the southern New England region for migration as well as feeding and socializing; observations of both feeding behavior and surface active groups have been observed in every season (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 of individual right whales in this area 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 Vineyard Wind 1 WFA; the WFA is farther west. 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 persistent areas of high density for right whales in southern New England waters and seasonally in the Vineyard Wind 1 WFA.

High use areas for North Atlantic right whales (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 Vineyard Wind 1 WFA. The exception is that during March - May, these high use areas overlap the Vineyard Wind 1 WFA (Quintana-Rizzo et al. 2021). During spring (March-May) in 2011- 2015 the central and southwestern and in 2017-2019 the central and northeastern portions of the Vineyard Wind 1 WFA, respectively, and adjacent waters to the north, east/southeast, and west were high use areas for right whales, with both feeding and social behavior (social active groups) observed (Leiter et al. 2017, Quintana-Rizzo et al. 2021). Conclusions about feeding behavior were based on sightings of right whales open-mouthed or just below the surface as feeding at depth could not be confirmed. Passive acoustic detections have confirmed right whale presence in and around the Vineyard Wind 1 WFA throughout the year (Estabrook et al. 2022, Van Parijs et al. 2023).

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 (Johnson et al. 2006, Ji et al. 2009, Bi et al. 2015). 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 is likely linked to the distribution and availability of planktonic prey distributed and aggregated by currents and oceanographic conditions (Pendleton et al. 2009). Similarly, the distribution of leatherback sea turtles is linked to planktonic prey resources (Dodge et al. 2014). Sei and fin whales are 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 and their distribution is not as well associated with oceanographic features that concentrate zooplankton.

Summary of Available Information on the Effects of Offshore Wind Facilities 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 turbines 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 modeled wind facility. 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 Vineyard Wind 1 project in particular.

Some literature is available that considers the potential impacts of wind power development on temperature. Miller and Keith (2018) developed a model to better understand climatic impacts due to wind power extraction; however, the paper addresses how a modeled condition would affect average surface temperatures over the continental U.S. and does not address offshore wind turbines or any effects on ocean water temperatures. Wang and Prinn (2010 and 2011) carried out modeling to simulate the potential climatic effects of onshore and offshore wind power installations; they found that while models of large scale onshore wind projects resulted in localized increases in surface temperature (consistent with the pattern observed in the Miller and Keith paper), the opposite was true for models of offshore wind projects. The authors found a local cooling effect, of up to 1°C, from similarly sized offshore wind installations. The authors provide an explanation for why onshore and offshore turbines would result in different localized effects.

Golbazi et al. 2022 simulated the potential changes to near-surface atmospheric properties caused by large offshore wind facilities equipped with 10 and 15 MW offshore wind turbines. In the model, they simulated 30 GW of offshore wind turbines located in identified lease and planning areas off the U.S. Atlantic coast. 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 facilities 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 Vineyard Wind 1 project, minor cooling of waters in the action area in the summer months would be expected. We do not anticipate that any minor cooling of waters in the action area in the summer months would have any effects on the abundance or distribution of ESA listed species or the abundance or distribution of their 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. In general, as an air current moves towards and past a turbine, the structure reduces air velocities (reduced kinetic energy in the atmosphere) 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 from the turbine. Wind wakes vary in size and magnitude and vary based on natural environmental conditions (i.e., wind speed, direction) and turbine size and layout. 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. No in-situ studies have been carried out in the U.S. to date. 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.

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. Wind wake propagation generally extends longer in stable atmospheric conditions where there is less influence from vertical mixing (Christiansen et al. 2022, Golbazi et al. 2022). 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). However, while models and observations indicate that the maximum wind speed deficit occurs at hub height inside the wind wake downstream of an offshore wind energy facility, reduction in average wind speeds near the ocean surface has also been modeled and observed (Christiansen 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 with 15 MW WTGs (150 m hub height) 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 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; their study describes wind wakes that extend up to or greater than 62 miles (100 km) downstream of large offshore wind facilities.

Models have predicted reductions in surface winds and wind stress over tens of kilometers downwind from turbine arrays and may be influenced by closely adjacent wind farms (Christiansen et al. 2022). A study on the effect of offshore wind projects (~ 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 facility, 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 facility, depending on the ambient wind speed, the atmospheric stability, and the number of turbines in operation (Christiansen & Hasager 2005). Christiansen et al. (2022) found that simulated wind wakes varied individually in size and intensity due to the different sizes of North Sea facilities and due to superposition of neighboring wakes, with the strongest wind speed deficits modeled in densely built areas. 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 facilities 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), an offshore wind facility 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, and 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 facility 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, 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 an offshore wind facility 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). Offshore wind facilities may create a damming effect where a regional high pressure zone is created upwind of the turbines and air deflects up and over the turbine causing a low pressure zone in the middle. This air mass returns to the surface downstream of the turbine field, creating a dipole local high/low pressure zone on the ocean surface which can affect local currents including upwelling and downwelling (Christiansen 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 MA-RI WEA. 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. Also, the wind turbine wake loss model and corresponding wind speed and sea surface wind stress reduction were only confined to the domain of the model that were inside the offshore wind development area which limits the application of the results outside of that area.

Using remote sensing, Vanhellemont and Ruddick (2014) showed that offshore wind facilities 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 facilities 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 wind facilities (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 wind facilities 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 or more) of the North Sea would need to be covered with wind turbines; 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 the foundations, 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 turbulence remained within the first 100 m from the turbine foundation under a range of stratified conditions. Field measurements at the offshore wind facility 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 foundations at DanTysk are 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 affected oceanic regions; however, the scale and degree of those effects is dependent in part on location. If wind projects 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 relation to the role of tides in wake-induced hydrodynamic perturbations, Christiansen et al. found that tide-related hydrodynamic features (e.g., currents and fronts) influence the development of wake effects in the coastal ocean. Tidal current were found to be able to counter changes in horizontal surface currents and in shallower waters, tidal stirring influences how wake effects translate to changes in vertical transport and density stratification (Christiansen et al. 2022). 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 facility in the North Sea. Vertical mixing was found to be increased within the footprint of the wind facility, leading to a doming of the thermocline and a subsequent transport of nutrients into the surface mixed layer. Though discerning a wind facility-induced relationship from natural variability is difficult, wind facilities 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 southern New England.

Van Berkel et al (2020) investigated available information on the effects of offshore wind facilities on hydrodynamics and implications for fish. The authors report that changes in the demersal community have been observed close to wind facilities (within 50 m) and that those changes are related to structure-based communities at the foundations (e.g., mussels). The authors also report on long-term studies of fish species at the Horns Rev 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 offshore wind energy facilities or inside/between the foundations at wind facilities. 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 (Cazenave et al. 2016). 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.

The National Academies of Sciences, Engineering, and Medicine recently released a report "Potential Hydrodynamic Impacts of Offshore Wind Energy on Nantucket Shoals Regional Ecology: An Evaluation from Wind to Whales" which considered the potential for offshore wind facilities in the Nantucket Shoals region to affect oceanic physical processes and how hydrodynamic alterations may affect the local to regional ecosystem, particularly North Atlantic right whale foraging and prey resources (NASEM 2023). The findings in the report acknowledge that offshore wind energy development may impact oceanic physical processes that influence right whales through the abundance and distribution of their prey, but acknowledge significant uncertainty in the potential impacts from offshore wind development, and therefore provided a number of recommendations for additional observational research and modeling studies (NASEM 2023). The report noted that the magnitude of potential effects from offshore wind development may be less than from ongoing climate induced changes. We note that this does not necessarily mean that impacts from offshore wind development will be non-significant or not detectable and that they may be incremental as additional development occurs. We also acknowledge that changes to the southern New England ecosystem that may result from offshore wind development may be difficult to discern from those attributable to climate change particularly absent a robust monitoring strategy.

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 foundations, 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. Under stratified conditions, layering in the oceanographic wake of the turbine foundations may occur where water moves around the cylinder foundation and multiple layers of different density gradients form. This in turn may cause alterations to the structure of the water column (Dorrell et al. 2022). The potential for increased mixing may also increase nutrients and therefore increase phytoplankton growth. However, decreased mixing from reduced wind stress due to farther field atmospheric wakes could also cause increased stratification and subsequently affect the exchange of nutrients, heat, and trap prey. Modeling studies in the Southern New England region have found changes in distribution patterns of planktonic larvae under offshore wind build-out scenarios (Johnson et al. 2021, Chen et al. 2021), suggesting similar impacts could occur with right whale's zooplankton 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 facility 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 effects on phytoplankton and zooplankton might extend to upper trophic level impacts, potentially modifying the distribution and abundance of finfish and invertebrates. The spatial scale of these effects remains unknown but could range from localized within individual facilities 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 facility in China. The facility 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 facility, 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 Vineyard Wind 1 WFA (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 Vineyard Wind 1 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 facility 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 offshore wind facility clusters in the inner German Bight and at Dogger Bank, which are both situated in highly productive frontal areas, and a netPP 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 facility 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, along the edges of Dogger Bank for example.

Consideration of Potential Effects of the Vineyard Wind 1 Project
The predominant wind direction in the Vineyard Wind 1 WFA is from the west, northwest, and southwest with some variability from eastern directions depending on time of year (New England Wind COP, Volume II, 2021). Average wind speed is 8.6 meters/second (m/s), with stronger winds observed during winter (New England Wind COP, Volume II, 2021). The predominant flow of ocean surface currents is bimodal, indicating an east/west tidal influence; the current direction modes are 98˚/278˚. Currents show some variability due to season, tides, winds, and bathymetry. Mean current speed varies with depth, highest mean speed of 0.19 m/s was recorded at 21 m depth, bottom currents are weaker during normal conditions, with average speeds less than 0.1 m/s (New England Wind COP, Volume II, 2021)[40].

[40] Environmental condition information from the New England Wind COP is cited here as this information was not provided in the Vineyard Wind COP. These data provide the best representation of local wind and current speeds that are expected in the Vineyard Wind 1 lease area as they were recorded from buoys deployed in the New England Wind lease area. The New England Wind project is directly southwest adjacent to the Vineyard Wind 1 project.

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 presence and operation. These impacts include increased turbulence generated by the presence of turbine foundations, extraction of wind/kinetic energy 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 facilities. However, discerning a wind facility-induced relationship from natural variability and climatic changes is difficult and very specific to local environmental conditions where the offshore wind project 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 facility size and orientation (Miles et al. 2021).

Here, we consider the *Environmental Baseline*, the information presented above regarding available studies, incorporate the layout and parameters of the Vineyard Wind 1 project and local oceanographic and atmospheric conditions, and evaluate anticipated effects to ESA listed species. We note that while we are using the best available information to assess effects of the Vineyard Wind 1 project, given the lack of site specific data, there is uncertainty about how offshore wind projects in the action area may alter oceanographic and atmospheric processes and the biological systems that rely on them. However, based on observed and modeled results described in the summary of the best available information above, we do expect effects to occur, but acknowledge there is uncertainty regarding the scale/magnitude and extent of these effects in the context of the southern New England ecosystem and in the Vineyard Wind 1 lease area and surrounding area specifically. The best 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 Vineyard Wind 1 project (up to 62 WTGs [maximum hub height of 144 m above mean lower low water] and their foundations and one ESP) and its specific geographic location in consideration of the Environmental Baseline, which takes into consideration the presence and operation of the South Fork, Revolution Wind, Sunrise Wind, and New England Wind, projects, which are all located within the Vineyard Wind 1 action area. The analysis and conclusions reached here may not be reflective of the consequences of larger scale offshore wind development in the region or even a single project in a different location.

As explained above, based on the available information, we do not find any evidence that installation of up to 63 foundations and operation of 62 WTGs and 1 ESP for the Vineyard Wind 1 project would lead to ocean warming that could affect ESA listed whales, sea turtles or fish or that there is the potential for the Vineyard Wind 1 project to contribute to or exacerbate warming ocean conditions; if anything, the project may result in minor, localized cooling.

When applying studies conducted outside southern New England and the greater Mid-Atlantic Bight region to our consideration of the potential effects of the Vineyard Wind 1 project on oceanographic and atmospheric 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 in 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 environments due to the influence of the energy extraction on the wind stress at the ocean surface; further, 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 strong stratification such as the cold pool, large regions would need to be covered by wind turbines. Given the scale of the Vineyard Wind 1 project (63 foundations), any effects of stratification are not expected to reach the scale that would affect the timing and rate of breakdown of the cold pool in the fall. Also, at this time, the available information does not suggest that the effects of the Vineyard Wind 1 project in addition to the other permitted offshore wind projects in the action area, would be sufficiently great to affect the timing and rate of breakdown of the cold pool.

Based on the available information, it is likely that the Vineyard Wind 1 project will produce atmospheric wakes from operation of the turbines and hydrodynamic wakes from the presence of the foundations that will lead to disruptions in local conditions. The scale of these effects is expected to range in distance, hydrodynamic effects in the primary form of turbulence, eddies, and turbidity extending on a scale of hundreds of meters and up to 1 km from each foundation (Floeter et al. 2017, van Berkel et al. 2020). Documented changes in mixed layer depth and thermocline conditions have been observed extending up to 12 km between the paired upwelling peak and downwelling patterns (dipole) at one wind facility with the upwelling and downwelling extending approximately 20 km from the wind facility (Floeter et al. 2022). Similar effects on mixed layer depth and thermocline conditions may occur in the lee of the Vineyard Wind 1 WFA when the wind and current direction is consistent. These changes in conditions may alter the distribution of nutrients, primary production, and plankton. Alterations to wind fields and the ocean–atmosphere interface have also been modeled as modifying both atmospheric and oceanographic patterns on large spatial scales of up 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).

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. There is limited information on which to base an assessment of the degree that the proposed project will result in any such impacts. The only utility scale offshore wind facility in operation in the offshore waters of the United States is the South Fork project, however, it was only fully commissioned in the spring of 2024 and we are not aware of any monitoring of, or available information on, effects of operations on the conditions addressed here; therefore, there are no projects in coastal waters of the United States that can be used to evaluate potential impacts of the proposed Vineyard Wind 1 project. Thus we only have results from modeling and 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 ESA listed species and their prey.

Results of in-situ research, and modeling and simulation studies, show that offshore wind facilities can reduce wind speed and wind stress which can lead to less mixing, lower current speeds, and variations in 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 through increased turbidity (Vanhellemont and Ruddick, 2014). We have considered if these impacts could result in disruption of prey aggregations, primarily of planktonic organisms transported by currents such as copepods and gelatinous organisms (e.g., salps, ctenophores, and jellyfish medusa).

This possible effect is primarily relevant to North Atlantic right whales and leatherback sea turtles as these are the only listed species that occur in the Vineyard Wind 1 WDA that feed solely on planktonic prey (primarily calanoid copepods and gelatinous organisms respectively) whose aggregations are primarily driven by hydrodynamic processes. As described in the Status of the Species and Environmental Baseline sections of this Opinion, right whale foraging areas have shifted since 2010. This foraging shift is likely at least partially due to changing ocean conditions that are attributable to climate change, resulting in changes in copepod abundance and distribution (Meyer-Gutbrod et al. 2023). This, in combination with other stressors, has impacted the health and reproductive status of individual right whales such that the population is considered to be vulnerable to disruptions of foraging and prey resources (Runge et al. 2023). As physical and oceanographic features concentrate aggregations of zooplankton, which provide a dense food source for North Atlantic right whales to efficiently feed upon, increased mixing may disperse aggregations and may decrease efficient foraging opportunities for North Atlantic 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. 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.

Based on the best available information as cited herein, we do not expect the scope of oceanographic, atmospheric, or hydrodynamic effects from the proposed Vineyard Wind 1 project to be large enough to influence regional conditions that could affect the biomass of prey, mainly plankton, or conditions that aggregate prey, in the southern New England region in a way that would have adverse effects on ESA listed species that are reasonably certain to occur. Given that right whale occurrence, and likely foraging, occur both within the Vineyard Wind 1 WFA (Leiter et al. 2017, Quintana-Rizzo et al. 2021) and in the lee of the WFA (east/northeast, based on predominant wind direction), we expect individual turbine/near-field effects to be the primary drivers of changes in zooplankton distribution with potential effects occurring due to far-field effects from energy extraction in the lee of the WFA. We expect localized impacts to oceanic conditions to extend tens of kilometers from the outermost rows of foundations in the Vineyard Wind 1 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 Vineyard Wind 1 WFA relative to the predominant westward flow of water in the southern New England region during the time of year when right whales are more likely to be present and foraging (winter and spring), we do not expect the impacts to oceanic conditions resulting from the Vineyard Wind 1 project to affect the oceanographic forces transporting plankton into the area from the Gulf of Maine or offshore; however, there may be effects on the distribution of plankton more locally. Based on the currently available information, we are not able to determine that any local disruptions would result in adverse effects to foraging right whales. Some copepod species are resident in southern New England and thus their presence in the area is not dependent on being advected into the region. However, other species are dependent on advection to be transported into the area. The best available information indicates that the dominant water flow bringing some zooplankton species to the region - particularly the copepod *C. finmarchicus,* a primary food source for right whales - flows south from the Gulf of Maine and from offshore areas to the east and wraps around Nantucket Shoals following bathymetric contours towards the Vineyard Wind 1 WDA (Johnson et al. 2006, Ji et al. 2009, Bi et al. 2015). We do not expect the construction and operation of the Vineyard Wind 1 project to alter this broad current pattern; however, residence time of water within the WFA may increase due to the presence of structures and potentially slow the transport of water (and thus prey) to the western parts of southern New England (Carpenter et al. 2016, van Berkel et al. 2020). These potential changes will not reduce the biomass of plankton in the southern New England region, however, they may alter the distribution and rate of distribution. However, we expect any alteration of the biomass of plankton in the region, and change in the total food supply, to be so small that adverse effects on ESA listed species are not reasonably certain to occur.

Although uncertainty remains as to the magnitude and intensity of effects that offshore wind facilities may have on altering oceanographic processes, studies demonstrate increased turbulence is expected to occur in the wake of 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 Vineyard Wind 1 project that would be a distance of 77 to 98 m from the 9.6-m diameter monopiles, we note this distance may be shorter (and an area of weaker disturbance) from the single jacket foundation(jacket foundations use multiple 2.5-m diameter pin piles to secure the foundation to the seafloor) as the diameter of piles are smaller and the jacket is a more open structure that allows water to flow through the structure. We expect that any effects on the distribution or density of zooplankton prey due to turbulence from the foundations 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 Vineyard Wind 1 WFA extending up to 300 m down-current from each foundation (Floeter et al. 2017). The wind facilities measured in Floeter et al. employed tripod/tri-pile foundations, which are similar to the jacket foundation installed for the Vineyard Wind 1 ESP, however, monopile foundations are being installed for the WTGs. Due to their open structure, the jacket foundations may not produce a wake effect as long as monopiles. Based on the spacing between the foundations (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 Vineyard Wind 1 WFA. Therefore, while there may be changes in the distribution of plankton within the WFA and in the lee during consistent wind and current conditions, we do not expect any overall reduction in biomass of plankton in the region. 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 almost 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 presence and operation of the Vineyard Wind 1 WTGs and the foundations to affect the abundance of copepods in the WFA area or broader region, the distribution of copepods in the Vineyard Wind 1 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 on wind facility induced effects. Given the predominant direction of water movement (west, depending on time of year) and wind flow (from the west/southwest, depending on time of year) 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 Vineyard Wind 1 WFA would only be expected from foundation-driven turbulence under some conditions and only within an estimated 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. Right whales have been observed feeding in well-mixed waters, however that feeding may not be as energetically efficient (O'Brien et al. 2021). If copepod aggregations are dispersed due to the presence of structures, it is possible aggregations could reform outside of areas of increased turbulence. 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. The increased turbulence may also form eddies in the wake of each foundation which will have uncertain effects on concentrating or dispersing zooplankton prey in a convergent current situation. However, given that the areas impacted by turbulence from foundations would be limited to discrete areas within an estimated 300 m of each of the 62 foundations, we expect the effects of turbulence on zooplankton prey, and therefore on foraging right whales in the Vineyard Wind 1 WFA are unlikely to be biologically significant; that is, considering the best available information, and recognizing the existing uncertainty, we do not expect any effects on the distribution of copepods in the area due to turbulence from this limited number of foundations to have any adverse effects on individual right whales. 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 not have adverse effects on any individual leatherback sea turtles foraging in the area.

Under stable conditions (i.e. sustained wind speed from a consistent direction), farther-field atmospheric effects may occur upwards of 100 km downwind of the Vineyard Wind 1 WFA, but the strongest impacts will likely be within 20-30 km (i.e. Gill et al. 2020, Christiansen et al. 2022, Floeter et al. 2022, Golbazi et al. 2022). From studies in the North Sea, these effects may include reduced wind speeds and wind stress and alterations to depth-averaged velocity, salinity, and sea-surface elevation (Christiansen et al. 2022). However, hub height of turbines and local ambient conditions may influence the extent of these effects. Given the predominant wind direction is from the west, with some variability from the northwest and southwest depending on time of year, under stable atmospheric conditions, we would expect any farther field effects to most commonly occur northeast of the Vineyard Wind 1 WFA and to the east in lease area OCS-A 0520[41] and also potentially beyond. The Vineyard Wind 1 WFA is directly northeast of New England Wind and directly west/northwest of lease area OCS-A 0520. Conditions are not expected to return to ambient between adjacent wind projects (Christiansen et al. 2022). Due to the possible combination of wakes from adjacent projects (New England Wind), under stable atmospheric conditions, the wakes interacting from the Vineyard Wind 1 project and New England Wind project may be lengthened as wake size is relative to the size of the wind facility (van Berkel et al. 2020). Effects may alter the tidal flow on to and off of Nantucket Shoals, which could influence characteristics of the tidal front in that region (Christiansen et al. 2022). Alterations to the tidal flow and tidal front could modify the mechanisms that aggregate zooplankton and also primary productivity and thus the nutrient supply for plankton/zooplankton. These alterations may disrupt areas of efficient foraging for North Atlantic right whales, but may only occur during stable conditions and would only occur directly in the lee of the Vineyard Wind 1 WFA. Under unstable conditions (i.e. variable wind speed from inconsistent direction(s)), these far field effects would be of reduced intensity and distance.

As described above, while there may be localized disruptions of zooplankton distribution due to the presence and operation of the Vineyard Wind WTGs and their foundations, the overall biomass of resident zooplankton is not expected to change in a way that would be significant to ESA listed species, and supply of zooplankton from other regions, such as *C. finmarchicus,* is also not expected to be altered; this conclusion is reached in consideration of the anticipated effects of the Vineyard Wind 1 project and other offshore wind projects that we have completed

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41 https://boem.maps.arcgis.com/apps/instant/sidebar/index.html?appid=e2079773d85b43059abf15a16bce7aa7&locale=en

ESA consultation for to date (note that this does not include the potential Beacon Wind project noted above). Regional distribution of plankton may vary from pre-wind facility conditions; however, acknowledging the information and uncertainty presented here, we are not able to conclude that adverse effects on right whale foraging success due to near-field effects of the Vineyard Wind project are reasonably certain to occur. Relative to far-field effects of the Vineyard Wind project, we do not anticipate disruption to conditions that would aggregate prey in or outside the WFA that would result in adverse effects on ESA listed species. This is due to the scale of the Vineyard Wind project and its location away from Nantucket Shoals, a bathymetric feature that may act to aggregate prey. However, as noted above during stable conditions, effects from the Vineyard Wind 1 project could influence characteristics of the tidal front in the region and impact the formation of dense aggregations of prey and the efficiency of foraging right whales. We have made this conclusion in consideration of the *Environmental Baseline,* which includes consideration of the operational effects of the offshore wind projects described as being in the action area (i.e., South Fork, Revolution Wind, Sunrise Wind, and New England Wind) and noting that the projects outside the MA/RI and MA WEAs (i.e., Empire, Ocean Wind, Atlantic Shores South, CVOW-C, Maryland Wind) are not expected to affect conditions in the Vineyard Wind 1 WFA.

In summary, based on the best available scientific information pertaining to the effects of offshore wind facilities on oceanic and atmospheric conditions, and in recognition of the existing uncertainty related to the impacts as acknowledged herein, we expect the presence and operation of the proposed Vineyard Wind 1 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 WFA or action area. Local turbulence may have effects (positive or negative) on the ability of plankton to aggregate and their local distribution due to changes in primary production patterns. Given the predominant wind direction is from the west, with some variability from the northwest and southwest depending on time of year, under stable atmospheric conditions, we would expect any farther field effects to most commonly occur in to the northeast of the Vineyard Wind 1 lease area and in the OCS-A 0520 lease area, east adjacent to the Vineyard Wind 1 WFA, depending on the predominant wind direction and also potentially beyond them to the northeast and east. Any effects to foraging individual right whales or leatherback sea turtles are not expected to be adverse and no take is anticipated to result from these effects.

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 feed on both small schooling fish and zooplankton, including copepods. We expect the Vineyard Wind 1 project to have localized effects on the distribution and aggregation of zooplankton prey species as described above; however, we do not expect any overall reduction in the amount of prey in the action area. Blue whales feed almost exclusively on krill; however, they occur primarily in deep offshore waters and are expected to be rare in the WFA, therefore there is a very low likelihood that any blue whales will be foraging in the area affected by the Vineyard Wind 1 project. Any effects to individual fin, sei, and blue whales are expected to be so small that they cannot be meaningfully measured, evaluated, or detected and are therefore, insignificant. Effects to the benthic prey base of green, Kemp's ridley, and loggerhead sea turtles are extremely unlikely to occur as a result of the operations of the Vineyard Wind 1 project. 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 foundations increases, the scope and scale of potential hydrodynamic impacts may also increase and influence the environmental baselines for future projects. We also note that development outside of this area (i.e., the Gulf of Maine) could affect regional patterns of zooplankton distribution, including copepods. Our Biological Opinions prepared for the South Fork, Revolution Wind, Sunrise Wind, and New England Wind, (i.e., the commercial scale wind projects in the action area) assessed the construction, operation, and decommissioning of each project and concluded that there may be localized changes in environmental conditions in the respective 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 is planned as 62 WTGs and 1 ESP (63 total foundations) located directly northeast of the proposed Park City Wind and Commonwealth Wind projects. The presence of structures and operation of these projects may have oceanographic, hydrodynamic, and atmospheric effects that overlap, interact, or compound the area affected by the Vineyard Wind 1 project, as noted above, these effects may only be realized during consistent and stable conditions. The South Fork, Revolution Wind, and Sunrise Wind projects are approximately 37, 29, and 21 kilometers, respectively, to the west/northwest of the proposed Vineyard Wind 1 project. The South Fork Wind project consists of 12 WTGs (13 total foundations), the Revolution Wind project will consist of up to 65 WTGs (and two OSSs), and the Sunrise Wind project will consist of 84 WTGs (up to 85 foundations). The New England Wind project will consist of 129 WTGs and 2-5 ESPs) and is directly to the southwest of the Vineyard Wind 1 lease area. Considering the anticipated effects of the Vineyard Wind 1 project in light of the WTGs and foundations of the South Fork, Revolution Wind, Sunrise Wind, and New England Wind projects, does not change our conclusions described above. Under conditions when wind is blowing consistently from the west, Vineyard Wind 1 may fall in the wind wake of these projects, this could reduce water column mixing in the Vineyard Wind 1 WFA; however, this could be offset by mixing from the Vineyard Wind 1 foundations. The Empire Wind project is approximately 250 kilometers to the southwest of the Vineyard Wind 1 project, the Atlantic Shores-South project is approximately 360 kilometers to the southwest of the Vineyard Wind 1 project, and the Ocean Wind 1 project is approximately 380 kilometers to the southwest of the Vineyard Wind project. Once built, we expect that these projects will be too far away for oceanographic, hydrodynamic, or atmospheric effects to impact the Vineyard Wind 1 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

In this section we consider the effects of the marine resource survey and monitoring activities on listed species in the action area by describing the effects of interactions between listed species, and proposed fishing gear (trawl and trap/pot) and the other sampling methodologies (benthic sampling, PAM, cable and scour protection monitoring, underwater debris surveys, plankton surveys), and then analyze risk and determine likely effects to sea turtles, listed whales, and Atlantic sturgeon. Activities will be conducted in Federal waters and along the OECC in Massachusetts State waters and will include: trap, pot, and trawl surveys 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 Project components in the WDA and along the OECC; moored PAM systems and mobile PAM platforms such as towed arrays, autonomous surface vehicles (ASVs), and autonomous underwater vehicles (AUVs) to characterize the presence of protected species, specifically marine mammals; underwater debris surveys to monitor marine debris accumulation on Project structures; plankton surveys to determine the relative abundance and distribution of the larvae of commercially fished crustaceans. Activities will be conducted for a six year period: two years pre-construction following issuance of the record of decision (ROD), during the year of construction, and up to three years post-construction. Section 3 of the Opinion describes the proposed activities over all phases of the project in detail and is not repeated here. Effects of Project vessels, including the ones that will be used for survey and monitoring activities are considered in section 7.2, above, and are not repeated here. In 2023, BOEM approved an amendment to the Vineyard Wind COP related to the deployment of three meteorological buoys; a confirming modification was made by the USACE to the permit issued in 2021. At that time, we reviewed the proposed action and agreed with the action agencies' determinations that the proposed modification would not cause an effect to listed species or critical habitat that was not considered in the 2021 Opinion. Here, we incorporate the consideration of meteorological buoy deployment. There are no other changes to the marine resource survey or monitoring activities since the issuance of the 2021 Opinion. The pre-construction and post-construction fisheries surveys (drop camera, trawl, ventless trap) have been completed; no take of any ESA listed species has been observed or reported as a result of these activities to date (Vineyard Wind 2019-2024 survey reports).

7.5.1 Assessment of Effects of Benthic Monitoring, PAM and other Buoy Deployments, Debris Surveys, and Plankton Surveys

Benthic Monitoring

Vineyard 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 WTG scour protection as well as the inter-array cabling and offshore export cable corridor from the WDA to shore. Monitoring will be conducted using a combination of high-resolution acoustic, video, and photographic imaging methods suited for each habitat type. In addition, ten monitoring sites may be surveyed for sand lance using nighttime benthic grabs. Benthic monitoring will occur based upon the project construction schedule, but will occur at roughly the same time of year in years one, three, and if necessary, year five post-construction. Additionally, in Federal waters, inter-array and export cable inspections will occur within six months following commissioning of the Project. Subsequent inspections will occur in years one, two, and every three years afterward (i.e., years 1, 2, 3, 6, 9, etc.). Additional cable inspections will occur after a major storm event. The inspection is expected to include high resolution geophysical (HRG) methods to identify seabed features, man-made and natural hazards, and site conditions along Federal sections of the cable routing. Prior to cable installation in Town of Nantucket waters, Vineyard Wind will conduct bottom profiling using high-resolution video monitoring to detail bottom composition, sediment profiles, species composition, and topography of the area to be disturbed during cable installation.

In collaboration with the University of Massachusetts Dartmouth School for Marine Science and Technology (SMAST), Vineyard Wind will conduct up to three years pre/during construction and three years post-construction drop camera surveys to examine the macroinvertebrate community and substrate habitat in the Vineyard Wind 1 WDA. The surveys will identify the distribution and abundance of the dominant benthic megafauna classify the substrate, and compare the benthic communities and substrate types between the WDA, a control area, and the broader region of the U.S. Continental Shelf. Surveys will be conducted in and near the Vineyard Wind WDA, with survey stations placed in a systematic grid design. A drop camera pyramid will be deployed four times at each pre-determined sampling station. The pyramid will be equipped with two downward-looking cameras, providing 2.3 m^2 and 2.5 m^2 quadrat samples of the seafloor for all stations. Following image collection, the pyramid will be raised, and the vessel allowed to drift 50 meters and the pyramid will be lowered to the seafloor again. This will be repeated for a total of four camera images at each station.

The drop camera pyramid and benthic grab will result in temporary disturbance of the benthos and a potential temporary loss of benthic resources. The drop camera and grab samples will affect an extremely small area at each of the sampling locations. The drop camera will rest on the seafloor temporarily to capture images before being raised and deployed to the next sampling station, thus the seafloor disturbance will be very minimal. The benthic grab will take a portion of the benthos that will then 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 and bentho-pelagic species at the sample sites, including potential forage items for listed species that feed on benthic and pelagic resources, the amount of resources potentially lost will be extremely small. Any loss of benthic resources will be small, temporary, and localized. These temporary, isolated reductions in the amount of benthic resources are not likely to have a measurable effect on any foraging activity or any other behavior of listed species; this is due to the small size of the affected areas and the temporary nature of any disturbance. As effects to listed species will be so small that they cannot be meaningfully measured, detected, or evaluated, effects are insignificant.

The underwater noise effects generated by the proposed HRG surveys methods and multibeam echosounder and side-scan sonar methods used for habitat monitoring are assessed in section 7.1 of the Opinion; as explained there, all effects of HRG surveys are insignificant or extremely unlikely to occur.

Passive Acoustic Monitoring

Passive acoustic monitoring (PAM) is used to measure, monitor, record, and determine the sources of sound in underwater environments. Moored PAM systems and mobile PAM platforms such as towed PAM, autonomous surface vehicles (ASVs), or autonomous underwater vehicles (AUVs) will be used prior to, during, and following Vineyard Wind 1 construction.

PAM will be used to characterize the presence of marine mammals through passive detection of vocalizations, and will be used to record ambient noise, project vessel noise, pile driving noise, and WTG operational noise. Moored PAM systems are stationary and may include platforms that reside completely underwater with no surface expression (i.e., HARPs: high-frequency acoustic recording packages) or may consist of buoys (at the surface) connected via a data and power cable to an anchor or bottom lander on the seafloor. Moored PAM systems will use the best available technology to reduce any potential risks of entanglement and deployment will comply with best management practices designed to reduce the risk of entanglement in anchored monitoring gear (see Appendix B of NMFS 2021, programmatic consultation). For moored PAM systems, there are cables connecting the hydrophones and/or buoy to the anchor or lander; however, entanglement is extremely unlikely to occur. The cables associated with moored systems have a minimum bend radius that minimizes entanglement risks and does not create loops during deployments, further minimizing entanglement risks. There are no records of any entanglement of listed species in moored PAM systems, and we do not anticipate any such entanglement will occur.

Mobile systems may include ASVs (i.e. wave gliders) that operate at the surface and AUVs (i.e. Slocum gliders) that operate throughout the water column. These vehicles produce virtually no self-generated noise and travel at slow operational speeds as they collect data. Towed hydrophone arrays may also be employed which consist of a series of hydrophones that are towed behind a vessel while it is moving along a survey trackline at slow speeds. Moored and mobile systems will be deployed and retrieved by vessels, maintenance will also be carried out from vessels. Potential effects of vessel traffic for all activities considered in this consultation are addressed in section 7.2.

The small size and slow operational speeds of mobile PAM systems make the risk of a collision between the system and a listed species extremely unlikely to occur. Even in the extremely unlikely event that a whale, sea turtle, or Atlantic sturgeon bumped into the mobile PAM system, it is extremely unlikely that there would be any consequences to the individual because of the relative light weight 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.

Other Buoy Deployments
Three data collection buoys, including MetOcean buoys, will continue to be deployed in the WDA to provide weather and other data in the project area. Best management practices for moored buoys used for data collection associated with offshore wind projects are described in the 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 A of this Opinion). The minimization measures in Appendix A are incorporated as elements of the proposed action for this opinion. BOEM has indicated that any data collection buoys deployed as part of the Vineyard 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.

Debris Surveys
Periodic surveys using remotely operated vehicles, divers, or other means will be conducted to monitor marine debris accumulation around WTG foundations to inform frequency and locations of debris removal. Given the survey methods all involve a human operator that will be able to readily detect listed species, it is extremely unlikely they will interact with listed species; any effects to ESA-listed species of the debris surveys are extremely unlikely to occur.

Plankton Surveys
Plankton sampling will occur concurrent with the ventless trap surveys to determine the relative abundance and distribution of the larvae of commercially fished crustaceans. The surveys will use a towed neuston net and sample the top 0.5 meters of the water column. At each ventless trap survey station (30 total), one ten-minute tow will be conducted at a target speed of four knots to assess pre-settlement and abundance of plankton resources in the Vineyard Wind WDA and the adjacent control area. The 2.4 x 0.6 x 6 meter sampling net made with 1320 microfiber mesh will be deployed off the stern of commercial fishing vessels from May to October on the days baiting and setting gear will occur for the ventless trap surveys.

The small size of the sampling net, relative location of the sampling net in the water column, short tow times, and slow operational speeds makes the risk of capture of any listed sea turtle or Atlantic sturgeon species extremely unlikely to occur, listed whales are too large to be captured by the sampling net. Based on the analysis herein, it is extremely unlikely that any ESA-listed species will interact with the plankton survey activities; any effects to ESA-listed species of the plankton survey activities are extremely unlikely to occur.

7.5.2 Assessment of Risk of Interactions with Trap and Pot Gear
In collaboration with SMAST, Vineyard Wind will conduct ventless trap surveys to assess lobster and crab resources and a pot survey to assess black sea bass resources in the Vineyard Wind 1 WDA and control sites adjacent to the WDA and to evaluate the differences between pre (2 years), during (1 year), and post-construction (3 years). To assess lobster and crab resources, a total of 30 sampling stations/strings of traps will be selected and split evenly between the Vineyard Wind WDA and the adjacent control area. Each station/string will consist of a total of 6 traps (standardized 40” x 21” x 16” traps), alternating between vented and ventless with two vertical lines marking each end of the string for a total 60 vertical lines/buoys. Trap deployment, maintenance, and hauling will be conducted between May 15 and October 31 by commercial lobstermen under the guidance of a SMAST researcher. To the greatest extent possible, gear will be hauled on a three-day soak time to standardize catchability among trips. To assess the black sea bass population, one un-baited fish pot will be deployed on the same string as the lobster traps (i.e., attached with a ground line, no additional vertical lines). All gear used use a 600 lb. breakaway swivel and 1,700 lb. breakaway sinking ropes. The trap/pot sampling will result in a total of 30 strings, each consisting of six traps and one pot, being deployed in Fisheries Statistical Area 537, this will equate to 60 vertical lines being placed in Fisheries Statistical Area 537 between May-October for six years.

No wet storage will occur, such that all trap/pot gear will be removed following the end of sampling in October and no gear will be set until May 15 of the following year. To date, no interactions with listed species have been reported from the Vineyard Wind trap/pot survey that have occurred since fall 2020.

ESA-Listed Whales

Factors Affecting Interactions and Existing Information on Interactions
Theoretically, any line in the water column, including line resting on or floating above, the seafloor set in areas where whales occur, has the potential to entangle a whale (Hamilton et al. 2018, 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 vulnerable to entanglement in vertical and ground lines 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. It is thought that the weak links (areas with lower breaking strengths) allow the buoy to break away to reduce further risk of entanglement and trailing gear an animal may carry. Similarly, the use of weak rope or weak insertions engineered to break at 1,700 pounds or less may allow large whales to break free from the ropes and avoid a life-threatening entanglement. Weak links and 1,700 pound or less breaking strength line is built into the proposed survey plan.

Consistent with the best available information on gear configurations to reduce entanglement risk, sinking groundlines, weak links and line with 1,700 pound breaking strength or less is incorporated into the survey plan and will be implemented in all trap and pot gear. Additionally, all trap and pot gear will be removed from the water between survey periods.

The overlap of the trap/pot gear and large whales in time and space also influences the likelihood that gear entanglement will occur. As established in previous sections of this Opinion, North Atlantic right, fin, sei, and sperm whales occur at least occasionally in the Project Area, including the WDA and portions of NMFS Statistical Area 537 where the trap/pot surveys will take place.

Fin and Right Whales
Fin and right whales occur year round in the area where the surveys will take place. Fin whales are most likely to occur in the area in the summer (June – September). During the months that trap/pot surveys will take place (May-October), density of fin whales ranges from 0.0025 fin whales/km^2 (October) to 0.0033 fin whales/km^2 (June and July) (Roberts et al. 2016, 2017, 2018, 2020). Density estimates indicate that March is the month with the highest density of right whales in the survey area that overall, 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. Monthly density estimates for the months that the trap/pot surveys will take place range from 0 (July, August, and September) to 0.0038 (May) right whales/km2 (Roberts et al. 2016, 2017, 2018, 2020). The majority of the lobster trap survey activity (May –

October) will occur at the time of year when the lowest numbers of right whales occur in the Project area.

The Environmental Impact Statement (EIS) prepared for the Atlantic Large Whale Take Reduction Plan (ALWTRP EIS, NOAA 2021b) determined that entanglement in commercial fisheries gear represents the highest proportion of all documented serious and non-serious incidents reported for North Atlantic right and fin whales. However, entanglement remains a relatively rare event, with approximately 8 entanglements a year of right whales estimated along the entire U.S. and Canada Atlantic coast (Hayes et al. 2020).

Recent tools developed by the NEFSC, in support of the ALWTRT, have helped inform and understand the spatiotemporal distribution of pot/trap gear and the spatiotemporal overlap of this gear with large whales. This assessment of trap/pot gear uses the information and results obtained from the NEFSC's Decision Support Tool (DST) version 3.1.0. For more information on the DST and the input data, assumptions, and uncertainty please see Volume II, Chapter 3 Appendices, in the ALWTRP Final Environmental Impact Statement, https://www.fisheries.noaa.gov/new-england-mid-atlantic/marine-mammal-protection/atlantic-large-whale-take-reduction-plan.

In Fisheries Statistical Area 537, there are approximately 987 to 2,650 vertical lines depending on month. These numbers represent only vertical lines associated with trap or pot gear. Between hauls, these vertical lines, in general, remain in the water column throughout the year. Reviewing the data by month, over the period of May through October, when the Vineyard Wind trap/pot surveys are scheduled to occur, there are approximately 1,717 to 2,650 vertical lines in Fisheries Statistical Area 537. Outside of this timeframe (November through April), there are approximately 987-1,631 vertical lines in Fisheries Statistical Area 537. There is, however, uncertainty in estimating total number of vertical lines in this and other regions of New England. Relative to current operating conditions in the lobster fishery, and the additional vertical lines the Vineyard Wind survey will place in the water is within the range of uncertainty and, therefore, may not necessarily equate to an increase in vertical lines within the Fisheries Statistical Area.

The DST provides information on the spatiotemporal overlap between gear and North Atlantic right whales in Fisheries Statistical Area 537, by month. Review of the data shows North Atlantic right whales are likely to occur, in greatest numbers, in Fisheries Statistical Area 537 from December through May; this is consistent with the density information reported above and presented in section 5 of this Opinion. Although we cannot discount the potential for right whales to be present in Fisheries Statistical Area 537 outside of the December through May timeframe, given the best available information, the number of right whales in Fisheries Statistical Area 537 is likely to be at its lowest from June through November. Based on this, the proposed trap and pot surveys will predominantly occur over a period of time in which North Atlantic right whales are likely to be present at their lowest numbers in this area of southern New England. Based on the number of vertical lines in Fisheries Statistical Area 537 under normal operating conditions of the trap/pot fisheries provided above, as well as the best available information on North Atlantic right whales occurrence in this Fisheries Statistical Area, the DST showed that the highest entanglement risk to right whales in Fisheries Statistical Area 537 occurred from January through April (vertical lines present + high numbers of whales=high co-occurrence), and the lowest entanglement risk occurred from May through December (vertical lines present + low whale presence=low co-occurrence).

Despite the general concerns about the risk of right and fin whale entanglements in vertical lines, we have determined that entanglement or capture of fin or right whales in Vineyard Wind trap/pot gear is extremely unlikely to occur. This is because the amount of gear (30 strings split equally between the WDA and Control Area), the short soak time (3 days), and the number of survey days (5 months annually over 6 years), make it extremely unlikely that a right or fin whale would encounter this gear. The risk is also lowered by the time of year the surveys will take place as the majority of survey work will occur during the months when right whale density is lowest and when their distribution is typically further east and when fin whale density is lowest. Risk reduction measures including the high frequency of which gear will be tended, the gear modifications that will be employed as part of the Vineyard Wind trap and pot surveys further reduce risk. We also note that the increase in the number of trap/pots and associated vertical lines that would be present in the survey area absent the proposed action is so small that it is within the anticipated daily variability and any effect of this increase to the risk of entanglement considered in the Environmental Baseline will be so small that it cannot be meaningfully measured, evaluated, or detected.

Sei and Sperm Whales
As described above, 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. Between 2009-2017, in the western North Atlantic as a whole there were two (one mortality/serious injury) documented interactions with sei whales in fishing gear from unknown country of origin and no documented interactions between fishing gear and sperm whales.

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. Based on the density information in Roberts et al. (2016, 2017, 2018, 2020), sperm whales are rare in the survey area year-round but most likely to occur in July – October. During the May – October period when the trap/pot surveys are planned, densities of sperm whales are reported at 0.0001 – 0.0004 animals/km^2 (or 1 sperm whale for every 2,500 km2). Sei whales are also infrequent in this area, the highest monthly density reported in Roberts et al. (2016, 2017, 2018, 2020) is in May (0.0005 sei whales/km^2 or 1 sei whale for every 2,000 km2); over the May to October period, monthly density estimates range from 0 - 0.0005 sei whales/km^2.

In order for a sei or sperm whale to be vulnerable to entanglement in the trap or pot 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 or pots are being fished. Given the rarity of sei and sperm whales in the survey area, the small amount of gear (30 trap/pot strings), the short soak time (3 days for lobster), and the number of survey days (5 months annually for 6 years), it is extremely unlikely that a sei or sperm whale would encounter this gear. The risk of entanglement is further reduced by the use of weak links and line with 1,700 pound breaking strength or less. We also note that the increase in the number of pots/traps and associated vertical lines that would be present in the survey area absent the proposed action is so small that it is within the anticipated daily variability and any effect of this increase to the risk of entanglement considered in the *Environmental Baseline* will be so small that it cannot be meaningfully measured, evaluated, or detected.

Effects to Prey

The proposed trap/pot survey activity 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 survey 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. Sea turtles in the survey area are too big to be caught in the pots or traps themselves since the vents/openings leading inside are far smaller than any of these species. The most commonly documented turtle entanglements are with the vertical lines of fishing gear. However, sea turtles also entangle in groundlines or surface system lines of trap/pot gear. 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. Leatherbacks entangled in fixed gear are often restricted with the 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.

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

As noted above, in Fisheries Statistical Area 537, there are approximately 982 to 2,636 vertical lines depending per month. These numbers represent only vertical lines associated with trap or pot gear. Between hauls, these vertical lines, in general, remain in the water column throughout the year. Reviewing the data by month, over the period of May through October, when the Vineyard Wind trap/pot surveys are scheduled to occur, there are approximately 1,702 to 2,636 vertical lines in Fisheries Statistical Area 537. Outside of this timeframe (November through April), there are approximately 982-1,628 vertical lines in Fisheries Statistical Area 537. There is, however, uncertainty in estimating total number of vertical lines in this and other regions of New England. Relative to current operating conditions in the lobster fishery, the additional vertical lines the Vineyard Wind survey proposes to place in the water is within the range of uncertainty and, therefore, may not necessarily equate to an increase in vertical lines within the Fisheries Statistical Area.

We queried the STSSN database for records from 2016-2020 of sea turtles entangled in vertical lines throughout the waters of Rhode Island, Massachusetts (south and west of Cape Cod), New York, and Connecticut, as a best reasonable representation of the greater waters where Vineyard Wind survey activities will occur. Of note, these are all vertical line cases, not necessarily attributed to a specific fishery as the gear is not always identifiable. From 2016-2020, there were 30 records of sea turtle entanglements in vertical lines, at an average of 5 entanglement records each year. All of these records were in waters of Massachusetts and Rhode Island and primarily in nearshore waters (Nantucket Sound, Buzzards Bay, Rhode Island Sound).

The Statistical Areas that these entanglement records overlap (537 and 539), have between 4,215 and 8,257 vertical lines associated with trap/pot gear at any given time during the months that sea turtles may be present. Entanglement in fixed gear is a relatively rare event and requires that a sea turtle not only occur at the exact place and time when and where the gear is located but also physically interact with the gear and become entangled. While sea turtles occur in these Statistical Areas, they are dispersed. Kraus et al. (2016) reports on sea turtle observations during aerial surveys of the MA/RI and MA WEAs from 2011-2015. Leatherbacks were the most frequently observed sea turtle during the surveys at a sighting rate of 4.65 individuals/1,000 km surveyed (an average of one individual sighted for every 215 km of the transect); loggerheads were sighted at an average rate of one individual for every 251 km of the transect. We have determined that entanglement of a sea turtle in any of the trap/pot survey gear is extremely unlikely to occur because of: the general rarity of entanglements (i.e., average of 5 records a year in an area with at least 4,215 vertical lines for trap/pot gear alone), the location of most sea turtle interactions with trap/pot gear in nearshore waters (Nantucket Sound, Buzzards Bay, Rhode Island Sound) whereas Vineyard Wind trap/pot gear will set in offshore waters, the relatively low density of sea turtles in the area (Kraus et al. 2016), the small number of vertical lines associated with these surveys (60 vertical lines), and the limited duration of these surveys (3-day sets, May – October). We also note that the increase in the number of pots/traps and associated vertical lines that would be present in the survey area absent the proposed action is so small that it is within the anticipated daily variability and any effect of this increase to the risk of entanglement considered in the Environmental Baseline will be so small that it cannot be meaningfully measured, evaluated, or detected; this is because the number of vertical lines is so small that it is well within the variability in the amount of gear set on a day to day basis due to normal fishing practices.

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 Vineyard Wind trap/pot surveys will not affect the availability of prey for leatherback and green sea turtles in the action area. Neritic juveniles and adults of both loggerhead and Kemp's ridley sea turtles are known to feed on these species that may be caught as bycatch in the 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/pot gear is extremely unlikely. 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 Vineyard 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 Vineyard Wind are aimed to replicate a number of these fisheries to assess the impact of offshore wind development in the WDA. Based on this information, it is extremely unlikely that Atlantic sturgeon from any DPS will be captured or entangled in the trap/pot gear deployed as part of the proposed surveys.

Effects to Prey
The trap/pot gear that will be used to assess lobster and crab species and black sea bass are considered to have low impact to bottom habitat, and is unlikely to incidentally capture Atlantic sturgeon prey. Given this information, it is extremely unlikely the trap/pot activities conducted by Vineyard Wind will have an effect on Atlantic sturgeon prey.

7.5.3 Assessment of Risk of Interactions with Bottom Trawl Gear

In collaboration with SMAST, Vineyard Wind will conduct up to six years of post-ROD trawl surveys (3 years pre/during construction and three years post-construction) to assess the finfish community in the Vineyard Wind 1 WDA (OCS-A 0501) and an adjacent control area (located immediately to the east). The surveys will be adapted to Northeast Area Monitoring and Assessment Program (NEAMAP) protocols. A total of 20 tows will be conducted in the Vineyard Wind 1 WDA and an additional 20 tows will occur in the adjacent control area per season. Tows will be conducted four times per year, spring (April – June), summer (July – September), fall (October – December) and winter (January – March), during daylight hours (after sunrise and before sunset) for 20 minutes each with a target tow speed of 3 knots. This results in a total of 80 tows in the lease area and 80 tows in the control area each year. Tows will be completed using a 400 x 12 centimeters (cm), three-bridle four-seam bottom trawl with a 12 cm cod end with a 2.54 cm knotless liner that is identical to those used in NEAMAP surveys. The net will also be paired with a three inch cookie-sweep and a set of Thyboron Type IV 66 inch doors. The three years of pre/during construction surveys were completed in winter 2024; no interactions with ESA-listed species were recorded. Below, we consider the effects of the remaining trawl surveys (three years post-construction).

ESA-Listed Whales

Factors Affecting Interactions and Existing Information on Interactions
Entanglement or capture of ESA-listed North Atlantic right whales, fin whales, sei whales, and sperm whales in trawl gear is extremely unlikely. While these species may occur in the study area where survey activities will take place, trawl gear is not expected to directly affect right, fin, sei, 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 or sperm whales with beam or bottom otter trawl gear (NEFSC observer/sea sampling database, unpublished data; GAR Marine Animal Incident database, unpublished data). The slow speed of the trawl gear being towed and the short tow times to be implemented further reduce the potential for entanglement or any other interaction. As a result, we have determined that it is extremely unlikely that any large whale would interact with the trawl survey gear.

Effects to Prey
The proposed bottom trawl survey activities will not have any effects on the availability of prey for right, fin, sei, 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). The trawl gear used in the Vineyard 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 burry into the benthos and would not be caught in the trawl. Sperm whales feed on deep water species that are not expected to 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 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, a total of 85 loggerhead sea turtles were captured. Only one of the 85 loggerheads suffered injuries (cracks to the carapace) causing death. All others were alive and returned to the water unharmed. One leatherback and one Kemp's ridley sea turtle have also been captured in the NEFSC bottom trawl surveys and both were released alive and uninjured. NEFSC bottom trawl survey tows are approximately 30 minutes in duration. All 20 loggerhead, 28 Kemp's ridley, and one green sea turtles captured in the NEAMAP surveys since 2007 have also been released alive and uninjured. NEAMAP surveys operate with a 20-minute tow time. Swimmer et al. (2014) indicates that there are few reliable estimates of post-release mortality for sea turtles because of the many challenges and costs associated with tracking animals released at sea. However, based on the best available information as cited herein, we anticipate that post-release mortality for sea turtles in bottom 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 survey area 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 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) and the information available from the Vineyard Wind trawl surveys carried out to date.

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. No leatherback, Kemp's ridley, or green sea turtles have been captured in NEFSC surveys in this area. Vineyard Wind is proposing to carry out 40 tows in each of the 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 80 summer and fall surveys (20 each in the summer and fall in the control and lease areas), as we expect similar abundance of sea turtles in the area in the summer and fall months, results in a prediction of 0.14 loggerheads captured per year or 0.42 loggerheads over the total three year post-construction 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 Vineyard 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 Vineyard 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 is well inshore of the area where Vineyard Wind 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 NEAMAP catch data to calculate a rate of sea turtle captures per tow (0.0111 loggerhead/tow, 0.0076 Kemp's ridley/tow, 0 leatherback/tow, and 0.0002 green/tow) and applying that to the number of tows remaining for the Vineyard Wind surveys (120 per year, which excludes the winter period when sea turtles do not occur in the survey area), we would predict the capture of 1.3 loggerheads, 0.9 Kemp's ridley, zero leatherbacks, and 0.02 green sea turtles per year. Over the remaining three years of surveys, we would predict the capture of 3.9 loggerheads, 2.7 Kemp's ridley, zero leatherbacks, and 0.06 green sea turtles.
Given the geographic distribution of the Vineyard Wind surveys, and considering that no sea turtle interactions have been recorded to date, it is likely that the number of sea turtles captured would be most similar to the number predicted using the NEFSC dataset and the NEAMAP dataset would result in an overestimate. 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 nor predicting future interaction rates, we do not expect the Vineyard Wind survey to result in the capture of a leatherback sea turtle. Therefore, using the NEFSC survey capture rate, and rounding up to whole animals, while considering that loggerhead, Kemp's ridley, and green sea turtles are present in the survey area, we expect no more than 1 sea turtle to be captured over the remaining three-year survey period and that while it is most likely to be a loggerhead, it may also be a Kemp's ridley or green sea turtle.

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, a 20-minute tow time for the bottom trawl gear to be used in the proposed Vineyard 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 do not anticipate any serious injuries or mortalities of captured sea turtles. 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.

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 Vineyard 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 these species that may be caught as bycatch in the bottom trawls. However, all bycatch is expected to be returned to the water alive, dead, or injured to the extent that the organisms will shortly die. Injured or deceased bycatch would still be available as prey for sea

turtles, particularly loggerheads, which are known to eat a variety of live prey as well as scavenge dead organisms. Given this information, any effects on sea turtles from collection of potential sea turtle prey in the trap/pot gear will be so small that they cannot be meaningfully measured, detected, or evaluated and, therefore, effects are insignificant.

Atlantic Sturgeon

Factors Affecting Interactions and Existing Information on Interactions
While migrating, Atlantic sturgeon may be present throughout the water column and could interact with trawl gear while it is moving through the water column. Atlantic sturgeon interactions with beam and bottom trawl gear are likely at times when and in areas where their distribution overlaps with the operation of the gear. Adult and subadult Atlantic sturgeon may be present in the action area year-round. In the marine environment, Atlantic sturgeon are most often captured in depths less than 50 meters. Some information suggests that captures in otter trawl gear are most likely to occur in waters with depths less than 30 meters (ASMFC TC 2007). The capture of Atlantic sturgeon in otter trawls used for commercial fisheries is well documented (see for example, Stein et al. 2004b and ASMFC TC 2007).

NEFOP data from Miller and Shepherd (2011) indicates that mortality rates of Atlantic sturgeon caught in otter trawl gear is approximately 5 percent. Atlantic sturgeon are also captured incidentally in trawls used for scientific studies, including the standard Northeast Fisheries Science Center bottom trawl surveys and both the spring and fall NEAMAP bottom trawl surveys. The shorter tow durations and careful handling of any sturgeon once on deck during fisheries research surveys is likely to result in an even lower potential for mortality, as commercial fishing trawls tend to be significantly longer in duration. None of the hundreds of Atlantic and shortnose sturgeon captured in past state ocean, estuary, and inshore trawl surveys have had any evidence of serious injury and there have been no recorded mortalities. Both the NEFSC and NEAMAP surveys have recorded the capture of hundreds of Atlantic sturgeon since the inception of each. To date, there have been no recorded serious injuries or mortalities. In the Hudson River, a trawl survey that incidentally captures shortnose and Atlantic sturgeon has been ongoing since the late 1970s. To date, no serious injuries or mortalities of any sturgeon have been recorded in those surveys.

Estimating Interactions with and Mortality of Sturgeon
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. As noted above, the largest and longest duration data sets for surveys in the general survey area 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 while the NEFSC survey area occurs farther offshore and overlaps with the areas where the Vineyard Wind trawl surveys will occur. We have also considered information on interactions with Atlantic sturgeon and commercial trawl fisheries available from fisheries observer data and the information available from the Vineyard Wind trawl surveys carried out to date.

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 160 tows planned annually for the Vineyard Wind surveys predicts 0.18 Atlantic sturgeon captured per year. Over the remaining three year survey period, this would result in a predicted total capture of 0.54 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 17.44 Atlantic sturgeon per year in the Vineyard Wind surveys (160 tows), resulting in a total predicted capture of 52.32 Atlantic sturgeon over the course of the remaining three survey period.

Given the geographic distribution of the Vineyard Wind surveys, and considering that no Atlantic sturgeon interactions have been recorded to date, it is likely that the number of Atlantic sturgeon captured would be most similar to the number predicted using the NEFSC dataset (less than 1 per year) and the NEAMAP dataset would result in an overestimate (18 per year). Therefore, we have determined that the NEFSC dataset combined with the Vineyard Wind trawl results to date comprise the best available information from which to predict the number of Atlantic sturgeon likely to be captured in the remaining survey years. Therefore, we expect no more than 1 Atlantic sturgeon will be captured over the remaining three years of trawl surveys. 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. The captured individual may experience minor abrasions or scrapes but these minor injuries are expected to be fully recoverable in a short period of time with no effects on individual health or fitness.

As explained in the *Status of Species* section, the range of all five DPSs overlaps and extends from Canada through Cape Canaveral, Florida. Atlantic sturgeon originating from all five DPSs use the area where trawl gear will be set. We have considered the best available information from a recent mixed stock analysis done by Kazyak et al. (2021) to determine from which DPSs individuals in the action area are likely to have originated. The authors used 12 microsatellite markers to characterize the stock composition of 1,704 Atlantic sturgeon encountered across the U.S. Atlantic Coast and provide estimates of the percent of Atlantic sturgeon in a number of geographic areas that belong to each DPS. The Vineyard Wind survey area falls within the "MID Offshore" area described in that paper. Using that data, we expect that Atlantic sturgeon in the area of the WDA where trawl surveys will occur likely originate from the five DPSs at the following frequencies: New York Bight (55.3%), Chesapeake (22.9%), South Atlantic (13.6%), Carolina (5.8%), Gulf of Maine (1.6%), and Gulf of Maine (1.6%) DPSs (Table 7.5.2). It is possible that a small fraction (0.7%) of Atlantic sturgeon in the action area may be Canadian origin (Kazyak et al. 2021); Canadian-origin Atlantic sturgeon are not listed under the ESA. This represents the best available information on the likely genetic makeup of individuals occurring throughout the action area. Given this, we expect that the Atlantic sturgeon captured in the Vineyard Wind surveys would belong to the New York Bight DPS.

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.

7.5.4 Impacts to Habitat
Here we consider any effects of the proposed marine resource survey and monitoring activities on habitat of listed species. The trap/pots will be set on the ocean floor which could result in disturbance of benthic resources. 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. 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 benthic sampling and bottom trawl gear will also interact with the ocean floor and may affect bottom habitat in the areas surveyed. However, given the infrequent survey effort, the limited duration of the surveys, and the very small footprint, any effects to ESA-listed species resulting from these minor effects to benthic habitat will be so small that they cannot be meaningfully measured, evaluated, or detected.

7.6 Repair and Maintenance Activities
Vineyard Wind would design WTGs and ESPs to operate by remote control, so personnel would not be required to be present except to inspect equipment and conduct repairs. Effects of vessel traffic associated with repairs and maintenance during the operations phase is considered in the

Effects of Project Vessels section above. Effects of noise associated with project vessels and aircraft are addressed in the section 7.1 above; these effects were determined to be insignificant. BOEM and BSEE have not provided any changes or updates to the repair and maintenance activities since the issuance of the 2021 Opinion; no additional information is available or analyzed in this Opinion.

Project components would be inspected regularly; these visual inspections would have no effects on listed species. Bathymetric and other surveys would be undertaken to monitor cable exposure and/or depth of burial; the effects of acoustic surveys of the cable corridor were considered in the acoustics analysis; no other effects are anticipated. Minor underwater work, associated with minor repairs of the metalwork of the foundations may involve welding by divers; no effects to listed species are anticipated from these activities. Periodic cleaning of the foundations will involve using a brush to break down the marine growth (where required) followed by high-pressure jet wash (seawater only). More significant repairs would be necessary if there was a major component failure (i.e., gearbox, blades, transformer). However, no in-water work is anticipated (other than vessels) to carry out these repairs; therefore, we do not anticipate any effects to listed species. Scour Protection Repair is expected to occur over two days every 18 months. This will involve using a fall pipe vessel to deploy additional rock scour protection as needed. This would not increase the footprint of the scour protection and thus would not introduce any new effects not already considered in our assessment of the loss of soft substrate and habitat conversion. Vineyard Wind would change WTG gearbox oil after years 5, 13, and 21 of service; the risk of spills is addressed in section 7.5 of this Opinion.

BOEM has indicated that given the burial depth of the cable, displacement, or damage by vessel anchors or fishing gear is unlikely. In the event that cable repair was necessary due to such an event or some other unexpected maintenance issue, it could be necessary to remove a portion of the cable and splice in a new section. We determined that acoustic and habitat based effects of cable installation would be insignificant or extremely unlikely to occur; as any cable repair will essentially follow the same process as cable installation except in only a small portion of the cable route and for a shorter period of time, we expect that the effects will be the same or less and therefore would also be insignificant.

Based on our review of the planned repair and maintenance activities described in the BA, DEIS and COP (Volume 1, Section 4.3; Epsilon 2020), 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.

7.7 Unexpected/Unanticipated Events

In this section, we consider the "low probability events" that were identified by Vineyard Wind in the COP (Volume III, section 8; Epsilon 2020). 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 ESPs, and accidental spills.

As described in the Environmental Baseline, in July 2024, during commissioning of one of the Vineyard Wind WTGs, a single turbine blade broke. This resulted in the release of a portion of the blade into the ocean. At the time this Opinion was being written, emergency response activities, including clean-up of blade debris was ongoing. Results from the root cause analysis, including BSEE's independent evaluation of the causes of the failure, are not yet available. BSEE has ordered thorough inspections of all Vineyard Wind blades; as such, at this time, we expect that the cause of the blade failure will be identified and that any blades that may exist that have characteristics that would make them vulnerable to the same failure (e.g., a manufacturing defect as is currently suspected by GE, the blade manufacturer) will be identified and removed from the project. Therefore, at this time, we consider that a future, similar blade failure is extremely unlikely to occur. Through the ongoing evaluation of the July 2024 event, should information become available that indicates that there would be effects to listed species of project operations that were not evaluated in this Opinion, consultation would need to be reinitiated. As noted in the Environmental Baseline, an emergency ESA consultation has been initiated and is ongoing.

7.7.1 Vessel Collision/Allision with Foundation

A vessel striking a wind turbine theoretically could result in a spill or catastrophic failure/collapse of the turbine. However, there are several measures in place that ensure such an event is extremely unlikely to occur and not reasonably certain to occur. These include: inclusion of project components on nautical charts which would limit the likelihood of a vessel operator being unaware of the project components while navigating in the area; compliance with lighting and marking required by the USCG which is designed to allow for detection of the project components by vessels in the area; and, spacing of turbines to allow for safe navigation through the project area. Because of these measures, a vessel striking a turbine or ESP foundation 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 WDA. Therefore, based on this information, any effects to listed species that could theoretically result from a vessel collision/allision are extremely unlikely to occur and thus discountable.

7.7.2 Failure of WTGs due to Weather Event

As explained in the COP (Epsilon 2020) and DEIS (BOEM 2018), Vineyard 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. The WTGs and ESP are designed to endure sustained wind speeds of up to 112 mph (97.3 knots; equivalent to a Category 3 hurricane) and gusts of 157 mph (136.4 knots; equivalent to a Category 5 hurricane). WTGs would also automatically shut down when wind speeds exceed 69 mph (60 knots). In addition, the structures are designed for maximum wave heights greater than 60 feet (18.3 meters).

Few hurricanes pass through New England, but 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. Knutson et al. (2020) expresses medium-to-high confidence that global average intensity of tropical cyclones will increase between 1% and

10% and that the proportion of tropical cyclones reaching Category 4 or 5 strength will increase. Frequency of tropical cyclones overall is projected to decrease globally, with low-to-medium certainty expressed by the authors. Taken in context with the historical record of hurricanes affecting New England, Category 3 hurricanes may become more frequent than the historical 50 years, and the future probability of a Category 4 or 5 hurricane affecting New England will likely be higher than the historical probability of these events.

As described in the Navigational Risk Assessment (Epsilon 2020), significant waves of up to 11.5 m (~38 ft.) have been measured at the Nantucket Shoals weather monitoring buoy (Station 44008) (available data from 1982 to 2008). The maximum significant wave height of 11.5 meters (37.73 ft.) was observed during the months of September in 1999, while the maximum wave period of 15.9 seconds occurred in February of 2004 (NDBC, 2017). Maximum wind gusts are also described in the NRA based on data collected from Station 44008 from 2007 to 2017. The maximum observed wind speed from 2007 to 2017 was 50.9 knots and occurred November 3-4, 2007 during extratropical storm Noel; Noel was observed to have wind speeds of 70 to 75 knots while traveling near the WDA (NOAA, 2017d as cited in NRA; Epsilon 2020).

BOEM has indicated that the proposed WTGs will meet design criteria to withstand extreme weather conditions that may be faced in the future and include consideration of 50 and 100-year 10 minute wind speed values and ocean forces. The 50-year 10 minute wind speed is estimated to be 96 knots and the 100-year 10 minute wind speed is estimated to be 105 knots. A 100-year 10-minute wind speed means there is a 1-percent chance of that event occurring in any given year, similarly a 50-year wind speed means there is a 2% chance of that happening in any given year. The design will also be in accordance with various standards including International Electrotechnical Commission (IEC) 61400-1 and 61400-3. These standards require designs to withstand forces based on a 50-year return interval for the turbines, and 100-year return interval for electrical substation platforms. The requirements for extreme metocean loading are based on 50-yr return interval site-specific conditions for most operating load cases with a 500-yr abnormal "robustness" load case check (a 500-year event has a 0.2% chance of occurring in any given year).

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 thirty years, even when considering a potential increase in hurricane activity in the area over this period. In other words, project components have been designed to withstand conditions that are not expected to occur more than once over the next 100years (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, any associated potential impacts to listed species are also extremely unlikely to occur and effects are discountable.

7.7.3 Oil Spill/Chemical Release

Several measures will be implemented to minimize the potential for any chemical or oil spills or accidental releases. Vineyard Wind is required to comply with USCG and Bureau of Safety and

Environmental Enforcement regulations relating to prevention and control of oil spills and will adhere to the Oil Spill Response Plan included in COP Appendix I-A (Volume III; Epsilon 2020). Vineyard Wind would conduct refueling and lubrication of stationary equipment in a manner that is designed to minimize the risk of accidental spills. Additionally, a Construction Spill Prevention, Control, and Countermeasure Plan would be prepared in accordance with applicable requirements, and would outline spill prevention plans.

The toppling of a WTG or ESP could theoretically result in a release of transformer oil, lubrication oil, and/or general oil. The ESPs would contain the greatest volumes of oils, with a maximum of approximately 123,210 gallons (466,400.6 liters) of transformer oil, 15 gallons (56.8 liters) of lubrication oil, and 348.7 gallons (1,320 liters) of general oil. The risk of a spill in the extremely unlikely event of a collapse is limited by the containment built into the structures. As explained above, catastrophic loss of any of the structures is not reasonably certain to occur; therefore, the spill of oil from these structures is also not reasonably certain to occur. Modeling presented by BOEM in the BA (from Bejarano et al. 2013) indicates that there is a 0.01% chance of a "catastrophic release" of oil from the wind facility in any given year. Given the 30-year life of this project, the modeling supports our determination that such a release is not reasonably certain to occur.

The Bejarano et al. (2013) modeling indicates the only incidents calculated to occur within the life of the Proposed Action are spills of up to 90 to 440 gallons (340.7 to 1,665.6 liters) of WTG fluid or a diesel fuel spill of up to 2,000 gallons (7,570.8) with model results suggesting that such spills would occur no more frequently than once in 10 years and once in 10-50 years, respectively. However, this modeling assessment does not account for any of the spill prevention plans that will be in place for the project which are designed to reduce risk of accidental spills/releases. Considering the predicted frequency of such events (i.e., no more than 3 WTG fluid spills over the 30-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 to occur; as such, any exposure of listed species to any such spill is also extremely unlikely to occur and thus, 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 Consideration of Potential Shifts or Displacement of Fishing Activity

As described in section 7.2 (*Effects of Project Vessels*) the WDA and OECC support moderate levels of commercial and recreational fishing activity throughout the year. Fishing activity includes a variety of fixed gear and mobile gear fisheries, including squid, lobster, black sea bass, Atlantic herring, Atlantic sea scallop, Atlantic surf clam/ocean quahog, monkfish, Northeast multispecies, shark species, summer flounder, tilefish, and tuna (DOC 2021). Fishing effort is highly variable due to factors including target species distribution and abundance, environmental conditions, season, and market value. 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. There is no new information to consider in this section of the analysis and no updates have been made.

Here, we consider how the potential shift or displacement of fishing activity from the WDA and along the OECC, as a result of the proposed project, may affect ESA-listed whales, sea turtles, and Atlantic sturgeon. As described in the FEIS, potential impacts to fishing activities in the WDA and OECC during the construction phase of the proposed project primarily are related to accessibility in the WDA and OECC. Potential effects include displacement of vessel transit routes and shifts in fishing effort due to disruption in access to fishing grounds in the WDA and OECC due to the presence of Project vessels and construction activities.

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 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., cod spawning), there is the potential for a decrease in fish abundance and future consequences on fishing activity. Impacts during the decommissioning phase of the Project are expected to be similar. Due to these potential impacts, displacement of fishing vessels and shifts in operations during the construction and decommissioning phases are expected; though the magnitude of the shifts is unknown based on the naturally variability of the fisheries, it is likely to be limited given the small geographic area impacted by construction or decommissioning and short construction and decommissioning periods (2 years each).

During the operational phase of the project, the potential impacts to fishing activity are anticipated to relate to potential accessibility issues due to the presence and spacing of WTGs and ESPs as well as potential avoidance of the cable route due to concerns related to avoiding the potential for snags or other interactions with the cable or cable protection. While there are no restrictions proposed for fishing activity in the WDA, the presence and spacing of structures (1x1 nautical miles) may impede fishing operations for certain gear types. Additionally, as explained in section 7.4.7 (*Effects of Physical Presence of the Structures on Listed Species*), 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.

The potential for shifts in fishing effort due to the proposed project is expected to vary by gear type and vessel size. Of the gear types that fish within the WDA, bottom tending mobile gear is more likely to be displaced than fixed gear, with larger fishing vessels using small mesh bottom-trawl gear and 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 WDA. Space use conflicts due to displacement of fishing activity from the WDA to surrounding waters could cause a temporary or permanent reduction in fishing activities within the WDA, but an increase in fishing activities elsewhere. Additionally, there could be increased potential for gear conflicts within the WDA 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 lobster fishery, may resume or even increase fishing activity in the WDA and along the OECC shortly after construction because these fisheries are relatively static and target species with an affinity for new structure that would be created by WTGs and ESPs, though there may be small shifts in gear placement to avoid areas very close to project infrastructure. Mobile fisheries, such as sea scallop and squid trawl fisheries may take longer to resume fishing activity within the WDA or OECC as the physical presence of the new Project infrastructure may alter the habitat, behavior of fishing vessels, and target species. However, for all fisheries, any changes in fishing location are expected to be limited to moves to nearby, geographically-adjacent areas given the relatively small footprint of the project, the distribution of target species, and distance from home ports, all of which limit the potential for significant geographic shifts in distribution of fishing effort. For example, if fishing effort were to shift for longfin squid, effort may shift north and west 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. The scale of the proposed Project (no more than 100 turbines) and the footprint of the WDA (75,614 acres, with project foundations occupying only a small fraction of that) relative to the size of available fishing area are small. Fishing activity will not be restricted within the WDA and the proposed spacing of the turbines could allow for fishing activity to occur, depending on the risk tolerance of the operator and weather conditions. Any reduction in fishing effort in the WDA would reduce the potential for interactions between listed species and fishing gear in the WDA, 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 where the risk of interaction between fishing gear and listed species is not any different than it is in the WDA.

As explained in Section 7.4.7 (*Effects of Physical Presence of the Structures on Listed Species*) above, the presence of new structures (e.g. WTG and ESP 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 7.3 (*Effects to Habitat and Environmental Conditions*), 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 WDA 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 whales are not expected to forage in the shallow waters of the WDA. As noted previously, we do not expect any effects on the distribution, abundance, or use of the WDA 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 Vineyard Wind 1 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, located approximately 37 nautical miles from Vineyard Wind 1 (and other offshore wind farms in Europe), recreational fishermen have expressed a generally positive sentiment about the wind farm as an enhanced fishing location due to the structures as there are no other offshore structures or artificial reefs in surrounding waters (Hooper, Hattam & Austern 2017, ten Brink & Dalton 2018, Smythe, Bidwell & Tyler 2021). Interactions between listed species, particularly sea turtles, and recreational fishing do occur, especially in areas where target species and listed species co-occur (Rudloe & Rudloe 2005, Seney 2016, Swingle et al. 2017, Cook, Dunch & Coleman 2020). Listed sea turtles may be attracted to the structures of the SFWF to forage and seek refuge and also may be attracted to bait used by anglers, depending on species.

If there is an increase in recreational fishing in the WDA, it is likely that this will represent a shift in fishing effort from areas outside the WDA to within the WDA and/or an increase in overall effort. Given the number of turbines (up to 100) 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.

Additionally, it is not likely that the proposed Project would increase the risk of whales colliding with vessels due to the presence of turbine foundations causing reduced maneuverability and the potential increase of vessels in and around the WDA. Whales colliding/hitting vessels, primarily recreational vessels engaged in fishing activities is uncommon to begin with, but can happen[42], primarily when prey of whales and species targeted by fishermen co-occur. As mentioned in section 7.3.7, it is expected whales will be able to transit the WDA freely given the spacing between turbine foundations and as explained in section 7.3.6, 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.

In summary, we expect the risks of entanglement, bycatch, or incidental hooking interactions due to any potential shifts or displacement of recreational or commercial fishing activity due to the proposed Project be so small that they cannot be meaningfully measured, evaluated, or detected.

7.9 Project Decommissioning

According to 30 CFR Part 585 and other BOEM and BSEE requirements, Vineyard 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

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

need to be removed 15 feet (4.6 meters) below the mudline (30 CFR § 585.910(a)). The portion buried below 15 feet (4.6 meters) would remain, and the depression refilled with the temporarily removed sediment. BOEM expects that WTGs and ESPs would be disassembled and the piles cut below the mudline. Offshore cables may be retired in place or removed. All scour protection is anticipated to be removed. We have no new information on proposed decommissioning or the effects of decommissioning activities since the issuance of the 2021 Opinion.

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, Vineyard 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. Vineyard 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 4.4 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 (Epsilon 2020). 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 (Volume 1, Section 4.4; Epsilon 2020), if cable removal is required, the first step of the decommissioning process would involve disconnecting the inter-array 66kV 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 220 kV offshore export cables. 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 the 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 ESP 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 below the mudline. The authors report that the highest sound levels were between 250 and 1,000 Hz. Frequent stopping and starting of the noise suggests that this is an intermittent, rather than continuous noise source. The authors state that values of 160 dB SELcum and 190 dB Peak were not exceeded during the jet cutting process. At a distance of 750 m from the pile, noise attenuated to 150.6 dB rms. For purposes of this consultation, and absent any other information to rely on, we assume that these results are predictive of the underwater noise that can be expected during pile removal during project decommissioning. As such, using these numbers, we would not expect any injury to any listed species because the expected noise levels are below the injury thresholds for whales, sea turtles, and Atlantic sturgeon. We also do not expect any exposure to noise that could result in behavioral disturbance of sea turtles or whales because the noise is below the levels that may result in behavioral disturbance.

Any Atlantic sturgeon within 750 m of the pile being cut would be exposed to underwater noise that is expected to elicit a behavioral response. Exposure to that noise could result in short-term behavioral or physiological responses (e.g., avoidance, stress). Exposure would be brief, just long enough to detect and swim away from the noise, and consequences limited to avoidance of the area within 750 m of the pile during. As such, effects to Atlantic sturgeon will be so small that they cannot be meaningfully measured, evaluated, or detected, and would be insignificant.

The sediments previously removed from the inner space of the pile would be returned to the depression left once the pile is removed. To minimize sediment disturbance and turbidity, a vacuum pump and diver or ROV-assisted hoses would likely be used. This, in combination with the removal of the stones used for scour protection and any concrete mattresses used along the cable route, would reverse the conversion of soft bottom habitat to hard bottom habitat that would occur as a result of project construction. Removal of the foundations would remove the potential for reef effects in the WDA. 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. We have updated this section to reflect more recent available information related to climate change predictions; however, after reviewing and assessing that information, there are no changes to the determination of effects to ESA listed species.

In general, waters in the Northeast are warming and are expected to continue to warm over the 34-year life of the Vineyard 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[43]). In its Sixth Assessment Report (AR6) from 2021, the Intergovernmental Panel on Climate Change (IPCC) stated that the "global surface temperature in the first two decades of the 21st century (2001–2020) was 0.99 [0.84 to 1.10] °C higher than 1850–1900" (IPCC 2021). Similarly, the total increase between the average of the 1850-1900 period and the 2010-2019 period is 1.07°C (likely range: 0.8° to 1.3°C). On a global scale, ocean warming has on average increased by 0.88 [0.68–1.01] °C from 1850-1900 to 2011-2020, with 0.60 [0.44–0.74] °C of this warming having occurred since 1980 (Fox-Kemper et al., 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 WDA. Data from the two NOAA weather buoys closest to the WDA (44020 and 44097) collected from 2009-2016 indicate a mean temperature range

[43] IPCC 2021 is used as a reference here consistent with NMFS 2023 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 April 15, 2024). This revised guidance was released after the issuance of the 2021 Vineyard Wind Opinion.

from a low of 5.9°C in the winter to a high of 21.8°C in the summer. Based on current predictions (IPCC 2021) of an increase in temperature of approximately 2°C, this could shift to a range of 7.9°C in the winter to 23.8°C in the summer. We note that sea surface temperatures in southern New England waters have experienced record highs in recent years (greater than 26°C) which suggests that future ocean temperatures in the action area could, at least occasionally, be even warmer. Ocean acidification is also expected to increase over the life of the project (Hare et. al 2016) which may affect the prey of a number of ESA listed species. Ocean acidification is contributing to reduced growth or the decline of zooplankton and other invertebrates that have calcareous shells (Pacific Marine Environmental Laboratory [PMEL] 2020).

We have considered whether it is reasonable to expect ESA listed species whose northern distribution does not currently overlap with the action area to occur in the action area over the project life due to a northward shift in distribution. We have determined that it is not reasonable to expect this to occur. This is largely because water temperature is only one factor that influences species distribution. Even with warming waters we do not expect hawksbill sea turtles to occur in the action area because there will still not be any sponge beds or coral reefs that hawksbills depend on and are key to their distribution (NMFS and USFWS 2013). We also do not expect giant manta ray or oceanic whitetip shark to occur in the action 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 action area and would not occur even with ocean warming over the course of the proposed action. As such, regardless of the extent of ocean warming that may be reasonably expected in the action area over the life of the project, the habitat will remain inconsistent with habitats used by ESA listed species that currently occur south of the action area. Therefore, we do not anticipate that any of these species will occur in the action 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 WDA by foraging sturgeon could become more or less common. However, even if the frequency and abundance of use of the WDA 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 also 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, and no nesting has ever been documented in New England. 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 WDA 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 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 WDA 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 density 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. Similarly, to the extent that climate change may affect the distribution of other species that right whales prey on while in or outside the WDA is unknown, but would also be expected to affect right whale distribution over the life of the project.

Right whale calving occurs off the coast of the Southeastern U.S. In the final rule designating critical habitat, the following features were identified as essential to successful calving: (1) calm sea surface conditions associated with Force 4 or less on the Beaufort Scale, (2) sea surface temperatures from 7 °C through 17 °C; and, (3) water depths of 6 to 28 meters where these features simultaneously co-occur over contiguous areas of at least 231 km^2 during the months of November through April. Even with a 2°C shift in mean sea surface temperature, waters off of 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 whales. Changes in use 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 not consequences of the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA. As explained in the Endangered Species Section 7 Consultation Handbook (1998): "The concept of cumulative effects is frequently misunderstood as it relates to determining likely jeopardy or adverse modification. Cumulative effects include effects of future State, tribal, local, and private actions, not involving a Federal action that are reasonably certain to occur within the action area under consideration. Future Federal actions requiring separate consultation (unrelated to the proposed action) are not considered in the cumulative effects section." 4-31. 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 Vineyard Wind FEIS or SEIS the contents of which are governed by the National Environmental Policy Act (NEPA) and the implementing regulations published by the Council on Environmental Quality (CEQ regulations). Under the CEQ regulations, cumulative effects "are effects on the environment that result from the incremental effects of the action when added to the effects of other past, present, and reasonably foreseeable actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions." 40 CFR 1508.1(i)(3). While the effects of past and ongoing Federal projects within the action area for which consultation has been completed are evaluated in both the NEPA and ESA processes (Section 6.0 *Environmental Baseline*), reasonably foreseeable future actions by federal agencies must be considered in the NEPA process but not the ESA Section 7 process.

"Gathering information on cumulative effects often requires more effort than merely gathering information on a proposed action. One of the first places to seek cumulative effects information is in documents provided by the action agency such as NEPA analyses for the action. The Services can review the broader NEPA" Handbook, 4-32. We reviewed the list of past, ongoing, and planned actions identified by BOEM in the FEIS and SEIS 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 SEIS. 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 section 7.X of the *Effects of the Action* section above. The remaining cumulative impacts identified in the FEIS and SEIS (marine transportation, coastal development, and state and private fisheries use and management) are addressed below.

In the SEIS, BOEM presented a cumulative activities scenario that identified the possible extent of reasonably foreseeable offshore wind development on the Atlantic OCS. As a result of this process, BOEM has assumed that approximately 22 gigawatts of Atlantic offshore wind development are reasonably foreseeable along the east coast. As defined by BOEM in the SEIS, reasonably foreseeable development includes 17 active wind energy lease areas (16 commercial and 1 research). The level of development expected to fulfill 22 gigawatts of offshore wind energy would result in the construction of about 2,000 wind turbines over a 10-year period on the

Atlantic OCS, with currently available technology. We note that additional information on planned offshore wind development has become available since the SEIS was published (see for example, information on BOEM's webpage regarding leasing on the Atlantic OCS, https://www.boem.gov/renewable-energy/offshore-renewable-activities). It is important to note that because any future offshore wind project will require section 7 consultation, these future wind projects do not meet the ESA definition of cumulative effects and, even those that are considered "reasonably foreseeable," have thus been excluded from the cumulative effects analysis in this Opinion consistent with regulation, guidance and agency practice. All offshore wind projects, however, are properly evaluated in the sequential Section 7 process. 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 a number of offshore wind project, including the South Fork, Sunrise Wind, Revolution Wind, and New England Wind projects in the *Environmental Baseline* of this Opinion to provide context for the effects of approved offshore wind projects in general and specifically those activities that are affecting listed species that occur in the action area.

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 (i.e., marine transportation), 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 as a result of implementing the proposed action. In Section 4, we determined that the project will have no effect on Giant manta rays, the Gulf of Maine DPS of Atlantic salmon, or critical habitat designated for the North Atlantic right whale. We concluded that the Vineyard Wind project is not likely to adversely affect blue whales, shortnose sturgeon, hawksbill sea turtles, the Northeast Atlantic DPS of loggerhead sea turtles, and oceanic whitetip sharks. Those species and critical habitat for which we reached a "not likely to adversely affect" conclusion are addressed in section 4 of this Opinion.

In this section, for species not addressed in section 4, 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 purpose of this analysis is to determine whether the action is likely to jeopardize the continued existence of North Atlantic right, fin, sei, or sperm whales, five DPSs of Atlantic sturgeon, the Northwest Atlantic DPS of loggerhead sea turtles, North Atlantic DPS of green sea turtles, or leatherback or Kemp's ridley sea turtles.

Below, for the listed species that may be adversely affected by the 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 the 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 of 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 Atlantic sturgeon

In the *Effects of the Action* section above, we determined that no more than 1 Atlantic sturgeon from the New York Bight DPS is likely to be captured and released alive with only minor, recoverable injuries over the three years of the post-construction trawl surveys.

While exposure to pile driving noise may result in a behavioral response from individuals close enough to the pile to be disturbed, we determined that effects of that noise exposure will be insignificant; no take of any type including harassment, harm, injury, or mortality is expected to result from exposure to project noise. We determined that all effects to habitat and prey will be insignificant or extremely unlikely to occur and determined that vessel strike was extremely unlikely to occur. All effects of project operations, including operational noise and the physical presence of the turbine foundations and electric cables, are extremely unlikely to occur or insignificant.

9.1.1 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 DPS 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"[44] 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.

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[44] 84 FR 18243; April 30, 2019 - Listing and Recovery Priority Guidelines.

As noted in the *Cumulative Effects* section of this Opinion, we have not identified any cumulative effects different from those considered in the *Status of the Species* and *Environmental Baseline* sections of this Opinion, inclusive of how those activities may contribute to climate change. As described in section 7.10, climate change may result in changes in the distribution or abundance of Atlantic sturgeon in the action area over the life of this project; however, we have not identified any different or exacerbated effects of the action due to in the context of anticipated climate change.

We have considered effects of the Vineyard Wind project over the construction, operations, and decommissioning periods in consideration of the *Environmental Baseline*, *Cumulative Effects*, and climate change. We do not anticipate any adverse effects from the project; all effects of the proposed action on the Gulf of Maine DPS of Atlantic sturgeon will be extremely unlikely to occur (discountable) and/or insignificant. We do not anticipate any adverse effects to result from exposure to pile driving 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 adverse effects to Gulf of Maine DPS Atlantic sturgeon. All effects to Gulf of Maine DPS Atlantic sturgeon from impacts to habitat and prey will be insignificant. As all effects of the Vineyard Wind project on the Gulf of Maine DPS of Atlantic sturgeon will be insignificant or discountable, the Vineyard Wind project is not likely to adversely affect any individual of the Gulf of Maine DPS; thus, it is also not likely to jeopardize the continued existence of the Gulf of Maine DPS of Atlantic sturgeon as the action will not directly or indirectly, reduce appreciably the likelihood of both the survival and recovery of the DPS in the wild by reducing the reproduction, numbers, or distribution of that species.

9.1.2 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 DPS, only the Hudson and Delaware rivers are known to support spawning populations. 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). Young of year (YOY) Atlantic sturgeon have been 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.

Estimates of effective population size (see section 5.0) as well as a study that used samples from juvenile Atlantic sturgeon captured in the Delaware from 2009-2019 to infer annual run size estimates, and new genetic analyses for sturgeon collected in mixed aggregations continue to support that the New York Bight DPS is primarily comprised of Atlantic sturgeon that originate from the Hudson River. The results of the coast wide mixed stock analysis and the Delaware River Estuary genetic analysis both indicate that the number of sturgeon that originated from the Delaware River spawning population was approximately one-third of those that originated from the Hudson River (Wirgin et al. 2015a; Wirgin et al. 2015b; Kazyak et al. 2021). The estimates of effective population size[45] for the Hudson River spawning population from separate studies and based on different age classes are relatively similar to each other: 198 (95% CI=171.7-230.7) based on sampling of subadults captured off of Long Island across multiple years, 156 (95% CI=138.3-176.1) based on sampling of natal juveniles in multiple years (O'Leary et al. 2014; Waldman et al. 2019), and 144.2 (95% CI=82.9-286.6) based on samples from a combination of juveniles and adults (ASMFC 2017). Estimates for the Delaware River spawning population by the same authors and using the same methods were: 108.7 (95% CI=74.7-186.1) and 40 (95% CI=34.7-46.2) for samples from subadults and natal juveniles, respectively (O'Leary et al. 2014; Waldman et al. 2019), and 56.7 (95% CI=42.5-77.0) based on samples from a combination of juveniles and adults (ASMFC 2017). Based on the genetic analysis of 45 of the captured juveniles in the Connecticut River, the effective population size for the Connecticut River was estimated to be 2.4 sturgeon (Savoy et al. 2017); the CT DEEP is further investigating the presence of and origins for a spawning population in the Connecticut River.

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.

As described in the 5-Year Review for the New York Bight DPS (NMFS 2022), the demographic risk for the DPS is "high"[46] because of its low productivity (i.e., relatively few adults compared to historical levels and irregular spawning success), low abundance (i.e., only a few known spawning populations and low DPS abundance, overall), and limited spatial distribution (i.e., limited spawning habitat within each of the few rivers known to support spawning). There is also new information indicating genetic bottlenecks as well as low levels of inbreeding in the Delaware and Hudson populations. 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

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[45] Effective population size measures how many adults contributed to producing the next generation based on genetic determinations of parentage from the offspring. Effective population size is always less than the total abundance of a population because it is only a measure of parentage, and it is expected to be less than the total number of adults in a population because not all adults successfully reproduce.
[46] 84 FR 18243; April 30, 2019 - Listing and Recovery Priority Guidelines.

project; however, we have not identified any different or exacerbated effects of the action in the context of anticipated climate change.

We have considered effects of the Vineyard Wind 1 project over the construction, operations, and decommissioning periods in consideration of the Environmental Baseline and in consideration of Cumulative Effects and climate change. The only adverse effects of the proposed action on New York Bight DPS Atlantic sturgeon are the non-lethal capture and release of 1 New York Bight DPS Atlantic sturgeon in the post-construction trawl survey. We do not anticipate any adverse effects to result from exposure to pile driving, 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. We do not expect the operation or existence of the turbines and other facilities, including the electric cables, to result in any adverse effects to Atlantic sturgeon. All effects to Atlantic sturgeon from impacts to habitat and prey will be insignificant. No serious injury or mortality of any Atlantic sturgeon is expected from any project activity.
Live sturgeon captured and released in the trawl surveys may have 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; the length of capture will be no more than the 20 minute tow time plus a short handing period on board the survey vessel. The capture and release 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.

As there will be no mortality, there will be no reduction in the number of New York Bight DPS Atlantic sturgeon. The reproductive potential of the New York Bight DPS will not be affected in any way. The proposed action will not affect the spawning grounds within the Hudson or Delaware River where New York Bight DPS fish spawn. The action will also not create any barrier to pre-spawning sturgeon accessing the overwintering sites or the spawning grounds. Any impacts to behavior will be minor and temporary and there will not be any delay or disruption of any normal behavior including spawning; there will also be no reduction in individual fitness or any future reduction in numbers of individuals.

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 concentration 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 Vineyard Wind project 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 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) there will be no mortality of New York Bight DPS Atlantic sturgeon; (2) there will be no change to the status or trends of the species as a whole; (3) there will be no consequence on the levels of genetic heterogeneity in the population; (4) there will be no consequence on reproductive output; (6) 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, (7) 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 "Improvement in the status of listed species to the point at which listing [as threatened or endangered] is no longer appropriate under the criteria set out in Section 4(a)(1) of the Act." Thus, we have considered whether the proposed action will appreciably reduce the likelihood that the New York Bight DPS can rebuild to a point where listing of the New York Bight DPS of Atlantic sturgeon as endangered or threatened is no longer appropriate.

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 affect 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 any mortality and no reduction in future reproductive output or genetic diversity. 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 and any avoidance will be temporary and limited to the period of time when pile driving is occurring. The proposed action will not result in any permanent loss of habitat. 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 or endangered; 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.

9.1.3 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 for 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). New 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.

There are no abundance estimates for the entire Chesapeake Bay DPS or for the spawning populations in the James River or the Nanticoke River system. Based on research captures of tagged adults, an estimated 75 Chesapeake Bay DPS Atlantic sturgeon spawned in the Pamunkey River in 2013 (Kahn et al. 2014). More recent information provided annual run estimates for the

Pamunkey River from 2013 to 2018. The results suggest a spawning run of up to 222 adults but with yearly variability, likely due to spawning periodicity (Kahn et al. 2019). New information for the Nanticoke River system suggests a small adult population based on a small total number of captures (i.e., 26 sturgeon) and the high rate of recapture across several years of study (Secor et al. 2021). By comparison, a total of 369 adult-sized Atlantic sturgeon were captured in the James River from 2010 through spring 2014 (Balazik and Musick 2015). This is a minimum count of the number of adult Atlantic sturgeon in the James River during the time period because capture efforts did not occur in all areas and at all times when Atlantic sturgeon were present in the river.

NMFS estimated adult and subadult abundance of the Chesapeake Bay 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 Chesapeake Bay DPS was 8,811 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. 2012c; 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 Chesapeake Bay 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 Chesapeake Bay 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[47] 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 Chesapeake Bay DPS.

In the Stock Assessment, the ASMFC concluded that abundance of the Chesapeake Bay DPS is "depleted" relative to historical levels and there is a relatively low probability (37 percent) that abundance of the Chesapeake Bay DPS has increased since the implementation of the 1998 fishing moratorium. However, the ASMFC also concluded that there is a relatively high likelihood (70 percent probability) that mortality for the Chesapeake Bay DPS does not exceed the mortality threshold used for the Stock 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

[47] 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).

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 the 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 in the context of anticipated climate change.

We have considered effects of the Vineyard Wind project over the construction, operations, and decommissioning periods in consideration of the *Environmental Baseline*, *Cumulative Effects*, the endangered status of the DPS and climate change. We do not anticipate any adverse effects to any individual Chesapeake Bay DPS Atlantic sturgeon from the project; all effects of the proposed action on the Chesapeake Bay DPS of Atlantic sturgeon will be extremely unlikely to occur (discountable) and/or insignificant. We do not anticipate any adverse effects to result from exposure to pile driving 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 adverse effects to Chesapeake Bay DPS Atlantic sturgeon. All effects to Chesapeake Bay DPS Atlantic sturgeon from impacts to habitat and prey will be insignificant. As all effects of the Vineyard Wind project on the Chesapeake Bay DPS of Atlantic sturgeon will be insignificant or discountable, the Vineyard Wind project is not likely to adversely affect the Chesapeake Bay DPS; thus, it is also not likely to jeopardize the continued existence of the Chesapeake Bay DPS of Atlantic sturgeon.

9.1.4 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 (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. 2012c; 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).

As described in the 5-Year Review for the Carolina DPS (NMFS 2023), the demographic risk for the DPS is "High" because of its productivity (i.e., relatively few adults compared to historical levels and irregular spawning success), abundance (i.e., riverine populations vary significantly and abundance is generally low in the DPS, overall), and spatial distribution (i.e., riverine populations and connectivity vary, creating inconsistent population coverage across the DPS and potentially limited ability to repopulate extirpated river populations). However, the recovery potential is considered high.

The effects of the action are in addition to the 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 in the context of anticipated climate change.

We have considered effects of the Vineyard Wind project over the construction, operations, and decommissioning periods in consideration of the *Environmental Baseline*, *Cumulative Effects*, the endangered status of the DPS and climate change. We do not anticipate any adverse effects from the project on any individuals from the Carolina DPS of Atlantic sturgeon; all effects of the proposed action on the Carolina DPS of Atlantic sturgeon will be extremely unlikely to occur

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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).

(discountable) and/or insignificant. We do not anticipate any adverse effects to result from exposure to pile driving 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 adverse effects to Carolina DPS Atlantic sturgeon. All effects to Carolina DPS Atlantic sturgeon from impacts to habitat and prey will be insignificant. As all effects of the Vineyard Wind project on the Carolina DPS of Atlantic sturgeon will be insignificant or discountable, the Vineyard Wind project is not likely to adversely affect the Carolina DPS; thus, it is also not likely to jeopardize the continued existence of the Carolina DPS of Atlantic sturgeon.

9.1.5 South Atlantic DPS of Atlantic sturgeon

The South Atlantic DPS Atlantic sturgeon is listed as endangered. The South Atlantic DPS originates from at least six rivers where spawning is thought to still occur: the Combahee River, Edisto River, Savannah River, Ogeechee River, Altamaha River, and Satilla River. The spawning subpopulation in the St. Marys River is continues to exist, albeit at very low levels. Two 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. There are an estimated 343 adults that spawn annually in the Altamaha River and less than 300 adults spawning annually (total of both sexes) in the river systems where spawning still occurs. No census of the number of Atlantic sturgeon in any of the other spawning rivers or for the DPS as a whole is available. NMFS estimated adult and subadult abundance of the South Atlantic 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 South Atlantic DPS was 14,911 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. 2012c; Hilton et al. 2016).

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.

We have considered effects of the Vineyard Wind project over the construction, operations, and decommissioning periods in consideration of the *Environmental Baseline*, *Cumulative Effects*, the endangered status of the DPS and climate change. We do not anticipate any adverse effects from the project; all effects of the proposed action on the Gulf of Maine DPS of Atlantic sturgeon will be extremely unlikely to occur (discountable) and/or insignificant. We do not anticipate any adverse effects to result from exposure to pile driving 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 adverse effects to Gulf of Maine DPS Atlantic sturgeon. All effects to Gulf of Maine DPS Atlantic sturgeon from impacts to habitat and prey will be insignificant. As all effects of the Vineyard

Wind project on the Gulf of Maine DPS of Atlantic sturgeon will be insignificant or discountable, the Vineyard Wind project is not likely to adversely affect the Gulf of Maine DPS; thus, it is also not likely to jeopardize the continued existence of the Gulf of Maine DPS of Atlantic sturgeon.

As described in the 5-year review for the South Atlantic DPS (NFMS 2023), the DPS' demographic risk is "High" because of its productivity (i.e., relatively few adults compared to historical levels and irregular spawning success), abundance (i.e., riverine populations vary significantly and abundance is generally low in the DPS, overall), and spatial distribution (i.e., riverine populations and connectivity vary, creating inconsistent population coverage across the DPS and potentially limited ability to repopulate extirpated river populations). However, the potential to recover is also "high."

The effects of the action are in addition to the 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 in the context of anticipated climate change.

We have considered effects of the Vineyard Wind project over the construction, operations, and decommissioning periods in consideration of the *Environmental Baseline*, *Cumulative Effects*, the endangered status of the DPS and climate change. We do not anticipate any adverse effects to any individual South Atlantic DPS Atlantic sturgeon from the project; all effects of the proposed action on the South Atlantic DPS of Atlantic sturgeon will be extremely unlikely to occur (discountable) and/or insignificant. We do not anticipate any adverse effects to result from exposure to pile driving 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 adverse effects to South Atlantic DPS Atlantic sturgeon. All effects to South Atlantic DPS Atlantic sturgeon from impacts to habitat and prey will be insignificant. As all effects of the Vineyard Wind project on the South Atlantic DPS of Atlantic sturgeon will be insignificant or discountable, the Vineyard Wind project is not likely to adversely affect any individual of the South Atlantic DPS; thus, it is also not likely to jeopardize the continued existence of the South Atlantic DPS of Atlantic sturgeon as the action will not directly or indirectly, reduce appreciably the likelihood of both the survival and recovery of the DPS in the wild by reducing the reproduction, numbers, or distribution of that species.

9.2 Marine Mammals

Our effects analysis determined that pile driving is likely to adversely affect ESA-listed marine mammals in the action area and cause temporary threshold shift (TTS), behavioral response, and stress in a small number of individual North Atlantic right, fin, sei, and sperm whales. Pile driving is also likely to result in permanent threshold shift (PTS; auditory injury) in five fin and two sei whales. Animals exposed to sufficiently intense sound exhibit an increased hearing threshold (i.e., poorer sensitivity) for some period of time following exposure; this is called a noise-induced threshold shift (TS). The magnitude of TS normally decreases over time following cessation of the noise exposure, TS that eventually returns to zero (i.e., the threshold returns to the pre-exposure value), is called TTS (Southall et al. 2007). TTS represents primarily tissue fatigue and is reversible (Southall et al., 2007). In addition, other investigators have suggested that TTS is within the normal bounds of physiological variability and tolerance and does not represent physical injury (*e.g.*, Ward, 1997). Therefore, NMFS does not consider TTS to constitute auditory injury.

No non-auditory injury, serious injury of any kind, or mortality is anticipated. We determined that exposure to other project noise will have effects that are insignificant or are extremely unlikely to occur. We also determined that effects to habitat and prey are also insignificant or extremely unlikely to occur and concluded that with the incorporation of vessel strike risk reduction measures that are part of the proposed action, strike of an ESA listed whale by a project vessel is extremely unlikely to occur and that entanglement or capture in fisheries surveys is extremely unlikely to occur. In this section, we discuss the likely consequences of these effects to the individual whales that have been exposed, the populations those individuals represent, and the species those populations comprise.

Our analyses identified the likely effects of the Vineyard Wind project, which requires authorizations from a number of federal agencies as described in section 3 of this Opinion, on the ESA-listed individuals that will be exposed to these actions. We measure effects to individuals of endangered or threatened marine mammals using changes in the individual's "fitness" or the individual's growth, survival, annual reproductive success, and lifetime reproductive success. When we do not expect listed marine mammals exposed to an action's effects to experience reductions in fitness, we would not expect the action to impact that animal's health or future reproductive success. Therefore, we would not expect adverse consequences on the overall reproduction, abundance, or distribution of the populations those individuals represent or the species those populations comprise. As a result, if we conclude that listed animals are not likely to experience reductions in their fitness, we would conclude our assessment. If, however, we conclude that listed animals are likely to experience reductions in their fitness, we would assess the consequences of those fitness reductions for the population or populations the individuals in an action area represent.

As documented in section 7 of this Opinion, the adverse effects anticipated on North Atlantic right, fin, sei, and sperm whales resulting from the proposed action are from sounds produced during pile driving in the action area. While this Opinion relies on the best available scientific and commercial information, our analysis and conclusions include uncertainty about the basic hearing capabilities of some marine mammals; how these animals use sounds as environmental cues; how they perceive acoustic features of their environment; the importance of sound to the normal behavioral and social ecology of species; the mechanisms by which human-generated sounds affect the behavior and physiology (including the non-auditory physiology) of exposed individuals; and the circumstances that could produce outcomes that have adverse consequences for individuals and populations of exposed species. Based on the best available information, we expect most exposures and potential responses of ESA-listed cetaceans to acoustic stressors associated with the Vineyard Wind project to have little effect on the exposed animals. As is evident from the available literature cited herein, responses are expected to be short-term, with the animal returning to normal behavior patterns shortly after the exposure is over (e.g., Goldbogen et al. 2013a; Silve et al. 2015). However, Southall et al. (2016) suggested that even minor, sub-lethal behavioral changes may still have significant energetic and physiological consequences given sustained or repeated exposure. We do not expect such sustained or repeated exposure of any individuals in this case.

9.2.1 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). Linden (2023) updated the population size estimate of North Atlantic right whales (at the beginning of 2022 using the most recent year of available sightings data (collected through December 2022). The estimated population size in 2022 was 356 whales, with a 95% credible interval ranging from 346 to 363 (Linden 2023). As noted in that paper, the sharp decrease observed from 2015-2020 appears to have slowed, though the right whale population continues to experience annual mortalities above recovery thresholds.

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 or reproduction) 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. As described in the most recent 5-year Review, North Atlantic right whales are considered to be at a high demographic risk because of rapid population decline, habitat destruction, and continuing threats to recovery (NMFS 2022). 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. We note here that the proposed action is not expected to result in any injury or mortality of any North Atlantic right whale.

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 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. As described in section 7.10, climate change is expected to negatively affect right whales throughout their range, including in the action area, over the life of this project; however, we have not identified any different or exacerbated effects of the action in the context of anticipated climate change.

As explained in the section 7 of this Opinion, the only adverse effects to right whales expected to result from the Vineyard 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 7 individual right whales. No injury (auditory or other), serious injury, or mortality is expected due to exposure to any aspect of the proposed action during the construction, operations, or decommissioning phases of the project.

The distribution of right whales overlaps with some parts of the vessel transit routes that will be used through the 33-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, as well as the use of PAM to enhance detection of right whales 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 Vineyard Wind project.

We concluded that all effects to right whales from the surveys of fishery resources planned by Vineyard 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 Vineyard 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 or discountable. We also determined that effects of construction, operation, and decommissioning, inclusive of project noise, will not have adverse 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 -100 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. 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 7 North Atlantic right whales to experience TTS and/or temporary behavioral disturbance (approximately 3 hours for an individual exposed to noise during WTG foundation installation), and associated temporary physiological stress during the construction period due to exposure to impact pile driving noise. As explained in the *Effects of the Action* section, all of these impacts, including TTS, are expected to be temporary with normal behaviors resuming quickly after the noise ends (see Goldbogen et al. 2013a; Melcon et al. 2012). Any TTS will resolve within a week of exposure (that is, hearing sensitivity will return to normal within one week of exposure) and is not expected to affect the health of any whale or its ability to migrate, forage, breed, or calve (Southall et al. 2007).

As explained in section 7.1, we have also considered whether TTS, masking, or avoidance behaviors experienced by the 7 right whales exposed to noise above the MMPA Level B harassment threshold would be likely to increase the risk of vessel strike or entanglement in fishing gear. We would not expect the TTS to span the entire communication or hearing range of right whales given the frequencies produced by pile driving do not span entire hearing ranges for right whales. Additionally, though the frequency range of TTS that right whales might sustain would overlap with some of the frequency ranges of their vocalization types, the frequency range of TTS from Vineyard 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 June – 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 hours for an individual exposed to noise during WTG 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. Based on the best available information that indicates whales resume normal behavior quickly after the cessation of sound exposure (e.g., Goldbogen et al. 2013a; Melcon et al. 2012), we anticipate that the up to 7 right whales exposed to harassing levels of noise 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 and is not expected to have any health consequences.

A single impact pile driving event will take approximately 3 hours for WTG foundation installation; therefore, even in the event that the 7 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 hours for an individual exposed to noise during WTG 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 Level B harassment threshold extends approximately 5.7 km for WTG 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 5.7 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 30 minutes, but at the median speed observed in Hatin et al. (1.3 kph, 2013), it would take the animal approximately 4 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 (4 km for a WTG foundation). 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 3 hours a day for a WTG monopile.

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 no more than 3 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 Vineyard 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 a; these adverse effects meet NMFS interim ESA definition of harassment. These adverse effects will be experienced by up to 7 individual right whales as a result of exposure to noise from pile driving. While we do not anticipate these effects to have long-term consequences, these behavioral consequences, combined with TTS, are expected to create a short-term likelihood of injury by substantially disturbing normal behavioral patterns as the disturbance is experienced: these adverse effects thus meet NMFS's interim guidance definition of take by harassment under the ESA. 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, will meet the ESA definition of harassment, there will not be long-term fitness consequences to any of the up to 7 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 Vineyard 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 7 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 7 individuals exposed to pile driving noise; 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, with the exception of 1 fin whale expected to experience PTS due to exposure to impact pile driving noise, the only adverse effects to fin whales expected to result from the Vineyard 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 6 individual fin whales as a result of exposure to noise from pile driving. No injury (auditory or other), serious injury or mortality is expected due to exposure to any aspect of the proposed action during the construction, operations, or decommissioning phases of the project.

The distribution of fin whales overlaps with some parts of the vessel transit routes that will be used through the 33-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 Vineyard 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 Vineyard 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 Vineyard 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 -100m 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. However, even with these minimization measures in place, we expect up to 1 fin whale to experience PTS due to impact pile driving noise and up to 6 fin whales to experience TTS, temporary behavioral disturbance (approximately 3 hours for an individual exposed to noise during WTG foundation installation), and associated temporary physiological stress during the construction period due to exposure to impact pile driving noise. As explained in the *Effects of the Action* section, all of these impacts, including TTS, are expected to be temporary with normal behaviors resuming quickly after the noise ends (see Goldbogen et al. 2013a; Melcon et al. 2012). Any TTS will resolve within a week of exposure (that is, hearing sensitivity will return to normal within one week of exposure) and is not expected to affect the longterm health of any whale or its ability to migrate, forage, breed, or calve (Southall et al. 2007).

PTS is permanent, meaning the effects of PTS last well beyond the duration of the proposed action and outside of the action area as animals migrate. As such, PTS has the potential to affect aspects of affected animal's life functions that do not overlap in time and space with the proposed action. As explained in section 7.1, we expect that the up to 1 fin whales estimated to be exposed to impact pile driving noise above the MMPA Level A harassment threshold would experience slight PTS, *i.e.* minor long-term or permanent degradation of hearing capabilities within regions of hearing that align most completely with the energy produced by pile driving (*i.e.* the low-frequency region below 2 kHz), not severe hearing impairment. If hearing impairment occurs, it is most likely that the affected animal would lose a few decibels in its hearing sensitivity, which in most cases is not likely to meaningfully affect its ability to forage and communicate with conspecifics, much less impact reproduction or survival (87 FR 64868; October 26, 2022). No severe hearing impairment or serious injury is expected because of the received levels of noise anticipated and the short duration of exposure. The PTS anticipated is considered a minor auditory injury and as such it constitutes take by harm under the ESA. The up to 1 fin whale that are harmed will also experience the physiological (i.e., stress) and behavioral effects described below for the animals that experience TTS. As discussed previously in Section 7.1, permanent hearing impairment has the potential to affect individual whale survival and reproduction, although data are not readily available to evaluate how permanent hearing threshold shifts directly relate to individual whale fitness. Our exposure and response analyses indicate that no more than 1 fin whale would experience PTS, but this PTS is expected to be minor. With this minor degree of PTS, we do not expect it to affect the individuals' overall health, reproductive capacity, or survival. The 1 individual fin whale could be less efficient at locating conspecifics or have decreased ability to detect threats at long distances, but these animals are still expected to be able to locate conspecifics to socialize and reproduce, and will still be able to detect threats with enough time to avoid injury. For this reason, we do not anticipate that the instances of PTS will result in changes in the number, distribution, or reproductive potential of fin whales in the North Atlantic.

For the up to 6 fin whales that are exposed to noise loud enough to result in TTS and disruption of behavior, but not loud enough to result in PTS, we expect normal behaviors to resume 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).

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 exposure to noise from Vineyard Wind 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. Before the TTS resolves, individual fin whales could be less efficient at locating conspecifics or have decreased ability to detect threats at long distances, but these animals are still expected to be able to locate conspecifics to socialize and reproduce, and will still be able to detect threats with enough time to avoid injury, including vessel strike.
The risks of TTS or masking affecting communication or threat avoidance 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 foundation installation 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 hours for an individual exposed to noise during WTG 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 7 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 hours for WTG foundation installation; therefore, even in the event that the 7 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 hours for an individual exposed to noise during WTG 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 MMPA Level B harassment threshold extends approximately 5.7 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 5.7 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 30 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 explained in section 7 of this Opinion, we determined that the adverse effects expected to result from the exposure of the 6 fin whales to noise below the Level A harassment threshold but above the Level B harassment threshold meet NMFS interim ESA definition of harassment. The proposed action will result in the harassment, but not harm, of these 6 individual fin whales; the only injury anticipated is of the up to 1 fin whale expected to experience PTS due to exposure to impact pile driving noise above the Level A harassment threshold. No other injury, and no harm, 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.

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 Vineyard 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 7 individuals exposed to pile driving noise; there will be no changes in the distribution of the species throughout the action area or throughout its range. The proposed action will have no effect on reproduction because it will not affect the health of any potential mothers or the potential for successful breeding or calving; the project will not cause any reduction in reproduction. As explained above, the proposed action will not affect the recovery potential of the species.

Based on this analysis, the proposed action is not likely to appreciable reduce the likelihood of both the survival and recovery of fin whales in the wild by reducing the reproduction, numbers, or distribution of the 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 and distribution of fin whales in the action area.

9.2.3 Sei Whales

The average spring 2010–2013 abundance estimate of 6,292 (CV=1.015) is considered the best available for the Nova Scotia stock of sei whales because it was derived from surveys covering the largest proportion of the range (Halifax, Nova Scotia to Florida), during the season when they are the most prevalent in U.S. waters (in spring), using only recent data (2010–2013), and correcting aerial survey data for availability bias (Hayes et al. 2021). However, as described in Hayes et al. 2021 (the most recent stock assessment report), there is considerable uncertainty in this estimate and there are insufficient data to determine population trends for the Nova Scotia stock of sei whales. As described in the Status of the Species, the most recent abundance estimate we are aware of for sei whales is 25,000 individuals worldwide (Braham 1991). According to the latest NMFS stock assessment report for sei whales in the western North Atlantic, there are insufficient data to determine population trends for sei whales (Hayes et al. 2021). Across its range, it is estimated that there are over 50,000 sei whales. In the North Pacific, an abundance estimate for the entire North Pacific population of sei whales is not available. However, in the western North Pacific, it is estimated that there are 35,000 sei whales (Cooke 2018a). In the eastern North Pacific (considered east of longitude 180^{o}), two stocks of sei whales occur in U.S. waters: Hawaii and Eastern North Pacific. Abundance estimates for the Hawaii stock are 391 sei whales (Nmin=204), and for Eastern North Pacific stock, 519 sei whales (Nmin=374) (Carretta et al. 2019a). In the Southern Hemisphere, recent abundance of sei whales is estimated at 9,800 to 12,000 whales.

Entanglement in fishing gear and vessel strikes as described in the *Environmental Baseline*, may occur in the action area over the life of the proposed action. As noted in the Cumulative Effects section of this Opinion, we have not identified any cumulative effects different 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. As described in section 7.10, climate change may result in changes in the distribution or abundance of sei whales in the action area over the life of this project; however, we have not identified any different or exacerbated effects of the action in the context of anticipated climate change.

As explained in the section 7 of this Opinion, with the exception of 1 sei whales expected to experience PTS (which meets the definition of harm in the context of the ESA definition of take), the only adverse effects to sei whales expected to result from the Vineyard 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 sei whales as a result of exposure to noise from pile driving. With the exception of the 1 sei whale expected to experience PTS, no injury (auditory or other), serious injury, or mortality is expected due to exposure to any aspect of the proposed action during the construction, operations, or decommissioning phases of the project.

The distribution of sei whales overlaps with some parts of the vessel transit routes that will be used through the 33-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 Vineyard 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 Vineyard 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 Vineyard 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 (50-100 m or less) and any effects to sei whales from avoiding that very small area would be insignificant. For HRG surveys, the best available data (Crocker and Fratantonio 2016) indicates that the area with noise above the level that would be disturbing to sei whales is very small (no more than 500 m from the sound source). Given the small area, the shutdown and clearance requirements, and that we only expect a whale exposed to that noise to swim just far enough away to avoid it (less than 500 m), effects are insignificant.

PTS is permanent, meaning the effects of PTS last well beyond the duration of the proposed action and outside of the action area as animals migrate. As such, PTS has the potential to affect aspects of affected animal's life functions that do not overlap in time and space with the proposed action. As explained in section 7.1, we expect that the 1 sei whale expected to be exposed to impact pile driving noise above the MMPA Level A harassment threshold would experience slight PTS, *i.e.* minor long-term or permanent degradation of hearing capabilities within regions of hearing that align most completely with the energy produced by pile driving (*i.e.* the low-frequency region below 2 kHz), not severe hearing impairment. If hearing impairment occurs, it is most likely that the affected animal would lose a few decibels in its hearing sensitivity, which in most cases is not likely to meaningfully affect its ability to forage and communicate with conspecifics, much less impact reproduction or survival (87 FR 64868; October 26, 2022). No severe hearing impairment or serious injury is expected because of the received levels of noise anticipated and the short duration of exposure. The PTS anticipated is considered a minor auditory injury and as such it constitutes take by harm under the ESA. As discussed previously in Section 7.1, permanent hearing impairment has the potential to affect individual whale survival and reproduction, although data are not readily available to evaluate how permanent hearing threshold shifts directly relate to individual whale fitness. The 1 sei whales that is harmed will also experience the physiological (i.e., stress) and behavioral effects described below for the animals that experience TTS. Our exposure and response analyses indicate that no more than 1 sei whale would experience PTS, but this PTS is expected to be minor. With this minor degree of PTS, we do not expect it to affect the individuals' overall health, reproductive capacity, or survival. The 1 sei whale could be less efficient at locating conspecifics or have decreased ability to detect threats at long distances, but this animal is still expected to be able to locate conspecifics to socialize and reproduce, and will still be able to detect threats with enough time to avoid injury. For this reason, we do not anticipate that the instances of PTS will result in changes in the number, distribution, or reproductive potential of sei whales in the North Atlantic.

Up to 2 additional sei whales are expected to be exposed to pile driving 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. However, even with these minimization measures in place, we expect 2 sei whales to experience TTS, temporary behavioral disturbance (approximately 3 hours for an individual exposed to noise during WTG foundation installation), and associated temporary physiological stress during the construction period due to exposure to impact pile driving noise. As explained in the *Effects of the Action* section, all of these impacts, including TTS, are expected to be temporary with normal behaviors resuming quickly after the noise ends (see Goldbogen et al. 2013a; Melcon et al. 2012). Any TTS will resolve within a week of exposure (that is, hearing sensitivity will return to normal within one week of exposure) and is not expected to affect the 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 3 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 Vineyard 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 hours for an individual exposed to noise during WTG 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 3 sei whales exposed to noise above 160 dB re 1upa RMS 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 hours for WTG foundation installation; therefore, even in the event that the 3 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 hours for an individual exposed to noise during WTG 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 5.7 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 5.7 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 about 30 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/or behavioral disturbance that meet the ESA definition of harassment but not harm to result in fitness consequences to the up to 2 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 Vineyard 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 not likely to affect the recovery potential of sei whales. 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 (NMFS 2021). Therefore, we have not relied on the reclassification criteria specifically when considering the effects of the Vineyard Wind project 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 Vineyard 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 sei whales.

The proposed action will not affect the abundance of sei whales; this is, because no serious injury or mortality is anticipated, the project will not cause there to be fewer sei whales. The only effects to distribution of sei whales will be minor changes in the movements of up to 3 individuals exposed to pile driving noise; 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 effects of the proposed action are 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 sections of this Opinion, and any anticipated effects of climate change on the abundance and distribution of sei whales in the action area.

9.2.4 Sperm Whales

As described in further detail in the Status of the Species, the most recent estimate indicated a global population of between 300,000 and 450,000 individuals (Whitehead 2009). The higher estimates may be approaching population sizes prior to commercial whaling, the reason for ESA listing. No other more recent rangewide abundance estimates are available for this species

(Waring et al. 2015). Hayes et al. (2020) reports that several estimates from selected regions of sperm whale habitat exist for select time periods, however, at present there is no reliable estimate of total sperm whale abundance for the entire North Atlantic. Sightings have been almost exclusively in the continental shelf edge and continental slope areas, however there has been little or no survey effort beyond the slope. The best recent abundance estimate for sperm whales in the North Atlantic is the sum of the 2016 surveys— 4,349 (CV=0.28) (Hayes et al. 2020).

Entanglement in fishing gear and vessel strikes as described in the *Environmental Baseline*, may occur in the action area over the life of the proposed action. As noted in the Cumulative Effects section of this Opinion, we have not identified any cumulative effects different 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. 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 described in the *Effects of the Action* section of this Opinion, the only adverse effects to sperm whales expected to result from the Vineyard 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 sperm whales as a result of exposure to noise from impact pile driving for the remaining 15 monopile foundations. 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 remaining 33-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 Vineyard 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 Vineyard 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 Vineyard 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 -100 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 that could result in PTS or any other injury. Only a small number of sperm whales (no more than 2) are expected to be exposed to pile driving noise that will be loud enough to result in TTS or behavioral disturbance that would meet the NMFS interim definition of ESA harassment. A number of measures that are part of the proposed action, including a seasonal restriction on impact pile driving, requirements to use noise attenuation devices, minimum visibility requirements, and clearance and shutdown measures during pile driving monitored by PSOs on multiple platforms, reduce the potential for exposure of sperm whales to pile driving noise. 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 2 sperm whales to experience TTS, temporary behavioral disturbance (approximately 3 hours for an individual exposed to noise during WTG foundation installation), and associated temporary physiological stress during the construction period due to exposure to impact pile driving noise. We have determined that the effects experienced by these 2 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 2 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 Vineyard 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 hours for an individual exposed to noise during WTG 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 expected to be rare due to the nearshore location and shallow depths. As such, disruption of foraging extremely unlikely to occur. A single impact pile driving event will take no more than approximately 3 hours for WTG foundation installation; therefore, even in the event that the 2 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 hours f. 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 5.7 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 5.7 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 10 minutes, but at normal cruise speed (5-15 kph), it would take the animal approximately 30 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 2 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 Vineyard 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 2010 Recovery 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 2 individuals exposed to pile driving noise; there will be no other 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 expected to cause an appreciable reduction in the likelihood of survival and recovery of sperm whales in the wild. These conclusions were made in consideration of the endangered status of sperm whales, other stressors that individuals are exposed to within the action area as described in the *Environmental Baseline* and *Cumulative Effects*, and any anticipated effects of climate change on the abundance and distribution of sperm whales in the action area.

9.3 Sea Turtles

Our effects analysis determined that impact pile driving for the remaining 15 foundations is likely to adversely affect a number of individual ESA-listed sea turtles (one loggerhead and one leatherback) 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 or otherwise result in actual injury or mortality as a result of impacts to hearing that affects detection of acoustic cues resulting in delayed response or limited detection of threats. 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 19 leatherback, 16 loggerhead, and 2 green, and 2 Kemp's ridley sea turtles over the life of the project, inclusive of the construction, operation, and decommissioning period. We expect that 1 sea turtle (a loggerhead, green, or Kemp's ridley) will be captured in the trawl surveys and be released alive with minor, recoverable injury. We do not expect the entanglement or capture of any sea turtles in any other fisheries surveys, including the trap/pot 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 DPS or species those populations comprise.

While this biological opinion relies on the best available scientific and commercial information, our analysis and conclusions include uncertainty about the basic hearing capabilities of sea turtles, such as how they use sound to perceive and respond to environmental cues, and how temporary changes to their acoustic soundscape could affect the normal physiology and behavioral ecology of these species. Vessel strikes are expected to result in more significant effects on individuals than other stressors considered in this Opinion because these strikes are expected to result in serious injury or mortality. Those that are killed and removed from the population would decrease reproductive rates, and those that sustain non-lethal injuries and permanent hearing impairment could have fitness consequences during the time it takes to fully recover, or have long lasting impacts if permanently harmed. Temporary hearing impairment and significant behavioral disruption from harassment could have similar effects, but given the duration of exposures, these impacts are expected to be temporary and a sea turtle's hearing is expected to return back 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 34-year life of the Vineyard 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 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.

9.3.1 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). These population studies are consistent with the definition of the Northwest Atlantic DPS.

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 Northwest Atlantic which is an indication of the size of the Northwest Atlantic DPS.

The impacts to loggerhead sea turtles from the proposed action are expected to result in the serious injury or mortality of 16 individuals due to vessel strike over the 33-year construction, operations and decommissioning period; the exposure of no more than 1 loggerhead sea turtles from the DPS to noise that will result in TTS and/or behavioral disturbance that meets the ESA definition of harassment as a result of exposure to impact pile driving noise; and the capture of up to 1 loggerheads over the remaining 3-year post-construction survey period in the 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 no more than 16 loggerheads over the 34-year life of the project.

The 1 loggerhead sea turtle that experiences harassment would experience behavioral disturbance and could suffer temporary hearing impairment (TTS); we also expect this turtle would experience physiological stress during the period that their normal behavioral patterns are disrupted. These temporary conditions are expected to return to normal over a relatively short period of time. 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. 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 and magnetic orientation (Avens and Lohmann 2003; Putman et al. 2015). Because sea turtles do not vocalize or use noise to communicate, any TTS would not impact communications. However, to the extent that sea turtles do rely on acoustic cues from their environment, 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 (Narazaki et al. 2013). If such cues increase survivorship (e.g., aid in avoiding predators, navigation), temporary loss of hearing sensitivity may have effects on the ability of a sea turtle to avoid threats which could decrease its ability to avoid those threats. TTS of sea turtles is expected to last for up to a week 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, while TTS may impact the ability of affected individuals to avoid threats during the several days that TTS is experienced, we do not anticipate single TTSs would have any long-term impacts on the health or reproductive capacity or success of individual sea turtles. TTS will resolve within one week while behavioral disturbance and stress will cease after exposure to pile driving noise ends (no more than three hours).

The energetic consequences of the evasive behavior and delay in resting or foraging will be disruptive for the period of time that the individual is exposed to the noise source; however, the limited duration means that these consequences 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. As a result of the energetic costs, evasive behaviors, and temporary impact on the ability to detect environmental cues which could affect the ability to avoid threats, TTS and behavioral disruption will create or increase the risk of injury for the affected sea turtles compared to those that are not exposed to these noise sources. However, as established herein, the temporary and limited nature of these effects means that it is unlikely that the behavioral disruption and temporary loss of hearing sensitivity would affect an individual sea turtle's fitness (i.e., survival or reproduction).

The mortality of 16 loggerhead sea turtles in the action area over the 33 year life of the project (inclusive of 1 remaining year of construction, 30 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 16 loggerheads over the 33 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 17 individuals would represent approximately 0.1% of the population. On an annual basis, the loss represents approximately 0.003% of the minimum population size. If the total NRU population was limited to 1,272 sea turtles (the number of nesting females), and all 17 individuals originated from that population, the loss of those individuals would represent approximately 1.3% of the population or approximately 0.004% on annual basis. 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 (i.e., adult nesting females plus males and all younger year classes) and represents an even smaller percentage of the DPS as a whole.

As noted in the *Environmental Baseline*, the status of Northwest Atlantic DPS 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 Northwest Atlantic DPS loggerhead sea turtles in the action area, and in consideration of the threats experienced by Northwest Atlantic DPS 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 Northwest Atlantic DPS 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 Northwest Atlantic DPS 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 16 loggerheads over the 33 year life span of the project will not appreciably reduce the likelihood of survival (i.e., it will not decrease the likelihood that the species will continue to persist into the future with sufficient resilience to allow for recovery and eventual delisting). The actions will not affect this DPS of 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 from completing their entire life cycle, including reproduction, sustenance, and shelter. This is the case because: (1) the death of 16 loggerheads represents an extremely small percentage of the DPS as a whole; (2) the death of 16 loggerheads will not change the status or trends of any recovery unit or the DPS as a whole; (3) the loss of 16 loggerheads is not likely to have an effect on the levels of genetic heterogeneity in any recovery unit or the DPS as a whole; (4) the loss of 16 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 Northwest Atlantic DPS 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 from this DPS.

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.

The Northwest Atlantic DPS of loggerheads have a stable trend; as explained above, the loss of 16 loggerheads from the DPS 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 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 their listing as threatened or endangered is no longer appropriate; 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 actions are not likely to appreciably reduce the likelihood of both the survival and recovery of the NWA DPS of loggerhead sea turtles. These conclusions were made in consideration of the threatened status of NWA DPS loggerhead sea turtles, 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 NWA DPS loggerhead sea turtles in the action area.

9.3.2 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). 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*, North Atlantic DPS 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 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. As described in section 7.10, climate change may result in changes in the distribution or abundance of North Atlantic DPS 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 61,000 in 2023. 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 2023, over 77,000 green turtle nests were counted in Florida, which was a record high. (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 adverse effects to green sea turtles from the proposed action are expected to result in the serious injury or mortality of 2 individuals due to vessel strike over the 33-year life of the project inclusive of construction, operations, and decommissioning. We determined that all other effects of the action would be insignificant or extremely unlikely, including consideration of project noise (including pile driving, HRG surveys, and WTG operations, etc.). We do not expect any green sea turtles to be captured in any fisheries surveys. All effects to green sea turtles from impacts to habitat will be insignificant or discountable. In total, we anticipate the proposed action will result in the mortality of two green sea turtles over the 34-year life of the project.

The death of two North Atlantic DPS green sea turtles, whether males or females, immature or mature, would reduce the number of North Atlantic DPS green sea turtles as compared to the number of individuals that would have been present in the DPS in the absence of the proposed actions assuming all other variables remained the same. The loss of two North Atlantic DPS green sea turtles represents a very small percentage of the North Atlantic 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 North Atlantic DPS green turtles, the mortality of two green represents less than 0.006% of the nesting population. The loss of these sea turtles 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 to increasing. As noted in the *Environmental Baseline*, the status of green sea turtles in the action area is expected to be the same as that of each recovery unit over the life of the project. As explained below, the death of these North Atlantic DPS green sea turtles will not appreciably reduce the likelihood of survival for the North Atlantic DPS 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 DPS/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 DPS/species has extremely low levels of genetic diversity. This situation is not likely in the case of North Atlantic DPS green sea turtles 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 North Atlantic DPS 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 two North Atlantic DPS green sea turtles over the 33 year life of the project, will not appreciably reduce the likelihood of survival (i.e., it will not decrease the likelihood that the species will continue to persist into the future with sufficient resilience to allow for the potential recovery from endangerment). The action will not affect green sea turtles in a way that prevents the species from having a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring and it will not result in effects to the environment which would prevent North Atlantic DPS green sea turtles from completing their entire life cycle, including reproduction, sustenance, and shelter. This is the case because: (1) the DPS' nesting trend is increasing; (2) the death of 2 green sea turtles represents an extremely small percentage of the North Atlantic DPS as a whole; (3) the loss of 2 green sea turtles will not change the status or trends of the North Atlantic DPS as a whole; (4) the loss of 2 green sea turtles is not likely to have an effect on the levels of genetic heterogeneity in the population; (5) the loss of 2 green sea turtles is likely to have an undetectable effect on reproductive output of the North Atlantic 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 its range; and (7) the action will have no effect on the ability of green sea turtles to shelter and only an insignificant effect on individual foraging green sea turtles.

In rare instances, an action may not appreciably reduce the likelihood of a species survival (persistence) but may affect its likelihood of recovery or the rate at which recovery is expected to occur. As explained above, we have determined that the proposed actions will not appreciably reduce the likelihood that green sea turtles will survive in the wild. Here, we consider the potential for the actions to reduce the likelihood of recovery. As noted above, recovery is defined as the improvement in status such that listing is no longer appropriate. Thus, we have considered whether the proposed actions will affect the likelihood that the species can rebuild to a point where listing is no longer appropriate. A Recovery Plan for Green sea turtles was published by NMFS and USFWS in 1991. The plan outlines the steps necessary for recovery and the criteria, which, once met, would ensure recovery. In order to be delisted, green sea turtles must experience sustained population growth, as measured in the number of nests laid per year, over time. Additionally, "priority one" recovery tasks must be achieved and 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 North Atlantic DPS green sea turtles. Also, it is not expected to modify, curtail or destroy the range of the species since it will result in an extremely small reduction in the number of green sea turtles in any geographic area and since it will not affect the overall distribution of green sea turtles other than to cause minor temporary adjustments in movements in the action area. As explained above, the proposed actions are likely to result in the mortality of two green sea turtles; however, as explained above, the loss of these individuals over this time period is not expected to affect the persistence of green sea turtles or the species trend. The actions will not affect nesting habitat and will have only an extremely small effect on mortality. The effects of the proposed actions will not hasten the extinction timeline or otherwise increase the danger of extinction; further, the actions will not prevent the species from growing in a way that leads to recovery and the actions will not change the rate at which recovery can occur. This is the case because while the actions may result in a small reduction in the number of greens and a small reduction in the amount of potential reproduction due to the loss of one individual, these effects will be undetectable over the long-term and the actions 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 North Atlantic DPS green sea turtles can be brought to the point at which their listing as endangered or threatened is no longer appropriate; the proposed action will not appreciably reduce the likelihood of recovery of this DPS of green sea turtles.

Despite the threats faced by individual North Atlantic DPS green sea turtles inside and outside of the action area, the proposed actions will not increase the vulnerability of individual sea turtles to these additional threats and exposure to ongoing threats will not increase susceptibility to effects related to the proposed actions. We have considered the effects of the proposed actions in light of the status of the species rangewide and in the action area, the environmental baseline, cumulative effects explained above, including climate change, and has concluded that even in light of the ongoing impacts of these activities and conditions; the conclusions reached above do not change.

Based on the analysis presented herein, the proposed actions, resulting in the mortality of 2 green sea turtles over 34 years, 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 North Atlantic DPS green sea turtles in the action area.

9.3.3 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 estimate 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 is 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 agencies have taken no action to list one or more DPSs. Therefore, 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). An increasing trend in nest counts in Florida have been observed in 2018 through 2023; 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 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. 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 1 individual due to exposure to pile driving noise. We also expect that 19 leatherbacks will be struck and seriously injured or killed by a project vessel over the 33-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 19 leatherbacks over the 33-year life of the project.

The 1 leatherback sea turtle that experiences harassment would experience behavioral disturbance and could suffer temporary hearing impairment (TTS); we also assume this turtle would experience physiological stress during the period that its normal behavioral patterns are disrupted. These temporary conditions are expected to return to normal over a short period of time.

Any sea turtles affected by TTS would experience a temporary, recoverable, hearing loss manifested as a threshold shift around the frequency of the noise from pile driving. 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 and magnetic orientation (Avens and Lohmann 2003; Putman et al. 2015). Because sea turtles do not vocalize or use noise to communicate, any TTS would not impact communications. However, to the extent that sea turtles do rely on acoustic cues from their environment, 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 (Narazaki et al. 2013). If such cues increase survivorship (e.g., aid in avoiding predators, navigation), temporary loss of hearing sensitivity may have effects on the ability of a sea turtle to avoid threats which could decrease its ability to avoid those threats. 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, while TTS may impact the ability of affected individuals to avoid threats during the few days that TTS is experienced, we do not anticipate single TTSs would have any long-term impacts on the health or reproductive capacity or success of individual sea turtles.

TTS will resolve within one week while behavioral disturbance and stress will cease after exposure to pile driving noise ends (no more than three hours to install a single pile). The energetic consequences of the evasive behavior and delay in resting or foraging will be disruptive for the period of time that the individual is exposed to the noise sourced; however, the limited duration means that these consequences 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. As a result of the energetic costs, evasive behaviors, and temporary impact on the ability to detect environmental cues which could affect the ability to avoid threats, TTS and behavioral disruption will create or increase the risk of injury for the affected sea turtle compared to those that are not exposed to these noise sources. However, as established herein, the temporary and limited nature of these effects means that it is unlikely that the behavioral disruption and temporary loss of hearing sensitivity would affect an individual sea turtle's fitness (i.e., survival or reproduction).

The death of 19 leatherbacks over the life span of the project represents an extremely small percentage of the number of leatherbacks in the North Atlantic, just 0.09% 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 these deaths 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 individuals killed. Even assuming that the mortalities were all reproductive females, given the number of nesting females in this population (20,659), it is unlikely that the expected loss of no more than one leatherback per year would affect the success of nesting in any year. Additionally, this extremely small reduction in 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 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 19 leatherbacks over the 33-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 19 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 19 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 19 leatherbacks is not likely to have an effect on the levels of genetic heterogeneity in the population; (4) the loss of 19 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 19 leatherbacks over the 33-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 tis 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 effects of the proposed actions, resulting in the mortality of up to 19 leatherback sea turtles, are not likely to appreciably reduce the likelihood of both the survival and recovery of the species. 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.

9.3.4 Kemp's Ridley Sea Turtles

Kemp's ridley sea turtles are listed as a single species classified as endangered under the ESA. They occur in the Atlantic Ocean and Gulf of Mexico, the only major nesting site for Kemp's ridleys is a single stretch of beach near Rancho Nuevo, Tamaulipas, Mexico (Carr 1963, NMFS and USFWS 2015, USFWS and NMFS 1992).

Nest count data provides the best available information on the number of adult females nesting each year. As is the case with other sea turtles species, nest count data must be interpreted with caution given that these estimates provide a minimum count of the number of nesting Kemp's ridley sea turtles. In addition, the estimates do not account for adult males or juveniles of either sex. Without information on the proportion of adult males to females and the age structure of the population, nest counts cannot be used to estimate the total population size (Meylan 1982, Ross 1996). Nevertheless, the nesting data does provide valuable information on the extent of Kemp's ridley nesting and the trend in the number of nests laid. It is the best proxy we have for estimating population changes.

Following a significant, unexplained one-year decline in 2010, Kemp's ridley sea turtle nests in Mexico reached a record high of 21,797 in 2012 (Gladys Porter Zoo nesting database, unpublished data). In 2013 and 2014, there was a second significant decline in Mexico nests, with only 16,385 and 11,279 nests recorded, respectively. In 2015, nesting in Mexico improved to 14,006 nests, and in 2016 overall numbers increased to 18,354 recorded nests. There was a record high nesting season in 2017, with 24,570 nests recorded (J. Pena, pers. comm. to NMFS SERO PRD, August 31, 2017 as cited in NMFS 2020c) and decreases observed in 2018 and again in 2019 (Figure 39). 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). In 2023, there were 256 Kemp's ridley nests counted, down from 284 in 2022. 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 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. 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 adverse effects to Kemp's ridley sea turtles from the proposed action are expected to be limited to the serious injury or mortality of two individuals resulting from vessel strike. We do not expect the capture of any Kemp's ridley sea turtles in the trawl surveys or any other fisheries survey. We determined that all other effects of the action, including exposure to project noise, would be insignificant or extremely unlikely to occur. In total, we expect the proposed action to result in the mortality of two Kemp's ridley sea turtles over the 34-year life of the project.

The mortality of two Kemp's ridleys over a 33 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 two Kemp's ridley represents less than 0.028% of the population. While the death of two 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 two Kemp's ridley over 34 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 individuals that would be killed as a result of the proposed actions, 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 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.

The proposed actions are not likely to reduce distribution because the actions 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 actions, 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 two Kemp's ridley sea turtles over 33years 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 actions 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 two Kemp's ridleys represents an extremely small percentage of the species as a whole; (3) the death of two Kemp's ridleys will not change the status or trends of the species as a whole; (4) the loss of these Kemp's ridleys is not likely to have an effect on the levels of genetic heterogeneity in the population; (5) the loss of these Kemp's ridleys 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 actions 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 actions 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 that include:

1. An increase in the population size, specifically in relation to nesting females[49];

[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

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 two Kemp's ridleys over the 33-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 actions 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 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 Kemp's ridleys and a small reduction in the amount of potential reproduction due to the average loss of one individual per year, 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 actions 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 actions 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, Environmental Baseline and cumulative effects explained above, including climate change, and have concluded that even in light of the ongoing impacts of these activities and conditions; the conclusions reached above do not change.

Based on the analysis presented herein, the proposed actions, resulting in the mortality of two Kemp's ridleys, is not likely to appreciably reduce the likelihood of both the survival and recovery of this species. These conclusions were made in consideration of the endangered status of Kemp's ridley sea turtles, other stressors that individuals are exposed to within the action area as described in the *Environmental Baseline* and *Cumulative Effects*, and any anticipated effects of climate change on the abundance and distribution of Kemp's ridleys in the action area.

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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).

10.0 CONCLUSION

After reviewing the current status of the ESA-listed species, the environmental baseline within the action area, the effects of the proposed action, any effects of interrelated and interdependent actions, 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 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, or any DPS of Atlantic sturgeon. We find that the proposed action is not likely to adversely affect blue whales, Oceanic whitetip shark, shortnose sturgeon, hawksbill sea turtles, or the Northeast Atlantic DPS of loggerhead sea turtles; thus, it is also not likely to jeopardize the continued existence of these species. We find that the proposed action will have no effect on the Giant manta ray, the Gulf of Maine DPS of Atlantic salmon, or critical habitat designated for the North Atlantic right whale.

11.0 INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulations promulgated 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 to such species through protective regulations.

"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, as explained below, 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, as we have explained, 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, identifying reasonable and prudent measures with implementing terms and conditions that will minimize the impact of anticipated incidental take and monitor incidental take that occurs, and providing exemption from the Section 9 prohibitions against take for endangered species and from any prohibition on take extended to threatened species by ESA Section 4(d) protective regulations for activities conducted in accordance with reasonable and prudent measures and implementing terms and conditions.

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(a)(1)(B) of the ESA become effective only upon the issuance of MMPA authorization to take the marine mammals identified here and the incorporation of its mitigation measures in this ITS. Absent such authorization, this ITS is inoperative for and does not exempt the incidental take of ESA-listed marine mammals.

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 grants, permits and/or contracts as appropriate, the protective coverage of section 7(o)(2) may lapse. The protective coverage of section 7(o)(2) also may lapse if the lessee/applicant fails to comply with the terms and conditions and the minimization and mitigation measures included in the ITS as well as those described in the proposed action and set forth in Section 3 of this Opinion as we consider those measures necessary and appropriate to minimize take but have not restated them here for efficiency. In order to monitor the impact of incidental take, BOEM, other action agencies, and Vineyard 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).

An Incidental Take Statement was included with our 2021 Opinion; as noted in this Opinion, the only documented incidental take is of three fin whales exposed to noise above the Level B harassment threshold that are considered to have had effects that meet the definition of harassment in the context of ESA take. Those incidental takes were exempted through the 2021 ITS.

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 an identified number of North Atlantic right, fin, sperm, and sei whales and NWA DPS loggerhead, NA DPS green, Kemp's ridley, and leatherback sea turtles and to result in harm (in the form of auditory injury (PTS) of an identified number of fin and sei whales. We anticipate the serious injury and mortality of an identified number 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 (i.e. meaning minor wounding for purposes of the ESA definition of take) of NWA DPS loggerhead, NA DPS green, and Kemp's ridley, sea turtles and Atlantic sturgeon from the New York Bight DPS in trawl surveys of fisheries resources. There is no incidental take anticipated to result from EPA's issuance of an Outer Continental Shelf Air Permit or the USCG's 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 Vineyard Wind project as approved by BOEM and pursuant to other permits, authorizations, and approvals by BSEE, USACE, and NMFS' Office of Protected Resources.

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 life of the project, inclusive of all three phases (construction, operations, decommissioning):

Species	**Vessel Strike**
	Serious Injury or Mortality
NWA DPS Loggerhead sea turtle	16
NA DPS green sea turtle	2
Kemp's ridley sea turtle	2
Leatherback sea turtle	19

No take of any ESA listed whales or any DPS of Atlantic sturgeon by vessel strike is anticipated or exempted.

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 remaining 3-year duration of the planned post-construction trawl surveys:

Species	**Capture, Minor Injury**	**Serious Injury/Mortality**
Gulf of Maine DPS Atlantic sturgeon	None	None
New York Bight DPS Atlantic sturgeon	1	None
Chesapeake Bay DPS Atlantic sturgeon	None	None
South Atlantic DPS Atlantic sturgeon	None	None
Carolina DPS Atlantic sturgeon	None	None
NA DPS green sea turtle	1*	None
Kemp's ridley sea turtle	1*	None
Leatherback sea turtle	None	None
NWA DPS Loggerhead sea turtle	1*	None

*the capture of one sea turtle is anticipated, a green, Kemp's ridley, or loggerhead

No take of any species of ESA listed whale is anticipated or exempted for any fisheries surveys. If any additional surveys are planned or the survey terms are extended, consultation may need to be reinitiated.

Pile Driving

We calculated the number of whales and sea turtles expected to be harmed (Permanent Threshold Shift/acoustic injury) or harassed (Temporary Threshold Shift and/or Behavioral Disturbance) due to exposure to pile driving noise based on the pile driving remaining for the installation of 15 monopile foundations. For ESA listed whales, this is consistent with the amount of Level A and Level B harassment from impact pile driving that NMFS OPR is proposing to authorize in the proposed IHA (89 FR 31008, April 23, 2024). No take of any Atlantic sturgeon due to exposure to pile driving noise is anticipated or exempted.

Species	Take due to Exposure to Pile Driving Noise (15 monopile foundations)	
	Harassment (TTS/Behavior)	Injury (PTS)
North Atlantic right whale	7	None
Fin whale	6	1
Sperm whale	2	None
Sei Whale	2	1
NWA DPS Loggerhead sea turtle	1	None
NA DPS green sea turtle	None	None
Kemp's ridley sea turtle	None	None
Leatherback sea turtle	1	None

11.2 Effects of the Take

In this opinion, we determined that the amount or extent of anticipated take, coupled with other effects of the proposed action, is not likely to jeopardize the continued existence of any ESA-listed species under NMFS' jurisdiction.

11.3 Reasonable and Prudent Measures

Section 7(b)(4) of the ESA requires that when a proposed agency action is found to be consistent with section 7(a)(2) of the ESA and the proposed action is likely to incidentally take individuals of ESA-listed species, NMFS will issue a statement that specifies the impact of any incidental taking of endangered or threatened species. To minimize such impacts, reasonable and prudent measures, and terms and conditions to implement the measures, must be provided. Only incidental take specified in this ITS that would not occur but for the agency actions described in the 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. 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 determined to be necessary and appropriate and implementing 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. In order for the take exemption to be effective, the RPMs and their terms and conditions are nondiscretionary for the action agencies and applicant. In addition to the minimization measures specified in Chapter 3 (inclusive of the cited appendixes), which, as noted, we consider necessary and appropriate but do not repeat for the sake of efficiency, 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.

NMFS has determined that 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. These RPMs and their implementing terms and conditions are in addition to the measures that Vineyard Wind has included in its COP, the additional measures that BOEM has required as conditions of COP approval, and the mitigation measures identified in the proposed IHA issued by NMFS as all these are considered part of the proposed action (see Section 3 above). All of the conditions identified in Section 3 of this Opinion, including those included in Appendix A, B, C and D, 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 – May 31 is considered part of the proposed action, and it is not repeated here as an RPM or term and condition. In some cases, the RPMs and Terms and Conditions provide additional detail or clarity to measures that are part of the proposed action (e.g., the SFV requirements). We note that a number of the Terms and Conditions included in the 2020 and 2021 ITS have been incorporated into conditions of COP approval; this includes requirements for a 500 m clearance zone for sea turtles and measures to minimize vessel strike of sea turtles. As these are now considered part of the action and we do not have any additional detail or clarity to provide, these are not included here. A failure to implement the measures identified as part of the proposed action in Section 3 of this Opinion would be a change in the action that may necessitate reinitiation of consultation and may render the conclusions of this Opinion and the take exemption inapplicable to the activities that are carried out, and may necessitate reinitiation of consultation.

We have determined that 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.

Reasonable and Prudent Measures

We have determined the following RPMs are necessary and appropriate to minimize, monitor, 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 species must be minimized and monitored during WTG foundation installation (pile driving).

2. Effects to ESA-listed species must be minimized during survey/monitoring activities of fisheries resources.

3. Effects to, or interactions with, ESA-listed species must be properly documented during all phases of the proposed action and all incidental take must be reported to NMFS GARFO.

4. Plans must be prepared that describe the implementation of activities or monitoring protocols for which the details were not available at the time this consultation was completed. All required plans must be submitted to NMFS GARFO with sufficient time for review, comment, and any required concurrence.

5. BOEM, BSEE, NMFS OPR, and USACE must exercise their authorities to assess and ensure compliance with the implementation of measures to avoid, minimize, monitor, and report incidental take of ESA listed species during activities described in this Opinion. On-site observation and inspection by appropriate agency personnel 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.

11.3 Terms and Conditions

To be exempt from the prohibitions of section 9 of the ESA, the federal action agencies (BOEM, BSEE, USACE, and NMFS Office of Protected Resources, each consistent with their own legal authority, must comply with the following terms and conditions, which implement the reasonable and prudent measures 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; that is, if the federal action agencies and/or Vineyard Wind fail to ensure compliance with, or fail to comply with, these terms and conditions and the reasonable and prudent measures they implement, the protective coverage of section 7(o)(2) may lapse.

1. To implement the requirements of RPM 1 for ESA listed whales, Vineyard Wind must comply with the measures included in the final MMPA IHA to be issued by NMFS OPR. To facilitate implementation of this requirement:
    a. BOEM must continue to require, through an enforceable condition of their approval of Vineyard Wind's Construction and Operations Plan, that Vineyard Wind comply with any measures in the final MMPA IHA that are revised from, or in addition to, measures included in the proposed IHA, which already have been incorporated into the proposed action, monitor compliance, and, in cooperation with BSEE and consistent with each agency's legal authority, take any responsive action within its statutory and regulatory authority it deems necessary to ensure compliance.
    b. NMFS' OPR must continue to ensure compliance with all mitigation measures as prescribed in the final IHA. We expect this will be carried out through NMFS OPR's review of plans and monitoring reports submitted by Vineyard Wind as required by the final IHA, monitoring ongoing compliance, and taking any

responsive action within its statutory and regulatory authority it deems necessary to ensure compliance.

c. The USACE must continue to ensure compliance with all mitigation measures incorporated into their issued permit decision, inclusive of the requirements to comply with the measures included in the final MMPA IHA; and taking any responsive action within its statutory and regulatory authority it deems necessary to ensure compliance.

2. To implement the requirements of RPM 1, the following measures related to sound field verification (SFV) for the remaining WTG foundation pile driving must be required by the relevant federal action agencies, and implemented by Vineyard Wind. The purpose of SFV and the steps outlined here are to ensure that Vineyard Wind does not exceed the distances to the auditory injury (i.e., harm) or behavioral harassment threshold (Level A and Level B harassment respectively) for ESA listed marine mammals, the injury or behavioral harassment thresholds for sea turtles, or the injury or behavioral disturbance thresholds for Atlantic sturgeon as analyzed in the Opinion and thus ensure that the amount or extent of take is not exceeded. These thresholds and the distances to them, identified and described in this Opinion, underpin the effects analysis, exposure analysis, and our determination of the amount and extent of incidental take anticipated and exempted in this ITS, including any determination that no incidental take is anticipated (i.e., for Atlantic sturgeon). The measures outlined here are based on the expectation that the initial pile driving methodology and sound attenuation measures will result in noise levels that do not exceed the identified distances (see Table 9.2 below) but, if that is not the case, provide a step-wise approach for modifying operations and/or modifying or adding sound attenuation measures that can reasonably be expected to avoid exceeding those thresholds for the next pile being driven.

   a. Vineyard Wind must implement a Sound Field Verification (SFV) Plan, addressing Thorough and Abbreviated SFV, consistent with the requirements in T&C 11.d below.
      i. <u>Thorough SFV</u> consists of: SFV measurements made at a minimum of four distances from the pile(s) being driven, along a single transect, in the direction of lowest transmission loss (i.e., projected lowest transmission loss coefficient), including, but not limited to, 750 m and three additional ranges selected such that measurement of identified isopleths are accurate, feasible, and avoid extrapolation. At least one additional measurement at an azimuth 90 degrees from the array at approximately 750 m must be made. At each measurement location, there must be a near-bottom and mid-water column hydrophone (measurement systems); the recordings must be continuous throughout the duration of all pile driving of each foundation.
      ii. <u>Abbreviated SFV</u> consists of: SFV measurements made at a single acoustic recorder, consisting of a near-bottom and mid-water hydrophone, at approximately 750 m from the pile, in the direction of lowest transmission loss, to record sounds throughout the duration of all pile driving of each foundation. For both Thorough and Abbreviated SFV,

recordings must begin 30 minutes prior to the start of the pile driving and continue for 30 minutes after pile driving is completed.

b. Vineyard Wind must implement Thorough SFV for at least the following monopile foundations:

  - Each construction year: the first monopile installed
  - In the event that pile driving occurs in December: the first monopile installed

c. During Thorough SFV, installation of the next foundation may not proceed until Vineyard Wind has reviewed the initial results from the Thorough SFV and determined that there were no exceedances of any distances to the identified thresholds (see Table 11.2). As noted below, Interim Thorough SFV monitoring reports must be submitted to NMFS GARFO (nmfs.gar.incidental-take@noaa.gov) within 48 hours of completion of the monitored pile; this report must include notification of any exceedances and planned next steps in compliance with 2.d. below.

d. If any of the Thorough SFV measurements from any pile indicate that the distance to any isopleth of concern for any species is greater than those identified in Table 11.2, Vineyard Wind must implement the following measures for the next pile of the same type/installation methodology, as applicable. These requirements are in place for all monopile foundations for which Thorough SFV is conducted and repeat until the criteria in 2.d.ii.a or 2.d.ii.b are met.

   i. Minimum Visibility, Clearance, and Shutdown Zones. If the distance to the cumulative Level A threshold for low frequency cetaceans is greater than 3.2 km, the minimum visibility distance must be increased to correspond to the Level A harassment distance plus twenty-percent, rounded up to the nearest 0.5 km. If the distance to the injury (peak or cumulative) threshold for sea turtles is greater than 500 m, the clearance and shutdown zones must be increased to correspond with the measured distance. Adjustments to clearance and shutdown zones for marine mammals must be made consistent with the requirements of the final IHA. Vineyard Wind must deploy any additional PSOs consistent with the approved Pile Driving Monitoring Plan in consideration of the size of the new zones and the species that must be monitored (i.e., sea turtles and/or whales); for every 1,500 m that a marine mammal clearance or shutdown zone is expanded, additional PSOs must be deployed from additional platforms/vessels to ensure adequate and complete monitoring of the expanded shutdown and/or clearance zone. A description of the expanded minimum visibility, clearance, and/or shutdown zones and deployment of any additional PSOs must be included in the 48-hour report noted above. Use of the expanded clearance and shutdown zones must continue for additional piles until Vineyard Wind requests and receives concurrence from NMFS GARFO and/or NMFS OPR to revert to the original clearance and shutdown zones.

   ii. Attenuation Measures. Vineyard Wind must identify one or more additional, modified, and/or alternative noise attenuation measure(s) and/or operational change(s) included in the approved SFV plan (see T&C 12d) that is expected to reduce sound levels to the distances identified in Table 11.2 and must implement that measure for all subsequent piles. Attenuation measures/operational changes that could be implemented include but are not limited to adding a noise attenuation device, adjusting hammer operations, and adjusting or otherwise modifying the noise mitigation system. A description of the additional, modified, and/or alternative noise attenuation measure(s) and/or operational change(s) must be included in the 48-hour report noted above.

a. If no additional, modified, and/or alternative measures or operational changes are identified for implementation, or if Thorough SFV of the third pile (of the same type and installation method; i.e., the pile installed with a second round of additional/modified noise attenuation or pile driving operations) indicates that the distance to any isopleths of concerns for any ESA listed species are still greater than those expected, NMFS GARFO, NMFS OPR, BOEM, BSEE, and USACE will meet within three business days to discuss: the results of the Thorough SFV monitoring, the severity of exceedance of distances to identified isopleths of concern, the species affected, modeling assumptions, and whether any triggers for reinitiation of consultation are met (50 CFR 402.16), including consideration of whether the Thorough SFV results constitute new information revealing effects of the action that may affect listed species in a manner or to an extent not previously considered in the consultation. Implementation of additional measures to reduce noise and additional Thorough SFV may also be required as a result of this meeting.
b. Following installation of a pile with additional, alternative, or modified noise attenuation measures/operational changes required by 2.d, if Thorough SFV results indicate that all isopleths of concern are within the expected distances, Thorough SFV must be conducted on two additional piles (for a total of at least three piles with consistent noise attenuation measures). If the Thorough SFV results from all three of those piles are within the expected distances to isopleths of concern (Table 11.2), then Vineyard Wind must continue to implement the additional, alternative, or modified sound attenuation measures/operational changes for all subsequent piles and can move to Abbreviated SFV for the next pile. Vineyard Wind can request concurrence from NMFS GARFO and NMFS OPR to return to the original minimum visibility, clearance, and shutdown zones (Table 11.1).

e. Vineyard Wind must implement Abbreviated SFV for all piles for which the Thorough SFV monitoring outlined above is not carried out. The transition to Abbreviated SFV requires concurrence from NMFS GARFO that the requirements outlined in Term and Condition 2 b-d have been met. The Abbreviated SFV data collected will be used to compare to the thresholds defined as a result of Thorough SFV. Results of all Abbreviated SFV must be submitted with the weekly pile driving report.

   i. Vineyard Wind must review Abbreviated SFV results for each pile within 24 hours of completion of the foundation installation. If measured levels at 750 m did not exceed the expected levels defined through Thorough SFV, Vineyard Wind does not need to take any additional action.

   ii. If measured levels from Abbreviated SFV for any pile are greater than expected levels (as defined by Thorough SFV), Vineyard Wind must evaluate the available information from the pile installation to determine if there is an identifiable cause of the exceedance (i.e., a failure of the noise attenuation system), identify and implement corrective action, and report this information (inclusive of an explanation of the suspected or identified cause) to BOEM, BSEE, USACE, and NMFS GARFO (by email, nmfs.gar.incidental-take@noaa.gov) within 48 hours of completion of the installation of the pile during which the greater than expected sound levels occurred.

   iii. If Vineyard Wind can demonstrate that this greater than expected sound level was the result of a failure of the noise attenuation system (e.g., loss of a generator supporting a bubble curtain such that one bubble curtain failed during pile driving) that can be remedied in a way that returns the noise attenuation system to pre-failure conditions, or there is another identifiable cause for the increase in sound that is not expected to be repeated for subsequent piles or can be remedied, Vineyard Wind must make the necessary changes prior to carrying out any additional pile driving. In all cases, Vineyard Wind must remedy any failure of the noise attenuation system prior to carrying out any additional pile driving. A report must be submitted to NMFS GARFO (by email nmfs.gar.incidental-take@noaa.gov) within 48 hours of such an event that describes the identified cause/noise attenuation system failure, and the remedies/corrective actions taken.

   iv. If after action is taken to remedy the identified cause of an exceedance, or no identified action can be taken to reduce noise levels, Vineyard Wind must resume Thorough SFV monitoring (as described in 2a above, subject to the exception in 2.e.iii above) for installation of the next pile, unless NMFS determines, based on situational information provided by Vineyard Wind, that thorough SFV is not required. Such a determination would be made in coordination with NMFS OPR.

      1. Vineyard Wind can request concurrence from BOEM, BSEE, NMFS OPR, and NMFS GARFO to resume Abbreviated SFV

monitoring following submission of an interim report from Thorough SFV that demonstrates ranges to the identified thresholds within expected values (see Table 11.2). Interim Thorough SFV monitoring reports must be submitted to BOEM, BSEE, USACE, NMFS OPR, and NMFS GARFO within 48 hours of completion of the monitored pile.

2. If results from any Thorough SFV monitoring triggered by results from Abbreviated SFV indicate that ranges to the identified thresholds are larger than expected values, the requirements for Thorough SFV outlined in 2.a, c, and d above apply (i.e., continuing Thorough SFV and implementing requirements for additional/modified attenuation measures). Additionally, BOEM, BSEE, USACE, NMFS OPR, and NMFS GARFO will meet within three business days to discuss: the results of SFV monitoring, the severity of exceedance of distances to identified isopleths of concern, the species affected, modeling assumptions, and whether any triggers for reinitiation of consultation are met (50 CFR 402.16), including consideration of whether the available SFV results constitute new information revealing effects of the action that may affect listed species in a manner or to an extent not previously considered in the consultation. Implementation of additional measures to reduce pile driving noise and/or additional Thorough SFV may also be required as a result of this meeting.

3. To implement the requirements of RPM 1, BOEM, BSEE, and/or USACE must require that Vineyard Wind inspect and carry out appropriate maintenance on the noise attenuation system prior to every foundation installation event (i.e., for each pile driven foundation) consistent with Vineyard Wind's enhanced maintenance protocols, and prepare and submit a Noise Attenuation System (NAS) inspection/performance report to NMFS GARFO and NMFS OPR. For piles for which Thorough SFV is carried out, 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. Performance reports for piles with Abbreviated SFV must be submitted with the weekly pile driving reports. All reports must be submitted by email to nmfs.gar.incidental-take@noaa.gov and submitted to BSEE through TIMSWeb.

    a. Vineyard Wind must develop and implement a maintenance plan that identifies the frequency of hose inspection, flushing, pressure tests, and re-drilling and that is designed to minimize the potential for sediment clogging to affect bubble curtain performance. Adjustments to the frequency of these maintenance steps must be made as necessary to ensure optimal performance of the bubble curtain system.

    b. Performance reports for each bubble curtain deployed must include water depth, current speed and direction, wind speed and direction, bubble curtain deployment/retrieval date and time, bubble curtain hose length, bubble curtain radius (distance from pile), diameter of holes and hole spacing, air supply hose length, compressor type (including rated Cubic Feet per Minute (CFM) and model number), number of operational compressors, performance data from each compressor (including Vineyards Per Minute (RPM), pressure, start times, and stop times), free air delivery (m^3/min), total hose air volume (m^3/(min m)), schematic of GPS waypoints during hose laying, maintenance procedures performed (pressure tests, inspections, flushing, re-drilling, and any other hose or system maintenance) before and after installation and timing of those tests, and the length of time the bubble curtain was on the seafloor prior to foundation installation. Additionally, the report must include any important observations regarding performance (before, during, and after pile installation), such as any observed weak areas of low pressure. The report may also include any relevant video and/or photographs of the bubble curtain(s) operating during pile driving.

4. To implement the requirements of RPM 2, the following measures must be implemented for all remaining fisheries surveys:
    a. All trap/pot sampling gear must be hauled 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.
    b. To facilitate identification of gear on any entangled animals, all vertical lines used in the trap surveys must be uniquely marked to distinguish it from other commercial or recreational gear. Using yellow and black paint, place a 3-foot long mark within 2 fathoms of the buoy. In addition, using yellow and black paint or tracer line, place 3 additional 12-inch marks on the top, middle, and bottom of the line. These gear marking colors were chosen as they are not gear markings used in other fisheries and are therefore distinct. Any changes in marking will not be made without notification and approval from NMFS.
    c. 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) 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.
    d. 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 will ensure that Vineyard Wind complies with the previously approved training plan. This requirement is in place for any trips where gear is set or hauled.
    e. Trawl and trap survey vessels must have a knife and boathook onboard and disentangle any sea turtles 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).

5. To implement the requirements of RPM 2, 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 must 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://www.fisheries.noaa.gov/s3/2024-08/Sturgeon-Sea-Turtle-Take-Sops-External-08142024.pdf).

    b. Fisheries 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://www.fisheries.noaa.gov/s3/2023-09/Sturgeon-Genetics-Sampling-Revised-September-2023.pdf).

        i. 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 must be 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.

        ii. Subsamples of all fin clips and accompanying metadata form must be held and submitted to 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-mid-atlantic/consultations/section-7-take-reporting-programmatics-greater-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 must 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 https://www.fisheries.noaa.gov/s3/2023-11/Take-Report-Form-11142023.pdf and submitted to NMFS as described below.

6. To implement the requirements of RPM 2, 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 must be minimized 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. To the extent there is a conflict between 50 CFR 223.206(d)(1) and this ITS, the terms of this ITS control.
    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 must be contacted via VHF marine radio on Channel 16. If requested, 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 possible 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.pdf).
    e. Provided that appropriate cold storage facilities are available on the survey vessel, following the report of a dead sea turtle or sturgeon to NMFS, and if NMFS requests, any <u>dead</u> 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 uninjured 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.
7. To implement the requirements of RPM 3, BOEM, BSEE, and/or USACE must require that Vineyard Wind prepare and submit interim and final SFV reports to NMFS GARFO (via email) and BSEE (via TIMSWeb) as outlined here:

a. Thorough SFV Interim Reports - Foundation Installation. Vineyard Wind must provide the initial results of the SFV measurements to NMFS GARFO and NMFS OPR in an interim report as soon as it is available but no later than 48 hours after the installation of each pile for which Thorough SFV is carried out. If technical or other issues prevent submission within 48 hours, Vineyard Wind must notify BOEM, BSEE, and 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 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 kurtosis and rise times, background noise levels recorded 30 minutes prior to and 30 minutes post pile driving, pile driving plots, activity logs, weather conditions. Additionally, any important sound attenuation device malfunctions (suspected or definite), must be summarized and substantiated with data (e.g. photos, positions, environmental data, directions, etc.). Such malfunctions include gaps in the bubble curtain, significant drifting of the bubble curtain, and any other issues which may indicate sub-optimal mitigation performance or are used by Vineyard Wind to explain performance issues. Requirements for actions to be taken based on the results of the SFV are identified above.

b. In addition to the requirements above, all Thorough SFV reports for foundation installation must include the information required by the final IHA as well as estimated sea turtle and Atlantic sturgeon injury (peak and cumulative) and behavioral disturbance isopleths, calculated using the maximum-over-depth L5 (95 percent exceedance level, maximum of both hydrophones) of the associated sound metric.

c. All Abbreviated SFV reports must include the results from the hydrophones at 750 m and a comparison to the expected levels at 750 m based on the previously completed Thorough SFV results. Abbreviated SFV reports must be submitted with the weekly pile driving report.

d. SFV Final Reports - The final results of Thorough SFV must be submitted as soon as possible, but no later than within 90 days following completion of pile driving for which the Thorough SFV was carried out. Within 90 days of the end of each construction season, Vineyard Wind must compile and submit all final Abbreviated SFV reports.

8. To implement the requirements of RPM 3, Vineyard 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).

9. To implement the requirements of RPM 3, BOEM, BSEE, USACE, and Vineyard 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 Vineyard 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. All sightings or acoustic detections of North Atlantic right whales must be reported immediately (no later than 24 hours). PAM detections and sightings of right whales with no visible injuries or entanglement must be reported as described in (i) below. Reporting requirements for suspected vessel strikes and injured/dead right whales are in (c) and (d) below.

        i. If a NARW is sighted with no visible injuries or entanglement or is detected via PAM at any time by project PSOs/PAM Operators or project personnel, Vineyard Wind must immediately report the sighting or acoustic detection to NMFS; if immediate reporting is not possible, the report must be submitted as soon as possible but no later than 24 hours after the initial sighting or acoustic detection.

            - To report the sighting or acoustic detection, download and complete the Real-Time North Atlantic Right Whale Reporting Template spreadsheet found here: https://www.fisheries.noaa.gov/resource/document/template-datasheet-real-time-north-atlantic-right-whale-acoustic-and-visual. Save the spreadsheet as a .csv file and email it to NMFS NEFSC-PSD (ne.rw.survey@noaa.gov), NMFS GARFO-PRD (nmfs.gar.incidental-take@noaa.gov), and NMFS OPR (PR.ITP.MonitoringReports@noaa.gov).

- If unable to report a sighting through the spreadsheet within 24 hours, call the relevant regional hotline (Greater Atlantic Region [Maine through Virginia] Hotline 866-755-6622; Southeast Hotline 877-WHALE-HELP) with the observation information provided below (PAM detections are not reported to the Hotline).
- Observation information: Report the following information: the time (note time format), date (MM/DD/YYYY), location (latitude/longitude in decimal degrees; coordinate system used) of the observation, number of whales, animal description/certainty of observation (follow up with photos/video if taken), reporter's contact information, and lease area number/project name, PSO/personnel name who made the observation, and PSO provider company (if applicable) (PAM detections are not reported to the Hotline).
- If unable to report via the template or the regional hotline, enter the sighting via the WhaleAlert app (http://www.whalealert.org/). If this is not possible, report the sighting to the U.S. Coast Guard via channel 16. The report to the Coast Guard must include the same information as would be reported to the Hotline (see above). PAM detections are not reported to WhaleAlert or the U.S. Coast Guard.

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, or other means by which project activities cause a non-auditory injury or death of an ESA listed species, Vineyard Wind or their contractors must report the incident or sighting to NMFS GARFO at the phone numbers and email addresses identified below and BSEE (via TIMSWeb and notification email to (protectedspecies@bsee.gov). Reports to NMFS must be made by phone and email:

   - Phone: If in the Greater Atlantic Region (ME-VA): the NMFS Greater Atlantic Stranding Hotline (866-755-6622); in the Southeast Region (NC-FL): the NMFS Southeast Stranding Hotline (877-942-5343).
   - Email: GARFO (nmfs.gar.incidental-take@noaa.gov), and if in the Southeast region (NC-FL), also to NMFS SERO (secmammalreports@noaa.gov) The report must include the following information: (A) Time, date, and location (coordinates) of the incident; (B) Species identification (if known) or description of the animal(s) involved (i.e., identifiable features including animal color, presence of dorsal fin, body shape and size); (C) Vessel strike reporter information (name, affiliation, email for person completing the report); (D) Vessel strike witness (if different than reporter) information (name, affiliation, phone number, platform for person witnessing the event); (E) Vessel name and/or MMSI number; (F) Vessel size and motor configuration (inboard, outboard, jet propulsion); (G) Vessel's speed leading up to and during the incident; (H) Vessel's course/heading and what operations were being conducted (if applicable); (I) Part of vessel that struck the animal (if

known); (J) Vessel damage notes; (K) Status of all sound sources in use at time of strike; (L) If animal was seen before strike event; (M) behavior of animal before strike event; (N) 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; (O) Environmental conditions (*e.g.*, wind speed and direction, Beaufort sea state, cloud cover, visibility) immediately preceding the strike; (P) Estimated (or actual, if known) size and length of animal that was struck; (Q) Description of the behavior of the marine mammal immediately preceding and following the strike; (R) If available, description of the presence and behavior of any other marine mammals immediately preceding the strike; (S) Other animal details if known (e.g., length, sex, age class); (T) Behavior or estimated fate of the animal post-strike (*e.g.*, dead, injured but alive, injured and moving, external visible wounds (linear wounds, propeller wounds, non-cutting blunt-force trauma wounds), blood or tissue observed in the water, status unknown, disappeared); (U) To the extent practicable, photographs or video footage of the animal(s); and (V) Any additional notes the witness may have from the interaction. For any numerical values provided (i.e., location, animal length, vessel length etc.), please provide if values are actual or estimated.

d. In the event that any PSO or other project personnel, including any project vessel operator or crew, observe or identify a stranded, entangled, injured or dead ESA listed species, Vineyard Wind or their contractor must report the incident to NMFS GARFO (by phone (marine mammals and turtles only) and email (marine mammal, sea turtle, listed fish) and BSEE (via TIMSWeb and notification email to (protectedspecies@bsee.gov):

- Phone: If in the Greater Atlantic Region (ME-VA): NMFS Greater Atlantic Stranding Hotline (866-755-6622); in the Southeast Region (NC-FL), the NMFS Southeast Stranding Hotline (877-942-5343). Note, the stranding hotline may request the report be sent to the local stranding network response team.
- Email: if in the Greater Atlantic region (ME to VA) to GARFO (nmfs.gar.incidental-take@noaa.gov) or if in the Southeast region (NC-FL) to NMFS SERO (secmammalreports@noaa.gov). The report must include: (A) Contact information (name, phone number, etc.), time, date, and location (coordinates) 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. Vineyard Wind must continue to compile and submit weekly reports during each month that foundation installation occurs 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 by PSOs and opportunistically 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 Vineyard 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. Vineyard Wind must continue to 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.

g. Vineyard Wind must continue to 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 2024 activities is due by February 15, 2025). In any years that fisheries surveys are not carried out, an email shall be submitted by February 15 that indicates that no surveys were carried out in the preceding year.

h. Vineyard 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 the completion of foundation installation have ended for the calendar year (i.e., if the last foundation of construction year 1 is installed on November 30, the report is due by March 1 of the following year). 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. Vineyard 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. Archiving guidelines outlined here (https://www.ncei.noaa.gov/products/passive-acoustic-data#tab-3561) must be followed. Confirmation of both submittals must be sent to NMFS GARFO via email.

To implement the requirements of RPM 3, Vineyard Wind must submit to NMFS GARFO (nmfs.gar.incidental-take@noaa.gov) a report at the end of each calendar year that uses the best available information to estimate the total number of sea turtle vessel strikes in the action area that are attributable to project vessels. This must include a description of project vessel activity for the calendar year (i.e., number of trips per month from the different ports and the lease area), any observations of sea turtles by lookouts, and any known or suspected vessel strikes. Each annual report is due by February 15 (i.e., the report of 2024 activities is due by February 15, 2025).

11. To implement RPM 4, the plans identified below must be submitted to NMFS GARFO at nmfs.gar.incidental-take@noaa.gov by BOEM, BSEE, and/or Vineyard Wind. For each plan, NMFS GARFO will provide comments to BOEM, BSEE, and Vineyard 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 Vineyard 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 Vineyard Wind must receive NMFS GARFO's concurrence that these plans are consistent with the requirements outlined herein before the identified activity is carried out. We note that this Term and Condition does not impose a requirement to resubmit any plans that have already been submitted to NMFS GARFO for review and does not require any additional review of plans that have been approved as of the date of issuance of this Opinion, unless such plans are modified by Vineyard Wind following previous approval in which case the modified plan must be submitted for review. If alternative review periods are requested by any action agency and/or Vineyard Wind (e.g., to accommodate pile installation schedules), NMFS GARFO will accommodate them to the maximum extent practicable.

a. *Passive Acoustic Monitoring Plan for Pile Driving*. BOEM, BSEE, and/or Vineyard Wind must submit this Plan to NMFS GARFO at least 30 calendar days before impact pile driving is planned. BOEM, BSEE, and Vineyard Wind must obtain NMFS GARFO's concurrence that this Plan meets the requirements outlined here 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 T&C 9.b.

b. *Marine Mammal and Sea Turtle Monitoring Plan – Pile Driving.* BOEM, BSEE, and/or Vineyard Wind must submit this Plan to NMFS GARFO at least 30 calendar days before any pile driving for foundation installation. BOEM, BSEE, and/or Vineyard Wind must obtain NMFS GARFO's concurrence that this Plan meets the requirements outlined here prior to the start of any pile driving for foundation installation. 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. 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 Vineyard

Wind would determine the number of sea turtles exposed to noise above the 175 dB harassment threshold during impact pile driving of WTG foundations and how Vineyard Wind would determine the number of ESA listed whales exposed to noise above the Level B harassment threshold during impact pile driving of WTG foundations.

c. *Reduced Visibility Monitoring Plan – Pile Driving*. BOEM, BSEE, and/or Vineyard Wind must submit this Plan to NMFS GARFO at least 30 calendar days before impact pile driving is planned to begin. BOEM, BSEE, and Vineyard Wind must obtain NMFS GARFO's concurrence that this Plan meets the requirements outlined here prior to the start of pile driving. This Plan must contain a thorough description of how Vineyard Wind will monitor pile driving activities during reduced visibility conditions (e.g. rain, fog) and in the event that pile driving started during daylight hours must continue after dark to maintain project safety. This must include 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. 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. Additionally, this Plan must contain a thorough description of how Vineyard 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.

d. *Sound Field Verification Plan - Monopile Installation*. BOEM, BSEE, and/or Vineyard Wind must submit this Plan to NMFS GARFO at least 30 calendar days before impact pile driving is planned to begin. BOEM, BSEE, and Vineyard Wind must obtain NMFS GARFO's concurrence that this Plan meets the requirements outlined here prior to the start of pile driving. The Plan must detail all plans and procedures for sound attenuation, including procedures for adjusting and optimizing the noise attenuation system(s), maintenance procedures and timelines, and detail the available contingency noise attenuation measures/systems if distances to modeled isopleths of concern are exceeded (as documented during SFV). The plan must describe how Vineyard Wind will conduct the required Thorough and Abbreviated SFV (T&C 2) including pile ID and location. The Plan must also include the piling schedule and sequence of events, communication and reporting protocols, and methodology for collecting, analyzing, and preparing SFV data for submission to NMFS, including instrument deployment, locations of all hydrophones (including direction and distance from the pile), hydrophone sensitivity, recorder/measurement layout, and analysis methods. The plan must include a template of the interim report to be submitted and describe all the information that will be reported in the SFV Interim Reports including the number, location, depth, distance, and predicted and actual isopleth distances that will be included in the final report(s). The Plan must describe how the interim SFV report results will be evaluated against the expected results, and include a decision tree of what happens if measured values exceed predicted values. The plan must describe the planned deployment of hydrophones for Abbreviated SFV, address reporting requirements, and include a decision tree of what happens if measured values exceed predicted values. The plan must also describe the procedure for identifying appropriate expected levels at 750 m during Abbreviated SFV. The Plan must address how Vineyard Wind will implement the measures associated with the required SFV which includes, but is not limited to, identifying additional or modified noise attenuation measures (e.g., additional noise attenuation device, adjust hammer operations, adjust or modify the noise mitigation system) that will be applied to reduce sound levels if measured distances are greater than those modeled as well as implementation of any expanded clearance or shutdown zones, including deployment of additional PSOs.

e. *Vessel Strike Avoidance Plan*. If Vineyard Wind plans to implement PAM in any transit corridor to allow vessel transit above 10 knots, Vineyard Wind must prepare a plan that describes: the location of each transit corridor (with a map); how PAM, in combination with visual observations, will be conducted to ensure highly effective monitoring for the presence of right whales in the transit corridor; and, the protocols that will be in place for vessel speed restrictions following detection of a right whale via PAM or visual observation. Any revisions to a previously approved plan must be provided to NMFS GARFO for review at least 60 days in advance of planned deployment of the PAM system. PAM information should follow what is required to be submitted for the PAM Plan in T&C 11.a. BOEM, BSEE, and Vineyard Wind must receive NMFS GARFO's concurrence that this Plan meets the requirements outlined here prior to implementation of the PAM-monitored transit corridor.

12. To implement the requirements of RPM 6, BOEM, BSEE, NMFS OPR, and USACE 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. These agencies shall immediately exercise their respective authorities to take effective action to ensure prompt implementation and compliance if Vineyard Wind is not complying with: any avoidance, minimization, and monitoring measures incorporated into the proposed action or any term and condition(s) specified in this statement, as currently drafted or otherwise amended in agreement between these agencies and NMFS; if agencies fail to do so, the protective coverage of Section 7(o)(2) may lapse.

13. To implement the requirements of RPM 6, Vineyard 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.

14. To implement the requirements of RPM 6, Vineyard Wind, BOEM, BSEE, NMFS OPR, and USACE must immediately notify NMFS GARFO of any identified or suspected non-compliance with any measure outlined in this Incidental Take Statement or in any measure incorporated into the proposed action, including measures included in the Final

MMPA authorization. This includes the suspected or identified failure in effectiveness of any such measure. This notification must be submitted as soon as the issue is identified to nmfs.gar.incidental-take@noaa.gov and must include a description of the non-compliance or failure of effectiveness of the measure, the date the issue was identified, and, any corrective actions that were taken. The report of non-compliance must be followed within 48 hours with a request to meet with NMFS GARFO to discuss the report and seek concurrence from NMFS GARFO on the corrective measures. Neither the lessee nor any action agency may interfere with any reporting to NMFS by a PSO or other personnel of any identified or suspected non-compliance with any such measures or any identified or suspected incidental take.

Table 11.1. Clearance and Shutdown Zones for ESA Listed Species - Pile Driving
These are the PAM detection, minimal visibility, clearance, and shutdown zones incorporated into the proposed action; the zones for marine mammals reflect the conditions of the proposed IHA and the zones for sea turtles reflect the zone sizes incorporated into the Conditions of COP approval (and are consistent with the RPMs and Terms and Conditions from NMFS 2021 Opinion). Pile driving will not proceed unless the visual PSOs can effectively monitor the full extent of the minimum visibility zones. Detection of an animal within the clearance zone triggers a delay of initiation of pile driving; detection of an animal in the shutdown zone triggers the identified shutdown requirements.

Species	Clearance Zone (m)	Shutdown Zone (m)
Remaining Monopile Foundation Installation - Impact pile driving, visual PSOs and PAM		
Minimum visibility zone from each PSO platform (pile driving vessel and at least two PSO vessels): 4,000 m; PAM monitoring out to 10,000 m for all monopile foundations		
North Atlantic right whale – visual PSO and PAM monitoring	At any distance (minimum visibility zone plus any additional distance observable by the visual PSOs on all PSO platforms); At any distance within the 10 km zone monitored by PAM	At any distance (Applicable minimum visibility zone plus any additional distance observable by the visual PSOs on all PSO platforms); At any distance within the 10 km zone monitored by PAM
Fin, sei, and sperm whale –	500 m	500 m
Sea Turtles	500 m	500 m

Table 11.2 Distances to Acoustic Thresholds Relevant for SFV Monitoring

Species	Injury/Level A Harassment (Peak)*	Injury/Level A Harassment (Cumulative)	Behavioral Disturbance/Level B Harassment
Right, fin, sei whales	<150 m	3.2 km	5.72 km

Sperm whales	<150 m	<500 m	5.72 km
Sea turtles	<150 m	<500 m	1.4 km
Atlantic sturgeon	<150 m	6.9 km	12.2 km

*the distance to peak noise thresholds is not expected to be exceeded outside the bubble curtains

As explained above, reasonable and prudent measures are non-discretionary 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/Term and Condition 1

The proposed IHA includes a number of general conditions and specific mitigation measures that are considered part of the proposed action. The final IHA issued under the MMPA may have modified or additional measures that clarify or enhance the measures identified in the proposed IHA. 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 IHA are necessary and appropriate to minimize the extent of take of these species and to ensure that take is documented.

RPM 1/Term and Condition 2 and 3

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. Additionally, this measure requires abbreviated SFV monitoring, using a single hydrophone, during all foundation pile driving where full SFV monitoring is not carried out. This requirement implements one of the recommendations included in BOEM's August 2023 *Recommendations for Offshore Wind*

Project Pile Driving Sound Exposure Modeling and Sound Field Measurement[51]. This measure is necessary and appropriate to monitor take; the exposure estimates and amount and extent of incidental take exempted in this ITS are based on the size of the area that will experience noise above the identified thresholds during pile driving. While the initial, full SFV monitoring, and the associated steps to require any changes to the noise attenuation system, are designed to ensure that pile driving will proceed in a way that is not expected to exceed the modeled distances, there is likely to be variability in pile driving and there may be issues with the sound attenuation systems (e.g., poor bubble curtain performance) that would be undetected without at least minimal SFV monitoring. We expect that the required abbreviated SFV will both allow a continuous check on noise levels and the attenuation system which will allow us to monitor take in a way that supplements detections of sea turtles and whales by the PSOs, but also allow for expeditious detection of any issues with the noise attenuation system or unanticipated variations in noise produced during pile driving so that adjustments can be made and Vineyard Wind can avoid exceeding the amount and extent of take exempted herein. Additionally, we have determined in this Opinion that take of Atlantic sturgeon as a result of exposure to pile driving noise is not expected and no take has been exempted; because PSOs cannot see sturgeon, this abbreviated SFV monitoring will allow for monitoring of noise levels to compare to the modeled distances to the injury and behavioral disturbance thresholds for sturgeon and ensure that these distances are not exceeded.

RPM 2/Term and Conditions 4-6
Incidental take of sea turtles and Atlantic sturgeon is expected to result from capture or entanglement in the post-construction trawl surveys. The measures identified here are designed to minimize the extent of take (i.e., reduce severity of any injury, prevent mortality). Requirements for uniquely marking gear that will be used in the fisheries survey facilitates identification of that gear should it becomes lost or breaks free; this may assist in documenting any take that occurs. Measures identified here also assist in ensuring that incidental take is monitored and that Atlantic sturgeon are identified to DPS. Requiring genetic samples (fin clips) from any Atlantic sturgeon and ensuring 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; as such, there are no additional effects of taking the fin clips.

RPM 3/Term and Conditions 7, 8, and 9
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 7, 8, and 9 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. While we note that it is unexpected, in the event that any interactions with sturgeon or ESA listed

[51] https://www.boem.gov/sites/default/files/documents/renewable-energy/BOEMOffshoreWindPileDrivingSoundModelingGuidance.pdf; last accessed June 10, 2024

fish occur in the fisheries surveys, proper identification and handling 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.

RPM 3/Term and Condition 10

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 Vineyard Wind document any and all observations of dead or injured sea turtles over the course of the project and that they submit a report at the end of year that provides an estimate of the number of vessel strikes of sea turtles. 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 when considering if any observed dead sea turtles may be attributable to project vessels.

RPM 4/Term and Condition 11

A number of plans are proposed for development and submission by Vineyard Wind and/or required for submission by BOEM, BSEE, or NMFS OPR. Term and Condition 11 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. Obtaining NMFS concurrence with these plans prior to implementation of the associated activity is necessary and appropriate to ensure that the activities are carried out in a way that is consistent with the proposed action described herein, including compliance with the avoidance, minimization, or monitoring measures built into the proposed action, or to ensure that the measures outlined in this ITS are implemented as intended. Preparation, review, and concurrence with these plans is necessary because the relevant details were not available at the time this consultation was initiated or completed.

RPM 5/Term and Condition 12-14

RPM 5 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. The action agencies exercising their authorities to assess and ensure compliance with the measures to avoid, minimize, monitor, and report incidental take of ESA listed species, including the measures that were incorporated into the description of the proposed action is an essential component of ensuring that incidental take is minimized and monitored. 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 Vineyard 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 Vineyard Wind must consent to NOAA (or other enforcement related) 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. Term and Condition 14 requires prompt notification of any non-compliance with measures that are designed to avoid, minimize, or monitor effects to ESA listed species; this is necessary not only to monitor incidental take and the implementation of this IT'S but also to ensure that appropriate corrective actions are taken. This will also facilitate identification of any need to reinitiate this consultation.

12.0 CONSERVATION RECOMMENDATIONS

Section 7(a) (1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on ESA-listed species or critical habitat, to help implement recovery plans or develop information (50 C.F.R. §402.02).

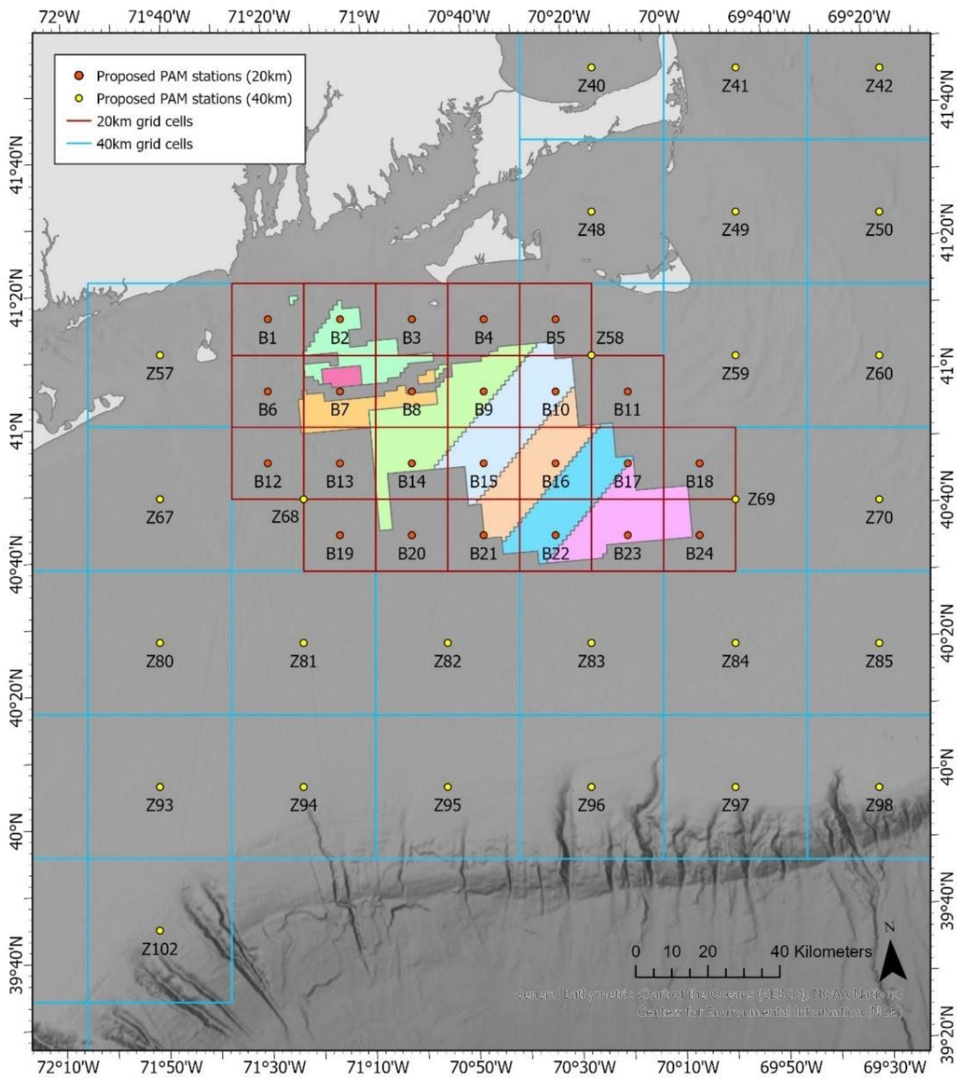
We make the following conservation recommendations, which would provide information for future consultations related to offshore wind that may affect ESA-listed species or would minimize or avoid adverse effects of the proposed action. The relevant action agencies should use their authorities to:

- Support research and development to aid in minimization of risk of vessel strikes on marine mammals and sea turtles.
- Support development of regional monitoring of cumulative impacts of this and future projects through the Regional Wildlife Science Entity (RWSE).
- Work with the NEFSC to support robust monitoring and study design with adequate sample sizes, appropriate spatial and temporal coverage, and proper design allowing the detection of potential impacts of offshore wind projects on a wide range of environmental conditions including protected species distribution, prey distribution, and habitat usage.
- Support research into understanding and modeling effects of offshore wind on regional oceanic and atmospheric conditions and potential impacts on protected species, their habitats, and distribution of zooplankton and other prey.
- Support the continuation of aerial surveys for post-construction monitoring of listed species in the lease area and surrounding waters; contribute all sightings of North Atlantic right whales to the NMFS Sighting Advisory System.
- 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.

- Develop an acoustic telemetry array in the WDA and support research for the tracking of sturgeon and deployment of acoustic tags on sea turtles as well as other acoustically tagged species.
- Conduct research regarding the abundance and distribution of Atlantic sturgeon in the wind lease area and surrounding region in order to understand the distribution and habitat use and aid in density modeling efforts, including the use of acoustic telemetry networks to monitor for tagged fish.
- Submit all acoustic telemetry data to the Mid-Atlantic Acoustic Telemetry Observation System (MATOS) database for coordinated tracking of marine species over broader spatial scales in US Animal Tracking Network and Ocean Tracking Network.
- Conduct long-term ecological monitoring to document the changes to the ecological communities on, around, and between wind turbine generator foundations and other benthic areas disturbed by the proposed Project.
- Conduct research to monitor noise levels during construction and operation. Record ambient noise in the WDA for three years prior to construction and three years post-construction to understand how wind turbine generators, including sound sources associated with turbine maintenance (e.g., service vessels) and turbine operations, may influence the acoustic soundscape. See NOAA/BOEM PAM Recommendations for specific details. Resulting data products should be provided according to the NOAA/BOEM PAM recommendations.
- Develop a PAM array in the WDA to monitor use of the area by baleen whales during the life of the Project, including construction, and to detect small scale changes at the scale of the WDA. Bottom mounted recorders should be deployed at a maximum of 20 km distance from each other throughout the given study area in order to ensure near to complete coverage of the area over which North Atlantic right whales and other baleen whales can be heard (see Figure 12.1 for example of deployment locations). See NOAA/BOEM PAM Recommendations for specific details. Resulting data products should be provided according to the NOAA/BOEM PAM recommendations.
- 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.
- 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.
- Support investigations into the feasibility of carrying out fish pot and lobster trap surveys associated with wind farm development with ropeless technology.

Figure 12.1. Example of 20 km and 40km array of bottom mounted recorders in the RI/MA and MA WEAs



13.0 REINITIATION NOTICE

This concludes formal consultation for the proposed authorizations associated listed herein for the Vineyard Wind 1 offshore energy project. As 50 C.F.R. §402.16 states, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if:

(1) The amount or extent of taking specified in the ITS is exceeded.
(2) New information reveals effects of the agency action that may affect ESA-listed species or critical habitat in a manner or to an extent not previously considered.
(3) The identified action is subsequently modified in a manner that causes an effect to ESA- listed species or designated critical habitat that was not considered in this opinion.
(4) A new species is listed or critical habitat designated under the ESA that may be affected by the action.

14.0 LITERATURE CITED

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88 FR 81351. November 22, 2023. Endangered and Threatened Wildlife and Plants; Technical Correction for the Giant Manta Ray

88 FR 46572. July 19, 2023. Endangered and Threatened Wildlife and Plants: Proposed Rule To Designate Marine Critical Habitat for Six Distinct Population Segments of Green Sea Turtles

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APPENDIXCES

Appendix A – NMFS 2021 Programmatic Informal Consultation
Appendix B – 2024 draft IHA
Appendix C – Conditions of COP Approval and USACE permit conditions

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

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[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	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

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 $\mu Pa^2 \cdot s$ SEL_{cum}	189 dB re: 1 $\mu Pa^2 \cdot s$ 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
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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Appendix A – Tables and Figures

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Figure 1. Action Area for this programmatic consultation.

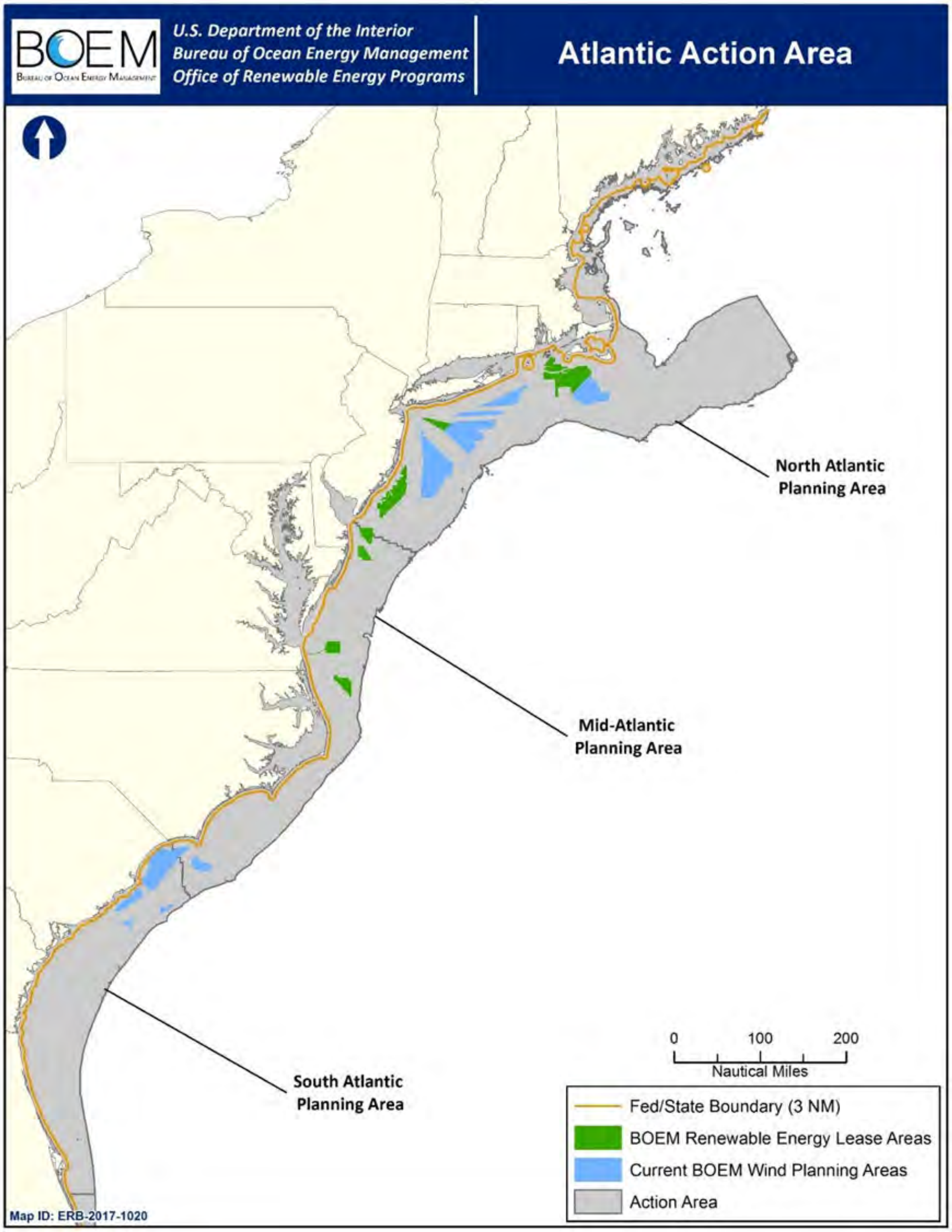

Table A.1 Description of Representative HRG Survey Equipment and Methods

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	≥200 kHz	0.2000 pps (unknown)
Echotrac CV100 Single-Beam Echosounder	Power 12, 80 cycles, 200 kHz	196	193	159	0.00036	≥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*

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
1315 East-West Highway
Silver Spring, Maryland 20910

INCIDENTAL HARASSMENT AUTHORIZATION

The Vineyard Wind, LLC (Vineyard Wind) is hereby authorized under section 101(a)(5)(D) of the Marine Mammal Protection Act (MMPA; 16 U.S.C. 1371(a)(5)(D)) to incidentally harass marine mammals, under the following conditions:

1. This incidental harassment authorization (IHA) is valid for one year from the date of issuance.

2. This IHA authorizes take incidental to pile driving associated with the construction of the Vineyard Wind Project in the Atlantic Ocean offshore of Massachusetts, as specified in the Vineyard Wind's IHA application, in the Bureau of Ocean Energy Management (BOEM) Lease Area OCS-A 0501.

3. General Conditions

   (a) A copy of this IHA must be in the possession of Vineyard 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 IHA.

   (b) The species and/or stocks authorized for taking are listed in Table 1. Taking is authorized for Level B harassment only and is limited to the species and/or stocks and numbers listed in Table 1.

   (c) The taking, by injury, serious injury, or death of any of the species listed in Table 1 or any taking of any other species of marine mammal is prohibited and may result in the modification, suspension, or revocation of this IHA. Any taking exceeding the authorized amounts listed in Table 1 is prohibited and may result in the modification, suspension, or revocation of this IHA.

   (d) Vineyard Wind must ensure that construction supervisors and crews, the monitoring team, and relevant Vineyard Wind staff are trained prior to the start of activities subject to this IHA, so that responsibilities, communication procedures, monitoring protocols, and operational procedures are clearly understood. New personnel joining during the project construction must be trained prior to commencing work. A description of the training program must be provided to NMFS at least 60 days prior to the initial training before in-water activities begin. Confirmation of all required training must be documented on a training course log sheet and reported to NMFS Office of Protected Resources prior to initiating project activities;

(e) PSOs and PAM operators have the authority to call for a delay or shutdown to an activity and Vineyard Wind must instruct all personnel regarding the authority of the PSOs and PAM operators. If a delay to commencing an activity is called for, Vineyard Wind must take the required mitigative action. If a shutdown of an activity is called for by a PSO or PAM operator, Vineyard Wind must take the required mitigative action unless shutdown would result in imminent risk of injury or loss of life to an individual, pile refusal, or pile instability. Any disagreements between the PSO, PAM operator, and the activity operator regarding delays or shutdowns must only be discussed after the mitigative action has occurred;

(f) Vineyard Wind and PSOs are required to use available sources of information on North Atlantic right whale presence to aid in monitoring efforts. These include daily monitoring of the Right Whale Sighting Advisory System, consulting of the WhaleAlert app, and monitoring of the Coast Guard's VHF Channel 16 to receive notifications of marine mammal sightings and information associated with any Dynamic Management Areas and Slow Zones;

(g) Any marine mammal observed by project personnel must be immediately communicated to any on-duty PSOs, PAM operator(s), and all vessel captains. Any large whale observation or acoustic detection by PSOs or PAM operators must be conveyed to all vessel captains;

(h) Marine mammals observed within a clearance or shutdown zone must be allowed to remain in the zone (i.e., must leave of their own volition), and their behavior must be monitored and documented;

(i) 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 clearance zone, pile driving activities must be delayed. If pile driving activities are ongoing and 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 shutdown zone, the activity must be shut down (i.e., cease) immediately unless a shutdown would result in imminent risk of injury or loss of life to an individual, pile refusal, or pile instability. Activities must not commence or resume until the animal(s) has been confirmed to have left the clearance or shutdown zones and is on a path away from the applicable zone or after 30 minutes for all baleen whale species and sperm whales, and 15 minutes for all other species;

(j) In the event that a large whale is sighted or acoustically detected that cannot be confirmed as a non-North Atlantic right whale, it must be treated as if it were a North Atlantic right whale for purposes of mitigation;

(k) For in-water construction, heavy machinery activities other than pile driving, if a marine mammal is detected within, or about to enter, 10 meters (m; 32.8 feet (ft)) of equipment, Vineyard 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;

(l) All vessels must be equipped with a properly installed, operation Automatic Identification System (AIS) device and Vineyard Wind must report all Maritime Mobile Service Identity (MMSI) numbers to the NMFS Office of Protected Resources;

(m) By accepting the IHA, Vineyard Wind consents to on-site observation and inspections by Federal agency personnel (including NOAA personnel) during pile driving activities, for the purposes of evaluating the implementation and effectiveness of measures contained within the IHA; and

(n) It is prohibited to assault, harm, harass (including sexually harass), oppose, impede, intimidate, impair, or in any way influence or interfere with a PSO, PAM operator, or vessel crew member acting as an observer, or attempt the same. This prohibition includes, but is not limited to, any action that interferes with an observer's' responsibilities, or that creates an intimidating, hostile, or offensive environment. Personnel may report any violations to the NMFS Office of Law Enforcement.

4. <u>Mitigation Requirements</u>

a) Monopile Installation. The following requirements apply to impact pile driving activities of monopiles:

(i) Foundation impact pile driving must not occur from January 1 through May 31. Foundation impact pile driving must not be planned in December; however, it may only occur if necessary to complete the Project with prior approval by NMFS and if Vineyard Wind implements a NMFS-approved Enhanced Monitoring Plan. Vineyard Wind must notify NMFS in writing by September 1 of that year that pile driving can not be avoided and circumstances are expected to necessitate pile driving in December

(ii) No more than one monopile may be installed per day;

(iii) Monopiles must be no larger than a 9.6-m diameter. The minimum amount of hammer energy necessary to effectively and safely install and maintain the integrity of the piles must be used. Hammer energies must not exceed 4,000 kilojoules (kJ);

(iv) Vineyard Wind must not initiate pile driving earlier than 1 hour after civil sunrise or later than 1.5 hours prior to civil sunset;

(v) Vineyard Wind must utilize a soft-start protocol at the beginning of foundation installation for each impact pile driving event and at any time following a cessation of impact pile driving of 30 minutes or longer. The soft start process must include an initial set of four to six single hammer strikes at less than 40 percent of the maximum hammer energy from the impact hammer followed by at least a one-minute delay before the subsequent hammer strikes. This process (e.g., 4-6 single strikes, delay) must be repeated at least three times prior to initiation of pile driving for a minimum of 20 minutes.;

(vi) Vineyard Wind must deploy, at minimum, a functionally optimized double bubble curtain (DBBC) and hydro-sound damper (HSD) during all foundation impact pile driving that are capable of reducing distances to harassment thresholds to those modeled (assuming 6 dB-attenuation for Level A harassment) and measured (Level B harassment);

a) The double bubble curtain(s) must distribute air bubbles using an air flow rate of at least 0.5 m^3 /(minute*m). The double bubble curtain 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 double bubble curtain 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;

b) 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;

c) No parts of the ring or other objects may prevent full seafloor contact with a bubble curtain ring;

d) Construction contractors must train personnel in the proper balancing of airflow to the ring. Vineyard Wind must provide NMFS Office of Protected Resources with a bubble curtain performance test and maintenance report to review within 72 hours after each pile using a bubble curtain is installed. Additionally, a full maintenance check (e.g., manually clearing holes) must occur prior to each pile being installed. Vineyard Wind must follow the Vineyard Wind enhanced bubble curtain maintenance procedures for bubble curtain maintenance;

e) Corrections to the bubble ring(s) to meet these performance standards must occur prior to foundation pile driving of foundation piles. Vineyard Wind must also inspect and carry out appropriate maintenance on the HSD system and ensure the system is functioning properly prior to every pile driving event. A DBBC inspection report must be submitted to NMFS;

f) Vineyard Wind must inspect and carry out maintenance on the noise attenuation system prior to every pile driving event and prepare and submit a Noise Attenuation System (NAS) inspection/performance report. For piles for which full SFV is carried out, 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. Vineyard Wind must submit performance reports for all subsequent piles with the weekly abbreviated SFV pile driving reports. All reports must be submitted by email to *PR.ITP.MonitoringReports@noaa.gov*.

(vii) At least three active on-duty PSOs must be on the pile driving platform visually monitoring for marine mammals at least 60 minutes prior to, during, and 30 minutes after pile driving;

(viii) Vineyard Wind must deploy a minimum of two PSO support vessels, each utilizing three active on-duty PSOs. The three active on-duty PSOs must visually monitor for marine mammals at least 60 minutes prior to, during, and 30 minutes after pile driving;

(ix) Concurrent with visual monitoring, PAM operator(s) must be on-duty and actively monitoring for marine mammals 60 minutes before, during, and 30 minutes after pile driving;

(x) Vineyard Wind must utilize NMFS-approved PAM systems. The PAM system components (i.e., acoustic buoys) must not be placed closer than 1 km (0.6 mi) to the pile being driven. The PAM system must be able to detect a vocalization of North Atlantic right whales up to 10 km (6.2 mi);

(xi) Vineyard Wind must obtain NMFS Office of Protected Resources approval on an updated Passive Acoustic Monitoring Plan (PAM Plan) prior to any foundation installation activities, and abide by the Plan.

(xii) Vineyard Wind must establish clearance and shutdown zones, which must be measured using the radial distance around the pile being driven. PSOs must visually monitor clearance zones for marine mammals for a minimum of 60 minutes prior to commencing pile driving. All clearance zones must be confirmed to be free of marine mammals for 30 minutes immediately prior to the beginning of soft-start procedures. If a marine mammal is detected within or about to enter the applicable clearance zones, during this 30 minute time period, impact pile driving, including soft-start, 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 30 minutes for all baleen whale species, sperm whales, and Risso's dolphins, and 15 minutes for all other species;

(xiii) For North Atlantic right whales, any visual observation by a protected species observer at any distance or acoustic detection within the 10 km PAM Monitoring Zone must trigger a delay to the commencement of pile driving;

(xiv) PSOs must be able to visually clear (*i.e.*, confirm no marine mammals are present), at minimum, the minimum visibility zone. The entire minimum visibility zone must be visible (*i.e.*, not obscured by dark, rain, fog, *etc*.) for a full 60 minutes immediately prior to commencing impact pile driving. Pile driving may only commence once all clearance zones have been determined to be clear of marine mammals for 30 minutes immediately prior to pile driving;

(xv) If a marine mammal is detected (visually or acoustically) entering or within the respective shutdown after pile driving has begun, the PSO or PAM operator must call for a shutdown of pile driving and Vineyard Wind must stop pile driving immediately, unless shutdown is not practicable due to imminent risk of injury or loss of life to an individual or risk of damage to a vessel that creates risk of injury or loss of life for individuals, or the lead engineer determines there is risk of pile refusal or pile instability. If pile driving is not shut down due to one of these situations, Vineyard Wind must reduce hammer energy to the lowest level practicable;

(xvi) If pile driving has been shut down due to the presence of a marine mammal other than a North Atlantic right whale, 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 30 minutes for all baleen whale species, sperm whales, and Risso's dolphins, and 15 minutes for all other species. In cases where these criteria are not met, pile driving may restart only if necessary to maintain pile stability at which time Vineyard Wind must use the lowest hammer energy practicable to maintain stability;

(xvii) From November 1 through December 31, if a North Atlantic right whale is detected either via real-time PAM or vessel-based surveys at any distance from the pile driving location, pile driving must be delayed and must not commence until the following day, unless a follow up vessel-based survey confirms the clearance zone is clear of North Atlantic right whales upon completion of the survey, as determined by the lead PSO. In November and December, if 3 or more North Atlantic right whales are observed at any distance, pile driving must be delayed until the following day;

(xviii) Vineyard Wind must submit an updated Foundation Installation Pile Driving Marine Mammal Monitoring Plan prior to the start of foundation pile driving. Vineyard Wind must obtain NMFS Office of Protected

Resources approval for this Plan prior to the start of any pile driving, and abide by this Plan;

(xix) Vineyard Wind must perform thorough sound field verification (SFV) measurements during installation of, at minimum, the first monopile foundation, and abbreviated SFV on all remaining foundations. If foundation installation occurs in December, thorough SFV measurements must be conducted on, at minimum, the first monopile installed in December;

(xx) If any of the SFV measurements from any pile indicate that the distance to any isopleth of concern is greater than those modeled or expected before the next pile is installed Vineyard Wind must implement the following measures as applicable: Identify and propose for review and concurrence: additional, modified, and/or alternative noise attenuation measures or operational changes that present a reasonable likelihood of reducing sound levels to the modeled distances (e.g., if the pile was installed with a single bubble curtain and a near field sound attenuation device, add a second bubble curtain or if the pile was installed with a double bubble curtain without a near field sound attenuation device, add a nearfield noise attenuation device; adjust hammer operations; adjust noise attenuation system to improve performance); provide a written explanation to NMFS OPR supporting that determination and requesting concurrence to proceed; and, following NMFS OPR's concurrence, 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);

(xxi) Vineyard Wind must conduct SFV measurements during turbine operations to estimate turbine operational source levels and transmission loss rates, in accordance with a NMFS-approved Foundation Installation Pile Driving SFV Plan;

(xxii) Vineyard Wind must obtain NMFS Office of Protected Resources approval on an updated Foundation Installation Pile Driving SFV Plan prior to any foundation installation activities and abide by the Plan. At minimum, the SFV Plan must include methodology for collecting, analyzing, and preparing SFV measurement data for submission to NMFS Office of Protected Resources and describe how the effectiveness of the sound attenuation methodology would be evaluated based on the results. SFV for pile driving may not occur until NMFS approves the SFV Plan for this activity;

(xxiii) Vineyard Wind must submit thorough SFV interim reports within 48 hours after each foundation is measured and before an additional foundation is installed. If any of the interim SFV reports submitted indicate that distances to the Level A harassment and Level B harassment thresholds exceed those modeled or previously measured in 2023, then Vineyard Wind implement additional measures on all subsequent foundations to ensure the measured Level A and Level B harassment isopleths do not exceed those modeled or expected for foundation installation. Vineyard Wind must also increase clearance and shutdown zone sizes to those identified by NMFS until SFV measurements on at least three additional foundations demonstrate acoustic distances to harassment thresholds meet or are less than those modeled or expected. For every 1,500 m that a marine mammal clearance or shutdown zone is expanded, additional PSOs must be deployed from additional platforms/vessels to ensure adequate and complete monitoring of the expanded shutdown and/or clearance zone with each observer responsible for maintaining watch in no more than 120° and of an area with a radius no greater than 1,500 m. Vineyard Wind must optimize the sound attenuation systems (e.g., ensure hose maintenance, pressure testing, etc.) to, at least, meet noise levels modeled or expected, within three piles or else foundation installation activities must cease until NMFS and Vineyard Wind can evaluate the situation and ensure future piles will not exceed noise levels modeled or expected;

(xxiv) Vineyard Wind must also conduct abbreviated SFV, using at least one acoustic recorder (consisting of a bottom and mid-water column hydrophone) for every foundation for which thorough SFV monitoring is not conducted. Vineyard Wind must review abbreviated SFV results for each pile within 24 hours of completion of the foundation installation (including of pile driving and any drilling), and, assuming measured levels at 750 m did not indicate noise levels are higher than expected , does not need to take any additional action. Abbreviated SFV results must be included in weekly reports. Any indications that distances to the identified Level A harassment and Level B harassment thresholds for marine mammals may be exceeded based on this abbreviated monitoring must be addressed by Vineyard Wind in the weekly report, including an explanation of factors that contributed to the exceedance and corrective actions that were taken to avoid exceedance on subsequent piles. Vineyard Wind must meet with NMFS within two business days of Vineyard Wind’s submission of a report that includes an exceedance to discuss if any additional action is necessary;

(xxv) The SFV plan must also include how operational noise would be monitored. Vineyard 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;

(xxvi) The PAM Plan must include a description of all proposed PAM equipment, the calibration data, bandwidth capability and sensitivity of hydrophones, address how the proposed passive acoustic monitoring must follow standardized measurement, processing methods, reporting metrics, and metadata standards for offshore wind. The Plan must describe all proposed PAM equipment, procedures, and protocols including proof that vocalizing North Atlantic right whales will be detected 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 include a description of Vineyard Wind's evaluation of the planned acoustic detection software using the PAM Atlantic baleen whale annotated data set available at National Centers for Environmental Information (NCEI) and provide evaluation/performance metrics (e.g., false negatives/positives); and

(xxvii) The Foundation Installation Pile Driving Marine Mammal Monitoring 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 include a description of all monitoring equipment and PAM operator and PSO protocols (including number and location of PSOs and PAM operators) for all foundation pile driving and an informal guide to aid personnel in identifying species if they are observed in the vicinity of the project area.

b) Marine Mammal Vessel Strike Avoidance – Vineyard Wind must comply with the following vessel strike avoidance measures while in the specific geographic region, unless a deviation is necessary to maintain safe maneuvering speed and justified because the vessel is in an area where oceanographic, hydrographic, and/or meteorological conditions severely restrict the maneuverability of the vessel; an emergency situation presents a threat to the health, safety, life of a person; or when a vessel is actively engaged in emergency rescue or response duties, including vessel-in distress or environmental crisis response. An emergency is defined as a serious event that occurs without warning and requires immediate action to avert, control, or remedy harm.

(i) Prior to the start of the Project's activities involving vessels, all vessel personnel must receive a protected species training that covers at minimum:

a) Identification of marine mammals that have the potential to occur where vessels would be operating;

b) Detection and observation methods in both good weather conditions (i.e., clear visibility, low winds, low sea states) and poor weather conditions (i.e., fog, high winds, high sea states, with glare);

c) Sighting communication protocols;

d) All vessel speed and approach limit mitigation requirements (e.g., vessel strike avoidance measures); and

e) Information on resources available to the project personnel regarding the applicability of Federal laws and regulations for protected species.

f) This training must be repeated for any new vessel personnel who join the Project.

g) Confirmation of the vessel personnel's training and understanding of the IHA requirements must be documented on a training course log sheet and reported to NMFS within 30 days of completion of training.

(ii) All vessel operators must maintain a vigilant watch for all marine mammals and slow down, stop their vessel, or alter course, to avoid striking any marine mammal.

(iii) All transiting vessels, operating at any speed, must have a dedicated visual observer on duty at all times to monitor for marine mammals with a 180° direction of the forward path of the vessels (90 °port to 90° starboard) located at an appropriate vantage point for ensuring vessels are maintaining appropriate separation distances. Visual observers may be PSOs or crew members, but crew members responsible for these duties must be provided sufficient training by Vineyard 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.

a) Dedicated visual observers must be equipped with alternative monitoring technology (e.g., night vision devices, infrared cameras) for periods of low visibility (e.g., darkness, rain, fog, etc.);

b) The dedicated visual observer must not have any other duties while observing and 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 measure; and

c) Dedicated visual observers may be third-party observers (*i.e.*, NMFS-approved PSOs (see condition 5(a,b)) or trained crew members.

(iv) All vessel operators and/or dedicated visual observers must continuously monitor US Coast Guard VHF Channel 16 at the onset of transiting through the duration of transition over which North Atlantic right whale sightings are broadcasted. At the onset of transiting and at least once every 4 hours, vessel operators and/or trained crew member(s) must monitor the project's Situational Awareness System (if applicable), WhaleAlert, and relevant NOAA information systems such as the Right Whale Sighting Advisory System (RWSAS) for the presence of North Atlantic right whales;

(v) All vessel operators must abide by vessel speed regulations in 50 CFR 224.105. Nothing in this measure exempts vessels from any other applicable marine mammal speed or approach requirements;

(vi) In the event that any DMA or Slow Zone is established that overlaps with an area where a project-associated vessel would operate, that vessel, regardless of size, must transit that area at 10 kn or less;

(vii) Between November 1st and April 30th, all vessels, regardless of size, must operate port to port (specifically from ports in New Jersey, New York, Maryland, Delaware, and Virginia) at 10 kn or less, except for vessels while transiting in Narragansett Bay or Long Island Sound;

(viii) All vessel operators must immediately reduce speed to 10 kn (11.5 mph) or less for at least 24 hours when a North Atlantic right whale is sighted, at any distance, by any project-related personnel or acoustically detected by any project-related PAM system. Each subsequent observation or acoustic detection in the Project area shall trigger an additional 24-hour period. If a vessel is traveling at speed greater than 10 kn (11.5 mph) (*i.e.* no speed restrictions are enacted) in the transit corridor (defined as from a port to the Lease Area or return), in addition to the required dedicated visual observer, Vineyard 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 vessels in the transit corridor must travel at 10 kn (11.5 mph) or less for 24 hours following the detection. Each subsequent detection shall trigger a 24-hour reset. A slowdown in the transit corridor expires when there has been no further North Atlantic right whale visual or acoustic detection in the transit corridor in the past 24 hours. 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 kn (11.5 mph) 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 turn away from the whale(s), 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;

(ix) All vessels, regardless of size, must immediately reduce speed to 10 kn (11.5 mph) or less when any large whale, (other than a North Atlantic right whale), mother/calf pairs, or large assemblages of cetaceans are sighted within 500 m (0.31 mi) of a transiting vessel;

(x) All vessels must maintain a minimum separation distance of 100-m (328 ft) sperm whales and non-North Atlantic right whale baleen whales. If one of these species is sighted within 100 m of an underway vessel, the vessel must turn away from the whale(s), reduce speed, and shift the engine(s) to neutral. Engines must not be engaged until the whale has moved outside of the vessel's path and beyond 100 m;

(xi) All vessels must maintain a minimum separation distance of 50-m (164 ft) from all delphinid 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 a transiting vessel, that vessel must turn away from the animal(s), reduce speed, and 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;

(xii) All vessels underway must not divert or alter course to approach any marine mammal;

(xiii) Prior to transit, vessel operators must check for information regarding the establishment of Seasonal and Dynamic Management Areas, Slow Zones, and any information regarding North Atlantic right whale sighting locations; and

(xiv) Vineyard Wind must submit an updated Marine Mammal Vessel Strike Avoidance Plan 180 days prior to the planned start of vessel activity that provides details on all relevant mitigation and monitoring measures for marine mammals, vessel speeds and transit protocols from all planned ports, vessel-based observer protocols for transiting vessels, communication and reporting plans, and proposed alternative monitoring equipment in varying weather conditions, darkness, sea states, and in consideration of the use of artificial lighting. If Vineyard Wind plans to implement PAM in any transit corridor to allow vessel transit above 10 kn, the plan must describe how PAM, in combination with visual observations, will be conducted. If an updated plan is not submitted and approved by NMFS prior to vessel operations under this authorization, all project vessels must travel at speeds of 10 kn (11.5 mph) or less. Vineyard Wind must comply with any approved Marine Mammal Vessel Strike Avoidance Plan.

5. Monitoring

(a) Vineyard Wind must use independent, NMFS-approved PSOs and PAM operators, meaning that the PSOs and PAM operators 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 crew with regard to the presence of protected species and mitigation requirements;

(b) All PSOs and PAM operators must have the following qualifications:

(i) All PSOs and PAM operators must have successfully attained a bachelor's degree from an accredited college or university with a major in one of the natural sciences, a minimum of 30 semester hours or equivalent in the biological sciences, and at least one undergraduate course in math or statistics. The educational requirements may be waived if the PSO or PAM operator has acquired the relevant skills through alternate experience. Requests for such a waiver shall be submitted to NMFS and must include written justification containing alternative experience. Alternate experience that may be considered includes, but is not limited to previous work experience conducting academic, commercial, or government sponsored marine mammal visual and/or acoustic surveys; or previous work experience as a PSO/PAM operator. All PSOs and PAM operators should demonstrate good standing and consistently good performance of all assigned duties;

(ii) PSOs must have visual acuity in both eyes (with correction of vision being permissible) sufficient enough to discern moving targets on the water's surface with the ability to estimate the target size and distance (binocular use is allowable); ability to conduct field observations and collect data according to the assigned protocols; sufficient training, orientation, or experience with the construction operation to provide for personal safety during observations; writing skills sufficient to document observations, and the ability to communicate orally, by radio, or in-person, with project personnel to provide real-time information on marine mammals observed in the area;

(iii) All PSOs must be trained in northwestern Atlantic Ocean marine mammal identification and behaviors and must be able to conduct field observations and collect data according to assigned protocols. Additionally, PSOs must have the ability to work with all required and relevant software and equipment necessary during observations (as described in condition 5(h)(v));

(iv) All PSOs and PAM operators must successfully complete a relevant training course within the last 5 years, including obtaining a certificate of course completion;

(v) PSOs and PAM operators are responsible for obtaining NMFS' approval. NMFS may approve PSOs as conditional or unconditional. A conditionally approved PSO may be one who has completed training in the last 5 years but has not yet attained the requisite field experience. An unconditionally approved PSO is one who has completed training within the last 5 years and attained the necessary experience (i.e., demonstrate experience with monitoring for marine mammals at clearance and shutdown zone sizes similar to those produced during the respective activity). Lead PSO or PAM operators must be unconditionally approved and have a minimum of 90 days in a northwestern Atlantic Ocean offshore environment performing the role (either visual or acoustic), with the conclusion of the most recent relevant experience not more than 18 months previous. At a minimum, at least one PSO located on each observation platform 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;

(vi) PSOs and PAM operators for foundation installation activities must be unconditionally approved;

(vii) To be approved as a PAM operator, the person must meet the following qualifications: The PAM operator must demonstrate that they have prior experience with real-time acoustic detection systems and/or have completed specialized training for operating PAM systems and detecting and identifying Atlantic Ocean marine mammals sounds, in particular: North Atlantic right whale sounds, humpback whale sounds, and how to deconflict them from similar North Atlantic right whale sounds, and other co-occurring species' sounds in the area including sperm whales; must be able to distinguish between whether a marine mammal or other species sound is detected, possibly detected, or not detected, and similar terminology must be used across companies/projects; where localization of sounds or deriving bearings and distance are possible, the PAM operators need to have demonstrated experience in using this technique; PAM operators must be independent observers (i.e., not construction personnel); PAM operators must demonstrate experience with relevant acoustic software and equipment; PAM operators must have the qualifications and relevant experience/training to safely deploy and retrieve equipment and program the software, as necessary; PAM operators must be able to test software and hardware functionality prior to operation; and PAM operators must have evaluated their acoustic detection software using the PAM Atlantic baleen whale annotated data set available at National Centers for Environmental Information (NCEI) and provide evaluation/performance metric;

(viii) PAM operators must be able to review and classify acoustic detections in real-time (prioritizing North Atlantic right whales and noting detection of other cetaceans) during the real-time monitoring periods; and

(c) For prospective PSOs and PAM operators not previously approved, or for PSOs and PAM operators whose approval is not current, Vineyard Wind must submit resumes for approval at least 60 days prior to PSO and PAM operator use. Resumes must include information related to relevant education, experience, and training, including dates, duration, location, and description of prior PSO or PAM operator experience. Resumes must be accompanied by relevant documentation of successful completion of necessary training and include which specific roles and activities the PSOs/PAM operators are being requested for. PAM operator experience must also include the information described in condition 5(b)(vii);

(d) At least one on-duty PSO and PAM operator must be designated as the Lead PSO or PAM operator.

(e) Vineyard Wind must submit NMFS previously approved PSOs and PAM operators to NMFS Office of Protected Resources for review and confirmation of their approval for specific roles at least 30 days prior to commencement of the activities requiring PSOs/PAM operators or 15 days prior to when new PSOs/PAM operators are required after activities have commenced;

(f) PSOs may work as PAM operators and vice versa, pending NMFS-approval; however, they may only perform one role at any time and must not exceed work time restrictions, which must be tallied cumulatively;

(g) Vineyard Wind must implement the following measures during foundation installation:

(i) Monitoring must be done while free from distractions and in a consistent, systematic, and diligent manner. If PSOs cannot visually monitor the minimum visibility zone at all times using the equipment described in 5(g)(vi), foundation pile driving operations must not commence or must shutdown if they are currently active;

(ii) PSOs must visually clear (i.e., confirm no observations of marine mammals) the entire minimum visibility zone for a full 30 minutes immediately prior to commencing activities;

(iii) All PSOs must be located at the best vantage point(s) on any platform, as determined by the Lead PSO, in order to obtain 360-degree visual coverage of the entire clearance and shutdown zones around the activity area, and as much of the Level B harassment zone as possible. These vantage points must maintain a safe work environment. The PAM operator must assist PSOs in ensuring full coverage of the clearance and shutdown zones, and monitor to and past the clearance zone for large whales;

(iv) All on-duty PSOs must remain in real-time contact with the on-duty PAM operator(s), PAM operators must immediately communicate all acoustic detections of marine mammals to PSOs, including any determination regarding species identification, distance, and bearing (where relevant) relative to the pile being driven and the degree of confidence (e.g., possible, probable detection) in the determination. All on-duty PSOs and PAM operator(s) must remain in contact with the on-duty construction personnel responsible for implementing mitigations (e.g., delay to pile driving) to ensure communication on marine mammal observations can easily, quickly, and consistently occur between all on-duty PSOs, PAM operator(s), and on-water Project personnel;

(v) The PAM operator must inform the Lead PSO(s) on duty of animal detections approaching or within applicable ranges of interest to the activity occurring via the data collection software system (i.e., Mysticetus or similar system) who must be responsible for requesting that the designated crewmember implement the necessary mitigation procedures (i.e., delay);

(vi) PSOs must use high magnification (25x) binoculars, standard handheld (7x) binoculars, and the naked eye to search continuously for marine mammals. During foundation installation, at least three PSOs on the pile driving-dedicated PSO vessel must be equipped with functional Big Eye binoculars (e.g., 25 x 150; 2.7 view angle; individual ocular focus; height control). These must be pedestal mounted on the deck at the best vantage point that provides for optimal sea surface observation and PSO safety. PAM operators must have the appropriate equipment (i.e., a computer station equipped with a data collection software system available wherever they are stationed) and use a NMFS-approved PAM system to conduct monitoring;

(vii) During periods of low visibility (i.e., fog, precipitation, darkness, poor weather conditions), PSOs must use alternative monitoring technology (e.g. infrared or thermal cameras) to monitor mitigation zones. PSOs aboard the pile driving vessel must have access to two FLIR cameras with two screens, thermal clip-ons, hand-held night vision devices, and thermal monoculars. PSOs aboard the PSO support vessels must have access to one FLIR camera with a single screen, thermal clip-ons, hand-held night vision devices, and thermal monoculars;

(viii) PSOs and PAM operators must not exceed 4 consecutive watch hours on duty at any time, must have a 2-hour (minimum) break between watches, and must not exceed a combined watch schedule of more than 12 hours in a 24-hour period. If the schedule includes PSOs and PAM operators on-duty for 2-hour shifts, a minimum 1-hour break between watches must be allowed;

(ix) PSOs and PAM operator(s), using a NMFS-approved PAM system, must monitor for marine mammals 60 minutes prior to, during, and 30 minutes following all pile driving activities. If PSOs cannot visually monitor the minimum visibility zone prior to foundation pile driving at all times using the equipment described in condition 5(h)(vi), pile driving operations must not commence or must shutdown if they are currently active;

(x) Vineyard Wind must conduct PAM for at least 24 hours immediately prior to foundation pile driving activities. The PAM operator must review all detections from the previous 24-hour period immediately prior to foundation pile driving activities;

(xi) Thorough SFV measurements must continue until noise levels are at or below those modeled or expected, based upon 2023 SFV measurements. Thorough SFV measurements must be made at a minimum of four distances from the pile(s) being driven, along a single transect, in the direction of lowest transmission loss (*i.e.*, projected lowest transmission loss coefficient), including, but not limited to, 750 m (2,460 ft) and three additional ranges, including, at least, the modeled Level B harassment isopleth. At least one additional measurement at an azimuth 90 degrees from the array at 750 m must be made;

(xii) At each SFV measurement distance, there must be a near bottom and mid-water column hydrophone (measurement system);

(xiii) The SFV measurements systems must have a sensitivity appropriate for the expected sound levels from pile driving received at the nominal ranges throughout the installation of the pile. The frequency range of SFV measurement systems must cover the range of at least 20 hertz (Hz) to 20 kilohertz (kHz). The SFV measurement systems must be designed to have omnidirectional sensitivity so that the broadband received level of all pile driving exceeds the system noise floor by at least 10 dB. The dynamic range of the SFV measurement system must be sufficient such that at each location, and the signals avoid poor signal-to-noise ratios for low amplitude signals and avoid clipping, nonlinearity, and saturation for high amplitude signals;

(xiv) All hydrophones used in SFV measurements systems are required to have undergone a full system, traceable laboratory calibration conforming to International Electrotechnical Commission (IEC) 60565, or an equivalent standard procedure, from a factory or accredited source to ensure the hydrophone receives accurate sound levels, at a date not to exceed 2 years before deployment. Additional in-situ calibration checks using a pistonphone are required to be performed before and after each hydrophone deployment. If the measurement system employs filters via hardware or software (e.g., high-pass, low-pass, etc.), which is not already accounted for by the calibration, the filter performance (i.e., the filter's frequency response) must be known, reported, and the data corrected before analysis; and

(xv) Vineyard Wind must be prepared with additional equipment (hydrophones, recording devices, hydrophone calibrators, cables, batteries, etc.), which exceeds the amount of equipment necessary to perform the measurements, such that technical issues can be mitigated before measurement.

6. <u>Reporting Requirements</u>

(a) Prior to initiation of project activities under this authorization, Vineyard Wind must demonstrate in a report submitted to NMFS Office of Protected Resources (*PR.ITP.MonitoringReports@noaa.gov*) that all required training for Vineyard Wind personnel (including vessel crews, vessel captains, PSOs, and PAM operators has been completed;

(b) Vineyard Wind must use a standardized reporting system during the effective period of the IHA. All data collected *PR.ITP.MonitoringReports@noaa.gov* related to the Project must be recorded using industry-standard software that is installed on field laptops and/or tablets. Unless stated otherwise, all reports must be submitted to NMFS Office of Protected Resources (*PR.ITP.MonitoringReports@noaa.gov*), dates must be in MM/DD/YYYY format, and location information must be provided in Decimal Degrees and with the coordinate system information (e.g., NAD83, WGS84, etc.);

(c) For all visual monitoring efforts and marine mammal sightings, the following information must be collected and reported to NMFS Office of Protected Resources:

(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., Beaufort sea state, tide state, water depth);

(viii) All marine mammal sightings, regardless of distance from the construction activity; species (or lowest possible taxonomic level possible);

(ix) Pace of the animal(s);

(x) Estimated number of animals (minimum/maximum/high/low/best);

(xi) Estimated number of animals by cohort (e.g., adults, yearlings, juveniles, calves, group composition, etc.);

(xii) Description of the animal(s) *(*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);

(xiii) 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;

(xiv) Animals' closest distance and bearing from the pile being driven and estimated time entered or spent within the Level A harassment and/or Level B harassment zone(s);

(xv) Activity at time of sighting (e.g., impact pile driving), use of any noise attenuation device(s), and specific phase of activity (e.g., soft-start for pile driving, active pile driving, etc.);

(xvi) Marine mammal occurrence in Level A harassment or Level B harassment zones;

(xvii) 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;

(xviii) Other human activity in the area and other applicable information.

(d) If a marine mammal is acoustically detected during PAM monitoring, the following information must be recorded and reported to NMFS:

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

(ii) Bottom depth and depth of recording unit (in meters);

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

(iv) Time zone for sound files and recorded date/times in data and metadata (in relation to Universal Coordinated Time (UTC); i.e., Eastern Standard Time (EST) time zone is UTC-5);

(v) Duration of recordings (start/end dates and times; in International Organization for Standardization (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. 1microPascal (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).

(e) 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) Name and version of detection or sound analysis software used, with protocol reference;

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

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

(f) Vineyard Wind must compile and submit weekly reports during foundation installation to NMFS Office of Protected Resources that document the daily start and stop of all pile driving associated with the Project; the start and stop of associated observation periods by PSOs; details on the deployment of PSOs; a record of all detections of marine mammals (acoustic and visual); any mitigation actions (or if mitigation actions could not be taken, provide reasons why); and details on the noise attenuation system(s) used and its performance. Weekly reports are due on Wednesday for the previous week (Sunday to Saturday) and must include the information required under this section. The weekly report must also identify which turbines become operational and when (a map must be provided);

(g) Vineyard Wind must compile and submit monthly reports to NMFS Office of Protected Resources during foundation installation (*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, MMIS number, and route), number of piles installed, all detections of marine mammals, and any mitigative action taken. Monthly reports are due on the 15th of the month for the previous month. The monthly report must also identify which turbines become operational and when (a map must be provided). Full PAM detection data and metadata must also 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 at *https://www.fisheries.noaa.gov/resource/document/passive-acoustic-reporting-system-templates;*

(h) Vineyard Wind must submit a draft final report to NMFS Office of Protected Resources (*PR.ITP.monitoringreports@noaa.gov)* no later than 90 days following the end of the effective date of the IHA. Vineyard Wind must provide a final report within 30 days following resolution of NMFS' comments on the draft report. If no comments are received from NMFS Office of Protected Resources within 60 calendar days of NMFS Office of Protected Resources receipt of the draft report, the report must be considered final. The draft and final reports must detail the following:

  (i) Total number of marine mammals of each species/stock detected and how many were within the designated Level A harassment and Level B harassment zone(s) with comparison to authorized take of marine mammals;

  (ii) Marine mammal detections and behavioral observations before, during, and after foundation installation activity;

  (iii) Mitigation measures that were implemented (i.e., number of shutdowns or clearance zone delays, etc.) or, if no mitigative actions was taken, why not;

(iv) Operational details (i.e., days and duration of foundation pile driving);

(v) Any PAM systems used;

(vi) Results, effectiveness, and which noise attenuation systems were used;

(vii) Summarized information related to situational reporting; and

(viii) Any other important information relevant to the Project.

(i) Vineyard Wind must also submit GIS shapefile(s) of the final location of all piles, including an indication of what year installed and began operating; GIS shapefile of all North Atlantic right whale sightings, including dates and group sizes; a summary and evaluation of all SFV data collected; a summary and evaluation of all PAM data collected; a summary and evaluation of marine mammal behavioral observations; a summary and evaluation of mitigation and monitoring implementation and effectiveness; and a list of recommendations to inform environmental compliance assessments for future offshore wind actions;

(j) For those foundation piles requiring SFV measurements, Vineyard Wind must provide the initial results of the SFV measurements to NMFS Office of Protected Resources in an interim report after each foundation installation event as soon as they are available and prior to a subsequent foundation installation, but no later than 48 hours after each completed foundation installation event. The report must include hammer energies/schedule used during pile driving or UXO/MEC weight (including donor charge weight), the model-estimated acoustic ranges ($R_{95\%}$) to compare with the real-world sound field measurements, estimated source levels at 1 m and/or 10 m, peak sound pressure level (SPL_{pk}) and median, mean, maximum, and minimum root-mean-square sound pressure level that contains 90 percent of the acoustic energy (SPL_{rms}) and sound exposure level (SEL, in single strike for pile driving ($SEL_{s\text{-}s}$) and SELcum) for each hydrophone, including at least the maximum, arithmetic mean, minimum, median (L50) and L5 (95 percent exceedance) statistics for each metric; estimated marine mammal Level A harassment and Level B harassment acoustic isopleths, calculated using the maximum-over-depth L5 (95 percent exceedance level, maximum of both hydrophones) of the associated sound metric; comparison of modeled results assuming 10-dB attenuation against the measured marine mammal Level A harassment and Level B harassment acoustic isopleths; estimated transmission loss coefficients; pile identifier name, location of the pile and each hydrophone array in latitude/longitude; depths of each hydrophone; one-third-octave band single strike SEL spectra; if filtering is applied, full filter characteristics must be reported; and hydrophone specifications including the type, model, and sensitivity. Vineyard Wind must also report any immediate observations which are suspected to have a significant impact on the results including but not limited to: observed noise mitigation system issues, obstructions along the measurement transect, and technical issues with hydrophones or recording devices. If any *in-situ* calibration checks for hydrophones reveal a calibration drift greater than 0.75

dB, pistonphone calibration checks are inconclusive, or calibration checks are otherwise not effectively performed, Vineyard Wind must indicate full details of the calibration procedure, results, and any associated issues in the 48-hour interim reports;

(k) The final results of all SFV measurements from each foundation installation must be submitted as soon as possible, but no later than 90 days following completion of SFV. The final reports must include all details included in the interim report and descriptions of any notable occurrences, explanations for results that were not anticipated, or actions taken during foundation installation. The final report must also include at least the maximum, mean, minimum, median (L50) and L5 (95 percent exceedance) statistics for each metric; the SEL and SPL power spectral density and/or one-third octave band levels (usually calculated as decidecade band levels) at the receiver locations should be reported; range of transmission loss coefficients; the 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); a description of depth and sediment type, as documented in the Construction and Operation Plan (COP), at the recording and foundation installation locations; the extents of the measured Level A harassment and Level B harassment zone(s); hammer energies required for pile installation and the number of strikes per pile; the hydrophone equipment and methods (i.e., recording device, bandwidth/sampling rate; distance from the pile where recordings were made; the depth of recording device(s)); a description of the SFV measurement 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; the spatial configuration of the noise attenuation device(s) relative to the pile; 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. A discussion which includes any observations which are suspected to have a significant impact on the results including but not limited to: observed noise mitigation system issues, obstructions along the measurement transect, and technical issues with hydrophones or recording devices. Vineyard Wind must submit a revised report within 30 days following receipt of NMFS' comments on the draft final report;

(l) If at any time during the project Vineyard Wind becomes aware of any issue or issues which may (to any reasonable subject-matter expert, including the persons performing the measurements and analysis) call into question the validity of any measured Level A harassment or Level B harassment isopleths to a significant degree, which were previously transmitted or communicated to NMFS Office of Protected Resources, Vineyard Wind must inform NMFS Office of Protected Resources within 1 business day of becoming aware of this issue or before the next pile is driven, whichever comes first; and

(m) Performance reports for each bubble curtain deployed must include water depth (m), current speed (m/s) and direction (degrees), wind speed (m/s) and direction (degrees), Beaufort sea state, bubble curtain deployment/retrieval date and time (UTC), bubble curtain hose length (m), bubble curtain radius (distance from pile) (m), diameter of holes and hole spacing (metric units), air supply hose length (m), compressor type (including rated Cubic Feet per Minute (CFM) and model number), number of operational compressors, performance data from each compressor (including Revolutions Per Minute (RPM), pressure, start and stop times [UTC]), free air delivery (m^3/min), total hose air volume (m^3/(min m)), schematic of GPS waypoints during hose laying, maintenance procedures performed and results (pressure tests, inspections, flushing, re-drilling, and any other hose or system maintenance) before and after installation and start and stop times of those tests (UTC), and the length of time the bubble curtain was on the seafloor prior to the associated foundation installation, and confirmation that the bubble curtain was in full contact with the seafloor throughout the use. Additionally, the report must include any important observations regarding performance (before, during, and after pile installation), such as any observed weak areas of low pressure, corrective measures conducted to ensure the system is working sufficiently. The report may also include any relevant video and/or photographs of the bubble curtain(s) operating during all pile driving.

(n) Vineyard Wind must submit situational reports if the following circumstances occur, including all instances wherein an exemption is taken must be reported to NMFS Office of Protected Resources within 24 hours, in specific circumstances, including but not limited to the following:

(i) All sightings of North Atlantic right whales must be reported immediately (no later than 24 hours). If a North Atlantic right whale is sighted with no visible injuries or entanglement at any time by project PSOs or project personnel, Vineyard Wind must immediately report the sighting to NMFS; if immediate reporting is not possible, the report must be submitted as soon as possible but no later than 24 hours after the initial sighting. All North Atlantic right whale acoustic detections within a 24-hour period should be collated into one spreadsheet and reported to NMFS as soon as possible but no later than 24 hours;

(ii) To report sightings and acoustic detections, download and complete the *Real-Time North Atlantic Right Whale Reporting Template* spreadsheet found here: *https://www.fisheries.noaa.gov/resource/document/template-datasheet-real-time-north-atlantic-right-whale-acoustic-and-visual*. Save the spreadsheet as a .csv file and email it to NMFS NEFSC-PSD (*ne.rw.survey@noaa.gov*), NMFS GARFO-PRD (*nmfs.gar.incidental-take@noaa.gov*), and NMFS OPR (*PR.ITP.MonitoringReports@noaa.gov*). If the sighting is in the Southeast (North Carolina through Florida), report via the template and to the Southeast Hotline 877-WHALE-HELP (877-942-5343) with the observation information provided below PAM detections are not reported to the Hotline;

(iii) If unable to report a sighting through the spreadsheet within 24 hours, call the relevant regional hotline (Greater Atlantic Region [Maine through Virginia] Hotline 866-755-6622; Southeast Hotline 877-WHALE-HELP) with the observation information provided below (PAM detections are not reported to the Hotline);

(iv) Observation information: Report the following information: the time (note time format), date (MM/DD/YYYY), location (latitude/longitude in decimal degrees; coordinate system used) of the observation, number of whales, animal description/certainty of observation (follow up with photos/video if taken), reporter's contact information, and lease area number/project name, PSO/personnel name who made the observation, and PSO provider company (if applicable);

(v) If unable to report via the template or the regional hotline, enter the sighting via the WhaleAlert app (*http://www.whalealert.org/*). If this is not possible, report the sighting to the U.S. Coast Guard via channel 16. The report to the Coast Guard must include the same information as would be reported to the Hotline (see above);

(vi) If a North Atlantic right whale is acoustic detected at any time by a project-related PAM system, Vineyard Wind must ensure the detection is reported as soon as possible to NMFS, but no longer than 24 hours after the detection 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;

(vii) North Atlantic 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/*). PAM detections are not reported to WhaleAlert or the U.S. Coast Guard;

(viii) If a non-North Atlantic right whale large whale is observed, report the sighting via WhaleAlert app (*http://www.whalealert.org/*) as soon as possible but within 24 hours;

(ix) Full detection data , metadata, and location of recorders (or GPS tracks, if applicable) from all real-time hydrophones used for monitoring during construction must be submitted within 90 calendar days following completion of activities requiring PAM for mitigation via the International Organization for Standardization (ISO) standard metadata forms available on the NMFS Passive Acoustic Reporting System website *(https://www.fisheries.noaa.gov/resource/document/passive-acoustic-*

reporting-system-templates). Submit the completed data templates to *nmfs.nec.pacmdata@noaa.gov*. The full acoustic recordings from real-time systems must also be sent to the National Centers for Environmental Information (NCEI) for archiving within 90 days following completion of activities requiring PAM for mitigation. Submission details can be found at: *https://www.ncei.noaa.gov/products/passive-acoustic-data*;

(x) When an observation of a marine mammal occurs during vessel transit, the following information must be recorded:

1. Time, date, and location;

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

3. Sea state, water depth, and visibility;

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

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

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

(xi) 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*).

(o) In the event that the personnel involved in the Project discover a stranded, entangled, injured, or dead marine mammal, Vineyard Wind must immediately report the observation to the NMFS Office of Protected Resources (OPR). If in the Greater Atlantic Region (Maine to Virginia) call the NMFS Greater Atlantic Stranding Hotline (866-755-6622); if in the Southeast Region (North Carolina to Florida), call the NMFS Southeast Stranding Hotline (877-942-5343). Separately, Vineyard Wind must report the incident to NMFS Office of Protected Resources (*PR.ITP.MonitoringReports@noaa.gov)*; if in the Greater Atlantic region (Maine to Virginia), to NMFS Greater Atlantic Regional Fisheries Office (GARFO; *nmfs.gar.incidental-take@noaa.gov*, *nmfs.gar.stranding@noaa.gov*); if in the Southeast region (North Carolina to Florida), to NMFS Southeast Regional Office

(SERO; *secmammalreports@noaa.gov*); and to the U.S. Coast Guard, as soon as feasible but within 24-hours. The report (via phone or email) must include:

(i) Contact (name, phone number, etc.);

(ii) Time, date, and location of the first discovery (and updated location information if known and applicable);

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

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

(v) Observed behaviors of the animal(s), if alive:

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

(vii) General circumstances under which the animal was discovered.

(p) In the event of a ship strike of a marine mammal by any vessel associated with the Project, or if project activities cause a non-auditory injury or death of a marine mammal, Vineyard Wind must report the incident to NMFS. If in the Greater Atlantic Region (Maine to Virginia), call the NMFS Greater Atlantic Stranding Hotline (866-755-6622) and if in the Southeast Region (North Carolina to Florida) call the NMFS Southeast Stranding Hotline (877-942-5343). Separately, Vineyard Wind must immediately report the incident to NMFS Office of Protected Resources (*PR.ITP.MonitoringReports@noaa.gov)* and, if in the Greater Atlantic region (Maine to Virginia), NMFS GARFO (*nmfs.gar.incidental-take@noaa.gov*, *nmfs.gar.stranding@noaa.gov*) or, if in the Southeast region (North Carolina to Florida), NMFS SERO (*secmammalreports@noaa.gov*). The report must include the following information:

(i) Time, date, and location (coordinates) of the incident;

(ii) Species identification (if known) or description of the animal(s) involved (i.e., identifiable features including animal color, presence of dorsal fin, body shape and size);

(iii) Vessel strike reporter information (name, affiliation, email for person completing the report);

(iv) Vessel strike witness (if different than reporter) information (name, affiliation, phone number, platform for person witnessing the event);

(v) Vessel name and/or MMSI number;

(vi) Vessel size and motor configuration (inboard, outboard, jet propulsion);

(vii) Vessel's speed leading up to and during the incident;

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

(ix) Part of vessel that struck whale (if known);

(x) Vessel damage notes;

(xi) Status of all sound sources in use;

(xii) If animal was seen before strike event;

(xiii) Behavior of animal before strike event;

(xiv) 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;

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

(xvi) Estimated (or actual, if known) size and length of animal that was struck;

(xvii) Description of the behavior of the marine mammal immediately preceding and following the strike;

(xviii) If available, description of the presence and behavior of any other marine mammals immediately preceding the strike;

(xix) Other animal details if known (e.g., length, sex, age class);

(xx) Behavior or estimated fate of the animal post-strike (e.g., dead, injured but alive, injured and moving, external visible wounds (linear wounds, propeller wounds, non-cutting blunt-force trauma wounds), blood or tissue observed in the water, status unknown, disappeared);

(xxi) To the extent practicable, photographs or video footage of the animal(s); and

(xxii) Any additional notes the witness may have from the interaction. For any numerical values provided (i.e., location, animal length, vessel length etc.), please provide if values are actual or estimated.

(q) Vineyard Wind must immediately cease all on-water activities that have the potential to result in take until the NMFS Office of Protected Resources 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 IHA. NMFS Office of Protected Resources may impose additional measures to minimize the likelihood of further prohibited take and ensure MMPA compliance. Vineyard Wind may not resume their activities until notified by NMFS Office of Protected Resources.

7. This Authorization may be modified, suspended or revoked if the holder fails to abide by the conditions prescribed herein (including, but not limited to, failure to comply with monitoring or reporting requirements), or if NMFS determines: (1) the authorized taking is likely to have or is having more than a negligible impact on the species or stocks of affected marine mammals, or (2) the prescribed measures are likely not or are not effecting the least practicable adverse impact on the affected species or stocks and their habitat.

Kimberly Damon-Randall, Date

Director, Office of Protected Resources,

National Marine Fisheries Service.

Table 1. Authorized incidental take by Level A harassment and Level B harassment

Species	Stock	Level A harassment	Level B harassment
North Atlantic right whale	Western North Atlantic	0	7
Fin whale	Western North Atlantic	1	6
Humpback whale	Gulf of Maine	2	4
Minke whale	Canadian Eastern Coastal	1	28
Sei whale	Nova Scotia	1	2
Sperm whale	North Atlantic	0	2
Atlantic white-sided dolphin	Western North Atlantic	0	32
Bottlenose dolphin	Western North Atlantic Offshore	0	13
Common dolphin	Western North Atlantic	0	462
Long-finned pilot whale	Western North Atlantic	0	13
Risso's dolphin	Western North Atlantic	0	2
Harbor porpoise	Gulf of Maine/Bay of Fundy	3	110
Gray seal	Western North Atlantic	0	241
Harbor seal	Western North Atlantic	1	29

Table 2. Radial distances to Foundation Impact Pile Driving Level A harassment and Level B harassment thresholds and ensonified area for Level B Harassment, assuming 6-dB attenuation (km)[1]

Marine Mammal Hearing Group	Distances to Level A (SEL_{cum}) harassment thresholds (km)[2]	Distance to Level B (SPL_{rms}) harassment threshold (km)[3]	Ensonified area for Level B harassment (km^2)[3]
Low-frequency cetaceans	3.191	5.72	102.7
Mid-frequency cetaceans	0.0043		
High-frequency cetaceans	0.071		
Phocid pinnipeds (underwater)	0.153		

1- These zone sizes may be adjusted based on SFV results with approval by NMFS.
2 - The distances to Level A harassment thresholds reflect modeling.

3 - The distance (and corresponding area) to the Level B harassment threshold reflects the acoustically monitored distance to the maximum range with absorption to the Level B harassment threshold of pile monitored during the 2023 monopile installation.

Table 3. Radial distances (in meters (m)) to minimum visibility for clearance and shutdown zones (m)[1]

Monitoring Zones	North Atlantic right whales [1]	Other Mysticetes/Sperm whales/Pilot whales/Risso's (m) [1]	Other delphinids (m) [1]	Harbor porpoises (m) [1]	Seals (m) [1]
Minimum Visibility Zone [2]	4,000				
Visual Clearance Zone	Any distance	500	160	160	160
PAM Clearance Zone [3]	10,000	500	160	160	160
Visual Shutdown Zone	Any distance	500	160	160	160
PAM Monitoring Zone [3]	10,000	500	160	160	160

1- These zone sizes may be adjusted based on SFV results with approval by NMFS.
2- Minimum visibility zone corresponds to the minimum distance that must be visible prior to initiating pile driving, as determined by the lead PSO. The minimum visibility zone corresponds to the modeled Level A harassment distance for low-frequency cetaceans plus twenty percent and rounded up to the nearest 0.5 km.
3- The PAM system must be able to detect North Atlantic right whales 10 km from the pile being driven. While not required, the PAM system should detect other marine mammals, as practicable (e.g., include a humpback whale detector). Opportunistically, if other marine mammals are acoustically detected within their respective clearance or shutdown zones, mitigative action must be taken.

Table 4. Vessel Separation Zones

Marine Mammal Species	Vessel Separation Zone (m)
North Atlantic right whale	500
Other ESA-listed species and large whales	100
Other marine mammals [1]	50

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

APPENDIX C

Conditions of COP Approval:
https://www.boem.gov/sites/default/files/documents/renewable-energy/state-activities/VW1-COP-Project-Easement-Approval-Letter_0.pdf

USACE Issued Permit:
https://www.nae.usace.army.mil/Portals/74/docs/regulatory/PublicNotices/2022/Permit-NAE-2017-01206.pdf