# CONTENTS

1. **INTRODUCTION** ......................................................................................................................... 1

2. **REGULATORY BACKGROUND AND CONSULTATION HISTORY** ................... 2

   2.1 Action Agencies and Regulatory Authorities ................................................................. 3
       2.1.1 Bureau of Safety and Environmental Enforcement ............................................ 3
       2.1.2 U.S. Army Corps of Engineers ........................................................................... 3
       2.1.3 U.S. Coast Guard ................................................................................................ 4
       2.1.4 Environmental Protection Agency ..................................................................... 4
       2.1.5 National Marine Fisheries Service ..................................................................... 4

3. **DESCRIPTION OF THE PROPOSED ACTION** ............................................................... 6

   3.1 Action Area and Description of Activities Proposed for COP Approval ..................... 6
       3.1.1 Action Area ........................................................................................................ 6
       3.1.2 Description of Activities .................................................................................... 9

   3.2 Description of IPFs ........................................................................................................... 46

   3.3 Proposed Mitigation, Monitoring, and Reporting Measures ............................................. 52

4. **ENVIRONMENTAL BASELINE** .............................................................................................. 75

   4.1 Benthic Habitat ................................................................................................................. 75

   4.2 Pelagic Habitat .................................................................................................................. 77

   4.3 Water Quality .................................................................................................................... 78

   4.4 Underwater Noise ............................................................................................................. 79

   4.5 EMFs .................................................................................................................................. 79

   4.6 Artificial Light .................................................................................................................... 80

   4.7 Vessel Traffic .................................................................................................................... 80

   4.8 Description of Critical Habitat in the Action Area ........................................................... 84
       4.8.1 Critical Habitat for North Atlantic Right Whale .............................................. 84
       4.8.2 Critical Habitat for the Chesapeake Bay DPS of Atlantic Sturgeon ............ 86

   4.9 Description of ESA-listed Species in the Action Area ..................................................... 88
       4.9.1 Species Considered but Discounted from Further Analysis ....................... 89
       4.9.2 Marine Mammals ............................................................................................. 91
       4.9.3 Sea Turtles ........................................................................................................ 98
       4.9.4 Fish ................................................................................................................. 105

   4.10 Climate Change Considerations ..................................................................................... 106

5. **EFFECTS OF THE PROPOSED ACTION** ............................................................................... 108

   5.1 Determination of Effects.................................................................................................... 108

   5.2 Underwater Noise ............................................................................................................ 109

       5.2.1 Impact and Vibratory Pile Driving ...................................................................... 111
# Table of Contents

5.2.2 Geotechnical and Geophysical Surveys ................................................................. 125  
5.2.3 Cable Laying ........................................................................................................ 129  
5.2.4 Dredging ............................................................................................................. 131  
5.2.5 UXO Detonation ................................................................................................... 134  
5.2.6 Summary of Underwater Noise Effects .............................................................. 140  

5.3 Other Noise Impacts .................................................................................................. 141  
5.3.1 Vessels ................................................................................................................ 141  
5.3.2 Helicopters and Drones ....................................................................................... 143  
5.3.3 Wind Turbine Generators ................................................................................... 145  
5.3.4 Summary of Other Noise Effects ....................................................................... 149  

5.4 Effects of Vessel Traffic .......................................................................................... 150  
5.4.1 Risk of Vessel Strike ............................................................................................ 150  
5.4.2 Vessel Discharges ............................................................................................... 155  
5.4.3 Summary of Vessel Traffic Effects .................................................................... 157  

5.5 Habitat Disturbance/Modifications ........................................................................ 158  
5.5.1 Geotechnical and Geophysical Surveys ............................................................... 158  
5.5.2 Fisheries and Habitat Surveys and Monitoring ................................................... 159  
5.5.3 Habitat Conversion and Loss ............................................................................. 164  
5.5.4 Turbidity ............................................................................................................. 173  
5.5.5 Dredging ............................................................................................................. 178  
5.5.6 Trenching ............................................................................................................ 180  
5.5.7 Presence of WTGs on Atmospheric/Oceanographic Conditions ....................... 181  
5.5.8 Physical Presence of WTGs on Listed Species .................................................. 187  
5.5.9 Electromagnetic Fields and Heat from Cables .................................................... 191  
5.5.10 Lighting and Marking of Structures .................................................................. 195  
5.5.11 Offshore Substations ......................................................................................... 196  
5.5.12 Summary of Habitat Disturbance Effects ....................................................... 201  

5.6 Air Emissions .......................................................................................................... 202  
5.6.1 Vessels ................................................................................................................ 203  
5.6.2 WTG Installation Equipment .............................................................................. 204  
5.6.3 Summary of Air Emissions Effects .................................................................... 204  

5.7 Port Modifications .................................................................................................... 204  

5.8 Repair and Maintenance Activities ......................................................................... 204  

5.9 Other Effects ........................................................................................................... 205  
5.9.1 Potential Shifts or Displacement of Ocean Users (vessel traffic, recreational and commercial fishing activity) ............................................................... 205  
5.9.2 Unexpected/Unanticipated Events .................................................................... 206
6. OTHER RELEVANT ACTION ALTERNATIVES .............................................................. 209
7. CUMULATIVE EFFECTS .............................................................................................. 215
8. CONCLUSION .................................................................................................................. 216
  8.1 Marine Mammals ..................................................................................................... 216
  8.2 Sea Turtles .............................................................................................................. 216
  8.3 Fish .......................................................................................................................... 217
  8.4 Climate Change Considerations .............................................................................. 217
9. REFERENCES .................................................................................................................. 221

Appendix A: Mayflower Wind National Pollutant Discharge Elimination System Permit Application
TABLES

Table 3.1-1. Mayflower Wind Project Design Envelope summary .............................................................. 9
Table 3.1-2. Mayflower Wind Project schedule summary ........................................................................ 12
Table 3.1-3. Indicative O&M WTG task and schedule ........................................................................ 13
Table 3.1-4. CWIS parameters ............................................................................................................. 14
Table 3.1-5. OSP O&M schedule .......................................................................................................... 15
Table 3.1-6. Maximum WTG foundation parameters ............................................................................ 16
Table 3.1-7. Maximum OSP foundation parameters ............................................................................. 17
Table 3.1-8 Temporary disturbance, permanent disturbance, and scour parameters for WTG and OSP foundations ............................................................................................................... 25
Table 3.1-9. Interarray cable—estimated seabed disturbance areas ........................................................... 27
Table 3.1-10. Proposed cable/pipeline crossing ................................................................................... 32
Table 3.1-11. Offshore export cables—estimated seabed disturbance areas ............................................. 32
Table 3.1-12. Area of disturbance at HDD exit pits for landfall locations ................................................. 38
Table 3.1-13. Estimated Proposed Action vessel and aircraft use parameters for Mayflower Wind offshore wind farm and export cable construction ........................................................ 42
Table 3.1-14. Estimated Proposed Action vessel and aircraft use parameters for Mayflower Wind offshore wind farm and export cable operation and maintenance ..................................... 43
Table 3.1-15. Mayflower Wind fisheries surveys .................................................................................... 45
Table 3.2-1. IPFs Associated with the Proposed Action mapped to species or critical habitat ............... 47
Table 3.3-1. Mitigation, monitoring, and reporting measures as proposed in the Petition for Incidental Take Regulations for the Construction and Operations of the Mayflower Wind Project submitted to NMFS (see 87 FR 62793; https://media.fisheries.noaa.gov/2022-10/MayflowerWindNewEng_2022ITA_App_OPR1.pdf) and the Mayflower Wind COP ............................................................................................................................... 54
Table 3.3-2. Additional proposed mitigation monitoring, and reporting measures – BOEM proposed .......................................................................................................................... 63
Table 4.7-1. Vessel details in the NSRA study area and vessel tracks that intersect the Project area (January 1 to December 31, 2019) ................................................................................... 83
Table 4.9-1. ESA-listed species in the Action Area ................................................................................... 88
Table 4.9-2. Mean monthly marine mammal density estimates for ESA-listed species within 5 km of the Mayflower Wind Lease Area ........................................................................... 91
Table 4.9-3. Sea turtle density estimates within 10 km of the Mayflower Lease Area .............................. 99
Table 5.2-1. Assumptions used in WTG and OSP foundation installation scenarios for which acoustic and sound exposure modeling was conducted to estimate potential incidental take of marine mammals ...................................................................................................................... 112
Table 5.2-2. Marine mammal acoustic thresholds for impulsive noise sources ........................................ 115
Table 5.2-3. Exposure ranges to injury (Level A SELcum) thresholds for marine mammals during different scenarios of WTG and OSP impact pile driving assuming 10 dB
of noise attenuation .............................................................................................................................................................................. 116

Table 5.2-4. Acoustic ranges (R95%) to the Level B, 160 dB re 1 μPa sound pressure level (SPL_{rms}) threshold from impact pile driving and Level B, 120 dB re 1 μPa SPL_{rms} from vibratory pile driving under Scenarios 1 and 2, assuming 10 dB of noise attenuation .............................................................................................................................................................................. 117

Table 5.2-5. Estimated Level A and Level B exposures from Scenarios 1 and 2 assuming 10 dB of noise attenuation. Level A exposure estimates assume no implementation of monitoring and mitigation measures. Level B exposure modeling take estimates are based on distances to the unweighted 160 dB threshold................................................................. 117

Table 5.2-6. Acoustic metrics and thresholds for sea turtles ....................................................................................................... 121

Table 5.2-7. Exposure ranges to injury (SEL_{cum}) thresholds for sea turtles during different scenarios of impact pile driving assuming 10 dB of noise attenuation ................................................................. 122

Table 5.2-9. Acoustic metrics and thresholds for fish ........................................................................................................ 124

Table 5.2-10. Summary of acoustic radial distances (R_{max} in kilometers) for fish during monopile impact pile installation at the higher impact of two modeled locations for both seasons, with 10 dB noise attenuation from a noise abatement system ................................................................. 124

Table 5.2-11. Summary of Level A (SEL_{cum}) and Level B (SLP_{rms}) horizontal impact distances .............................................................................................................................................................................. 126

Table 5.2-12. Estimated Level B exposures for ESA-listed marine mammals during the 5-year period in mean number of individuals .............................................................................................................. 127

Table 5.2-13. Navy “bins” and corresponding maximum charge weights (equivalent TNT) modeled .............................................................................................................................................................................. 134

Table 5.2-14. Thresholds for Onset Effects for Mitigation Consideration ...................................................................................... 135

Table 5.2-15. Estimated Level A and Level B exposures from potential UXO detonations for construction years 1 and 2 assuming 10 dB of attenuation. ECC=Export Cable Corridor, LA=Lease Area .............................................................................................................. 136

Table 5.2-16. Range to Level A and Level B exposure SEL PTS-onset and SEL TTS-onset thresholds in the ECC and Lease Area for LFC(183 dB re 1 μPa·s) and MFC (Sperm whale)( 185 dB re 1 μPa·s) for five UXO charge sizes assuming 10 dB of noise attenuation, and the maximum area exposed above this threshold ................................................................. 136

Table 5.2-17. Ranges (m) to the onset of mortality, non-auditory lung injury, and gastrointestinal (GI) injury thresholds in the Lease Area and ECCs for five UXO size classes assuming 10 dB of noise attenuation for Baleen and Sperm whales. GI injury combines ECC and Lease Area, Calf/Pup and Adult. Thresholds are based on animal mass and submersion depth. .............................................................................................................................................................................. 137

Table 5.2-18. Effects of detonation pressure exposures ........................................................................................................ 139

Table 5.5-1. Area (acres) of different habitat types in the Project area ...................................................................................... 164

Table 5.5-2. Results from thermal plume modeling conducted for Mayflower Wind HVDC OSP .............................................................................................................................................................................. 198

Table 8.4-1. Summary of Effects of Proposed Action on ESA-Listed Species in the Action Area .............................................................................................................................................................................. 219
FIGURES

Figure 3.1-1. Project area .............................................................................................................................. 8
Figure 3.1-2. Mayflower Wind indicative construction schedule ............................................................... 12
Figure 3.1-3. Approximate location of an HVDC converter OSP ............................................................... 14
Figure 3.1-4. Indicative WTG monopile foundation diagram ................................................................. 18
Figure 3.1-5. Indicative WTG piled jacket foundation diagram ................................................................. 19
Figure 3.1-6. Indicative WTG suction-bucket foundation diagram ............................................................ 20
Figure 3.1-7. Indicative GBS foundation design ........................................................................................ 21
Figure 3.1-8. Indicative interarray cable layout .......................................................................................... 26
Figure 3.1-9. Potential areas for anchoring inside Falmouth export cable corridor ..................................... 30
Figure 3.1-10. Potential areas for anchoring inside Brayton Point export cable corridor ......................... 30
Figure 3.1-11. Potential cable and pipeline crossings ............................................................................... 31
Figure 3.1-12. Falmouth ECC and landfall options ..................................................................................... 35
Figure 3.1-13. Brayton Point ECC and landfall options ............................................................................. 36
Figure 3.1-14. Brayton Point ECC and intermediate landfall options on Aquidneck Island ................... 37
Figure 3.1-15. UXO risk in Lease Area and ECCs ..................................................................................... 40
Figure 3.3-1. Enhanced mitigation area ....................................................................................................... 74
Figure 4.2-1. WTG/OSP positions in the Lease Area relative to MLLW ................................................... 78
Figure 4.7-1. NSRA study area ................................................................................................................ 81
Figure 4.7-2. AIS traffic density in the NRSA study area (January to December 2019) ................................ 83
Figure 4.8-1. North Atlantic right whale critical habitat in the Action Area ............................................. 85
Figure 4.8-2. Critical habitat for Chesapeake Bay DPS of Atlantic sturgeon, specifically the James River, where the Port of Virginia is located ................................................................. 87
Figure 5.5-1. Map of ECCs depicting segments where various seafloor preparation and installation temporary disturbance activities would occur .......................................................... 169
Figure 5.9-1. Alternative D WTG Removal and NARW seasonal density ............................................. 214
1. Introduction


The Proposed Action in this BA entails the construction, operation and maintenance (O&M), and decommissioning of the Mayflower Wind Project in Lease Area OCS-A 0521 (the Project or Proposed Action). Mayflower Wind Energy LLC (hereafter Mayflower Wind) is proposing to construct and operate a commercial-scale offshore wind energy facility within Lease OCS-A 0521 (Lease Area) that would generate approximately 2,400 megawatts (MW) of electricity. The Lease Area encompasses 127,388 acres (51,552 hectares) located in federal waters off the southern coast of Massachusetts, 26 nautical miles ([nm], 48 kilometers [km]) south of Martha’s Vineyard and 20 nm (37 km) south of Nantucket, Massachusetts, in the Massachusetts Wind Energy Area (WEA); it will deliver power via undersea cables to Massachusetts, making landfall at Brayton Point in Somerset, Massachusetts, and Falmouth, Massachusetts, and then be connected to the power grid.

BOEM is the lead federal agency for purposes of Section 7 consultation and coordination under the National Environmental Policy Act (NEPA); the other action agencies include the Bureau of Safety and Environmental Enforcement (BSEE), the U.S. Army Corps of Engineers (USACE), the U.S. Coast Guard (USCG), the U.S. Environmental Protection Agency (USEPA), and the National Marine Fisheries Service (NMFS). Mayflower Wind has submitted the construction and operations plan (COP) for the Mayflower Wind Project to BOEM for review and approval. Consistent with the requirements of 30 Code of Federal Regulations (CFR) 585.620 to 585.638, COP submittal occurs after BOEM grants a lease for the Proposed Action and an applicant completes all studies and surveys defined in their site assessment plan (SAP). BOEM’s renewable energy development process is described in Section 2.

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1 On February 1, 2023, Mayflower Wind Energy LLC changed its name to SouthCoast Wind Energy LLC and changed the project name from the Mayflower Wind Project to the SouthCoast Wind Project. Because the name change occurred after this BA was initially drafted, this document still refers to Mayflower Wind.
2. Regulatory Background and Consultation 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. This section authorized the Secretary of Interior (Secretary) to issue leases, easements, and rights-of-way (ROW) in the Outer Continental Shelf (OCS) for renewable energy development, including wind energy. The Secretary delegated this authority to the former Minerals Management Service, and later to BOEM. Final regulations implementing this authority (30 CFR part 585) were promulgated on April 22, 2009. These regulations prescribe BOEM’s responsibility for determining whether to approve, approve with modifications, or disapprove Mayflower Wind’s COP.

Under BOEM’s renewable energy regulations, the issuance of leases and subsequent approval of wind energy development on the OCS is a phased decision-making process. BOEM’s wind energy program occurs in four distinct phases:

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

2. **Phase 2.** Lease Issuance (complete). The second phase is the issuance of a commercial wind energy lease. The competitive lease process is set forth at 30 CFR 585.210 to 585.225, and the noncompetitive process is set forth at 30 CFR 585.230 to 585.232. A commercial lease gives the lessee the exclusive right to subsequently seek BOEM approval for the development of the leasehold. The lease does not grant the lessee the right to construct any facilities; rather, the lease grants the right to use the leased area to develop its plans, which must be approved by BOEM before the lessee can move on to the next phase of the process (30 CFR 585.600 and 585.601).

3. **Phase 3.** Approval of site assessment plan (SAP) (complete). The third phase of the renewable energy development process is the submission of a SAP, which contains the lessee’s detailed proposal for the construction of a meteorological tower and/or the installation of meteorological buoys on the leasehold (30 CFR 585.605 to 585.618). The lessee’s SAP must be approved by BOEM before it conducts these “site assessment” activities on the leasehold. BOEM may approve, approve with modification, or disapprove a lessee’s SAP (30 CFR 585.613). As a condition of SAP approval, meteorological towers will be required to have visibility sensors to collect data on climatic conditions above and beyond wind speed, direction, and other associated metrics generally collected at meteorological towers. These data will assist BOEM and the U.S. Fish and Wildlife Service (USFWS) with evaluating the impacts of future offshore wind facilities on threatened and endangered birds, migratory birds, and bats.

4. **Phase 4.** Approval of COP. The fourth and final phase of the process is the submission of a COP; a detailed plan for the construction and operation of a wind energy facility on the Lease Area (30 CFR 585.620 to 585.638). BOEM approval of a COP is a precondition to the construction of any wind energy facility on the OCS (30 CFR 585.628). As with a SAP, BOEM may approve, approve with modification, or disapprove a lessee’s COP (30 CFR 585.628).

As noted, phases 1 through 3 have been completed for the Project. On October 19, 2018, BOEM published a Final Sale Notice in the *Federal Register* (FR), which stated a commercial lease sale would be held December 13, 2018, for the WEA offshore Massachusetts. BOEM offered three leases, including OCS-A 0521, which are located within the former Leases OCS-A 0502 and OCS-A 0503 that were unsold during the ATLW-4 sale on January 29, 2015. Mayflower Wind was the winner of Lease OCS-A 0521. On April 1, 2019, BOEM and Mayflower Wind executed the lease agreement for Lease OCS-A 0521. On May 26, 2020, BOEM approved Mayflower Wind’s SAP.
As part of Phase 4, Mayflower Wind has completed site characterization activities and has developed a COP in accordance with BOEM regulations. On February 15, 2021, Mayflower Wind submitted its COP for the construction, operations, and conceptual decommissioning of the Project within the Lease Area. Mayflower Wind submitted updated versions of the COP on August 30, 2021, October 28, 2021, March 17, 2022, and December 22, 2022. On November 1, 2021, BOEM published a Notice of Intent to Prepare an EIS for Mayflower Wind’s Proposed Wind Energy Facility Offshore Massachusetts (86 CFR part 60274). A draft EIS was published on February 17, 2023.

BOEM is consulting on the proposed approval of the COP for the Mayflower Wind offshore wind energy facility and offshore export cables, as well as other permits and approvals from other agencies that are associated with the approval of the COP. This BA considers the potential effects of the Proposed Action on ESA-listed whales, sea turtles, fish, and designated critical habitat in the Action Area. This BA is being submitted concurrently with a request for initiation of ESA Section 7 consultation. The proposed federal actions described in this request for consultation includes: USEPA’s proposal to issue an OCS Air Permit; USEPA’s proposal to issue a National Pollutant Discharge Elimination System (NPDES) permit; USACE’s proposal to issue a permit for in-water work, structures, and fill under Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. part 403) and Section 404 of the Clean Water Act (33 U.S.C. part 1251 et seq.); NMFS’ proposal to issue a Marine Mammal Protection Act (MMPA) Letter of Authorization (LOA); and USCG’s proposal to issue a Private Aid to Navigation (PATON) Authorization.

2.1 Action Agencies and Regulatory Authorities

As noted, BOEM has the authority to issue leases, easements, and ROW on the OCS for renewable energy development and has responsibility for determining whether to approve, approve with modifications, or disapprove Mayflower Wind’s COP. Other action agencies associated with approval of the COP include BSEE (Section 2.1.1), USACE (Section 2.1.2), USCG (Section 2.1.3), USEPA (Section 2.1.4), and NMFS (Section 2.1.5). The action agencies are proposing to issue permits or authorizations for activities related to the Proposed Action.

2.1.1 Bureau of Safety and Environmental Enforcement

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

2.1.2 U.S. Army Corps of Engineers

USACE regulates discharges of dredged or fill material into waters of the United States and structures or work in navigable waters of the United States under Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act of 1899, which would include construction of the offshore wind turbine generators (WTGs), scour protection around the base of the WTGs, offshore substation platforms (OSPs), interarray cables, offshore export cables, dredging, and other activities subject to USACE approval. Mayflower Wind has applied for authorization from USACE to construct up to 147 offshore WTGs, scour protection around the base of the WTGs, up to five OSPs, interarray cables connecting the WTGs to the OSPs, and offshore export cables. The cable routes would originate from the OSPs and make landfall in Falmouth and Somerset, Massachusetts, with an intermediate landfall in Portsmouth, Rhode Island. Mayflower Wind submitted the pre-construction notification/application to USACE on December 2, 2022, and it was deemed complete on February 2, 2023 (USACE file number NAE-2020-00958). BOEM
and BSEE will enforce COP conditions and ESA terms and conditions on the OCS. USACE will enforce ESA terms and conditions landward of the Submerged Lands Act (SLA) boundary.

### 2.1.3 U.S. Coast Guard

The USCG administers the permits for PATONs located on structures positioned in or near navigable waters of the United States. PATONS and federal aids to navigation—including radar transponders, lights, sound signals, buoys, and lighthouses—are located throughout the Project area. It is anticipated that USCG approval of additional PATONs during construction of the WTGs, OSPs, and along the offshore export cable corridor (ECC) may be required. These aids serve as a visual reference to support safe maritime navigation. Mayflower Wind will submit requests for up to 149 PATONs from the USCG, one for each of the WTG or OSP positions, approximately 3 to 6 months prior to offshore construction.

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

### 2.1.4 Environmental Protection Agency

The Outer Continental Shelf (OCS) Air Regulations, found at 40 CFR part 55, establish the applicable air pollution control requirements, including provisions related to permitting, monitoring, reporting, fees, compliance, and enforcement, for facilities subject to Section 328 of the Clean Air Act (42 U.S.C. 7401 et seq.). USEPA issues OCS Air Permits. Emissions from Project activities on the OCS would be permitted as part of an OCS air permit and must demonstrate compliance with National Ambient Air Quality Standards. Mayflower Wind submitted an application to USEPA for the OCS Air Permit on November 23, 2022.

In Massachusetts, USEPA is also responsible for issuing NPDES permits under the Clean Water Act for discharge of water into United States federal waters. Mayflower Wind submitted an application to USEPA for a NPDES permit on October 31, 2022. The NPDES permit application is for discharge from a cooling water intake structure (CWIS) for one high voltage direct current (HVDC) converter station located at an OSP in the Lease Area. Depending on the design selected for the other OSP(s), Mayflower Wind may apply for an additional NPDES permits(s).

### 2.1.5 National Marine Fisheries Service

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. Incidental take is defined under the MMPA (50 CFR 216.3) as, “harass, hunt, capture, collect, or kill, or attempt to harass, hunt, capture, collect, or kill any marine mammal. This includes, without limitation, any of the following: The collection of dead animals, or parts thereof; the restraint or detention of a marine mammal, no matter how temporary; tagging a marine mammal; the negligent or intentional operation of an aircraft or vessel, or the doing of any other negligent or intentional act which results in disturbing or molesting a marine mammal; and feeding or attempting to feed a marine mammal in the wild.”

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

On March 18, 2022, Mayflower Wind submitted a request for a rulemaking and LOA pursuant to Section 101(a)(5) of the MMPA and 50 CFR part 216 subpart I to allow for the incidental harassment of marine mammals resulting from the installation of WTGs and OSPs; potential detonations of unexploded ordnance (UXO); and performance of high-resolution geophysical (HRG) surveys. Mayflower Wind is including activities in the LOA request that could cause acoustic disturbance to marine mammals during construction of the Project pursuant to 50 CFR 216.104. The application was reviewed and considered complete on September 19, 2022. NMFS published a Notice of Receipt in the *Federal Register* on October 17, 2022.
3. **Description of the Proposed Action**

Under the ESA, “action” means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by federal agencies in the United States or upon the high seas (50 CFR 402.02). The Proposed Action addressed in this BA covers the construction, O&M, and decommissioning of the Mayflower Wind Project. The Lease Area (OCS-A 0521) is sited 26 nm (48 km) south of Martha’s Vineyard and 20 nm (37 kilometers) south of Nantucket, Massachusetts, in the Massachusetts WEA. The Proposed Action would consist of up to 149 structure positions to be occupied by up to 147 WTGs and up to 5 OSPs connected by interarray cables within the Lease Area, and two offshore ECCs with landfalls at Falmouth and Brayton Point, Massachusetts, and an intermediate landfall on Aquidneck Island, Rhode Island, along the corridor to Brayton Point. The 149 positions will conform to a spacing of a 1.0 nm x 1.0 nm (1.9 km x 1.9 km) grid layout with an east-west and north-south orientation across the entire WEA.

Before a lessee may build an offshore wind energy facility on their commercial wind lease, they must submit a COP for review and approval by BOEM (see 30 CFR 585.620 to 585.638). Pursuant to 30 CFR 585.626, the COP must include a description of all planned facilities, including onshore and support facilities, as well as anticipated easement needs for the Proposed Action. It must also describe all activities related to Proposed Action construction, commercial operations, maintenance, decommissioning, and site clearance procedures. There are benefits to allowing lessees to describe a reasonable range of designs in a COP, because of the complexity, the unpredictability of the environment in which it will be constructed, and the rapid pace of technological development within the industry. In the renewable energy industry, a permit application or plan that describes a reasonable range of designs is referred to as a Project Design Envelope (PDE) approach.

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

Mayflower Wind has elected to use a PDE approach for describing the Proposed Action consistent with BOEM policy. Therefore, this BA and associated outcomes of the ESA consultation will cover the menu of potential alternatives that may be authorized by BOEM in the record of decision (ROD) and approval of the COP. For the purpose of describing the action that is the subject of this ESA consultation, BOEM assumes that Mayflower Wind may select the design alternative resulting in the greatest potential impact on the environment. Construction, O&M, and decommissioning activities are described in Section 3.1.2, Description of Activities. The impact-producing factors (IPFs) associated with these activities are described in Section 3.2, Description of IPFs, and mitigation measures included in the Proposed Action are described in Section 3.3, Proposed Mitigation, Monitoring, and Reporting Measures.

3.1 **Action Area and Description of Activities Proposed for COP Approval**

3.1.1 **Action Area**

The Action Area is defined 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) and also includes all consequences to listed species or critical habitat that are caused by the federal action, including actions that would occur outside the immediate area involved in the action (50 CFR 402.17). The Action Area for the Proposed
Action encompasses all areas to be directly or indirectly affected by construction, O&M, and decommissioning of the Mayflower Wind Project, including the Project area, defined below, as well as vessel transit routes between the Project area and ports used for Project activities, and areas affected by noise, electromagnetic field (EMF), water quality, benthic, and other impacts associated with the Proposed Action. Ports to be used for Project activities include Sheet Harbor, Canada; New London, Connecticut; New Bedford and Salem, Massachusetts; Providence, Rhode Island; and Port of Virginia, Virginia, for construction and decommissioning, and Port of New Bedford and the Port of Fall River, Massachusetts, for O&M. Vessel transit routes between the Project area and these ports is part of the Action Area. This Action Area encompasses all effects of the Proposed Action considered here.

For purposes of this BA, the Project area is considered the portion of the Action Area where construction and eventual O&M of the Proposed Action will take place. The Project area, therefore, encompasses the Lease Area, including all WTG and OSP foundations and interarray cable routes, and the export cable routes from the OSPs to shore (Figure 3.1-1).
Figure 3.1-1. Project area
3.1.2 Description of Activities

Activities considered in this BA include offshore, nearshore, and onshore/upland activities during the construction, O&M, and decommissioning phases of the Proposed Action. The construction, O&M, and decommissioning of the Project would result in impacts on aquatic species in the nearshore and offshore waters of the southern New England OCS. Offshore activities for the construction of the Proposed Action would include installation of WTGs and OSPs, including their foundations, installation of interarray and export cables, and pre- and post-construction surveys. Nearshore activities for the Proposed Action would include sea-to-shore transition cabling at landfall locations and pre- and post-construction surveys. Upland activities for the construction of the Proposed Action would include installation of onshore cables and onshore converter station/substation. A description of onshore cable construction is provided in Section 3.1.2.4.4; however, the effects from upland activities are not analyzed in this BA as they are not anticipated to result in impacts on aquatic species in nearshore and offshore waters under NMFS jurisdiction. As noted, Mayflower Wind has elected to use a PDE approach for the Proposed Action, which is reflected in the description of the activities in this BA. Maximum PDE parameters for the Mayflower Wind project are summarized in Table 3.1-1 and the general construction schedule is provided in Figure 3.1-2 and in Table 3.1-2. This schedule is approximated based on several assumptions, including the estimated timeframe in which permits are received, anticipated regulatory seasonal restrictions, environmental conditions, planning, and logistics. O&M would result in impacts on aquatic species in the nearshore and offshore waters of the New England OCS associated with aquatic activities. Additional information about Project O&M requirements is provided in the COP (Mayflower Wind 2022). Decommissioning activities, described in Section 3.1.2.9, Decommissioning, are expected to result in similar, or lesser, impacts on ESA-listed species as construction activities.

Table 3.1-1. Mayflower Wind Project Design Envelope summary

<table>
<thead>
<tr>
<th>Project Component</th>
<th>Location</th>
<th>Project Details and Envelope Characteristic(s)</th>
</tr>
</thead>
</table>
| Layout and Project Size | Offshore | • Up to 149 WTG/OSP positions  
                      |          | • Up to 147 WTGs  
                      |          | • Up to 5 OSPs  
                      |          | • 1 nm x 1 nm (1.9 km x 1.9 km) grid layout with east-west and north-south orientation |
| Foundations | Offshore | • Monopile, piled jacket, suction-bucket jacket, and/or gravity-based structure (up to two different concepts will be installed)  
                      |          | • Seabed penetration: 0–295.3 feet (0–90.0 meters)  
                      |          | • Scour protection for up to all positions |
| WTGs | Offshore | • Rotor diameter: 721.7–918.6 feet (220.0–280.0 meters)  
                      |          | • Blade length of 351.0–452.8 feet (107.0–138.0 meters)  
                      |          | • Hub height above MLLW: 418.7–605.1 feet (127.6–184.4 meters)  
                      |          | • Total coolant: 73,500 gallons  
                      |          | • Total oils and lubricants: 433,650 gallons  
<pre><code>                  |          | • Total diesel fuel: 132,300 gallons |
</code></pre>
<table>
<thead>
<tr>
<th>Project Component</th>
<th>Location</th>
<th>Project Details and Envelope Characteristic(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>OSPs</td>
<td>Offshore</td>
<td>• Maximum structures envisaged located on grid positions: 5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• HVAC and HVDC converter OSP options</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Top of topside height above MLLW: 160.8–344.5 feet (49.0–105.0 meters)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Scour protection for all positions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Total coolant: 1,500 gallons</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Total oils and lubricants: 755,000 gallons</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Total diesel fuel: 200,000 gallons</td>
</tr>
<tr>
<td>Interarray Cables</td>
<td>Offshore</td>
<td>• Nominal interarray cable voltage: 60 to 72.5 kV</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Length of interarray cables beneath seafloor: Up to 497.1 miles (800 km)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Target burial depth (below level seabed): 6 feet (1.8 meters)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Possible burial depth range (below level seabed): 3.2–8.2 feet (1.0–2.5 meters)</td>
</tr>
<tr>
<td>Falmouth Offshore</td>
<td>Offshore, Nearshore</td>
<td>• Number of offshore export cables: up to 5</td>
</tr>
<tr>
<td>Export Cables</td>
<td></td>
<td>• Anticipated nominal export cable voltage (AC or DC): 200–345 kV (AC) or ±525 kV (DC)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Length per export cable beneath seabed: Up to 87.0 miles (140.0 km)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Cable/pipeline crossings: up to 9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Target burial depth (below level seabed): 6 feet (1.8 meters)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Possible burial depth range (below level seabed): 3.2–13.1 feet (1.0–4.0 meters)</td>
</tr>
<tr>
<td>Falmouth Landfall</td>
<td>Offshore, Nearshore</td>
<td>• Number of offshore export cables: up to 6</td>
</tr>
<tr>
<td>Site</td>
<td></td>
<td>• Nominal export cable voltage (DC): ±320 kV</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Length per export cable beneath seabed: Up to 124 miles (200 km)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Cable/pipeline crossings: up to 16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Target burial depth (below level seabed): 6 feet (1.8 meters)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Possible burial depth range (below level seabed): 3.2–13.1 feet (1.0–4.0 meters)</td>
</tr>
<tr>
<td>Brayton Point</td>
<td>Offshore, Nearshore</td>
<td>• Portsmouth, Rhode Island</td>
</tr>
<tr>
<td>Offshore Export</td>
<td></td>
<td>• Nominal underground onshore export cable voltage for DC transmission: ±320 kV</td>
</tr>
<tr>
<td>Cables</td>
<td></td>
<td>• Up to 4 onshore export cables and up to 2 communications cables</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Up to 3 miles (4.8 km) per cable</td>
</tr>
<tr>
<td>Aquidneck Island</td>
<td>Nearshore, Onshore</td>
<td>• Three locations under consideration: Worcester Avenue, Central Park, and Shore Street</td>
</tr>
<tr>
<td>Onshore Export</td>
<td></td>
<td>• Installation methodology: HDD</td>
</tr>
<tr>
<td>Cable Route</td>
<td></td>
<td>(Intermediate landfall)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Brayton Point: Two locations under consideration: Eastern and Western shorelines of Brayton Point</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Brayton Point: Installation methodology: HDD</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Aquidneck Island: Several locations under consideration for the intermediate landfall across the island</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Aquidneck Island: Installation methodology: HDD</td>
</tr>
<tr>
<td>Project Component</td>
<td>Location</td>
<td>Project Details and Envelope Characteristic(s)</td>
</tr>
<tr>
<td>-------------------</td>
<td>----------</td>
<td>-----------------------------------------------</td>
</tr>
</tbody>
</table>
| Onshore Export Cables from Landfall to Onshore Substation | Onshore | • Falmouth, Massachusetts  
• Nominal underground onshore export cable voltage for AC transmission: 200–345 kV  
• Up to 12 onshore export power cables and up to 5 communications cables  
• Up to 6.4 miles (10.3 km) per cable |
| Onshore Export Cables from Landfall to HVDC Converter Station | Onshore | • Somerset, Massachusetts  
• Nominal underground onshore export cable voltage for DC transmission: ±320 kV  
• Up to 6 onshore export cables and up to 2 communications cables  
• Up to 0.6 mile (1.0 km) per cable |
| Onshore Substation | Onshore | • Falmouth, Massachusetts  
• Two locations under consideration: Lawrence Lynch and Cape Cod Aggregates  
• Up to 26 acres (10.5 hectares) for the substation yard  
• Transform to 345 kV  
• Air-insulated substation or gas-insulated substation configurations |
| HVDC Converter Station | Onshore | • Somerset, Massachusetts  
• HVDC converter station  
• Up to 7.5 acres (3 hectares)  
• Convert the power from DC to 345 kV AC for injection to the existing ISO-NE grid system |
| Transmission Line from Onshore Substation to Falmouth POI | Onshore | • Falmouth, Massachusetts  
• New 345-kV overhead transmission line along existing utility ROW (preferred)  
• To be designed, permitted, constructed, and operated by transmission system owner, Eversource  
• New, 345-kV underground transmission line (alternate)  
• Up to 2.1 miles (3.4 km) in length |
| Transmission Line from HVDC Converter Station to Brayton Point POI | Onshore | • Somerset, Massachusetts  
• New, 345-kV underground transmission line  
• Up to 0.2 mile (0.3 km) in length |
| Falmouth POI | Onshore | • Falmouth, Massachusetts  
• Upgrades to existing Falmouth Tap (new or upgraded POI by Eversource) |
| Brayton Point POI | Onshore | • Somerset, Massachusetts  
• Existing, National Grid substation 345-kV gas-insulated switchgear breaker building at National Grid substation |

Source: COP Volume 1, Table 3-1; Mayflower Wind 2022.
AC = alternating current; DC = direct current; HDD = horizontal directional drilling; HVAC = high-voltage alternating current; HVDC = high-voltage direct current; kV = kilovolt; MLLW = mean lower low water; POI = point of interconnection
Table 3.1-2. Mayflower Wind Project schedule summary

<table>
<thead>
<tr>
<th>Construction Activity</th>
<th>Mayflower Wind Indicative Construction Schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scour Protection, Seabed Preparation, and Substructure Installation</td>
<td>Q1 of 2025 to Q3 of 2030</td>
</tr>
<tr>
<td>Onshore Export Cables and Onshore Substations</td>
<td>Q3 of 2024 to Q4 of 2030</td>
</tr>
<tr>
<td>OSP Installation and Commissioning</td>
<td>Q3 of 2027 to Q3 of 2029</td>
</tr>
<tr>
<td>Offshore Export Cable Installation</td>
<td>Q4 of 2024 to Q2 of 2029</td>
</tr>
<tr>
<td>Interarray Cable Installation</td>
<td>Q2 of 2026 to Q3 of 2030</td>
</tr>
<tr>
<td>WTG Installation and Commissioning</td>
<td>Q2 of 2027 to Q4 of 2030</td>
</tr>
</tbody>
</table>

Source: COP Volume 1, Figure 3-6; Mayflower Wind 2022.

Q = quarter

Project 1 refers to Project components associated with the Point of Interconnection (POI) at Brayton Point. Project 2 refers to Project components associated with the Falmouth POI.

Figure 3.1-2. Mayflower Wind indicative construction schedule

3.1.2.1 Wind Turbine Generators

3.1.2.1.1 Description

The proposed Project would use WTGs designed to operate in offshore conditions specific to the Lease Area. The Proposed Action includes installation and operation of up to 147 WTGs. Each WTG would extend up to 1,066.3 feet (325 meters) above mean lower low water (MLLW). Spacing between the WTGs would be 1 nm (1.9 km) within the Lease Area. The main components of the WTG include the nacelle, the rotor, three blades, and the tower. The rotor transfers rotational energy to the nacelle through the main shaft. The nacelle contains the vital components of the WTG including the generator, transformers, converter, and additional subsystems necessary to generate electricity and control WTG functionality. The nacelle would be positioned on a multi-sectional tower attached to a transition piece or foundation depending on the foundation design selected. Foundations under consideration for the WTGs are described in Section 3.1.2.3, Foundations.

Each WTG would contain oils, greases, and fuels used for lubrication, cooling, and hydraulic transmission. Indicative volumes are listed in Table 3.1-1. Final quantities will be dependent upon final component selection. The WTGs would be designed to minimize the potential for spills. At the end of their operational life, these fluids would be disposed of according to applicable regulations and guidelines.
3.1.2.1.2 Operation and Maintenance

Planned maintenance activities involve inspecting components and equipment that are commonly known to need replacement for signs of wear and tear in accordance with the WTG supplier’s specified maintenance schedule. Statutory inspections of WTGs’ safety and electrical equipment would occur in conformance with all applicable regulations. Unplanned maintenance may involve responding to an unplanned outage or equipment failure. This may require the use of a jack-up vessel or transportation vessel to carry, install, and/or repair the failure in question. Table 3.1-3 lists the primary maintenance activities along with the potential frequency of visits.

Table 3.1-3. Indicative O&M WTG task and schedule

<table>
<thead>
<tr>
<th>O&amp;M Task</th>
<th>Inspection Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planned annual maintenance</td>
<td>Annually</td>
</tr>
<tr>
<td>Routine maintenance and regulatory inspection including lifesaving equipment</td>
<td>Annually</td>
</tr>
<tr>
<td>Blade inspections (may be inspected by drone)</td>
<td>Every 1 to 3 years</td>
</tr>
<tr>
<td>Hydraulic oil change per WTG on average</td>
<td>Every 10 years</td>
</tr>
<tr>
<td>Gear oil change per WTG (not applicable to direct drive)</td>
<td>Every 6 to 10 years</td>
</tr>
<tr>
<td>Unplanned maintenance</td>
<td>As needed</td>
</tr>
<tr>
<td>Approximate visits for unscheduled maintenance</td>
<td>Annually</td>
</tr>
</tbody>
</table>

Source: COP Volume 1, Figure 3-9; Mayflower Wind 2022.

3.1.2.2 Offshore Substation Platform

3.1.2.2.1 Description

The proposed Project includes up to five OSPs to be located on the same 1 nm x 1 nm (1.9 km x 1.9 km) grid layout as the WTGs. Three OSP designs are under consideration: Option A – Modular, Option B – Integrated, and Option C – HVDC converter. Option A and Option B would use high-voltage alternating current (HVAC) technology, with Option B designed to support a higher number of interarray and export cable connections than Option A. Option C would use HVDC technology. Each OSP design includes a topside, which will house the electrical equipment, and a foundation substructure, which will support the topside. Foundations under consideration for the OSPs are described in Section 3.1.2.3.

Mayflower Wind has selected an HVDC converter OSP (Option C) for the Brayton Point interconnection. For Falmouth, Mayflower Wind will select an OSP design, which may entail one or more OSPs, based on future offtake agreements and through its supplier/equipment contracting process. Selection of HVDC for Falmouth would mean that two OSPs (one for Brayton Point and one for Falmouth) would be required, while selection of HVAC may require additional OSPs. Mayflower Wind filed a NPDES permit application for the HVDC converter OSP for Brayton Point on October 31, 2022, which is included as Appendix A, Mayflower Wind National Pollutant Discharge Elimination System Permit Application, to this BA (Tetra Tech and Normandeau Associates, Inc. 2022). Figure 3.1-3 shows the approximate location of the HVDC converter OSP. The HVDC converter OSP would include a CWIS, requiring the use of up to 10 million gallons per day (MGD) of once-through non-contact cooling water at a maximum intake velocity of 0.5 feet (0.2 meter) per second, discharged to a vertical pipe attached to the OSP foundation. Table 3.1-4 lists parameters of the CWIS system. The NPDES permit application in Appendix A includes additional details on the HVDC converter OSP design and a discussion of potential effects, including impingement/entrainment and thermal plumes, which are assessed in detail in Section 5, Effects of the Proposed Action.
Table 3.1-4. CWIS parameters

<table>
<thead>
<tr>
<th>Configuration Parameter</th>
<th>HVDC Converter OSP CWIS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source water</td>
<td>Atlantic Ocean</td>
</tr>
<tr>
<td>CWIS</td>
<td>Non-contact, once-through cooling</td>
</tr>
<tr>
<td>Configuration of intake</td>
<td>Up to three, approximately 3.3-foot (1-meter) diameter vertical-shaft intake pipes, with flared ends to accommodate intake velocity requirements, set perpendicular to the seafloor</td>
</tr>
<tr>
<td>Configuration of discharge</td>
<td>One or two, approximately 3.3-foot (1-meter) diameter vertical-shaft discharge caisson, set perpendicular to the seafloor</td>
</tr>
<tr>
<td>Trash/debris bar rack</td>
<td>Each intake pipe will be equipped with a bar rack to minimize entrapment of debris or marine organisms within the intake pipe</td>
</tr>
<tr>
<td>Pump screens/strainers</td>
<td>Each seawater intake pipe is equipped with a dedicated filter (mesh size ranging from 250 microns to 25 millimeters), intended to protect the equipment and for reliable operation of the CWIS. The filter is provided with an automated backwash cleaning system; no chemicals are involved in the cleaning cycles</td>
</tr>
</tbody>
</table>
### Configuration Parameter

<table>
<thead>
<tr>
<th>Parameter</th>
<th>HVDC Converter OSP CWIS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water depth of withdrawal, below surface at MLLW</td>
<td>Ranges from approximately 25 to 115 feet (7.6 to 35.0 meters) below the surface</td>
</tr>
<tr>
<td>Water depth of withdrawal, above seafloor</td>
<td>Approximately 32.8 feet (10 meters) above the seafloor</td>
</tr>
<tr>
<td>Through-screen velocity</td>
<td>Intake velocity will not exceed 0.5 foot (0.2 meter) per second.</td>
</tr>
<tr>
<td>Circulating water intake pumps (seawater lift pumps)</td>
<td>Up to three, approximately 5,315 GPM raw seawater vertical lift pumps, each with a rated design flow of 7.7 MGD</td>
</tr>
<tr>
<td>Maximum discharge temperature</td>
<td>90°F (32.2°C), with maximum anticipated temperature change of 18°F (10°C) from ambient water</td>
</tr>
<tr>
<td>Total design intake flow</td>
<td>7.7 MGD = rated design flow on each seawater lift pump (75% of total platform flow); 10.2 MGD = maximum average flow of 2 seawater lift pumps running at 50% each to provide the design 100% total platform flow (the Proposed Action is seeking 10.2 MGD maximum design intake flow)</td>
</tr>
<tr>
<td>Chlorination system</td>
<td>The CWIS is equipped with an antifouling system to prevent marine growth in the pump caissons and the Seawater System, which consists of Hypochlorite Generator Packages; the Hypochlorite Generator Packages produces Sodium Hypochlorite by seawater electrolysis; the hypochlorite is injected into the pump caissons near the suction level of the Seawater Lift Pumps; Hypochlorite Generator Packages are designed to achieve a hypochlorite solution flow rate of sufficient concentration, corresponding with a 0 to 2 parts per million equivalent free chlorine concentration in the seawater intake lines</td>
</tr>
</tbody>
</table>


Each OSP would contain oils, greases, and fuels used for lubrication, cooling, and hydraulic transmission. Indicative volumes are listed in Table 3.1-1. Final quantities will be dependent upon final component selection. At the end of their operational life, these fluids would be disposed of according to applicable regulations and guidelines.

### Operation and Maintenance

During operation, the OSPs would be remotely monitored from an onshore facility through supervisory control and data acquisition systems, which acts as an interface for a number of sensors and controls throughout the Lease Area. O&M personnel would visit the site routinely for equipment inspections and to perform planned and unplanned maintenance activities (see Table 3.1-5 for general list of O&M activities and timeframes).

#### Table 3.1-5. OSP O&M schedule

<table>
<thead>
<tr>
<th>O&amp;M Task</th>
<th>Inspection Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Routine inspections</td>
<td>As required based on final OSP design</td>
</tr>
<tr>
<td>Maintenance of switchgear and equipment</td>
<td>Annually</td>
</tr>
<tr>
<td>Transformer oil sample and targeted maintenance</td>
<td>Every 3 years</td>
</tr>
<tr>
<td>Extended maintenance routines</td>
<td>Every 5 and 10 years</td>
</tr>
<tr>
<td>Unplanned maintenance</td>
<td>As needed</td>
</tr>
</tbody>
</table>

Source: COP Volume 1, Table 3-11, Mayflower Wind 2022.
3.1.2.3 Foundations

3.1.2.3.1 Description

Foundations refer to the structures that support both the WTGs and OSPs. Mayflower Wind is considering four foundation concepts: monopile, piled jacket, suction-bucket jacket, and gravity-based structure (GBS). The Proposed Action would develop and install up to two different foundation concepts for the WTGs and may use a third different concept for the OSPs. See Table 3.1-6 and Table 3.1-7 for the maximum foundation parameters within the PDE.

### Table 3.1-6. Maximum WTG foundation parameters

<table>
<thead>
<tr>
<th>Foundation Type</th>
<th>Number of Foundations (Pile, Bucket, GBS)</th>
<th>Penetration Below Level Seabed</th>
<th>Foundation Diameter (Pile, Bucket, or GBS)</th>
<th>Seabed Centerline Diameter</th>
<th>Footprint Diameter&lt;sup&gt;1&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monopiles</td>
<td>1</td>
<td>164.0 ft (50.0 m)</td>
<td>52.5 ft (16.0 m)</td>
<td>--</td>
<td>374.0 ft (114.0 m)</td>
</tr>
<tr>
<td>Piled Jacket</td>
<td>4</td>
<td>229.6 ft (70.0 m)</td>
<td>14.7 ft (4.5 m)</td>
<td>164.0 ft (50.0 m)</td>
<td>380.5 ft (116.0 m)</td>
</tr>
<tr>
<td>Suction-Bucket Jacket</td>
<td>4</td>
<td>65.6 ft (20.0 m)</td>
<td>65.6 ft (20.0 m)</td>
<td>180.4 ft (55.0 m)</td>
<td>521.6 ft (159.0 m)</td>
</tr>
<tr>
<td>GBS</td>
<td>1</td>
<td>0–29.6 ft (0–9 m)</td>
<td>229.6 ft (70.0 m)</td>
<td>--</td>
<td>480.3 ft (146.4 m)</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td></td>
<td>131.2 ft (40 m)</td>
<td>393.7 ft (120 m)</td>
<td>696.2 ft (212.2 m)</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td></td>
<td>114.8 ft (35 m)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: COP Volume 1, Table 3-2, Mayflower Wind 2022.
<sup>1</sup> Diameter measures across combined area from foundation, scour protection, and mud mats

ft = foot; m meter.
### Table 3.1-7. Maximum OSP foundation parameters

<table>
<thead>
<tr>
<th>OSP Option</th>
<th>Foundation Type</th>
<th>Number of Foundations</th>
<th>Penetration Below Level Seabed</th>
<th>Piles or Bucket Diameter at Mudline</th>
<th>Seabed Centerline Diameter or Dimension</th>
<th>Permanent Footprint Area¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option A – Modular</td>
<td>Monopile</td>
<td>1</td>
<td>164.0 ft (50.0 m)</td>
<td>52.5 ft (16.0 m)</td>
<td>52.5 ft (16.0 m)</td>
<td>2.52 ac (1.02 ha)</td>
</tr>
<tr>
<td></td>
<td>Piled Jacket</td>
<td>3 to 4 foundations and 1 to 2 piles/foundation = 3 to 8 piles</td>
<td>229.6 ft (70.0 m)</td>
<td>14.7 ft (4.5 m)</td>
<td>164.0 ft (50.0 m)</td>
<td>2.61 ac (1.05 ha)</td>
</tr>
<tr>
<td></td>
<td>Suction-Bucket Jacket</td>
<td>4 foundations and 1 Bucket/Foundation = 4 buckets</td>
<td>65.6 ft (20.0 m)</td>
<td>65.6 ft (20.0 m)</td>
<td>180.4 ft (55.0 m)</td>
<td>4.90 ac (1.98 ha)</td>
</tr>
<tr>
<td></td>
<td>GBS</td>
<td>1 to 4 foundations</td>
<td>-</td>
<td>229.6 ft (70.0 m)</td>
<td>-</td>
<td>11.55 ac (4.67 ha)</td>
</tr>
<tr>
<td>Option B – Integrated</td>
<td>Piled Jacket</td>
<td>4 to 6 foundations and 1 to 3 pile/foundation = 4 to 18 piles</td>
<td>277.2 ft (84.5 m)</td>
<td>11.7 ft (3.57 m)</td>
<td>213 x 105 ft (65 x 32 m)</td>
<td>7.54 ac (3.05 ha)</td>
</tr>
<tr>
<td></td>
<td>GBS</td>
<td>4 to 9 foundations</td>
<td>N/A</td>
<td>N/A</td>
<td>361 x 328 ft (110 x 100 m)</td>
<td>10.90 ac (4.41 ha)</td>
</tr>
</tbody>
</table>

Source: COP Volume 1, Table 3-3, Mayflower Wind 2022.

¹ Includes combined area from foundation, scour protection, and mud mats.

dc = acre; ft = foot; ha = hectare; m = meter; N/A = not applicable.
**3.1.2.3.1.1 Monopile**

Monopiles consist of a single vertical, hollow steel pile connected to a transition piece, which attaches the WTG tower/OSP topside to the monopile above the water line. Monopiles can be used for both supporting the WTGs and the Modular OSP, Option A. A diagram of a monopile with typical dimensions can be seen in Figure 3.1-4.

![Figure 3.1-4. Indicative WTG monopile foundation diagram](image-url)
3.1.2.3.1.2 **Piled Jacket**

Jacket structures are large lattice structures fabricated of steel tubes welded together. Jackets will consist of three- or four-legged structures to support WTGs and four- to nine-legged structures to support OSPs. If the jacket is piled, each leg will be anchored by one pile foundation for WTGs and up to three pile foundations per leg for OSPs. A diagram of a pile jacket with typical dimensions can be seen in Figure 3.1-5.

![Figure 3.1-5. Indicative WTG piled jacket foundation diagram](image-url)
3.1.2.3.1.3 Suction-Bucket Jacket

Suction-bucket jackets have a similar steel lattice design to the piled jacket but diverge at the connection to the sea floor. These foundations use suction-bucket foundations instead of piles to secure the structure to the seabed. A diagram of a suction-bucket jackets with typical dimensions can be seen in Figure 3.1-6.

![Figure 3.1-6. Indicative WTG suction-bucket foundation diagram](image)
3.1.2.3.1.4 Gravity-Based Structure

Typically constructed of steel, concrete, or some combination of both, a GBS sits on top of the sea floor and is not pile driven. Most typical is a structure with one or multiple hollow segments inside, which, once installed on site, is filled with ballast to provide the additional weight required. Ballast material can be water only or a combination of water and solid ballast material such as sand, rock, or special high density ballast materials. Seabed preparation and scour protection are necessary for installation of a GBS. A diagram of a GBS with typical dimensions can be seen in Figure 3.1.

![Figure 3.1-7. Indicative GBS foundation design](image)

3.1.2.3.2 Foundation Installation

During construction, Mayflower Wind would receive equipment and materials to be staged and loaded onto installation vessels at one or more existing port facilities (Section 3.1.1). Installation vessels would then transport equipment and materials to the Lease Area. Use of these vessels, and other construction vessels that would be used for installation of WTG and OSP foundations, is described in Section 3.1.2.6. At a maximum, the Project would have up to two vessels working simultaneously. For all foundation types, seabed preparation may be anticipated, consisting of installation of scour protection/rock layer and leveling using dredges, although this would be most common for suction-bucket and GBS foundations. Maximum area of seabed preparation disturbance by foundation type is identified in Table 3.1-8 including...
the temporary impacts from seabed preparation from dredging. Dredge types that would be used for seabed level/preparation at WTG/OSP foundation locations include:

- **Trailing suction hopper dredges**: Hopper dredges are typically self-propelled sea-going vessels. They are equipped with propulsion machinery, sediment containers (i.e., hoppers) dredge pumps, and other specialized equipment required to excavate sediment. Hopper dredges remove material from the bottom of the seafloor in thin layers usually 2 to 12 inches (5 to 30 centimeters) depending on the density and cohesiveness of the dredge material (Taylor 1990). The dredge works in a “back and forth” motion over the dredge area similar to a vacuum (NMFS and GARFO 2014; NMFS and GARFO 2019).

- **Cutter suction dredges**: Cutter suction dredges are essentially a barge hull with a moveable rotation cutter apparatus surrounding the intake of a suction pipe (Taylor 1990). By combing the mechanical cutting action with the hydraulic suction, the hydraulic cutterhead has the capability of efficiently dredging a wide range of material including clay, silt sand, and gravel. Cutter dredges have 30- to 42-inch (76- to 107-centimeter) diameter pumps with 15,000 to 20,000 horsepower (NMFS and GARFO 2014).

- **Mechanical dredges**: Mechanical dredging differs from the hydraulic dredging mentioned above in that the dredging is conducted from a stationary barge mounted crane, backhoe or cable arm with an attached bucket to excavate the bottom-material. The material is lifted from the bottom and placed in a on the barge for transport to the disposal site by tug. Buckets on mechanical dredges typically range in size from 1 to 25 cubic yards (0.8 to 10 cubic meters) and include different design such as clamshell, environmental bucket, and excavator (NMFS and GARFO 2019; NMFS 2015b).

For monopiles and piled jacket foundations, pile-driving activity would be limited to May 1 to December 31 based on time of year restrictions to reduce impacts on North Atlantic right white (NARW) and other marine mammals, which are most present in the Project area from January to April. During this period, pile driving may occur 24 hours per day. Monitoring and mitigation measures for pile-driving activities, including nighttime pile driving, is provided in Section 3.3.

### 3.1.2.3.2.1 Monopile Installation

WTG and OSP monopile foundations with a maximum diameter of 52-foot (16-meter) monopiles (52.5 feet) would be installed within the Lease Area using an impact pile driver with a maximum hammer energy of 6,600 (kilojoules [kJ]) or a vibratory hammer (or both). Monopiles would be installed to a maximum depth of 164 feet (50 meters). Under normal conditions, installation of a single monopile foundation is estimated to require approximately 4 hours of piling. It is anticipated that a maximum of two monopile foundations can be driven into the seabed per day assuming 24-hour pile-driving operation. The time required to install each pile would also include a 1-hour pre-start clearance period and then 4 hours to move to the next piling location.

### 3.1.2.3.2.2 Piled Jacket Installation

WTG piled jacket foundations, with four legs and one pin-pile per leg, with a maximum pile diameter of 14.7 feet (4.5 meters) would be installed using an impact pile driver with a maximum hammer energy of 3,500 kJ or a vibratory hammer (or both) to a maximum penetration depth of 229.6 feet (70 meters). Installation of a single pin-piled jacket substructure is estimated to require approximately 8 hours of pile driving (2 hours of pile driving per pin pile foundation, four piles per jacket substructure). It is anticipated that a single piled jacket substructure involving four pin-pile foundations can be driven into the seabed per day assuming 24-hour pile-driving operation. Piled jacket installation is multi-stage where the seabed is prepared and then a reusable template is placed on the seabed for accurate positioning of piles. Pin piles will be individually lowered into the template and driven to the target penetration depth using an impact hammer.
hammer. Then the template is picked up and moved to the next location. In the subsequent stage of the installation process, a vessel installs the jacket to the piles. This could occur directly after the piling vessel completes operations, or a year later.

OSP piled jacket foundations would be similar to the WTG piled jacket foundations described above. However, OSP piled jackets would be installed using a post-piling installation sequence. Post-piling installation is a sequence where the seabed is prepared and the jacket is set on the seafloor, then the piles are driven through the jacket legs to the designed penetration depth (depending on which OSP design is used). The piles are connected to the jacket via grouted or swaged connections or a combination of the two. OSP piled jackets may have up to nine legs, and each leg could be anchored by up to three pin piles. The number of jacket legs and pin piles would vary depending on the OSP design being supported as follows:

- Option A (modular) OSP design would be the smallest and include three to four legs with one to two pin piles per leg (three to eight total pin piles per pile jacket). Pin piles would have a diameter of up to 14.7 feet (4.5 meters) and would be installed using up to a 3,500-kJ hammer to a target penetration depth of 229.6 feet (70 meters) below the seabed.

- Option B (integrated) OSP design would include four to six legs with one to three piles per leg (4 to 18 total pin piles per jacket). The pin pile diameter would be up to 11.7 feet (3.57 meters), and they would be installed using up to a 3,500-kJ hammer to a target penetration depth of 277.2 feet (84.5 meters) below the seabed.

- Option C (HVDC converter) OSP design with a piled jacket substructure would include four to nine legs with one to three pin piles per leg (4 to 27 total pin piles per jacket) with a pile diameter of 12.8 feet (3.9 meters) installed using a 3,500-kJ hammer to a target penetration depth of 295.3 feet (90 meters) below the seabed.

For all three OSP piled jacket options (modular, integrated, and HVDC-converter), installation of a single pin pile is anticipated to take up to 2 hours of pile driving. A maximum of eight pin piles could be driven into the seabed per day during 24-hour pile driving operation.

3.1.2.3.2.3 Suction-Bucket Jacket Installation

During installation of this foundation type for WTGs and OSPs, the jacket is lowered to the seabed, and the open bottom of the bucket and weight of the jacket embeds the bottom of the bucket in the seabed. To complete the installation and secure the foundation, water and air are pumped out of the bucket creating a negative pressure within the bucket, which embeds the foundation buckets into the seabed. The jacket can also be leveled at this stage by varying the applied pressure. The pumps will be released from the suction buckets once the jacket reaches its designed penetration depth. The connection of the required suction hoses is typically completed using a remotely operated vehicle (ROV). Parameters for suction-bucket foundation installation, including seabed preparation and leveling, are provided in Table 3.1-8.

3.1.2.3.2.4 Gravity-Based Structure Installation

Installation of WTG and OSP GBS foundations would involve seabed preparation, which may include rock layer/scour protection and dredging. Dredging is necessary when the seabed surface layers are too soft for a GBS to rest on. Dredging can be done using trailing suction hopper dredgers, cutter suction dredgers, mechanical dredging vessels, or subsea excavators. Once the seabed is prepared, the GBS would be set down on the rock layer. The GBS would be lowered by adding water as ballast. The next step would be to add the solid ballast, if required, using a dredging vessel, a rockdump vessel, or any other vessels able to carry the bulk material and transfer it into the GBS. Parameters for GBS installation, including seabed preparation and leveling, are provided in Table 3.1-8.
### 3.1.2.3.3 Scour Protection

Scour protection would be installed around WTG and OSP foundations to prevent scouring of the seabed around the foundations. The type and amount of scour protection utilized will vary based on a variety of factors, including foundation type and water flow and substrate type (hydrodynamic scour modeling). The scour protection types proposed are:

- **Rock**: the installation of crushed rock or boulders around a structure.
- **Rock bags**: pre-filled bags made of meshed steel or synthetic materials containing crushed rock to be placed around a structure.
- **Concrete mattresses**: the installation of pre-cast blocks of concrete around a structure.
- **Sandbags**: pre-filled bags containing sand.
- **Artificial seaweeds/reefs/frond mats**: mattresses including polypropylene or similar fronds that accumulate soft sediment.
- **Self-deploying umbrella systems**: used for suction-bucket jackets, the system entails pre-installed frond mats that deploy during installation of the suction buckets.

Synthetic material may be used for some scour protection options, including rock bags and fronded mattress, which would be tested for long-term durability. The material would be designed and tested to maintain integrity under ultraviolet (UV) exposure, though UV exposure becomes much less significant on the seabed.

Installation activities and order of events of scour protection would largely depend on the type and material used. In the case of rock scour protection, a rock placement vessel may be deployed. The thin layer of filter stones is typically placed before driving the piles, while the armor rock layer is typically installed afterward. Final scour protection strategy and installation will be refined during detailed design. Scour protection would follow the installation of these foundations. Frond mats or umbrella-based structures may be pre-attached to the substructure, so are therefore simultaneously installed.

Maximum seabed disturbance parameters, including scour protection, for 147 WTGs and 2 OSPs (includes OSPs with largest seabed footprint) are presented in Table 3.1-8.
### Table 3.1-8 Temporary disturbance, permanent disturbance, and scour parameters for WTG and OSP foundations

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Monopile</th>
<th>Piled Jacket</th>
<th>Suction Bucket Jacket</th>
<th>GBS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permanent Footprint Area per WTG (including scour protection)</td>
<td>2.52 ac</td>
<td>2.61 ac</td>
<td>4.91 ac (1.99 ha)</td>
<td>11.55 ac (4.67 ha)</td>
</tr>
<tr>
<td>Total Permanent Footprint Area (147 WTG foundations, including scour protection)</td>
<td>370.44 ac (149.94 ha)</td>
<td>383.67 ac (154.35 ha)</td>
<td>720.30 ac (291.06 ha)</td>
<td>1,697.85 ac (666.49 ha)</td>
</tr>
<tr>
<td>Scour Protection Volume per WTG</td>
<td>36,256 cy (27,720 m³)</td>
<td>37,635 cy (28,774 m³)</td>
<td>75,583 cy (57,787 m³)</td>
<td>189,839 cy (145,142 m³)</td>
</tr>
<tr>
<td>Total Scour Protection Volume (147 WTGs)</td>
<td>5,329,632 cy (4,074,840 m³)</td>
<td>5,532,345 cy (4,229,778 m³)</td>
<td>11,110,701 cy (8,494,689 m³)</td>
<td>27,906,333 cy (21,335,874 m³)</td>
</tr>
<tr>
<td>Additional Temporary Disturbance from Seafloor Preparation During Construction per WTG (includes dredging)</td>
<td>0.5 ac (0.2 ha)</td>
<td>0.5 ac (0.2 ha)</td>
<td>0.6 ac (0.3 ha)</td>
<td>1.0 ac (0.4 ha)</td>
</tr>
<tr>
<td>Total Additional Temporary Disturbance from Seafloor Preparation During Construction (147 WTGs) (includes dredging)</td>
<td>73.5 ac (29.4 ha)</td>
<td>73.5 ac (29.4 ha)</td>
<td>88.2 ac (44.1 ha)</td>
<td>147.0 ac (58.8 ha)</td>
</tr>
<tr>
<td>Permanent Footprint Area per WTG (including scour protection)</td>
<td>9.79 ac (3.96 ha)</td>
<td></td>
<td>8.87 ac (3.59 ha)</td>
<td></td>
</tr>
<tr>
<td>Total Permanent Footprint Area (2 OSPs, including scour protection)</td>
<td>19.6 ac (7.4 ha)</td>
<td></td>
<td>21.8 ac (8.8 ha)</td>
<td></td>
</tr>
<tr>
<td>Scour Protection Volume per OSP</td>
<td>157,193 cy (120,183 m³)</td>
<td></td>
<td>141,158 cy (107,923 m³)</td>
<td></td>
</tr>
<tr>
<td>Total Scour Protection Volume (2 OSPs)</td>
<td>314,386 cy (240,366 m³)</td>
<td></td>
<td>282,316 cy (215,846 m³)</td>
<td></td>
</tr>
<tr>
<td>Additional Temporary Disturbance from Seafloor Preparation During Construction per OSP (includes dredging)</td>
<td>0.5 ac (0.2 ha)</td>
<td></td>
<td>1.5 ac (0.6 ha)</td>
<td></td>
</tr>
<tr>
<td>Total Additional Temporary Disturbance from Seafloor Preparation During Construction (2 OSPs) (includes dredging)</td>
<td>1.0 ac (0.4 ha)</td>
<td></td>
<td>3.0 ac (1.2 ha)</td>
<td></td>
</tr>
</tbody>
</table>

Source: adapted from COP Volume 1, Tables 3-6, 3-7, 3-36, and 3-37; Mayflower Wind 2022.

ac = acre; cy = cubic yard; ha = hectare; m³ = cubic meter

### 3.1.2.3.4 Operation and Maintenance

Internal and external inspections of foundations will occur every 2 years to ensure structural integrity. ROVs or Autonomous Underwater Vehicles (AUVs) will be deployed for general underwater visual inspections that will include detection of corrosion, damage to the substructure, cracks at welds, excessive
marine growth, and seabed scour. Divers may be used in a limited capacity for inspection or repair activities.

### 3.1.2.4 Cable Types

#### 3.1.2.4.1 Interarray Cables

**3.1.2.4.1.1 Description**

The interarray cables would connect the WTGs into strings and then connect these strings to the OSPs. The proposed interarray cable is an alternating current (AC), three-core (three separate conductors/cores), armored submarine cable that would be a maximum length of 497.1 miles (800 km) in length with a voltage between 60 and 72.5 kilovolts (kV) (Table 3.1-1). The final layout of the interarray cables would be determined at a later date based on site characterization data, cable capacity, and installation and operating conditions. For illustrative purposes, an indicative layout is presented in Figure 3.1-8.

![Figure 3.1-8. Indicative interarray cable layout](image)

**3.1.2.4.1.2 Interarray Cable Installation**

Seabed preparation activities would be conducted prior to the installation to prepare for cable installation and ensure consistent burial is achieved. Boulders in the cable route that cannot be easily avoided by micro-routing could be removed with a grab lift or plow as necessary. Dredging and sand wave clearance
is not proposed in the Lease Area in preparation for inter-interarray cable installation. It is anticipated that a pre-lay grapnel run would be completed along the entire length of each interarray cable route within the Lease Area shortly before cable installation. A pre-lay grapnel run would be conducted to clear the cable route of buried hazards along the installation route to remove obstacles that could impact cable installation, such as abandoned mooring lines, wires, or derelict fishing gear. Mayflower Wind will coordinate with relevant federal and state agencies in addition to Mayflower Wind’s other outreach efforts (i.e., direct outreach, outreach via Fisheries Representatives) to notify commercial and recreational fishermen prior to initiation of the pre-lay grapnel run. Table 3.1-9 shows acres of seabed disturbance from seabed preparation activity.

Interarray installation methods would be similar to offshore export cable installation and include a combination of jetting ROV, pre-cut plow, mechanical plow, or mechanical cutting ROV system. These installation methods are described in Section 3.1.2.4.2.2. A dynamic positioning (DP) vessel would be used for cable installation and there would be no anchoring in the Lease Area (refer to Section 3.1.2.6 for vessel use description). Cables would be buried to a target depth of 6 feet (1.8 meters) where possible. In locations where target burial depth cannot be achieved (minimum anticipated burial depth is 3.1 feet [1 meter]) and at existing cable crossings, cable protection would be used. Mayflower Wind estimates 10 percent of the interarray cable layout would require cable protection (approximately 49.7 miles [80 km]). Locations requiring cable protection, the type of protection selected, and the amount of cable protection would be determined based on a variety of factors, including water flow and substrate type. The proposed cable protection types are as follows:

- Rock berm: the creation of a sloped rock berm over the cable.
- Concrete mattresses: concrete blocks, or mats, connected via rope or cable.
- Rock placement: the installation of crushed boulders over a cable.
- Fronded mattress: mat made of polypropylene or similar fronds (as described previously for scour protection, fronded mattress would be designed to ensure that integrity from UV exposure).
- Half shells: typically used to protect cable ends at pull-in areas and where trenching is not possible.

Seabed disturbance from the interarray cables is summarized in Table 3.1-9.

Table 3.1-9. Interarray cable—estimated seabed disturbance areas

<table>
<thead>
<tr>
<th>Interarray Cable Activity</th>
<th>Area in Acres (Hectares)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seabed Preparation</td>
<td>99 (40)</td>
</tr>
<tr>
<td>Cable Installation(^1)</td>
<td>1,186 (480)</td>
</tr>
<tr>
<td>Cable Protection(^2)</td>
<td>122 (50)</td>
</tr>
<tr>
<td><strong>Total Area Disturbed</strong></td>
<td><strong>1,408 (570)</strong></td>
</tr>
</tbody>
</table>

Source: COP Volume 1, Table 3-30, Mayflower Wind 2022.

\(^1\) Width of surface impact estimated to be 19.7 feet (6 meters) around each cable.

\(^2\) A maximum of 19.7-foot-wide (6-meter-wide) form of cable protection would be installed along 10 percent of the interarray cable layout.

### 3.1.2.4.1.3 Operation and Maintenance

The interarray cables are buried and not expected to require regular maintenance, except for manufacturer-recommended cable testing. Periodic visual inspections of the interarray cables would be planned based on survey data and manufacturer recommendations based on the as-built drawings. Episodic repairs of cable faults, failures, and exposed cables would be conducted as necessary. These
repairs would require the use of various cable installation equipment, as described for construction activities.

### 3.1.2.4.2 Offshore Export Cables

#### 3.1.2.4.2.1 Description

The Proposed Action includes two offshore ECCs, the Falmouth ECC and the Brayton Point ECC. Within the Falmouth ECC, a maximum of five offshore export cables, including four power cables and one dedicated communications cable, would connect the OSPs to the landfall site in Falmouth. Length of all cables within the 87-mile (140-km) corridor would be a maximum of 435 miles (700 km). Within the Brayton Point ECC, a maximum of six offshore export cables, including four HVDC power cables and two dedicated communications cables, would connect the OSPs to the landfall site at Brayton Point. The cables would be installed in two cable bundles, consisting of two power cables and one communication cable. The length of all cables within the 124-mile (200-km) corridor would be a maximum of 744 miles (1,200 km). Mayflower Wind intends to maintain a maximum corridor width of 3,280 feet (1,000 meters) for the Falmouth ECC and 2,300 feet (700 meters) for the Brayton Point ECC to allow for maneuverability during installation and maintenance. The ECCs may be locally narrower or wider to accommodate sensitive locations and to provide sufficient area at landfall locations, at crossing locations, or for anchoring.

#### 3.1.2.4.2.2 Offshore Export Cables Installation

Seabed preparation activities would be conducted prior to the installation to prepare for cable installation and ensure consistent burial is achieved. Seabed preparation activities may include boulder removal, grapnel runs, localized dredging, and seabed leveling. Boulders in the cable route that cannot be easily avoided by micro-routing could be removed with a grab lift or plow as necessary. If deemed necessary, a pre-lay grapnel run would be conducted to clear the cable route of buried hazards along the installation route to remove obstacles that could impact cable installation such as abandoned mooring lines, wires, or fishing equipment. Localized dredging using a hopper dredge or water injection dredge may be required in areas where sand waves are present, approximately five percent of the Falmouth ECC, primarily in Muskeget Channel in water depths less than 65 feet (20 m). Hopper dredges are discussed previously. Dredged material would be disposed of within the ECC on similar substrate (i.e., other exiting sand waves). Mounted on a barge, a water injection dredge jets water into the sediments at low pressure (10-12 pounds per square inch) and relatively high-volume flow rates to fluidize, displace, and mobilize sediments. The displaced sediments will be transported by gravity and natural water current. Table 3.1-11 identifies the areal extent of seabed preparation disturbance, including dredging, for both ECCs.

Once any necessary seabed preparations are completed, Mayflower Wind would install the offshore export cables that would link OSPs to a sea-to-shore transition at their respective landfalls (refer to Section 3.1.2.4.3). Mayflower Wind is proposing several preparation and installation methods. Cable burial would utilize one or a combination of the following methods:

- **Vertical Injector**: A vertical injector is a deep burial jetting tool used for cable installation and burial. The vertical injector uses water propelled from jet nozzles to fluidize the seabed material to allow for lowering of the cable. This tool is towed along the back of a vessel and acts as a trowel creating a space for the cable to be installed and subsequently buried.

- **Jetting Sled**: A jetting sled, possibly used along the export cable route, is towed from a vessel and can be launched either during post-lay trench mode or fitted with the cable to simultaneously create a trench through soft seabed material and lay the cable. The trench is created by water jetting through unconsolidated, softer seabed material. As such, jetting is optimal in unconsolidated soils and sands
with low shear strengths. The trenching systems suffices for any curves that an offshore export cable may be laid in.

- Jetting ROV: This jet trencher is an ROV based system that can be launched from cable installation vessels or from a dedicated support vessel. This method is typically used in non-consolidated soils.

- Pre-Cut Plow: This method is deployed when surface and sub-surface boulders are present. A basic mechanical plow will pre-cut a V-shaped trench ahead of cable installation. This allows for the boulders and soils to be lifted to the edges of the trenches for backfill purposes later. Once the cable is laid into the trench, the plow is reconfigured into backfill mode where the boulders and soils that were previously relocated are then re-deposited.

- Mechanical Plow: A mechanical plow is towed from the back of a vessel and simultaneously cuts a narrow trench in the seafloor, while also simultaneously laying and burying cable. Plowing capability can increase from firm unconsolidated soils/sands to more consolidated soils and clays with medium shear strengths.

- Mechanical Cutting ROV System: A mechanical cutting ROV cable burial system is a self-propelled system most suitable for soil with increased strength. This system can be utilized at any water depth. The mechanical cutting ROV system utilizes a cutting wheel or chain to break up and excavate any material. It is used only in hard, consolidated soils; a rotating chain or cutting wheel with dedicated teeth will excavate the soil from beneath.

The final cable burial method(s) would be selected based on seabed conditions, the required burial depths, and pre-installation cable burial surveys and studies. More than one installation and burial method may be selected per route and has the potential to be used pre-installation, during installation, and/or post-installation. Target cable burial can be directly verified during installation of jetting type tools that are suitable for simultaneous laying and burial of the cables. These tools may be configured with a “depressor” or similar mechanical device that directly verifies the depth of the cable as it is being buried. Additionally, cable burial depth can be assessed post-installation using magnetic or acoustic remote-sensing techniques. The amount of seabed disturbance during installation activities is shown in Table 3.1-11.

Target horizontal separation between each proposed cable and cable bundle is a maximum of 328 feet (100 meters) for both ECCs. Final cable spacing will depend on bathymetry and other detailed seabed characteristics and may be wider or narrower.

A combination of moored vessels and DP vessels would be used for the offshore export cable installation (refer to Section 3.1.2.6 for vessel use description). The split between vessels will be determined based on the water depth profile along the route and the route length compared to cable-carrying capacity. DP vessels would be used for water depths greater than 49.2 feet (15.0 meters) while moored vessels would be used in nearshore areas and areas with shallow water less than 49.2 feet (15.0 meters). See Figure 3.1-9 and Figure 3.1-10 for potential anchoring areas along the Falmouth and Brayton Point ECCs, which would occur along a maximum of 30 percent (26 miles [41 km]) of the Falmouth ECC and 15 percent (19 miles [30 km]) of the Brayton Point ECC. Anchoring disturbance is included in the cable installation disturbance acreage in Table 3.1-11.
Figure 3.1-9. Potential areas for anchoring inside Falmouth export cable corridor

Figure 3.1-10. Potential areas for anchoring inside Brayton Point export cable corridor
Project cables would be buried to a target depth of 6 feet (1.8 meters) where possible. In locations where target burial depth cannot be achieved (minimum anticipated burial depth is 3.1 feet [1 km]) and at existing cable crossings, cable protection would be used. A maximum of 10 percent of the Falmouth ECC (8.7 miles [14.0 km]) and 15 percent of the Brayton Point ECC (18.6 miles [29.9 km]) would require cable protection (refer to Table 3.1-11 for total area of cable protection). Locations requiring cable protection, the type of protection selected, and the amount of cable protection would be determined based on a variety of factors, including water flow and substrate type. The proposed cable protection types are as follows:

- Rock berm: the creation of a sloped rock berm over the cable.
- Concrete mattresses: concrete blocks, or mats, connected via rope or cable.
- Rock placement: the installation of crushed boulders over a cable.
- Fronded mattress: mat made of polypropylene or similar fronds (as described previously for scour protection, fronded mattress would be designed to ensure integrity from UV exposure).
- Half shells: typically used to protect cable ends at pull-in areas and where trenching is not possible.

At locations where the offshore export cables cross existing cables and pipelines, Mayflower Wind would employ crossing designs consistent with typical industry practices, which typically employ use of concrete mattresses. Information on the locations and number of cable crossings by ECC are provided on Figure 3.1-11 and in Table 3.1-10. Cable crossing design will be determined by the cable crossing’s proximity to shore and the third-party crossing agreement requirements.
Table 3.1-10. Proposed cable/pipeline crossing

<table>
<thead>
<tr>
<th>Cable Crossing Area (see Figure 3.1-11)</th>
<th>Number of Cables/Pipelines to be Crossed</th>
<th>Location</th>
<th>Offshore Export Cable Corridor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potential Crossing Area A</td>
<td>2 cables</td>
<td>Between Martha’s Vineyard and Falmouth (cables make landfall at Shore Street in Falmouth)</td>
<td>Falmouth ECC</td>
</tr>
<tr>
<td>Potential Crossing Area B</td>
<td>7 cables</td>
<td>South of Muskeget Channel</td>
<td>Falmouth ECC</td>
</tr>
<tr>
<td>Potential Crossing Area C</td>
<td>7 cables</td>
<td>South of Muskeget Channel</td>
<td>Brayton Point ECC</td>
</tr>
<tr>
<td>Potential Crossing Area D</td>
<td>4 cables</td>
<td>South of Nomans Land</td>
<td>Brayton Point ECC</td>
</tr>
<tr>
<td>Potential Crossing Area E</td>
<td>2 cables</td>
<td>South of Sakonnet River</td>
<td>Brayton Point ECC</td>
</tr>
<tr>
<td>Potential Crossing Area F</td>
<td>1 pipeline</td>
<td>Sakonnet River (charted Pipeline Area)</td>
<td>Brayton Point ECC</td>
</tr>
<tr>
<td>Potential Crossing Area G</td>
<td>Sakonnet River (charted Pipeline Area)</td>
<td>Sakonnet River (charted Pipeline Area)</td>
<td>Brayton Point ECC</td>
</tr>
</tbody>
</table>

Source: COP Volume 1, Table 3-15; Mayflower Wind 2022.

Table 3.1-11. Offshore export cables—estimated seabed disturbance areas

<table>
<thead>
<tr>
<th>Offshore Export Cable Activity</th>
<th>Area in Acres (Hectares)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Falmouth Export Cable</td>
<td></td>
</tr>
<tr>
<td>Seabed Preparation (per cable)</td>
<td>138 (56)</td>
</tr>
<tr>
<td>Cable Installation (per cable)</td>
<td>186 (75)</td>
</tr>
<tr>
<td>Cable Protection (per cable)</td>
<td>27 (11)</td>
</tr>
<tr>
<td>Total Seabed Disturbance Area (per cable)</td>
<td>351 (142)</td>
</tr>
<tr>
<td>Total Seabed Disturbance Area (5 cables)</td>
<td>1,753 (709)</td>
</tr>
<tr>
<td>Brayton Point Export Cable</td>
<td></td>
</tr>
<tr>
<td>Seabed Preparation (per cable bundle)</td>
<td>65 (26)</td>
</tr>
<tr>
<td>Cable Installation (per cable bundle)</td>
<td>242 (98)</td>
</tr>
<tr>
<td>Cable Protection (per cable bundle)</td>
<td>56 (23)</td>
</tr>
<tr>
<td>Total Seabed Disturbance Area (per cable bundle)</td>
<td>363 (147)</td>
</tr>
<tr>
<td>Total Seabed Disturbance Area (2 cable bundles)</td>
<td>727 (294)</td>
</tr>
</tbody>
</table>

Source: COP Volume 1, Table 3-29; Mayflower Wind 2022.

1 Width of surface impact estimated to be 19.7 feet (6 meters) around each cable.
2 A maximum of 19.7-foot-wide (6-meter-wide) form of cable protection would be installed along 10 percent of the Falmouth ECC and 15 percent of the Brayton Point ECC.

3.1.2.4.2.3 Operations and Maintenance

The offshore export cables would be buried and not expected to require regular maintenance, except for manufacturer-recommended cable testing. Inspections and preventive maintenance would occur on a frequency advised by the manufacturer’s recommendations. Burial inspection visuals would occur periodically to be determined after final design. Episodic repairs of cable faults, failures, and exposed cables would be conducted as necessary. These repairs would require the use of various cable installation equipment, as described for construction activities.
3.1.2.4.3 Sea-to-Shore Transition

3.1.2.4.3.1 Description

For the Falmouth ECC, Mayflower Wind is considering three potential sea-to-shore transition locations in Falmouth, Massachusetts. For the Brayton Point ECC, Mayflower Wind is considering two potential locations at Brayton Point in Somerset, Massachusetts, and four potential locations at the intermediate landfall on Aquidneck Island in Portsmouth, Rhode Island. The landfall locations in Falmouth, Massachusetts, include Worcester Avenue, Central Park, and Shore Street, as depicted in Figure 3.1-12. The landfall locations at Brayton Point in Somerset, Massachusetts, include the Western landfall location from the Lee River and the Eastern landfall location from the Taunton River, as depicted in Figure 3.1-13. Additionally, the Brayton Point offshore export cables would make intermediate landfall on Aquidneck Island in Portsmouth, Rhode Island, in order to avoid a narrow and highly constrained area of the Sakonnet River at the old Stone Bridge and Sakonnet River Bridge, as depicted on Figure 3.1-14. This choice would require landfalls at two locations, one entering and one exiting Aquidneck Island. One landfall location is under consideration for entering Aquidneck Island, and four locations among three route options are under consideration for exiting Aquidneck Island.

3.1.2.4.3.1.1 Falmouth ECC

- **Falmouth Landfall Option A: Worcester Avenue (preferred).** The preferred landfall is the easternmost potential landfall site located at Worcester Avenue. This location is protected by a short seawall, a broad beach, and Surf Drive. This landfall site would be located on a previously disturbed, off-road grassy median strip (also known as Worcester Park) that runs between the two lanes of Worcester Avenue.

- **Falmouth Landfall Option B: Central Park.** This potential landfall site is approximately 700 feet (213 meters) west of the Worcester Avenue landfall location, situated at Central Park on Falmouth Heights Beach north of Grand Avenue. This landfall site would occur at a public recreational park with a baseball diamond and basketball court. The park is flanked on the southern side by paved parking spaces, which could be used for construction staging operations.

- **Falmouth Landfall Option C: Shore Street.** The potential landfall site at Shore Street is west of the Central Park and Worcester Avenue landfall sites. It is located on Surf Drive Beach at the intersection of Surf Drive and Shore Street. The Shore Street location has a large, over 2-acre (0.8-hectare) public parking lot that would be used to site the cable transition joint bays and accommodate vehicles and equipment during installation operations. The Shore Street landfall location involves the crossing of two existing submarine cables that also make landfall at Shore Street. The existing arrangement would allow Mayflower Wind to use horizontal directional drilling (HDD) underneath the existing cables in the approach to the landfall location.

3.1.2.4.3.1.2 Brayton Point ECC

- **Brayton Point Landfall Option A: Western (preferred).** The preferred site for the Brayton Point landfall is located in the western portion of the former Brayton Point Power Station adjacent to where two cooling towers were previously located. This landfall occurs on the previously disturbed Brayton Point property where there is an open paved area for construction staging operations.

- **Brayton Point Landfall Option B: Eastern.** The Eastern alternate location for the Brayton Point landfall is located in the eastern portion of the former Brayton Point Power Station southeast of Brayton Point Road. This landfall occurs on the previously disturbed Brayton Point property that would hold construction staging operations.
 Intermediate Landfalls on Aquidneck Island (Intermediate Landfall). The Brayton Point ECC would make intermediate landfall on Aquidneck Island in Portsmouth, Rhode Island, for an underground onshore export cable route section. For the entry HDD to Aquidneck Island, one location is being considered at the intersection of Boyds Lane and Park Avenue. For the exit HDD into Mount Hope Bay, four locations are under consideration: one location northeast of the Mount Hope Bridge, one location along an existing overhead utility line corridor, one location in an existing parking lot, and one location on the northeastern side of the Montaup Country Club golf course.
Figure 3.1-12. Falmouth ECC and landfall options
Figure 3.1-13. Brayton Point ECC and landfall options
Figure 3.1-14. Brayton Point ECC and intermediate landfall options on Aquidneck Island
3.1.2.4.3.2 Sea-to-Shore Transition Installation

Installation of the landfall facilities would include the use of onshore excavation and construction equipment, HDD equipment, and offshore cable handling vessels and equipment. Drilling activities would occur on land with the borehole extending under the seabed to an exit point offshore, outside of the intertidal zone. To support this installation, both onshore and offshore work areas are required. Once the onshore work area is set up, the HDD activities would commence using a rig that drills a borehole underneath the surface.

HDD seaward exit points would be within 3,500 feet (1,069 meters) of the shoreline for the Falmouth ECC landfall, and within 1,000 feet (305 meters) of the shoreline for the Brayton Point landfalls. At the seaward exit point, construction activities may include either a temporary gravity-based structure (i.e., gravity cell or gravity-based cofferdam) and/or a dredged exit pit. Installation of both the temporary gravity-based structure and/or a dredged exit pit would not require pile driving or hammering. Additionally, a conductor pipe made of high-density polyethylene or similar material may be installed at the exit point to support the drill activity. Conductor pipe installation would include pushing, and no pile driving is planned. Seabed disturbances from HDD exit pits for landfall locations are shown in Table 3.1-12.

For the Falmouth landfall locations, the HDD trajectory is anticipated to be 0.9 mile (1.5 km) in length with a cable burial depth of up to 90 feet (27.4 meters) below the seabed. HDD boreholes would be separated by a distance of 33 feet (10 meters). Each offshore export cable is planned to require a separate HDD, with an individual bore and conduit for each export cable. The Falmouth ECC would include up to four power cables with up to four boreholes at each landfall site (four total HDDs). The one communications cable would be installed within the same bore as one of the power cables, likely within a separate conduit.

For the Brayton Point and Aquidneck Island intermediate landfall locations, the HDD trajectory is anticipated to be 0.3 mile (0.5 km) in length with a cable burial depth of up to 90 feet (27.4 meters) below the seabed. HDD bores would be separated by a distance of 33 feet (10 meters). The two HVDC cable bundles would be unbundled at landfall. Each HVDC power cable is planned to require a separate HDD, with an individual bore and conduit for each power cable. The Brayton Point ECC and Aquidneck Island landfalls would include up to four power cables for a total of up to four boreholes at each landfall site (12 total HDDs – 4 at entry to Aquidneck Island, 4 at exit of Aquidneck Island, and 4 at Brayton Point landfall). The two communications cables would be installed within the same bore as a power cable, likely within a separate conduit.

Table 3.1-12. Area of disturbance at HDD exit pits for landfall locations

<table>
<thead>
<tr>
<th>Sea-to-Shore HDD</th>
<th>Area Disturbed, Acre (Hectare)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Falmouth</strong></td>
<td></td>
</tr>
<tr>
<td>Exit Pit /cofferdam (per HDD)</td>
<td>0.10 (0.04)</td>
</tr>
<tr>
<td>Total Area Disturbed (4 HDDs)</td>
<td>0.40 (0.16)</td>
</tr>
<tr>
<td><strong>Brayton Point/Aquidneck Island</strong></td>
<td></td>
</tr>
<tr>
<td>Exit Pit /cofferdam (per HDD)</td>
<td>0.30 (0.12)</td>
</tr>
<tr>
<td>Total Area Disturbed (12 HDDs)</td>
<td>3.6 (1.45)</td>
</tr>
</tbody>
</table>

Source: adapted from COP Volume 1, Tables 3-34 and 3-35; Mayflower Wind 2022.

3.1.2.4.3.3 Operation and Maintenance

Offshore export cable maintenance near the HDD exit points would be the same as described previously
3.1.2.4.4 Onshore Cables

From the landfall site options, the underground onshore export cables would be routed to a new onshore substation in Falmouth, Massachusetts, and a converter station in Somerset, Massachusetts (Figure 3.1-1). The underground Falmouth onshore export cables would consist of up to four circuits with three, single-core cables per circuit, for a total of 12 onshore export power cables. Additionally, there would be up to four smaller insulated single-core ground continuity cables for carrying fault currents, and up to five communications cables containing fiber optics (one per circuit plus one dedicated communications cable). Several onshore cable route options are under consideration from the potential landfall site to one of two onshore substation options (Figure 3.1-1):

- Lawrence Lynch Substation (preferred): Worcester Avenue (2.0 miles [3.3 km]), Shore Street (2.3 miles [3.6 km]), Central Park (2.2 miles [3.5 km])
- Cape Cod Aggregates Substation Site (alternate): Worcester Avenue (5.9 miles [9.4 km]), Shore Street (6.4 miles [10.25 km]), Central Park (6.1 miles [9.8 km])

The underground Brayton Point onshore export cables would consist of up to four onshore export power cables. Additionally, there would be up to two communications cables containing fiber optics. Two onshore route options are under consideration from the landfall site to the converter station, and three route options are under consideration at the intermediate landfall at Aquidneck Island (Figure 3.1-1):

- Brayton Point Converter Station: Western (0.6 mile [1 km]), Eastern (0.4 mile [0.6 km])
- Aquidneck Island: All three route options are approximately 3 miles (4.8 km)

The onshore export cables would be installed within existing roadways through open cut trenches. Construction of the onshore substation and converter station and cable installation onshore of the landfalls are not expected to affect ESA-listed species under NMFS jurisdiction. Therefore, these onshore activities are not considered further in this BA.

3.1.2.5 Unexploded Ordnance

Mayflower Wind is conducting a three-phase UXO study to assess possible UXO presence and impact within the Lease Area and ECCs. Phase one, which has been completed, included a desktop study on publicly available data covering the full Project area including both the Lease Area and the ECCs. Based on the conclusions of the research and risk assessment undertaken, a varying low and moderate risk of encountering UXO on site was found (Figure 3.1-15). The risk is moderate throughout all of the Lease Area, and a relatively equal ratio between low and moderate within the ECCs. The identified risk is primarily due to the presence of Allied HE Bombs, Torpedoes, and Depth Charges. Phase two will include a further study in areas of potential interest identified during phase one and utilizes select available survey data. The final phase includes identification of any potential areas of further interest and data gaps. Additionally, phase three will present suggestions for the path forward on further reducing risk to as low as reasonably practicable, consistent with standard industry practice, prior to construction activities.

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

To detonate a UXO, a small charge would be placed on the UXO and detonated, causing the UXO itself to then detonate. The exact number and type of UXOs in the Project area are not yet known, but Mayflower Wind conservatively estimates that up to five UXOs in the Lease Area and up to five along the ECCs may have to be detonated in place. To avoid times when marine mammal species are more likely to be present, UXO detonations are only planned to occur from May through November. If required, UXO detonations would occur starting in Quarter (Q) 2 2025 and occur periodically through Q2 2030, corresponding to WTG/OSP foundation installation and cable installation.

![Figure 3.1-15. UXO risk in Lease Area and ECCs](image)

### 3.1.2.6 Vessel and Aircraft Types and Usage

Probable vessels used to transport and install WTGs and OSPs, with their associated foundations, include heavy lift crane vessels, heavy transport vessels, jack-up vessels, DP vessels, scour protection installation vessels, crew transport vessels, and multipurpose support vessels (Table 3.1-13). Heavy lift crane and transport vessels would be used to transport foundations, WTG components, and OSP topsides. Jack-up vessels, DP vessels, and service operation vessels (SOVs) would be used for installation of the WTG and OSP foundations, WTG components and OSPs, and scour protection installation vessels would be used for installation of scour protection. Additional barges, and accompanying tugboats, may be used for transporting other construction materials. Crew transport vessels (CTVs) would be used to rotate construction crews to and from area ports.
Probable vessels used to transport and install the interarray and offshore export cables include carousel- or static tank-equipped cable lay vessels, dedicated cable transport and lay vessels, and cable lay barge (Table 3.1-13). CTVs would be used to rotate construction crews to and from area ports.

During construction, Mayflower Wind would receive equipment and materials to be staged and loaded onto installation vessels at one or more existing third-party port facilities. The following ports may be used for fabrication, assembly, deployment, or decommissioning activities for Project: Sheet Harbor, Canada; New London, Connecticut; New Bedford and Salem, Massachusetts; Providence, Rhode Island; and Port of Virginia, Virginia. It is estimated that the Project would require approximately 15–35 vessels per day on average, with an expected maximum peak of 50 vessels in the Lease Area at one time, depending on construction activities. In addition, aircraft use is expected during construction and decommissioning activities to transport crew and equipment to and from the Lease Area, and drones may be used similarly for part delivery, or substructure and WTG inspections. Total seabed disturbance footprint from jack-up vessel use during WTG/OSP installation in the Lease Area would be 442 acres (179 hectares). Anticipated vessel utilization parameters, including estimated work duration, are provided in Table 3.1-13.

During O&M activities, service technicians would be delivered to the Lease Area by service operations vessels and CTVs. ROVs, tugs, and other vessels would be used for repair and maintenance activities, as described in Table 3.1-14. Port of New Bedford and the Port of Fall River, Massachusetts, will be used for O&M activities. The Proposed Action would generate one to three vessel trips per day from O&M ports.
Table 3.1-13. Estimated Proposed Action vessel and aircraft use parameters for Mayflower Wind offshore wind farm and export cable construction

<table>
<thead>
<tr>
<th>Vessel / Aircraft Type</th>
<th>Activity</th>
<th>No. of Each Type of Vessel/Aircraft</th>
<th>Vessel/Aircraft Length (meters)</th>
<th>Vessel Beam (meters)</th>
<th>Vessel Draft (meters)</th>
<th>Vessel Deadweight Tonnage (metric tons)</th>
<th>Operational Speed/Max Speed (knots)</th>
<th>Estimated Work Duration (days)</th>
<th>Supply Trips to Port (1-way)</th>
<th>Estimated Number of Nautical Miles Traveled (mileage includes all round-trip mileage for entire buildout)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airplane</td>
<td>Mammal watch, general support</td>
<td>1–2</td>
<td>10–15</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>100–120</td>
<td>260</td>
<td>260</td>
<td>146</td>
</tr>
<tr>
<td>Anchor Handling Tug</td>
<td>Anchor handling, general support</td>
<td>1–10</td>
<td>50–90</td>
<td>12–18</td>
<td>5–8</td>
<td>Up to ~2,500</td>
<td>10/15</td>
<td>240</td>
<td>30</td>
<td>28</td>
</tr>
<tr>
<td>Cable Lay Barge</td>
<td>Transportation and installation of cable and/or dredging (shallow water sections)</td>
<td>1–3</td>
<td>40–130</td>
<td>15–35</td>
<td>2–6</td>
<td>Currently unknown</td>
<td>&lt;5/15</td>
<td>0</td>
<td>120</td>
<td>120</td>
</tr>
<tr>
<td>Cable Transport and Lay Vessel</td>
<td>Transportation and installation of export cable and interarray and/or cable burial activities</td>
<td>1–5</td>
<td>118–165</td>
<td>28–35</td>
<td>5–9</td>
<td>Up to ~20,000</td>
<td>2/11.5</td>
<td>930</td>
<td>110</td>
<td>108</td>
</tr>
<tr>
<td>Crew Transfer Vessel</td>
<td>Commissioning, crew transport, general operations, environmental monitoring and marine mammal observers</td>
<td>2–5</td>
<td>25–40</td>
<td>8–12</td>
<td>1–2.5</td>
<td>50</td>
<td>10/35</td>
<td>1,960</td>
<td>1,608</td>
<td>1,608</td>
</tr>
<tr>
<td>Dredging Vessel</td>
<td>Seabed preparation, inspection, mattress installation, general support</td>
<td>1–5</td>
<td>90–230</td>
<td>20–45</td>
<td>5–18</td>
<td>5,500 – 80,000</td>
<td>2/15</td>
<td>400</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>Drones (Fixed wing, single and/or multi-rotor)</td>
<td>Onsite inspection, marine mammal monitoring and identification</td>
<td>1–5</td>
<td>1.25</td>
<td>1–3</td>
<td>N/A</td>
<td>N/A</td>
<td>0–100</td>
<td>800</td>
<td>84</td>
<td>84</td>
</tr>
<tr>
<td>Heavy Lift Crane Vessel</td>
<td>Transport, transfer and installation of Substructures, WTG, OSP(s) and related components</td>
<td>1–5</td>
<td>130–385</td>
<td>45–125</td>
<td>4–32</td>
<td>Up to ~22,000</td>
<td>0/15</td>
<td>828</td>
<td>90</td>
<td>90</td>
</tr>
<tr>
<td>Heavy Transport Vessel</td>
<td>Transportation of substructures, WTG, OSP(s) and other project components</td>
<td>1–20</td>
<td>140–300</td>
<td>23–70</td>
<td>5.5–12</td>
<td>Up to ~60,000</td>
<td>12/15</td>
<td>28</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Helicopter</td>
<td>Crew changes, part transport, general support</td>
<td>1–4</td>
<td>16</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>100–145</td>
<td>348</td>
<td>348</td>
<td>290</td>
</tr>
<tr>
<td>Jack-up Accommodation Vessel</td>
<td>Commissioning activities</td>
<td>1–2</td>
<td>50–151</td>
<td>42–72</td>
<td>4–10</td>
<td>Currently unknown</td>
<td>0/15</td>
<td>480</td>
<td>98</td>
<td>98</td>
</tr>
<tr>
<td>DP Accommodation Vessel</td>
<td>Commissioning activities</td>
<td>1–2</td>
<td>100–110</td>
<td>65–95</td>
<td>5.5–17</td>
<td>Currently unknown</td>
<td>0/15</td>
<td>720</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>Multipurpose Support Vessel</td>
<td>Seabed preparation, inspection, mattress installation, diving, general support, environmental monitoring and marine mammal observers, noise mitigation, pre- and post-installation inspection surveys</td>
<td>1–8</td>
<td>12–100</td>
<td>5–25</td>
<td>1.5–10</td>
<td>Currently unknown</td>
<td>10/15</td>
<td>4,156</td>
<td>1,170</td>
<td>1,164</td>
</tr>
<tr>
<td>Scour Protection Installation Vessels</td>
<td>Scour protection installation</td>
<td>1–2</td>
<td>135–175</td>
<td>30–40</td>
<td>6–9.5</td>
<td>Up to ~20,000</td>
<td>2/15</td>
<td>400</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>Service Operations Vessel</td>
<td>Commissioning using SOV, general operations</td>
<td>1–4</td>
<td>60–100</td>
<td>15–25</td>
<td>1.5–5</td>
<td>1,700 – 4,500</td>
<td>10/25</td>
<td>480</td>
<td>480</td>
<td>480</td>
</tr>
<tr>
<td>Survey Vessel</td>
<td>Specialized survey work, if required</td>
<td>1–5</td>
<td>28–75</td>
<td>6.5–12</td>
<td>4–7</td>
<td>Currently</td>
<td>2/12</td>
<td>120</td>
<td>24</td>
<td>24</td>
</tr>
</tbody>
</table>
### Table 3.1-14. Estimated Proposed Action vessel and aircraft use parameters for Mayflower Wind offshore wind farm and export cable operation and maintenance

<table>
<thead>
<tr>
<th>Vessel / Aircraft Type</th>
<th>Activity</th>
<th>No. of Each Type of Vessel/Aircraft</th>
<th>Vessel/Aircraft Length (meters)</th>
<th>Vessel Beam (meters)</th>
<th>Vessel Draft (meters)</th>
<th>Vessel Deadweight Tonnage (metric tons)</th>
<th>Operational Speed/Max Speed (knots)</th>
<th>Estimated Work Duration (days)</th>
<th>Federal Waters</th>
<th>Massachusetts Waters</th>
<th>Rhode Island Waters</th>
<th>Supply Trips to Port (1–way)</th>
<th>Estimated Number of Nautical Miles Traveled (mileage includes all round-trip mileage for entire buildout)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tugboat</td>
<td>Transportation to site from staging port, port operations</td>
<td>1–12</td>
<td>30–90</td>
<td>10–13</td>
<td>3–7</td>
<td>Up to ~2,700</td>
<td>5/16</td>
<td>908</td>
<td>512</td>
<td>512</td>
<td>256</td>
<td>917,216</td>
<td></td>
</tr>
<tr>
<td>Barge</td>
<td>Transportation of components to Site from staging port</td>
<td>1–6</td>
<td>76–146</td>
<td>15–33</td>
<td>3.65–9</td>
<td>Currently unknown</td>
<td>N/A</td>
<td>880</td>
<td>492</td>
<td>492</td>
<td>246</td>
<td>131,856</td>
<td></td>
</tr>
</tbody>
</table>

Source: modified from COP Volume 1, Table 3-21; Mayflower Wind 2022

N/A = not applicable
3.1.2.7 Pre- and Post-Construction Surveys

Prior to construction, one or more pre-installation surveys of the cable routes will be conducted. This survey will utilize sonar, sub-bottom profilers, echo-sounder, and/or magnetometer to create images and collect data on features present on the seafloor and within the subsurface. These surveys will further inform installation and protection methods to be applied to the cables, aid in avoiding potential seafloor and subsurface hazards, and identify any anomalies or changes from prior surveys.

HRG and geotechnical will be conducted intermittently during construction (2 of the 5 years to be covered by the requested incidental take regulations [ITR], Q4 of 2024 to Q4 of 2030) to identify any anomalies or changes from prior surveys (such as fishing gear, boulders, or mobile sand waves). These surveys assist in building a framework for the seafloor and subsurface along the export cable route and highlight areas requiring pre-lay route clearance. These surveys may utilize equipment such as multi-beam echosounders, sidescan sonars, shallow penetration sub-bottom profilers (e.g., “Chirp”, parametric, and non-parametric sub-bottom profilers), medium penetration sub-bottom profilers (e.g., sparkers), ultra-short baseline positioning equipment, and marine magnetometers within the Lease Area and along the export cable routes.

During the construction phase an estimated 2,485 miles (4,000 km) may be surveyed within the Lease Area and 3,106 miles (5,000 km) along the ECCs in water depth ranging from 6.5 feet (2 meters) to 204 feet (62 meters). A maximum of four total vessels will be used concurrently for surveying. On average, 50 miles (80-line km) will be surveyed per vessel each day at approximately 3 knots (5.6 km/hour). HRG survey operations will occur on a 24-hour basis, although some vessels may only operate during daylight hours (~12-hour survey vessels). While the final survey plans will not be completed until construction contracting commences, HRG surveys are anticipated to operate at any time of year for a maximum of 112.5 active sound source days.

During the operations phase of construction (3 of the 5 years to be covered by the requested incidental take regulations) an estimated 1,739.8 miles (2,800 km) may be surveyed in the Lease Area and 1,988.4 miles (3,200 km) along the ECCs each year. Using the same estimate of 50 miles (80 km) of survey completed each day per dedicated survey vessel, approximately 75 days of survey activity would occur each year. During the O&M phase years beyond construction, periodic risk-based export cable surveys will be performed, but the frequency and scope of these surveys have yet to be developed.

NMFS (2021b) has completed a programmatic consultation addressing the effects of site assessment and characterization activities anticipated to support siting of offshore wind energy development projects off the U.S. Atlantic coast, including HRG and geotechnical surveys. In its consultation, NMFS (2021b) evaluated potential effects of these activities, including effects on individual animals associated with survey noise exposure; effects of environmental data collection, buoy deployment, operation, and retrieval; effects on habitat; and effects of vessel use, and concluded that the site assessment and characterization activities considered are not likely to adversely affect any ESA-listed species or critical habitat. The pre- and post-construction HRG and geotechnical surveys that would be required for the Proposed Action are anticipated to be similar to the programmatic consultation (BOEM 2021e). Any HRG and geotechnical surveys conducted for the Proposed Action would be required to follow BOEM’s (2021e) Project Design Criteria and Best Management Practices developed to address the mitigation, monitoring, and reporting conditions identified in the programmatic consultation (refer to Section 3.3, Table 3.3-2).

In addition to HRG surveys, Mayflower Wind has proposed a variety of survey methods to evaluate the effect of construction and O&M on benthic habitat structure and composition and economically valuable fish and invertebrate species. Mayflower Wind will be working with the University of Massachusetts Dartmouth’s School for Marine Science and Technology (SMAST) and the Anderson Cabot Center of
Ocean Life at the New England Aquarium to conduct baseline of existing fisheries information in and around the Lease Area and establish monitoring plans for pre-construction, construction, operations, and decommissioning phases of the Project area. Mayflower Wind is working with SMAST, the Anderson Cabot Center, and federal and state agencies to prepare fisheries monitoring plans that are aligned with BOEM guidelines (BOEM 2019), and additional recommendations provided by the Responsible Offshore Science Alliance (ROSA) Fisheries Monitoring Working Group. These plans will incorporate coordination with neighboring lease holders and agencies’ research and monitoring, leverage existing surveys and control sites based on previous work conducted by both institutes, and provide adaptability and flexibility to adjust as new information is learned and/or new regional programs are established.

The survey methods in Table 3.1-15 either directly or indirectly assess fish species and essential fish habitat (EFH) and could affect these resources.

**Table 3.1-15. Mayflower Wind fisheries surveys**

<table>
<thead>
<tr>
<th>Fish Surveys and Studies in the Planning Stage</th>
<th>Focus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trawl Surveys</td>
<td>Collect baseline data to evaluate changes to mesoscale abundance and distribution of fish (demersal and benthic species) within the Project area. Trawl surveys would be video trawls of finfish and squid resources in the Lease Area and control areas.</td>
</tr>
<tr>
<td>Acoustic Surveys</td>
<td>Collect baseline data to evaluate changes to abundance and distribution of fish (pelagic and highly migratory species) around offshore structures. These surveys would be incorporated into innovation and environmental research partnerships.</td>
</tr>
<tr>
<td>Underwater video/photography surveys (drop camera system, ROVs)</td>
<td>Collect baseline data to evaluate changes to abundance and distribution of invertebrate (scallops, etc.) and benthic habitats. Monitor reef effects of offshore structures and foundations. Surveys would use SMAST drop camera and net camera technology. A component of these is incorporated into innovation and environmental research partnerships.</td>
</tr>
</tbody>
</table>

Source: COP Volume 2, Table 11-20; Mayflower Wind 2022.

Benthic habitat surveys using sonar, video, and photographic imaging are used to evaluate changes in benthic habitat structure and invertebrate community composition. These surveys involve similar methods to and would complement other survey efforts conducted by various state, federal, and university entities supporting regional fisheries research and management. The trawl and underwater video surveys would target specific finfish/invertebrate species using methods and equipment commonly employed in regional commercial fisheries. If physical biological sampling is proposed, organisms captured during surveys would be removed from the environment for scientific sampling and commercial use. In the event of physical sampling, non-target organisms would be returned to the environment where practicable, but some of these organisms may not survive.

Moored passive acoustic monitoring (PAM) systems or mobile PAM platforms such as towed PAM, autonomous surface vehicles, or autonomous underwater vehicles may be used prior to, during, and following construction. PAM devices may be required in the COP, through USACE permits, under the MMPA LOA, or required as a condition of the biological opinion. PAM data may be used to characterize the presence of protected species, specifically marine mammals, through passive detection of vocalizations; to record ambient noise and marine mammal vocalizations in the Lease Area before, during, and after construction to monitor project impacts relating to project activities in the Lease Area. In addition to specific requirements for monitoring surrounding the construction period, periodic PAM deployments may occur over the life of the Project for other scientific monitoring needs.
3.1.2.8 Port Modifications

The Proposed Action does not include port modifications.

3.1.2.9 Decommissioning

BOEM’s decommissioning requirements are stated in Section 13, Removal of Property and Restoration of the Leased Area on Termination of Lease, of the April 1, 2019, lease for OCS-A 0521. Unless otherwise authorized by BOEM, pursuant to the applicable regulations in 30 CFR Part 585, Mayflower Wind would be required to “remove or decommission all facilities, projects, cables, pipelines, and obstructions and clear the seafloor of all obstructions created by activities on the leased area, including any project easements(s) within two years following lease termination, whether by expiration, cancellation, contraction, or relinquishment, in accordance with any approved SAP, COP or approved Decommissioning Application and applicable regulations in 30 CFR Part 585.”

Decommissioning is intended to recover valuable recyclable materials, including steel piles, turbines and related control equipment, and the transmission lines. The decommissioning process involves the same types of equipment and procedures used during Proposed Action construction, absent pile driving, and would have similar impacts on the environment.

In accordance with BOEM requirements, Mayflower Wind would be required to remove and/or decommission all Project infrastructure and clear the seafloor of all obstructions when the Project reaches the end of its 35-year designed service life. Before ceasing operation of individual WTGs or the entire Project and prior to decommissioning and removing project components, Mayflower Wind would consult with BOEM and submit a decommissioning plan for review and approval. Upon receipt of the necessary BOEM approval and any other required permits, Mayflower Wind would implement the decommissioning plan to remove and recycle equipment and associated materials. Decommissioning of project components may involve removing their associated chemicals. Alternatively, chemicals may be removed prior to the removal of the Project component. Removal, treatment, and disposal of any chemicals will be completed in accordance with the approved Decommissioning Plan, as well as any federal, state, and local regulations.

The decommissioning process for the WTGs and OSPs, with their associated foundations, is anticipated to be the reverse of installation, with Project components transported to an appropriate disposal and/or recycling facility. All foundations and other Project components would need to be removed 15 feet (4.6 meters) below the mudline, unless other methods are deemed suitable through consultation with the regulatory authorities (Section 2.1), including BOEM. Submarine export and interarray cables would be retired in place or removed in accordance with the BOEM-approved decommissioning plan. Mayflower Wind would need to obtain separate and subsequent approval from BOEM to retire any portion of the Project in place. Project components will be decommissioned using a similar suite of vessels, as described in Section 3.1.2.6.

3.2 Description of IPFs

The Proposed Action would result in various IPFs that could affect ESA-listed species in the Action Area. These IPFs are described in Table 3.2-1. There is no critical habitat designated for any ESA-listed species within the Project area; however, there is critical habitat designated for ESA-listed species within the Action Area, notably NARW foraging ground. Table 3.2-1 describes the IPFs associated with the Proposed Action, identifies the sources or activities that contribute to these IPFs, identifies the listed species that could be exposed to these IPFs (see Section 4 for information on listed species in the Action Area), and differentiates between IPFs that are Not Likely to Adversely Affect (NLAA) and those that may be Likely to Adversely Affect (LAA) listed species or critical habitats.
<table>
<thead>
<tr>
<th>IPF</th>
<th>Description</th>
<th>Sources and/or Activities</th>
<th>Listed Species or CH Exposed to IPF and Expected Level of Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accidental releases</td>
<td>Refers to unanticipated release or spills into receiving waters of a fluid or other substance such as fuel, hazardous materials, suspended sediment, trash, or debris. Accidental releases are distinct from routine discharges, the latter typically consisting of authorized operational effluents controlled through treatment and monitoring systems and permit limitations.</td>
<td>• Offshore stationary sources (e.g., renewable energy structures, transmission lines, cables) • Mobile sources (e.g., vessels)</td>
<td>Not likely to adversely affect (NLAA): • Whales: blue, fin, NARW, sei, sperm • Sea turtles: green, hawksbill, Kemp's ridley, leatherback, loggerhead • Fish: Atlantic salmon, Atlantic sturgeon, giant manta ray, oceanic whitetip shark, shortnose sturgeon • CH: Loggerhead, NARW, Atlantic sturgeon Likely to adversely affect (LAA): • none</td>
</tr>
<tr>
<td>Intakes and discharges</td>
<td>Refers to water intakes and routine permitted operational effluent discharges to receiving waters. There can be numerous types of vessel and structure discharges, such as bilge water, ballast water, deck drainage, gray water, fire suppression system test water, chain locker water, exhaust gas scrubber effluent, condensate, and seawater cooling system effluent, among others. These discharges are restricted to uncontaminated or properly treated effluents that may have best management practice or numeric pollutant concentration limitations imposed through USEPA National Pollutant Discharge Elimination System (NPDES) permits or U.S. Coast Guard regulations.</td>
<td>• Dredged material ocean disposal • Vessels • Structures (e.g., OSPs) • Submarine transmission lines, cables, and infrastructure</td>
<td>Same as for Accidental releases</td>
</tr>
<tr>
<td>Air emissions</td>
<td>Refers to the release of gaseous or particulate pollutants into the atmospheres.</td>
<td>• Internal combustion engines (such as generators) aboard stationary sources or structures • Internal combustion engines within mobile sources such as vessels or aircraft</td>
<td>Same as for Accidental releases</td>
</tr>
<tr>
<td>IPF</td>
<td>Description</td>
<td>Sources and/or Activities</td>
<td>Listed Species or CH Exposed to IPF and Expected Level of Impact</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Anchors/Mats</td>
<td>Anchors, anchor chain sweep, mooring, and the installation of bottom-founded structures can alter the seafloor. Does not refer to designated anchorage areas for marine transportation, all of which are far from wind energy lease or planning areas.</td>
<td>• Anchoring of vessels&lt;br&gt;• Attachment of a structure to the sea bottom by use of an anchor, mooring, or gravity-based weighted structure (i.e., bottom-founded structure)</td>
<td>Same as for Accidental releases</td>
</tr>
<tr>
<td>Electromagnetic fields (EMFs) and heat</td>
<td>Power lines produce electric fields (proportional to the voltage of the lines) and magnetic fields (proportional to flow of electric current) in the air around the power line. For undersea power cables, the voltage on the wire conductors within the cable does not produce an electric field in the seafloor or ocean because it is locked (shielded) by the outer grounded metallic sheath encircling the conductors. However, the metal sheath magnetic around the undersea power cable do not shield the environment from the magnetic field; therefore, a 60-Hz magnetic field surrounds each cable. Three major factors determine levels of the magnetic and induced electric fields from offshore wind energy projects: 1) the amount of electrical current being carried by the cable, 2) the design of the cable, and 3) the distance of marine organisms from the cable.</td>
<td>• Electricity generation&lt;br&gt;• Substations&lt;br&gt;• Power transmission cables&lt;br&gt;• Interarray cables</td>
<td>Same as for Accidental releases</td>
</tr>
<tr>
<td>Lighting</td>
<td>Refers to the presence of light above the water as well as underwater associated with offshore wind development and activities that utilize offshore vessels.</td>
<td>• Lighting on vessels or offshore structures above or under water</td>
<td>Same as for Accidental releases</td>
</tr>
<tr>
<td>Cable emplacement/maintenance</td>
<td>Refers to disturbances associated with site clearance and installation new offshore submarine cables on the seafloor, commonly associated with offshore wind energy.</td>
<td>• Boulder relocation&lt;br&gt;• Pre-grapnel run&lt;br&gt;• Dredging or trenching&lt;br&gt;• Cable placement&lt;br&gt;• Seabed profile alterations&lt;br&gt;• Sediment deposition and burial</td>
<td><em>Not likely to adversely affect (NLAA):</em>&lt;br&gt;• Whales: blue, fin, NARW, sei, sperm&lt;br&gt;• Fish: Atlantic salmon, Atlantic sturgeon, giant manta ray, oceanic whitetip shark, shortnose sturgeon&lt;br&gt;• CH: Loggerhead, NARW, Atlantic sturgeon</td>
</tr>
<tr>
<td>IPF</td>
<td>Description</td>
<td>Sources and/or Activities</td>
<td>Listed Species or CH Exposed to IPF and Expected Level of Impact</td>
</tr>
<tr>
<td>-----</td>
<td>-------------</td>
<td>---------------------------</td>
<td>---------------------------------------------------------------</td>
</tr>
</tbody>
</table>
| Noise: in-air | Refers to noise from various sources. Commonly associated with construction activities, such as the noise generated by aircrafts or interactions of the turbines with wind and waves. | • Aircraft  
• Operation and maintenance  
• Turbines | Likely to adversely affect (LAA):  
• Sea turtles: green, hawksbill, Kemp’s ridley, leatherback, loggerhead |
| Noise: underwater | Refers to noise from various sources. Commonly associated with construction activities, geophysical and geotechnical surveys, and vessel traffic. May be impulsive (e.g., pile driving), or may be broad spectrum and continuous (e.g., from project-associated marine transportation vessels). May also include noise generated from turbines themselves. | • Geological and geophysical surveys  
• Operation and maintenance  
• Pile driving / foundation installation  
• Turbines  
• Vessels  
• UXO Detonation | Not likely to adversely affect (NLAA):  
• none  
Likely to adversely affect (LAA):  
• Whales: blue, fin, NARW, sei, sperm  
• Sea turtles: green, hawksbill, Kemp’s ridley, leatherback, loggerhead  
• Fish: Atlantic salmon, Atlantic sturgeon, giant manta ray, oceanic whitetip shark, shortnose sturgeon  
• CH: Loggerhead, NARW, Atlantic sturgeon |
| Port utilization | Refers to effects associated with port activity, upgrades, or maintenance that occur only as a result of the project. Includes activities related to port expansion and construction from increased economic activity and maintenance dredging or dredging to deepen channels for larger vessels. | • Expansion / Rehabilitation  
• Near-shore pile driving  
• Cofferdams | None (not proposed) |
| Presence of structures | Refers to effects associated with onshore or offshore structures other than construction-related effects, including the following:  
Space-use conflicts  
Fish aggregation/dispersion  
Scour protection  
Allisions  
Allisions  
Entanglement | • Onshore and offshore structures including WTGs, OSPs, towers and transmission cable infrastructure | Same as for Accidental releases |
<table>
<thead>
<tr>
<th>IPF</th>
<th>Description</th>
<th>Sources and/or Activities</th>
<th>Listed Species or CH Exposed to IPF and Expected Level of Impact</th>
</tr>
</thead>
</table>
| Gear loss/damage | Fishing effort displacement  
Habitat alteration (creation and destruction)  
Migration disturbances  
Navigation hazard  
Seabed alterations  
Turbine strikes (birds, bats)  
Oceanographic/Hydrodynamic impacts  
Viewshed (physical, light) |                              |                                                                  |
| Traffic      | Refers to marine vessel congestion, including vessel strikes of sea turtles and marine mammals, collisions, and allisions. | • Aircraft  
• Marine Vessels | Not likely to adversely affect (NLAA):  
• Whales: blue, fin, NARW, sei, sperm  
• Fish: Atlantic salmon, Atlantic sturgeon, giant manta ray, oceanic whitetip shark, shortnose sturgeon  
• CH: Loggerhead, NARW, Atlantic sturgeon  
Likely to adversely affect (LAA):  
• Sea turtles: green, hawksbill, Kemp’s ridley, leatherback, loggerhead |
| Biological surveys | Refers to effects from biological surveys conducted pre-, post-, and during construction including entanglement/entrapment in gear | • Aerial- and vessel-based surveys  
• Fishery Surveys  
• Benthic surveys | Same as for Accidental releases |
| Turbidity    | Refers to effects from turbidity associated with construction and installation activities, port modifications, and vessel traffic. | • Installation of offshore infrastructure  
• Port Modifications (e.g., dredging)  
• Cable emplacement  
• Vessel activity | Same as for Accidental releases |
### Description of the Proposed Action

<table>
<thead>
<tr>
<th>IPF</th>
<th>Description</th>
<th>Sources and/or Activities</th>
<th>Listed Species or CH Exposed to IPF and Expected Level of Impact</th>
</tr>
</thead>
</table>
| Unexpected/unanticipated events | Effects associated with unexpected and unanticipated events, such vessel collision with foundation, failure of turbines due to weather events, oil spills, and unexploded ordnance encounters. | • Vessel Traffic  
• Offshore Structures  
• UXO Encounters/Response | Same as for Accidental releases |

CH = critical habitat
3.3 Proposed Mitigation, Monitoring, and Reporting Measures

This section outlines the mitigation, monitoring and reporting conditions that are intended to minimize or avoid potential impacts on ESA-listed protected species. Mitigation measures committed to by Mayflower Wind in the COP are considered a part of the Proposed Action and are binding. For marine mammals, such conditions may also be contained in the LOA from NMFS, which has been applied for under the MMPA by Mayflower Wind. Conditions would also be required under the ESA consultation process. Notably, the temporal scope of ESA consultation is broader than the LOA and covers the life of the Project, whereas the LOA regulations are valid for 5 years for construction and the initial years of O&M of the Project. Therefore, the scope of some measures such as vessel strike avoidance conditions and reporting requirements may apply beyond the scope of the LOA. Mitigation measures to which Mayflower Wind commits as part of the MMPA process will be included as conditions of the final LOA and will be required. A requirement to follow final LOA conditions that apply to ESA-listed whales will also be included as a condition in the final record of decision.

Descriptions of applicant-proposed measures under the Proposed Action are provided in Table 3.3-1. During the development of the draft BA, and in coordination with cooperating agencies, BOEM considered additional mitigation measures that could further avoid, minimize, or mitigate impacts on the physical, biological, socioeconomic, and cultural resources assessed in this document. These potential additional mitigation measures are described in Table 3.3-2. Some or all of these BOEM-proposed mitigation measures may be required as a result of consultation completed under Section 7 of the ESA, or through the Magnuson Stevens Act. Mitigation imposed through consultations will be included in the Final BA. The additional mitigation measures presented in Table 3.3-2 may not all be within BOEM’s statutory and regulatory authority to require; however, other jurisdictional governmental agencies may potentially require them. BOEM may choose to incorporate one or more additional measures in the record of decision and adopt those measures as conditions of COP approval.

BOEM is considering several measures to mitigate impacts from the Project on species and habitat in Nantucket Shoals, which is an area of high foraging value for several ESA-listed species near the northeastern portion of the Lease Area. These measures identify restrictions on Project activities within an “enhanced mitigation area” of the Lease Area nearest to Nantucket Shoals, as shown in Figure 3.3-1. The enhanced mitigation area was delineated by evaluating the density and abundance of wildlife adjacent to Nantucket Shoals. This analysis included avian abundance, greatest NARW densities (fall and winter), zooplankton, and chlorophyll a (Northeast Ocean Data 2022). For NARW density, the enhanced mitigation area includes all cells containing one animal or more based on the latest right whale density models for February which produced the greatest densities within the Lease Area. BOEM has proposed three measures, NS-1, NS-2, and NS-4, which appear in Table 3.3-2. In addition, BOEM is in the process of evaluating the financial feasibility and practicability of two additional measures (NS-3 and NS-5), which are described below. If selected, these measures will be identified in the Final BA.

- **Potential Measure under Evaluation: NS-3 Vessel-strike avoidance.** A real-time detection and reporting PAM system must be implemented during the construction period. The PAM system must operate in the enhanced mitigation area (Figure 3.3-1) 24 hours per day. The system must be capable of detection of NARW vocalizations, report the detections to a PAM operator in near-real time, and share all detections with NMFS. Upon a confirmed detection of a NARW, all Project construction and crew transfer vessels of all sizes must travel at 10 knots (18.5 km per hour) or less in a 4-square-mile (10-square-kilometer) area around the location of the detection. Speed restriction must remain in place until there are no PAM detections within 48 hours of implementation of the speed restrictions, or daily aerial surveys result in no NARW sightings within 48 hours of implementation of the speed restrictions. This precautionary measure would be in place during offshore construction no matter the time of year when such work is being done. While NARW occurrence around Nantucket Shoals is
greatest in the fall and winter, this measure addresses avoidance during offshore construction throughout the year to reduce the potential of any interaction between vessels and NARWs.

- **Potential Measure under Evaluation: NS-5 Pile Driving shut down provisions in enhanced mitigation area.** Mayflower Wind will be required to implement a real-time monitoring system (PAM or aerial imagery) capable of detecting and localizing the direction of NARW calls around foundation installation in the enhanced mitigation area (Figure 3.3-1). The system must be able to detect NARWs within the permanent threshold shift (PTS) and behavioral harassment distances modeled or modified through approved sound field verification measurements. If a NARW is detected within the PTS and behavioral harassment distances from pile driving, subsequent pile driving shall be temporarily suspended. Pile driving may not commence until acoustic monitoring or visual surveillance confirms no NARW occurrence within these distances for a continuous 48 hours.
Table 3.3-1. Mitigation, monitoring, and reporting measures as proposed in the Petition for Incidental Take Regulations for the Construction and Operations of the Mayflower Wind Project submitted to NMFS (see 87 FR 62793; https://media.fisheries.noaa.gov/2022-10/MayflowerWindNewEng_2022ITA_App_OPR1.pdf) and the Mayflower Wind COP

<table>
<thead>
<tr>
<th>No</th>
<th>Measure Description</th>
<th>Project Phase</th>
<th>Expected Effects</th>
</tr>
</thead>
</table>
| AMM-1 | Observer Qualifications and Training  
PSOs and Acoustic PSOs (APSOs / PAM Operators) will have met NMFS and BOEM training and experience requirements.  
PSOs and APSOs will be employed by a third-party observer provider.  
Briefings between construction supervisors and crews and the PSO/APSO team will be held prior to the start of all pile driving activities as well as when new personnel join the vessel(s).  
At least one PSO on duty at all times will have prior experience working as a PSO.  
APSOs responsible for determining if an acoustic detection originated from a NARW will be trained in identification of mysticete vocalizations. | C             | Increase effectiveness of monitoring with comprehensive training                      |
| AMM-2 | Responsibilities and Authorities of PSOs  
PSOs will have no other responsibilities while on watch.  
Any PSO or APSO on duty will have the authority to delay the start of operations or to call for a shutdown based on their observations or acoustic detection.  
A clear line and method of communication between the PSOs/APSOs and pile driving crew will be established and maintained to ensure mitigation measures are conveyed without delay. | C             | Increase effectiveness of monitoring to minimize impacts                           |
| AMM-3 | Visual Monitoring Equipment  
The following types of equipment will be used to monitor for marine mammals from one or more locations.  
Reticle binoculars  
Mounted thermal/IR camera system. The camera systems will be automated with detection alerts that will be checked by a PSO on duty; however, cameras will not be manned by a dedicated observer.  
Mounted “big-eye” binocular  
Monitoring station for real time PAM system (impact pile driving only)  
The selected PAM system will transmit real time data to PAM monitoring stations on the vessels and/or shore side monitoring station.  
Hand-held or wearable NVDS  
IR spotlights  
Data collection software system  
PSO-dedicated VHF radios  
Digital single-lens reflex camera equipped with 300-mm lens. | C             | Increase effectiveness of monitoring by using the best available equipment            |
| AMM-4 | Number of PSOs  
A sufficient number of PSOs will be stationed aboard the installation and/or nearby support vessels to meet the following criteria:  
At least two PSOs on duty during all pre-clearance periods and active pile driving;  
At least one PSO on duty during all other daylight periods;  
A maximum of four consecutive hours on watch per PSO  
A maximum of 12 hours on watch during a 24-hour period. | C             | Increase effectiveness of monitoring to avoid or minimize impacts                  |
| AMM-5 | Visual Monitoring Methods – Pile Driving  
Observations will be conducted from the best safe vantage point(s) on the construction or nearby support vessel to ensure visibility of the clearance zones.  
When conducting observations during pile driving, PSOs will scan systematically with the unaided eye, high-magnification (25x) binoculars, and/or standard handheld (7x) binoculars to search continuously for marine mammals during all observational periods.  
When monitoring at night, PSOs will monitor for marine mammals and other protected species using night-vision goggles with thermal clip-ons and a hand-held spotlight.  
PSOs will watch for and record all marine mammal sightings regardless of the distance from the observer and/or sound source.  
Distances to observed animals will be estimated with range finders, reticule binoculars, or clinometers when possible and based on the best estimate of the PSO when necessary.  
PSOs will record watch effort and environmental conditions on a routine basis. | C             | Increase effectiveness of mitigations to avoid or minimize impacts on marine mammals and sea turtles from underwater noise-producing activities |
| AMM-6 | Visual Monitoring During Vessel Transit  
PSOs and/or trained vessel crew will observe for marine mammals and sea turtles at all times when vessels are transiting to/from and within the Project area and port.  
PSOs and/or vessel crew will request ship-strike avoidance measures if necessary. | C             | Increase effectiveness of monitoring to minimize impacts                           |
| AMM-7 | Daytime Visual Monitoring  
Follow BOEM and NMFS Protected Species Observer (PSO) and Acoustic Protected Species Observer (APSO) Experience and Responsibilities for BOEM-approved training and NMFS-approved PSOs, respectively  
Adhere to PSO rotation requirements to reduce PSO fatigue  
Two PSOs on duty will keep watch on a construction vessel during the pre-start clearance period, throughout pile driving, and 30 minutes after piling is completed. | C             | Increase effectiveness of monitoring to avoid or minimize impacts on marine mammals from underwater noise-producing activities |
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<th>No</th>
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<th>Description</th>
<th>Project Phase</th>
<th>Expected Effects</th>
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<td></td>
<td><strong>AMM-8</strong></td>
<td><strong>Nighttime Periods of Reduced Visibility</strong></td>
<td>C</td>
<td>Increase effectiveness of monitoring to avoid or minimize impacts on marine mammals from underwater noise-producing activities during low visibility conditions using enhanced detection equipment.</td>
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<td>When monitoring in low visibility conditions, PSOs will monitor for marine mammals and other protected species using night-vision devices with thermal clip-ons, a hand-held spotlight, and/or a mounted thermal camera system or other electronic methods. These measures will apply during the pre-start clearance period, during active pile driving, and 30 minutes after piling is completed. If the Level B harassment zone is obscured, the two PSOs on watch will continue to monitor the shutdown zone utilizing thermal camera systems and/or other electronic method(s) and PAM. During nighttime or low visibility conditions, the two PSOs on watch will monitor the shutdown zone with the mounted IR camera (further described in 11.2.4), available handheld night vision, and/or other electronic method(s). All on-duty PSOs will be in contact with the APSOs who will monitor the PAM systems for acoustic detections of marine mammals that are vocalizing in the area (impact pile driving only). Low visibility monitoring will be supplemented by PAM.</td>
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<td><strong>AMM-9</strong></td>
<td><strong>Nighttime Visual Monitoring</strong></td>
<td>C</td>
<td>Increase effectiveness of monitoring to avoid or minimize impacts on marine mammals from underwater noise-producing activities at night using enhanced detection equipment.</td>
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<td>During nighttime operations, night vision equipment (night vision goggles and infrared/thermal imaging technology) will be used. Recent studies have concluded that the use of infrared/thermal imaging technology allow for the detection of marine mammals at night (Verfluss et al. 2018). Guazzo et al. (2019) showed that probability of detecting a large whale blow by a commercially available infrared camera was similar at night as during the day; camera monitoring distance was 2.1 km (1.3 mi) from an elevated vantage point at night versus 3 km (1.9 mi) for daytime visual monitoring from the same location. The following nighttime piling monitoring and mitigation methods use the best currently available technology to mitigate potential impacts and result in the least practicable adverse impact. During nighttime operations, visual PSOs on-watch will rotate in pairs: one PSO observing with an NVD and one monitoring the IR thermal imaging camera system. There will also be an APSO on duty conducting acoustic monitoring in coordination with the visual PSOs. The PSOs on duty will monitor for marine mammals and other protected species using night-vision goggles with thermal clip-ons, a hand-held spotlight (one set plus a backup set) and/or other electronic method(s), such that PSOs can focus observations in any direction. If possible, deck lights will be extinguished or dimmed during night observations when using the NVDs (strong lights compromise the NVD detection abilities); alternatively, if the deck lights must remain on for safety reasons, the PSO will attempt to use the NVDs in areas away from potential interference by these lights. Nighttime visual monitoring will be supplemented by PAM.</td>
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<td><strong>AMM-10</strong></td>
<td><strong>Acoustic Monitoring</strong></td>
<td>C</td>
<td>Use mitigation PAM to increase detection of marine mammals and increase the area capable to be effectively monitored to avoid or minimize exposure of marine mammals to pile driving noise that may cause harassment or PTS.</td>
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<td>Since visual observations within the applicable shutdown zones can become impaired at night or during daylight hours due to fog, rain, or high sea states, visual monitoring with thermal and NVDs will be supplemented by PAM during these periods. An APSO will be on watch during all pre-start clearance, piling, and post-piling monitoring periods (daylight, reduced visibility, and nighttime monitoring). A combination of alternative monitoring measures, including PAM, has been demonstrated to have comparable detection rates (although limited to vocalizing individuals) to daytime visual detections for several species (Smith et al., 2020). A PAM Plan will be submitted to NMFS and BOEM prior to the planned start of pile driving. There will be one APSO on duty monitoring a real-time PAM system during pre-start clearance, piling, and post-piling periods during both daytime and nighttime/low visibility conditions. All on-duty PSOs will be in contact with the APSO on duty, who will monitor the PAM systems for acoustic detections of marine mammals that are vocalizing in the area. For real-time PAM systems, at least one APSO will be designated to monitor each system by viewing data or data products that are streamed in real-time or near-real-time to a computer workstation and monitor located on a Project vessel or onshore. The PAM operator will inform the PSOs on duty, who will be responsible for recording that the Lead PSO implement the necessary mitigation procedures, of animal detections approaching or within the applicable mitigation zones to the pile location via the data collection software system (i.e., Mysticetus or similar system). The PAM system will be deployed with a capability of monitoring up to 10 km radii from the pile. APSOs will rotate on a 4-hour basis when monitoring from a 24-hour operation vessel or base of operations. PAM will be used in conjunction with visual monitoring equipment, such as night vision and IR cameras (described in AMM-8 and AMM-9.) to allow initiation of pile driving when visual observation of the entire pre-start clearance zone is not possible due to poor visibility, including darkness during nighttime operations.</td>
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<td>There will be one APSO on duty during both daytime and nighttime/low visibility monitoring. APSOs will immediately communicate all acoustic detections of marine mammals to PSOs performing visual observations including any determination regarding species identification, distance, and bearing of the marine mammal. The PAM system will not be located on the pile installation vessel to reduce masking of marine mammal sounds. A detailed description of the real-time PAM system will be developed and submitted to NMFS and BOEM for review and approval.</td>
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<td>C Increase detection of marine mammals and increase the area capable to be effectively monitored</td>
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<tr>
<td>AMM-11</td>
<td>Number of APSOs</td>
<td>At least one APSO during all pre-clearance periods and active pile driving. A maximum of four consecutive hours on watch per APSO. A maximum of 12 hours of watch time per 24-hour period per APSO.</td>
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<td>C Increase detection of marine mammals and increase the area capable to be effectively monitored</td>
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<tr>
<td>AMM-12</td>
<td>Passive Acoustic Monitoring Methods</td>
<td>A real-time PAM system will be used to supplement visual monitoring during pre-piling clearance and throughout pile driving. Use of PAM will allow initiation of pile driving when visual observation of the entire clearance zone is not possible due to poor visibility, including darkness. A detailed description of the real-time PAM system will be developed during the Marine Mammal Protection Act Incidental Take Authorization process. The PAM system may not be located on the pile installation vessel to reduce masking of marine mammals sounds. The APSOs will immediately communicate all acoustic detections of marine mammals to PSOs performing visual observations including any determination regarding species identification, distance, and bearing of the marine mammal.</td>
<td></td>
<td>C Increase detection of marine mammals and increase the area capable to be effectively monitored to avoid or minimize exposure of marine mammals to pile driving noise that cause harassment or PTS.</td>
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<tr>
<td>AMM-13</td>
<td>Sound Source Verification – UXO Detonation</td>
<td>Measurements will be made of at least one detonation for each charge weight class that must be detonated using methods available in the ITR. A sound field verification plan for UXO detonation will be submitted to NMFS prior to planned start of UXO detonations.</td>
<td></td>
<td>C Adaptive monitoring and reporting to verify the appropriateness of clearance and shutdown zones. These zones may be adjusted as needed based on these reported measurements.</td>
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<tr>
<td>AMM-14</td>
<td>Sound Source Verification – Pile Driving</td>
<td>Measurement of each pile type (monopiles and/or piled jackets) to be installed to determine the sound levels produced and effectiveness of the NASs(s). Procedures for how measurement results will be used to justify any requested changes to planned monitoring and mitigation distances. Measurements of received levels will be taken at various distances and azimuths relative to the pile location designed to gather data on sounds produced during installation scenarios specific to the Project. These measurements are designed to assess whether or not the distances to the Level A and Level B harassment isotropes and/or other mitigation action distances align with the distances modeled. SSV will include at least one recorder in each of the four azimuths around the pile (to capture potential directivity of the sound field). Additionally, there will be 3-4 recorders along one azimuth to capture the propagation loss in at least one direction to allow assessment of the modeled Level A and Level B isotrope.</td>
<td></td>
<td>C Adaptive monitoring and reporting to verify the appropriateness of clearance and shutdown zones. These zones may be adjusted as needed based on these reported measurements.</td>
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<tr>
<td>AMM-15</td>
<td>Reporting Protocols</td>
<td>All vessels will utilize a standardized data entry format. A quality assurance/quality control (QA/QC) database of all sightings and associated details (e.g., distance from vessel, behavior, species, group size/composition) within and outside of the designated shutdown zone, monitoring effort, environmental conditions, and Project-related activity will be provided after field operations and reporting are complete. During all pile driving activities, weekly reporting summarizing sightings, detections, and activities will be provided to NMFS and BOEM on the Wednesday following a Sunday-Saturday period. Final reports will follow a standardized format for PSO reporting from activities requiring marine mammal mitigation and monitoring. An annual report summarizing the prior year’s activities will be provided to NMFS and BOEM 90-days after completion of each 12-month period during the effectiveness of the ITRs.</td>
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<td>C Monitoring effectiveness of mitigation measures via reporting.</td>
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<tr>
<td>AMM-16</td>
<td>Underwater Noise (pile driving) – Pre-Start Clearance</td>
<td>A 30-minute pre-start clearance period will be implemented for impact and vibratory pile driving activities. Visual PSOs will begin surveying the pre-start clearance zone at least 30 minutes prior to the start of pile driving. For impact pile driving, PAM will begin 30-minutes prior to the start of pile driving. Pre-start clearance zones will follow the same zone sizes as presented below. All pre-start clearance zones will be confirmed to be free of marine mammals and sea turtles through the use of visual monitoring (including the use of IR and NVO systems, as appropriate) and PAM for at least 30 minutes prior to commencing soft-start. If a marine mammal or sea turtle is observed entering or within the relevant pre-start clearance zones prior to the initiation of pile driving activity, pile driving activity will be delayed. An acoustic detection localized to a position within the pre-start clearance zone(s) will trigger a delay. Impact and/or vibratory pile driving may commence when either the sea turtle(s) or marine mammal(s) has voluntarily left the respective pre-start clearance zones and been visually or acoustically confirmed beyond that pre-start clearance zone, or, when the additional time period has elapsed with no further sighting or acoustic detection (i.e., 15 minutes for small odontocetes and seals and 30 minutes for all other species).</td>
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<td>C Minimize impacts on marine mammals and sea turtles from underwater noise-producing activities by ensuring the area is clear</td>
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<tr>
<td>AMM-17</td>
<td>Underwater Noise (pile driving) – Soft Start</td>
<td>Soft start procedures will be followed, to the extent practicable, at the beginning of each pile driving event or any pile time pile driving has stopped for longer than 30 minutes. A soft start procedure will not begin until the shutdown zone has been cleared by the visual PSO or APSOs.</td>
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<td>C Avoid or minimize impacts on marine mammals and sea turtles from underwater noise-producing activities by using a soft start to allow animals to...</td>
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<tr>
<td>AMM-18</td>
<td>Underwater Noise (pile driving) – Shutdowns</td>
<td>If a marine mammal or sea turtle is detected within or about to enter the shutdown zone, prior to or during the soft-start procedure, pile driving will be delayed until the animal has been observed exiting the relevant shutdown zone or until an additional time period has elapsed with no further sighting (i.e., 15 minutes for odontocetes and seals and 30 minutes for all other species). If a marine mammal or sea turtle is detected entering or within the respective shutdown zone after pile driving has commenced, an immediate shutdown of pile driving will be requested unless the PSOs or APSOs determine shutdown is not feasible. If a shutdown is not feasible at that time in the installation process because of a risk to human or vessel safety or the risk of jeopardizing the installation process, a reduction in the hammer energy of the greatest extent possible will be implemented. The shutdown zone will be continually monitored by PSOs and APSOs during any pauses in pile driving.</td>
<td>C</td>
<td>Avoid or minimize impacts on marine mammals or sea turtles from underwater noise-producing activities by halting activities when animals enter an unsafe area</td>
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<tr>
<td>AMM-19</td>
<td>Underwater Noise (pile driving) – Shutdown Zones</td>
<td>The ranges of shutdown zones below are based upon the Level A exposure ranges with 10 dB of noise attenuation. The shutdown zones are the largest zone sizes expected to result from foundation installations for each scenario. If smaller diameter piles, lower maximum hammer energies and/or total strikes per pile, or more effective NAS are decided upon and used during the construction activities, modeled Level A exposure ranges applicable to those revised parameters would be used, likely to result in smaller maximum distances to the Level A harassment isopleths, relative to those on which the shutdown distances are based. Further details of scenarios and cetacean frequency classifications can be found in the ITR.</td>
<td>C</td>
<td>Establish safety measures to avoid or minimize impacts on marine mammals from underwater noise-producing activities</td>
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<tr>
<td>AMM-20</td>
<td>Underwater Noise (pile driving) – Post Piling Monitoring</td>
<td>PSOs will continue to survey the shutdown zone throughout the duration of pile installation and for a minimum of 30 minutes after piling has been completed.</td>
<td>C</td>
<td>Increase effectiveness of mitigations to avoid or minimize impacts on marine mammals from underwater noise-producing activities</td>
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<tr>
<td>AMM-21</td>
<td>Underwater Noise (pile driving) – Noise Attenuation</td>
<td>Several recent studies summarizing the effectiveness of noise attenuation systems (NAS) have shown that broadband sound levels are likely to be reduced by anywhere from 7 to 17 dB, depending on the environment, pile size, and the size, configuration and number of systems used, such as single bubble curtain, large bubble curtains with two rings, double bubble curtains, etc. Combinations of systems (e.g., double big bubble curtain, hydrodsound damper plus single big bubble curtain) potentially achieve much higher attenuation. The type and number of NAS to be used during construction have not yet been</td>
<td>C</td>
<td>Increase effectiveness of mitigations to avoid or minimize impacts on marine mammals from underwater noise-producing activities by dampening sound</td>
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<td>No</td>
<td>Measure Description</td>
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<td>AMM-22</td>
<td>Underwater Noise (pile driving) – Avoidance of NARW Activity</td>
<td>C</td>
<td>Avoid or minimize impacts on NARWs from Project activities</td>
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<td></td>
<td>Potential Additional Measures to Protect North Atlantic Right Whales</td>
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<td>To complete installation within as few years as possible during the multiple year</td>
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<td>installation campaign expected for the entire Lease Area build-out, impact pile</td>
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<td>driving 24-hours per day is deemed necessary.</td>
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<td>The period from January through April is when the highest number of NARW are present</td>
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<td>in the region which means foundation installations during this period would result</td>
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<td>in greater potential impacts on this species. To reduce these impacts and associated</td>
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<td>impacts on the NARW, Mayflower Wind may conduct nighttime impact pile driving of</td>
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<td>monopile or piled jacket foundations during time periods when the fewest number of</td>
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<td>NARW are likely to be present in the region. Specific measures will include:</td>
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<td>Concentrating construction activities when NARW are less likely to be present within</td>
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<td>the region (May 1 through December 31), including in the Lease Area.</td>
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<td>Specific monitoring tools and plans will be developed as part of the ongoing ITR</td>
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<td>Application process, but may include the use of advanced infrared systems, real-time</td>
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<td>PAM, autonomous underwater vehicles, autonomous aerial vehicles, or other advanced</td>
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<td>technologies that could improve the probability of detecting marine mammals at night.</td>
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<td>AMM-23</td>
<td>Vessel Strike Avoidance – General Measures</td>
<td>C,O,D</td>
<td>Establish operational standards to minimize risk to marine mammals and sea turtles</td>
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<td>All vessels, including those transiting to and from local ports and the Project area,</td>
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<td>will follow the vessel strike avoidance measures outlined below, except in cases</td>
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<td>where following these requirements would put the safety of the vessel or crew at</td>
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<td>risk. Captain, first mate, and/or designated vessel personnel working offshore will</td>
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<td>receive training on marine mammal awareness and vessel strike avoidance measures.</td>
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<td>A minimum of one PSO or trained vessel crew member will be present on all vessels</td>
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<td>when transiting. Observers will maintain a vigilant watch for all marine mammals</td>
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<td>and slow down, change course, slow down or stop vessels to avoid striking protected</td>
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<td>species. Observers will monitor the NMFS NARW reporting systems from November 1</td>
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<td>through May 30 and whenever a dynamic management area (DMA) is established in the</td>
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<td></td>
<td>operational area.</td>
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<td>AMM-24</td>
<td>Vessel Strike Avoidance – Separation Distances</td>
<td>C,O,D</td>
<td>Establish operational standards to minimize risk to marine mammals</td>
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<td>Maintaining &gt;500 m distance from any sighted NARW or an unidentified large marine</td>
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<td>mammal.</td>
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<td>Maintaining &gt;100 m from all ESA-listed whales or humpback whales.</td>
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<td>Maintaining &gt;50 m from all other marine mammals, with the exception of delphinids</td>
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<td>and pinnipeds that approach the vessel, in which case the vessel operator must</td>
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<td>avoid excessive speed or abrupt changes in direction.</td>
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<td>AMM-25</td>
<td>Vessel Strike Avoidance – Actions Given Observed Marine Mammal</td>
<td>C,O,D</td>
<td>Establish operational standards to minimize risk to marine mammals</td>
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<td>If underway, vessels will steer a course away from any NARW at 10 kts or less</td>
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<td>until the 500 m minimum separation distance has been established.</td>
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<td>If the vessel is stationary, the vessel will not engage engines until the NARW</td>
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<td>has moved beyond 100 m in which case any vessel will steer a course away from</td>
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<td>the animal at 10 kts or less until the 500 m minimum separation distance has been</td>
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<td>established. If the vessel comes within 100 m of a non-NARW whale:</td>
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<td>If underway, the vessel must remain parallel to the animal’s course, reduce speed</td>
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<td>and shift the engine to neutral, and must not engage the engines until the whale</td>
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<td>(e.g., large whale and/or ESA-listed whales besides NARW) has moved beyond 100 m.</td>
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<td>If stationary, the vessel must not engage engines until the whale has moved beyond</td>
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<td>100 m.</td>
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<td>Operating vessels, except CTVs, will travel at speeds ≤10 kts in SMA and DMA during</td>
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<td>migratory and calving periods from November 1 to April 30, except for CTVs.</td>
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<td>Operating vessels, except CTVs, will travel at speeds ≤10 kts in any DMA.</td>
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<td>Vessels will comply with NMFS regulations and speed restrictions (≤10 kts) in NARW</td>
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<td>management areas including SMAs and active DMAs during migratory and calving</td>
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<td>periods from November 1 to April 30, except for CTVs.</td>
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<td>To facilitate the safe transit of CTVs at &gt;10 kts in SMAs and DMAs Mayflower Wind</td>
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<td>will implement (or participate in a joint program, if developed) a PAM system</td>
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<td>designed to detect NARW within the transit corridor and additional visual monitoring</td>
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<td>measures as described Mayflower Wind Energy LLC Request for Incidental Take</td>
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<td></td>
<td>A Vessel Strike Avoidance Plan that provides a more detailed description of the</td>
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<td>equipment and methods to conduct the monitoring summarized here will be provided to</td>
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<td>NMFS at least 90-days prior to commencement of vessel movements associated with the</td>
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<td>activities covered by the requested incidental take regulations.</td>
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<td></td>
<td>Report sightings of all dead or injured marine mammals or sea turtles within 24</td>
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<td>hours.</td>
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<td></td>
<td>Acoustic Monitoring A PAM system consisting of near real-time bottom mounted and/or</td>
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<td></td>
<td>mobile acoustic monitoring systems will be installed such that NARW and other large</td>
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<tr>
<td>No</td>
<td>Measure Description</td>
<td>Project Phase</td>
<td>Expected Effects</td>
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<td>1</td>
<td><strong>AMM-27 Vessel Encounters – Sea Turtles</strong>&lt;br&gt;Mayflower Wind will ensure that all vessels underway do not intentionally approach any sighted sea turtle. Mayflower Wind will ensure that all vessels maintain a separation distance of 164 ft (50 m) or greater from any sighted sea turtles. Mayflower Wind will require all vessels operating within and transiting to/from the Lease Area comply with the vessel strike avoidance measures specified in lease stipulations or NMFS authorization, including:&lt;br&gt;- Ensure that vessel operators and crews maintain a vigilant watch for sea turtles and slow down or stop their vessels to avoid striking these protected species.&lt;br&gt;- Employ reporting system to NMFS in the event of a vessel strike.</td>
<td>C,O,D</td>
<td>Avoid and minimize the risk of vessel encounters with sea turtles while watching for marine mammals and implementing avoidance measures.</td>
<td></td>
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<tr>
<td>2</td>
<td><strong>AMM-28 Marine Debris</strong>&lt;br&gt;Mayflower Wind will adhere to all regulations under the USEPA Clean Water Act. Mayflower Wind will ensure that any structures or devices attached to the seafloor for continuous periods greater than 24 hours use the best available mooring systems (vertical and float lines, swivels, shackles, and anchor designs) for minimizing the risk of entanglement or entrapment of sea turtles, while still ensuring the safety and integrity of the structure or device. Mayflower Wind will ensure that all mooring lines and ancillary attachment lines will 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 or wrapping around animals or entrapping protected species. If an entangled live or dead marine protected species is reported, Mayflower Wind personnel must provide any assistance to authorized stranding response personnel as requested by BOEM or NMFS.</td>
<td>C,O,D</td>
<td>Increase effectiveness of mitigations to avoid or minimize impacts on sea turtles from marine debris.</td>
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<tr>
<td>3</td>
<td><strong>AMM-29 Habitat Disturbance and Modification</strong>&lt;br&gt;Mayflower Wind will design the sea-to-shore transition to reduce the dredging footprint and effects to Atlantic sturgeon (e.g., cofferdam and/or gravity cell) unless it is necessary for the project to proceed. Mayflower Wind will incorporate use of HDD at landing(s) and avoid disturbance to fish and invertebrate EFH to the extent practicable. Mayflower Wind will incorporate use of HDD of subsea cables, as appropriate, to minimize spatial and temporal effects to Atlantic sturgeon.</td>
<td>C</td>
<td>Increase effectiveness of mitigations to avoid or minimize impacts on marine mammals and ESA listed animals from habitat disturbance.</td>
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<tr>
<td>4</td>
<td><strong>AMM-30 Incident Reporting</strong>&lt;br&gt;The following situations would require reporting as defined below:&lt;br&gt;- If a stranded, entangled, injured, or dead protected species is observed, the sighting will be reported immediately and within 24 hours to NMFS Sighting Advisory System (SAS) hotline: (800-755-6622) or via the Whale Alert Application. Any NARW sightings will be reported as soon as feasible and no later than within 24 hours to the NMFS Right Whale Sighting Advisory System (RWSAS) hotline (866-775-6622) or via the Whale Alert Application.</td>
<td>C,O,D</td>
<td>Increase operational awareness to minimize risk to marine mammals and sea turtles.</td>
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<tr>
<td>5</td>
<td><strong>AMM-31 Actions Given a Marine Mammal Is Taken in a Prohibited Manner by Construction Activities</strong>&lt;br&gt;Actions resulting in the injury/death will cease immediately. The incident will be reported to the NMFS OPR (301-427-8401), NMFS New England Stranding Network Coordinator, and the Greater Atlantic Regional Fisheries Office (GARFO) no later than within 24 hours. Additional reporting by the vessel captain or PSO onboard will be to NMFS Fisheries Marine Mammal and Sea Turtle Stranding and Entanglement Hotline (866-775-6622), or alternative electronic reporting systems as approved by the NMFS stranding program, as well as the U.S. Coast Guard (USCG). The report will include all available information required by the ITR or the NMFS stranding report form. Mayflower Wind will not resume the activity which resulted in the injury until NMFS OPR is able to review the circumstances of the incident determine the appropriate course of action.</td>
<td>C,O,D</td>
<td>Increase effectiveness of mitigations to minimize impacts on marine mammals after a take occurs.</td>
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<tr>
<td>6</td>
<td><strong>AMM-32 Actions Given an Unknown and Recent Observed Dead or Injured Marine Mammal</strong>&lt;br&gt;Mayflower Wind will immediately report the incident to the NMFS OPR and the NMFS New England Stranding Network Coordinator (as stated above). The report will include the same information identified for a take by construction activity. Activities will continue while NMFS reviews the circumstances of the incident and works with Mayflower Wind to determine whether modifications to the activities are appropriate.</td>
<td>C,O,D</td>
<td>Increase effectiveness of mitigations to minimize impacts on marine mammals after a take occurs.</td>
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<td>7</td>
<td><strong>AMM-33 Actions Given a Dead or Injured Marine Mammal Not Associated with or</strong>&lt;br&gt;Mayflower Wind will report the incident to the NMFS Office of Protected Resources and the NMFS New England Stranding Network Coordinator, within 24 hours of the discovery. Mayflower Wind will include any documentation of the stranded animal sighting to NMFS and the Marine Mammal Stranding Network including photographs</td>
<td>C,O,D</td>
<td>Increase effectiveness of mitigations to minimize impacts on marine mammals after injury occurs.</td>
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<tr>
<td>No</td>
<td>Measure</td>
<td>Description</td>
<td>Project Phase</td>
<td>Expected Effects</td>
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<td>Related to Construction Activities</td>
<td>and video footage if available. Construction activity may continue.</td>
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<tr>
<td>AMM-34</td>
<td>Seabed Preparation</td>
<td>Mayflower Wind will use BMPs to minimize sediment mobilization during offshore component installation</td>
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<td>C,O,D</td>
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<td>Mayflower Wind, when feasible, will use technologies that minimize sediment mobilization and seabed sediment alteration for cable burial operations</td>
<td></td>
<td>Minimize impacts of turbidity on ESA listed animals</td>
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<td>Mayflower Wind, where practical and safe, will utilize DP vessels</td>
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<td>Mayflower Wind will utilize HDD for sea-to-shore transition</td>
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<tr>
<td>AMM-35</td>
<td>Avoiding Scour</td>
<td>Mayflower Wind will utilize scour protection methods to avoid developing scour holes at the base of structures</td>
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<td>C,O,D</td>
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<td></td>
<td>Mayflower Wind will bury submarine cables at depths to guard against exposure from seabed mobility</td>
<td></td>
<td>Minimize impacts of habitat conversion and seabed disturbance for ESA listed animals</td>
</tr>
<tr>
<td>AMM-36</td>
<td>Prevention of Unplanned Releases</td>
<td>Mayflower Wind will comply with the regulatory requirements related to the prevention and control of discharges and accidental spills as documented in the proposed Project’s OSRP</td>
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<td>C,O,D</td>
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<td>Mayflower Wind’s SWPPP will include a Project-specific SPCC plan to prevent inadvertent releases of oils and other hazardous materials to the environment to the extent practicable</td>
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<td>Increase effectiveness of mitigations to minimize impacts of Accidental Events/ Hazards on ESA listed animals</td>
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<td></td>
<td>Mayflower Wind will have an HDD Contingency Plan in place to mitigate, control, and avoid unplanned discharges related to HDD activities</td>
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<tr>
<td>AMM-37</td>
<td>Minimization of EMF</td>
<td>Mayflower Wind will install offshore export cables and interarray cables to target burial depths and use cable shielding materials to minimize effects of EMFs</td>
<td></td>
<td>C,O,D</td>
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<tr>
<td></td>
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<td>Mayflower Wind will have an HDD Contingency Plan in place to mitigate, control, and avoid unplanned discharges related to HDD activities</td>
<td></td>
<td>Increase effectiveness of mitigations to minimize impacts of EMF on ESA listed animals</td>
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<tr>
<td>AMM-38</td>
<td>Minimization of Entanglement Risk</td>
<td>Mayflower Wind will ensure that any structures or devices attached to the seafloor for continuous periods greater than 24 hours use the best available mooring systems (vertical and float lines, swivels, shackles, and anchor designs) for minimizing the risk of entanglement or entrapment of marine mammals while still ensuring the safety and integrity of the structure or device</td>
<td></td>
<td>C,O,D</td>
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<td>Mayflower Wind will ensure that all mooring lines and ancillary attachment lines 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 or wrapping around animals, or entrapping protected species</td>
<td></td>
<td>Minimize the risk of entanglement for marine mammals and sea turtles</td>
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<td></td>
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<td>If an entangled live or dead marine protected species is reported, Mayflower Wind personnel must provide any assistance to authorized stranding response personnel as requested by BOEM or NMFS</td>
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<tr>
<td>AMM-39</td>
<td>Minimizing Risk of Planned Discharges</td>
<td>Mayflower Wind will use approved OSRP mitigation measures to prevent animals from going to affected area including translocation to unaffected areas as necessary</td>
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<td>C,O,D</td>
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<td>To minimize potential impacts on zooplankton from impingement and entainment, the northernmost HVDC converter OSP will be located outside of a 10-km buffer of the 30-meter isobath from Nantucket Shoals.</td>
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<td>Minimize impacts and exposure of ESA listed animals to planned discharges</td>
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<tr>
<td>AMM-40</td>
<td>HRG Surveys</td>
<td>HRG survey activities may be required during construction and the operations and maintenance (O&amp;M) phases of the Project. When necessary, HRG survey operations will be conducted 24-hours per day, although some vessels may only operate during daylight hours. Mitigation and monitoring measures for HRG surveys apply only to sound sources with operating frequencies below 180 kHz. There are no mitigation or monitoring protocols required for sources operating &gt;180 kHz. Additionally, shutdown, pre-start clearance, and ramp-up procedures will not be conducted during HRG operations using only non-impulsive sources (e.g., USBL and parametric sub-bottom profilers) other than non-parametric sub-bottom profilers (e.g., CHIRPs). Pre-start clearance and ramp-up, but not shutdown will be conducted when using non-impulsive, non-parametric sub-bottom profilers.</td>
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<td></td>
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<td>Increase effectiveness of mitigations to minimize impacts of HRG surveys</td>
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<tr>
<td>AMM-41</td>
<td>HRG Surveys – Monitoring Equipment</td>
<td>Two pairs of reticle binoculars</td>
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<td>Two hand-held or wearable night vision devices (NVDs)</td>
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<td>Increase effectiveness of monitoring by using the best available equipment</td>
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<td></td>
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<td>Two IR spotlights</td>
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<td>One data collection software system</td>
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<td></td>
<td></td>
<td>Two PSO-dedicated very high frequency (VHF) radios</td>
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<td>One digital single-lens reflex camera equipped with a 300-mm lens</td>
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<tr>
<td>AMM-42</td>
<td>HRG Surveys – Visual Monitoring</td>
<td>Four PSOs on board any 24-hour survey vessels. Two PSOs on board any daylight survey vessels. One PSO on watch during all daylight surveying. Two PSOs on watch during nighttime surveying. Vessels conducting activities in very-shallow waters: o One visual PSO will be on board. The vessel captain (or crew member on watch) will conduct observations when the PSO is on required breaks.</td>
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<td></td>
<td></td>
<td>Increase effectiveness of monitoring to minimize impacts of HRG surveys</td>
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</table>
The PSO on duty will remain available to confirm sightings and any related mitigation measures while on break. PSOs will begin observation of the shutdown zones prior to initiation of HRG survey operations and will continue throughout the survey activity and/or while equipment operation below 180 kHz is in use. PSO will monitor the NMFS NARW reporting systems including WhaleAlert and SAS once every 4-hour shift during Project related activities.

PSOs will use reticle binoculars and the naked eye to scan the shutdown zone for marine mammals

The Lead PSO will determine if conditions warrant implementing reduced visibility protocols. Two PSOs on watch during pre-start clearance periods, all operations, and for 30 minutes following use of HRG sources operating below 180 kHz. Each PSO will monitor for marine mammals and other protected species using night-vision goggles with thermal clip-ons and a hand-held spotlight (one set plus a back-up set), such that PSOs can focus observations in any direction.

PSOs will establish and monitor marine mammal shutdown zones. Distances to shutdown zones will be from any acoustic sources, not the distance from the vessel. Shutdown zones will be as follows: 500 m from NARW for use of impulsive acoustic sources (e.g., boomers and/or sparkers) and non-impulsive nonparametric sub-bottom profilers. 100 m from all other marine mammals for use of impulsive acoustic sources (e.g., boomers and/or sparkers), except for delphinids when approaching the vessel or towed acoustic sources, shutdown is not required.

PSOs will establish and monitor pre-start clearance zones. Distances to pre-start clearance zones for HRG surveys will be the same as those for shutdown zones described above. PSOs will conduct 30 minutes of pre-start clearance observation prior to the initiation of HRG operations. The pre-start clearance zones must be visible using the naked eye or appropriate technology during the entire pre-start clearance period for operations to start. If the pre-start clearance zones are not visible, source operations <180 kHz will commence. Ramp-up may not be initiated if any marine mammal(s) is detected within its respective pre-start clearance zone. If a marine mammal is observed entering or within the pre-start clearance zones during the pre-start clearance period, relevant acoustic sources must not be initiated until the marine mammal(s) is confirmed by visual observation to have exited the relevant zone, or, until an additional time period has elapsed with no further sighting of the animal (15 minutes for small odontocetes and seals and 30 minutes for all other species).

The ramp-up procedure will not be initiated during periods of inclement weather or if the pre-start clearance zones cannot be adequately monitored by the PSOs, using the appropriate visual technology for a 30-minute period immediately prior to ramp-up. Ramp-up will begin with the power of the smallest acoustic equipment at its lowest practical 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. Ramp-up activities will be delayed if marine mammal(s) enters its respective shutdown zone. Ramp-up will continue if the animal(s) has been observed exiting its respective shutdown zone, or until an additional time period has elapsed with no further sighting of the animal (15 minutes for odontocetes and 30 minutes for all other marine mammals).

Immediate shutdown of impulsive, non-parametric HRG survey equipment other than CHIRP sub-bottom profilers operating at frequencies <180 kHz is required if a marine mammal is observed within or entering the relevant shutdown zone. Any PSO on duty has the authority to call for shutdown of acoustic sources. When there is certainty regarding the need for mitigation action on the basis of visual detection, the relevant PSOs must call for such action immediately. Upon implementation of a shutdown, survey equipment may be reactivated when all marine mammals that triggered the shutdown have been confirmed by visual observation to have exited the relevant shutdown zone or an additional time period has elapsed with no further sighting of the animal that triggered the shutdown (15 minutes for small odontocetes and 30 minutes for all other marine mammals). If the acoustic source is shutdown for reasons other than mitigation (e.g., mechanical difficulty) for less than 30 minutes, the acoustic sources may be reactivated as soon as is practicable at full operational level if PSOs have maintained constant visual observation during the shutdown and no visual detections of marine mammals occurred within the applicable shutdown zone during that time. If the acoustic source is shutdown for a period longer than 30 minutes or PSOs were unable to maintain constant observation, then ramp-up and pre-start clearance procedures will be initiated. If delphinids are visually detected approaching the vessel or towed acoustic sources, shutdown is not required.

UXO Detonation

For UXOs that are positively identified in proximity to planned activities on the seabed, several alternative strategies will be considered prior to detonating the UXO in place. These may include relocating the activity away from the UXO (avoidance), moving the UXO away from the activity (lift and shift), cutting the UXO open to apportion large ammunition or deactivate fused munitions, using shaped charges to reduce the net explosive yield of a UXO (low-order detonation), or using shaped charges to ignite the explosive materials and allow them to burn at a slow rate rather than detonate instantaneously (deflagration). Only after these alternatives are considered would a decision to detonate the UXO in place be made. If deflagration is conducted, mitigation and a monitoring measure would be implemented as if it was a high order detonation based on UXO size. Decision on removal method will be made in...
## Table: Expected Effects of Proposed Actions

<table>
<thead>
<tr>
<th>No</th>
<th>Measure</th>
<th>Description</th>
<th>Project Phase</th>
<th>Expected Effects</th>
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<tr>
<td>AMM-50</td>
<td>UXO Detonation – Pre-start Clearance</td>
<td>All mitigation and monitoring zones assume the use of an NAS resulting in a 10 dB reduction of noise levels. Mitigation and monitoring zones specific to marine mammal hearing groups for the five different charge weight bins are available in the ITR. A 30-minute pre-start clearance period will be implemented prior to any UXO detonation. The pre-start clearance zone must be fully visible for at least 30 minutes prior to commencing detonation. All marine mammals must be confirmed to be out of the pre-start clearance zone prior to initiating detonation. If a marine mammal is observed entering or within the relevant pre-start clearance zones prior to the initiation of detonation, the detonation must be delayed without redetection of dolphins, porpoises, and seals.</td>
<td>C</td>
<td>Ensure the area is clear prior to the start of UXO detonation.</td>
</tr>
<tr>
<td>AMM-51</td>
<td>UXO Detonation – Visual Monitoring</td>
<td>The number of vessels deployed will depend on monitoring zone size and safety set back distance from the detonation. A sufficient number of vessels will be deployed to cover the clearance and shutdown zones. PSOs will visually monitor the Low Frequency Cetacean pre-start clearance zone for a given charge weight. This zone encompasses the maximum Level A exposure ranges for all marine mammal species except harbor porpoise, where Level A take has been requested due to the large zone sizes associated with High Frequency cetaceans. Primary Vessel Measures: Two PAMs on duty on the primary vessel. Visual PAMs will survey the monitoring zones at least 30 minutes prior to a detonation event. Two PSOs will maintain watch at all times during the pre-start clearance period and 30 minutes after the detonation event. There will be a PAM operator on duty conducting acoustic monitoring in coordination with the visual PSOs during all pre-start clearance periods and post-detonation monitoring periods. Secondary Vessel Measures: Based on the pre-start clearance zones for low-frequency cetaceans, a secondary vessel will be used for UXO charge weight bins E10 and E12. Visual monitoring will be conducted on a secondary vessel following the same methods as stated for the primary vessel.</td>
<td>C</td>
<td>Increase effectiveness of monitoring to minimize impacts of UXO detonations.</td>
</tr>
<tr>
<td>AMM-52</td>
<td>UXO Detonation – Acoustic Monitoring</td>
<td>There will be one PAM team for all deployed PSO vessels. PAM will be conducted in the daylight only as no UXO will be detonated during nighttime hours. There will be a PAM operator stationed on at least one of the dedicated monitoring vessels (primary or secondary) in addition to the PSO; or located remotely/onshore. PAM will begin 30 minutes prior to a detonation event. PAM operator will be on duty during all pre-start clearance periods and post-detonation monitoring periods. Acoustic monitoring will extend beyond the Low Frequency Cetacean pre-start clearance zone for a given charge weight. For real-time PAM systems, at least one PAM operator will be designated to monitor each system by viewing data or data products that are streamed in real-time or near real-time to a computer workstation and monitor located on a Project vessel or onshore. PAM operator will inform the Lead PSO on duty of animal detections approaching or within applicable ranges of interest to the detonation activity via the data collection software system. PAM devices used may include independent (e.g., autonomous or moored remote) systems.</td>
<td>C</td>
<td>Increase effectiveness of monitoring to minimize impacts of UXO detonations.</td>
</tr>
<tr>
<td>AMM-53</td>
<td>UXO Detonation – Noise Attenuation</td>
<td>Mayflower Wind will use an NAS for all detonation events as feasible and will strive to achieving the modeled ranges associated with 10 dB of noise attenuation. Zones without 10 dB attenuation would be implemented if use of a big bubble curtain was not feasible due to location, depth, or safety related constraints. If a NAS system is not feasible, Mayflower Wind will implement mitigation measures for the larger unmitigated zone sizes with deployment of vessels adequate to cover the entire pre-start clearance zones.</td>
<td>C</td>
<td>Increase effectiveness of mitigations to minimize impacts of underwater noise from UXO detonations on ESA listed animals by dampening noise.</td>
</tr>
<tr>
<td>AMM-54</td>
<td>UXO Detonation – Seasonal Restriction</td>
<td>No UXO detonations are planned between January and April.</td>
<td>C</td>
<td>Avoid detonations in the time of year where NARW activity is highest.</td>
</tr>
<tr>
<td>AMM-55</td>
<td>UXO Detonation – Post Detonation Monitoring</td>
<td>Post-detonation monitoring will occur for 30 minutes.</td>
<td>C</td>
<td>Ensure that UXO detonation was performed safely.</td>
</tr>
</tbody>
</table>

Source: LGL 2022; Mayflower Wind 2022.  
AMM = applicant mitigation measure; APSO = Acoustic Protected Species Observer; BMPs = best management practices; BOEM = Bureau of Ocean Energy Management; C = construction; CHP = compressed high intensity radar pulse; CTV = crew transfer vessel; D = Decommissioning; dB = decibel; DMA = dynamic management area; DP = dynamic positioning; EFH = essential fish habitat; ESA = Endangered Species Act; GARFO = Greater Atlantic Regional Fisheries Office; HDD = horizontal direction drilling; HRG = high resolution geophysical; IR = infrared; ITR = incidental take regulations; Kg = kilogram; kHz = kilohertz; km = kilometer; kts = knots; M = meter; MMPA = Marine Mammal Protection Act; NARW = North Atlantic right whale; NAS = noise attenuation system; NMFS = National Marine Fisheries Service; NVD = night.
### Table 3.3-2. Additional proposed mitigation monitoring, and reporting measures – BOEM proposed

<table>
<thead>
<tr>
<th>No</th>
<th>Measure</th>
<th>Description</th>
<th>Project Phase</th>
<th>Expected Effects</th>
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<tbody>
<tr>
<td>NS-1</td>
<td>Nantucket Shoals (NS-1)</td>
<td>HVDC Open-Loop Cooling System Avoidance Area To minimize potential impacts onto zooplankton from impingement and entrainment in offshore wind HVDC converter station open-loop cooling systems, no open-loop cooling systems would be permitted within the enhanced mitigation area (Figure 3.3-1) of the Lease Area. No geographic restrictions on the offshore export cable corridor, nor the installation of an HVAC OSP are included in this mitigation measure.</td>
<td>O&amp;M</td>
<td>Nantucket Shoals supports dense aggregations of zooplankton such as gammarid shrimp and copepods, which in turn, support higher trophic levels of wildlife. While the Mayflower Wind Project would not overlap with the highest modeled densities of zooplankton in the Nantucket Shoals region, BOEM is proposing a precautionary measure to reduce the magnitude of potential mortality from entrainment of zooplankton in an HVDC open-loop cooling system. This measure is anticipated to result in less mortality to prey species for higher trophic level animals than compared with project design envelope which could include HVDC OSP locations closer to Nantucket Shoals and thus closer to higher densities of zooplankton.</td>
</tr>
<tr>
<td>NS-2</td>
<td>Pile-Driven Foundations Only</td>
<td>Only monopile or piled jacket foundations may be used east of the enhanced mitigation area (Figure 3.3-1), which would minimize the overall structure impact on benthic prey species.</td>
<td>C, O&amp;M</td>
<td>The foundation footprint, including scour protection, on the seabed would be reduced by a minimum of 8.84 acres (3.62 hectares) per foundation in comparison to if GBS foundations were used. This would mean a total reduction in seabed footprint of at least 206 acres (83 hectares) for the 23 WTGs located in the enhanced mitigation area. Nantucket Shoals is known to support shellfish species important to food supply for birds. To reduce the potential impact on shellfish populations adjacent to Nantucket Shoals, BOEM is proposing this measure to reduce the potential direct mortality, smoothing, by the larger foundation footprint of suction-bucket and GBS foundations in this area when compared to the design envelope of the Proposed Action.</td>
</tr>
<tr>
<td>NS-4</td>
<td>Pile-Driving Time of Year Restriction in Enhanced Mitigation Area</td>
<td>Pile driving within the enhanced mitigation area (Figure 3.3-1) will occur only between June 1 to October 31 when NARW presence is at its lowest.</td>
<td>C</td>
<td>The most recent modeled density of NARW indicate higher densities of NARW on Nantucket Shoals in the fall and winter, with the highest densities in February. The enhanced mitigation area includes all areas where modeled NARW density is greater than or equal to 1 animal. This will further ensure that no NARW are exposed to injurious levels of noise from pile driving activity when combined with other measures such as protected species observers and acoustic attenuation devices.</td>
</tr>
<tr>
<td>BA-1</td>
<td>LOA Requirements</td>
<td>The measures required by the final MMPA LOA for Incidental Take Regulations would be incorporated into COP approval.</td>
<td>C</td>
<td>Incorporates all LOA requirements into COP approval.</td>
</tr>
<tr>
<td>BA-3</td>
<td>Fisheries and Benthic Habitat Monitoring Surveys</td>
<td>The Lessee must develop monitoring plans and conduct fisheries research and monitoring surveys, including the benthic survey. The Lessee must conduct these surveys for durations of, at a minimum, 1 year during pre-construction, 1 year during construction, and 2 years post-construction. The Lessee must submit an annual report within 90 days of the completion of each survey season to DOI (<a href="mailto:renewable_reporting@boem.gov">renewable_reporting@boem.gov</a>) that includes results and analyses as described in the monitoring plans. The Lessee must share data in accordance with their data sharing plan.</td>
<td>Pre-C, C, O&amp;M</td>
<td>Measure the impact of offshore wind development on marine resources</td>
</tr>
<tr>
<td>BA-4</td>
<td>Protected Species Detection and Vessel Strike Avoidance: Vessel Crew and Visual Observer Training Requirements</td>
<td>The Lessee must provide Project-specific training to all vessel crew members, Visual Observers, and Trained Lookouts on the identification of sea turtles and marine mammals, vessel strike avoidance and reporting protocols, and the associated regulations for avoiding vessel collisions with protected species. Reference materials for identifying sea turtles and marine mammals must be available aboard all Project vessels. Confirmation of the training and understanding of the requirements must be documented on a</td>
<td>C, O&amp;M, D</td>
<td>Increase effectiveness of mitigations to avoid or minimize impacts on marine mammals and sea turtles from vessel encounters</td>
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### Protected Species Detection and Vessel Strike Avoidance: Vessel Observer Requirements

The Lessee must ensure that vessel operators and crew members maintain a vigilant watch for marine mammals and sea turtles, and reduce vessel speed, alter the vessel's course, or stop the vessel as necessary to avoid striking marine mammals or sea turtles. All vessels transiting to and from the Mayflower Wind wind farm must have a trained lookout for NARWs on duty at all times, during which the trained lookout must monitor a vessel strike avoidance zone around the vessel. The trained lookout must maintain a vigilant watch at all times a vessel is underway, and when technically feasible, be capable of monitoring the 500-meter Vessel Strike Avoidance Zone for ESA-listed species and to maintain minimum separation distances. Alternative monitoring technology (e.g., night vision, thermal cameras) must be available to maintain a vigilant watch at night and in any other low visibility conditions.

If a vessel is carrying a trained lookout for the purposes of maintaining watch for NARWs, a trained lookout for sea turtles is not required, provided that the trained lookout maintains watch for marine mammals and sea turtles. If the trained lookout is a vessel crew member, the lookout obligations, as noted above, must be that person's designated role and primary responsibility while the vessel is transiting. Vessel personnel must be provided an Atlantic reference guide to help identify marine mammals and sea turtles that may be encountered. Vessel personnel must also be provided material regarding NARW Seasonal Management Areas (SMAs), Dynamic Management Areas (DMAs), and Slow Zones, sightings information, and reporting. All observations must be recorded per reporting requirements.

Outside of active watch duty, members of the monitoring team must check NMFS Right Whale Sighting Advisory System (RWSAS) for the presence of NARWs in the Mayflower Wind farm. The trained lookout must check https://seaturtlesightings.org before each trip and report any detections of sea turtles in the vicinity of the planned transit to all vessel operators or captains and lookouts on duty on that day. For all vessels operating north of the Virginia/North Carolina border, between June 1 and November 30, the Lessee must have a trained lookout posted on all vessel transits during all phases of the Project to observe for sea turtles. For all vessels operating south of the Virginia/North Carolina border, year-round, vessels operating north of the Virginia/North Carolina border, year-round, the Lessee must have a trained lookout posted on all vessel transits during all phases of the Project to observe for sea turtles. The trained lookout will communicate any sightings in real time to the captain to implement required avoidance measures.

All vessels transiting to and from the Mayflower Wind wind farm must have a trained lookout for NARWs in the vicinity of the planned transit to all vessel operators or captains and lookouts on duty on that day. For all vessels operating north of the Virginia/North Carolina border, between June 1 and November 30, the Lessee must have a trained lookout posted on all vessel transits during all phases of the Project to observe for sea turtles. For all vessels operating south of the Virginia/North Carolina border, year-round, the Lessee must have a trained lookout posted on all vessel transits during all phases of the Project to observe for sea turtles. The trained lookout will communicate any sightings in real time to the captain to implement required avoidance measures.

The Lessee must 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 (PSO), vessel captains, or both associated with other Project vessels. The Lessee may only request a waiver from any visually triggered Slow Zone/DMA vessel speed requirements.

### Expected Effects

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<tr>
<td>BA-5</td>
<td>Protected Species Detection and Vessel Strike Avoidance: Vessel Observer Requirements</td>
<td>The Lessee must ensure that vessel operators and crew members maintain a vigilant watch for marine mammals and sea turtles, and reduce vessel speed, alter the vessel’s course, or stop the vessel as necessary to avoid striking marine mammals or sea turtles. All vessels transiting to and from the Mayflower Wind wind farm must have a trained lookout for NARWs on duty at all times, during which the trained lookout must monitor a vessel strike avoidance zone around the vessel. The trained lookout must maintain a vigilant watch at all times a vessel is underway, and when technically feasible, be capable of monitoring the 500-meter Vessel Strike Avoidance Zone for ESA-listed species and to maintain minimum separation distances. Alternative monitoring technology (e.g., night vision, thermal cameras) must be available to maintain a vigilant watch at night and in any other low visibility conditions. If a vessel is carrying a trained lookout for the purposes of maintaining watch for NARWs, a trained lookout for sea turtles is not required, provided that the trained lookout maintains watch for marine mammals and sea turtles. If the trained lookout is a vessel crew member, the lookout obligations, as noted above, must be that person’s designated role and primary responsibility while the vessel is transiting. Vessel personnel must be provided an Atlantic reference guide to help identify marine mammals and sea turtles that may be encountered. Vessel personnel must also be provided material regarding NARW Seasonal Management Areas (SMAs), Dynamic Management Areas (DMAs), and Slow Zones, sightings information, and reporting. All observations must be recorded per reporting requirements. Outside of active watch duty, members of the monitoring team must check NMFS Right Whale Sighting Advisory System (RWSAS) for the presence of NARWs in the Mayflower Wind farm. The trained lookout must check <a href="https://seaturtlesightings.org">https://seaturtlesightings.org</a> before each trip and report any detections of sea turtles in the vicinity of the planned transit to all vessel operators or captains and lookouts on duty on that day. For all vessels operating north of the Virginia/North Carolina border, between June 1 and November 30, the Lessee must have a trained lookout posted on all vessel transits during all phases of the Project to observe for sea turtles. For all vessels operating south of the Virginia/North Carolina border, year-round, the Lessee must have a trained lookout posted on all vessel transits during all phases of the Project to observe for sea turtles. The trained lookout will communicate any sightings in real time to the captain to implement required avoidance measures.</td>
<td>C, O&amp;M, D</td>
<td>Increase effectiveness of mitigations to avoid or minimize impacts on marine mammals and sea turtles from vessel encounters</td>
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| BA-6 | Protected Species Detection and Vessel Strike Avoidance: Communication of Threatened and Endangered Species Sightings | The Lessee must 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 (PSO), vessel captains, or both associated with other Project vessels. | Pre-C, C, O&M, D | Increase effectiveness of mitigations to avoid or minimize impacts on marine mammals and sea turtles from vessel encounters |

| BA-7 | Protected Species Detection and Vessel Strike Avoidance: Vessel Speed Requirements | 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 upon the sighting of a single individual. Vessels underway must not divert their course to approach any protected species. During construction, vessels of all sizes will operate port to port at 10 knots or less between November 1 and April 30 and while operating in the Lease Area, along the export cable route, or transit area to and from ports. Regardless of vessel size, vessel operators must reduce vessel speed to 10 knots (11.5 mph) or less while operating in any Seasonal Management Area (SMA) or visually detected Slow Zones. This requirement does not apply when necessary for the safety of the vessel or crew. Any such events must be reported (see reporting requirements). Otherwise, these speed limits do not apply in areas of Narragansett Bay or Long Island Sound where the presence of NARWs is not expected. The Lessee may only request a waiver from any visually triggered Slow Zone/DMA vessel speed reduction requirements during operations and maintenance, by submitting a vessel strike risk reduction plan that details revised measures and an analysis demonstrating that the measure(s) will provide a | C, O&M, D | Increase effectiveness of mitigations to avoid or minimize impacts on marine mammals and sea turtles from vessel encounters |
level of risk reduction at least equivalent to the vessel speed reduction measure(s) proposed for replacement. The plan included with the request must be provided to NMFS’s Greater Atlantic Regional Fisheries Office, Protected Resources Division and BOEM at least 90 days prior to the date scheduled for the activities for the waiver is requested. The plan must not be implemented unless NMFS and BOEM reach consensus on the appropriateness of the plan. BOEM encourages increased vigilance through voluntary implementation of best management practices to minimize vessel interactions with NARWs, and by voluntarily reducing speeds to 10 knots or less when operating within an acoustically triggered slow zone, and when feasible, avoid Slow Zones.

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<tr>
<td>BA-8</td>
<td>Vessel Strike Avoidance of Large Cetaceans</td>
<td>C, O&amp;M, D</td>
<td>Increase effectiveness of mitigations to avoid or minimize impacts on marine mammals and sea turtles from vessel encounters</td>
</tr>
<tr>
<td>BA-9</td>
<td>Vessel Strike Avoidance of Small Cetaceans and Seals</td>
<td>C, O&amp;M, D</td>
<td>Increase effectiveness of mitigations to avoid or minimize impacts on marine mammals from vessel encounters</td>
</tr>
<tr>
<td>BA-10</td>
<td>Vessel Strike Avoidance of Sea Turtles</td>
<td>C, O&amp;M, D</td>
<td>Increase effectiveness of mitigations to avoid or minimize impacts on sea turtles from vessel encounters</td>
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### Table: Biological Assessment Description of the Proposed Action

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<thead>
<tr>
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<tbody>
<tr>
<td>BA-11</td>
<td>Reporting of All NARW Sightings</td>
<td>Pre-C, C, O&amp;M, D</td>
<td>Enhanced measures to protect NARW</td>
</tr>
<tr>
<td>BA-12</td>
<td>Detected or Impacted Protected Species Reporting</td>
<td>Pre-C, C, O&amp;M, D</td>
<td>Reporting to inform on the condition of ESA-listed species to provide critical information for endangered species to regulators</td>
</tr>
<tr>
<td>BA-13</td>
<td>Detected or Impacted Dead Non-ESA-Listed Fish</td>
<td>Pre-C, C, O&amp;M, D</td>
<td>Reporting to inform on unusual mortality events for fish species to measure potentially unforeseen impacts</td>
</tr>
<tr>
<td>BA-14</td>
<td>Wind Turbine Foundations Pile Driving/Impact Hammer Activity: Pile-Driving Time-of-Year Restriction</td>
<td>C</td>
<td>Increase effectiveness of mitigations to avoid or minimize impacts on ESA-listed species from underwater noise</td>
</tr>
</tbody>
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The Lessee must immediately report all NARWs observed at any time by PSOs or vessel personnel on any Project vessels, during any Project-related activity, or during vessel transit. Reports must be submitted to: BOEM (at renewable_reporting@boem.gov) and BSEE (at protectedspecies@bsee.gov); the NOAA Fisheries 24-hour Stranding Hotline number (866-755-6622); the Coast Guard (via Channel 16); and WhaleAlert (through the WhaleAlert app at http://www.whalealert.org). The report must include the time, location, and number of animals.

The Lessee is responsible for reporting dead or injured protected species, regardless of whether they were observed during operations or due to Project activities. The Lessee must report any potential take, strikes, dead, or injured protected species caused by Project vessels or sighting of an injured or dead marine mammal or sea turtle, regardless of the cause, to the NMFS Greater Atlantic Regional Fisheries Office, Protected Resources Division (at nmfs.gar.incidental-take@noaa.gov), NOAA Fisheries 24-hour Stranding Hotline number (866-755-6622), BOEM (at renewable_reporting@boem.gov), and BSEE (at protectedspecies@bsee.gov). Reporting must be as soon as practicable but no later than 24 hours from the time the incident took place (Detected or Impacted Protected Species Report). Staff responding to the hotline call will provide instructions for the handling or disposing of any injured or dead protected species by individuals authorized to collect, possess, and transport sea turtles.

Reports must include a minimum: (1) survey name and applicable information (e.g., vessel name, station number); (2) GPS coordinates describing the location of the interaction (in decimal degrees); (3) gear type involved (e.g., bottom trawl, gillnet, longline); (4) soak time, gear configuration and any other pertinent gear information; (5) time and date of the interaction; and (6) identification of the animal to the species level. Additionally, the e-mail would transmit a copy of the NMFS Take Report Form and a link to or acknowledgement that a clear photograph or video of the animal was taken (multiple photographs are suggested, including at least one photograph of the head scutes). If reporting within 24 hours is not possible due to distance from shore or lack of ability to communicate via phone, fax, or email, reports would be submitted as soon as possible; late reports would be submitted with an explanation for the delay.

At the end of each survey season, a report will be sent to NMFS that compiles all information on any observations and interactions with ESA-listed species. This report will also contain information on all survey activities that took place during the season including location of gear set, duration of soak/trawl, and total effort. The report on survey activities would be comprehensive of all activities, regardless of whether ESA-listed species were observed.

Any occurrence of at least 10 dead non-ESA-listed fish within established shutdown or monitoring zones must also be reported to BOEM (at renewable_reporting@boem.gov) as soon as practicable (taking into account crew and vessel safety), but no later than 24 hours after the sighting. Reports must include at a minimum: (1) survey name and applicable information (e.g., vessel name, station number); (2) GPS coordinates describing the location of the interaction (in decimal degrees); (3) gear type involved (e.g., bottom trawl, gillnet, longline); (4) soak time, gear configuration and any other pertinent gear information; (5) time and date of the interaction; and (6) identification of the animal to the species level. Additionally, the e-mail would transmit a copy of the NMFS Take Report Form and a link to or acknowledgement that a clear photograph or video of the animal was taken (multiple photographs are suggested, including at least one photograph of the head scutes). If reporting within 24 hours is not possible due to distance from shore or lack of ability to communicate via phone, fax, or email, reports would be submitted as soon as possible; late reports would be submitted with an explanation for the delay.

The Lessee must notify BOEM in writing by September 1 that the Lessee believes that circumstances necessitate pile driving in December. The Lessee must submit to BOEM (at renewable_reporting@boem.gov) for written concurrence an enhanced survey plan for December. The Lessee must notify BOEM in writing that the Lessee believes that circumstances necessitate pile driving in December. The Lessee must submit to BOEM (at renewable_reporting@boem.gov) for written concurrence an enhanced survey plan for December. The Lessee must resolve all comments on the enhanced survey plan to BOEM’s satisfaction and receive BOEM’s written concurrence before any pile driving occurs. However, the Lessee may conclusively presume BOEM’s concurrence with the enhanced survey plan if BOEM provides no comments on the plan within 90 calendar days of its submittal.

The Lessee must also follow the time-of-year enhanced mitigation measures specified in the applicable Biological Opinion. The Lessee must confirm adherence to time-of-year restrictions on pile driving in the pile-driving reports submitted with the FIR.
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<tr>
<td>BA-15</td>
<td>Wind Turbine Foundations Pile Driving/Impact Hammer Activity; Pile-Driving Weather, Time, and Visibility Restrictions</td>
<td>The Lessee must ensure effective visual monitoring in all directions and must not commence pile-driving until at least 1 hour after civil sunrise to minimize the potential of pile-driving to continue after civil sunset when visibility will be impaired. Pile driving may continue after dark only when the installation of the same pile began during daylight (1.5 hours before civil sunset), when clearance zones were fully visible for at least 30 minutes (as described under condition, and must proceed for human safety or installation feasibility reasons. The Lessee may commence pile driving only when all clearance zones are fully visible (e.g., not obscured by darkness, rain, fog, or snow) for at least 30 minutes between civil sunrise and civil sunset. The lead PSO must determine when sufficient light exists to allow effective visual monitoring in all cardinal directions. If light is insufficient, the lead PSO must call for a delay until the clearance zone is visible in all directions. If conditions such as darkness, rain, fog, or snow impede the visual detection of marine mammals in the clearance zones, the Lessee must not initiate construction activities until all parts of all clearance zones are fully visible as determined by the lead PSO. The Lessee must develop and implement an Alternative Monitoring Plan in the event that poor visibility conditions unexpectedly arise and pile-driving cannot be stopped if stopping pile driving would pose risks to human safety or pile instability. If necessary, the Lessee must prepare and submit an Alternative Monitoring Plan (AMP) to NMFS (at <a href="mailto:nmfs.gar.incidental-take@noaa.gov">nmfs.gar.incidental-take@noaa.gov</a>) and BOEM (at <a href="mailto:renewable_reporting@boem.gov">renewable_reporting@boem.gov</a>) at least 90 calendar days before beginning any pile-driving activities for the Project. DOI will review the AMP and will provide any comments on the plan within 30 calendar days of its submittal. The Lessee must resolve all comments on the AMP to DOI's satisfaction before implementing the plan. If BOEM provides no comments on the AMP within 90 calendar days of its submittal, then the Lessee may conclusively presume BOEM's concurrence with the plan. The Lessee is encouraged to include additional observers or alternative monitoring technologies in the AMP such as night vision, thermal, infrared, or PAM technologies if including these will help to ensure that.</td>
<td>C</td>
<td>Increase effectiveness of mitigations to avoid or minimize impacts on ESA-listed species from underwater noise</td>
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| BA-16 | Wind Turbine Foundations Pile Driving/Impact Hammer Activity: PSO Requirements | The Lessee must use PSOs provided by a third party. PSOs must have no Project-related tasks other than to observe, collect and report data, and communicate with and instruct relevant vessel crew regarding the presence of protected species and mitigation requirements (including brief alerts regarding maritime hazards). PSOs or any PAM operators serving as PSOs must have completed a commercial PSO training program for the Atlantic with an overall examination score of 80 percent or greater. The Lessee must provide training certificates for individual PSOs to BOEM upon request. And PSOs and PAM operators must be approved by NMFS before the start of a survey. Application requirements to become a NMFS-approved PSO for construction activities can be found online or for geological and geophysical surveys by sending an inquiry to nmfs.psoreview@noaa.gov. Specific PSO Requirements include:  
- At least one PSO must be on duty at all times as the lead PSO or as the PSO monitoring coordinator during pile driving. Total PSO coverage must be adequate to ensure effective monitoring to reliably detect whales and sea turtles in the identified clearance and shutdown zones and execute any pile driving delays or shutdown requirements.  
- At least one lead PSO must be present on each vessel. PSOs on transit vessels must be approved by NMFS but need not be authorized as a lead PSO. Lead PSOs must have prior approval from NMFS as an unconditionally approved PSO.  
- All PSOs on duty must be clearly listed and the lead PSO identified on daily data logs for each shift.  
- A sufficient number of PSOs, consistent with the Biological Opinion and as prescribed in the final Incidental Take Authorization (ITA), must be deployed to record data in real time and effectively monitor the required clearance, shutdown, or monitoring zone for the Project.  
- The duties of these PSOs include visual surveys in all directions around a pile; PAM; and continuous monitoring of sighted NARWs. Where applicable, the number of PSOs deployed must meet the NARW enhanced seasonal monitoring requirements.  
- A PSO must not be on watch for more than 4 consecutive hours and must be granted a break of no fewer than 2 hours after a 4-hour watch. | Pre-C, C, O&M, D | Increase effectiveness of mitigations to avoid or minimize impacts on ESA-listed species from underwater noise |
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| BA-17 | Wind Turbine Foundations | At least 90 calendar days before beginning the first pile-driving activities for the Project, the Lessee must submit a Pile-Driving Monitoring (PDM) Plan for review to BOEM (at renewable_reporting@boem.gov), BSEE (at OSWsubmittals@bsee.gov), and NMFS. DOI will review the PDM Plan and provide any comments on the plan within 90 calendar days of its submittal. The Lessee must resolve all comments on the PDM Plan to DOI’s satisfaction before implementing the plan. If DOI provides no comments on the PDM Plan within 90 calendar days of its submittal, then the Lessee may conclusively presume DOI’s concurrence with the plan. The PDM Plan must:  
• Contain information on the visual and PAM components of the monitoring describing all equipment, procedures, and protocols;  
• The PAM system must demonstrate a near-real-time capability of detection to the full extent of the 160 dB distance from the pile-driving location;  
• The PAM plan must include a detection confidence that a vocalization originated from within the clearance and shutdown zones to determine that a possible NARW has been detected. Any PAM detection of a NARW within the clearance/shutdown zone surrounding a pile must be treated the same as a visual observation and trigger any required delays in pile installation.  
• Ensure that the full extent of the harassment distances from piles are monitored for marine mammals and sea turtles to document all potential take.  
• Include number of PSOs or Native American monitors, or both, that will be used, the platforms or vessels upon which they will be deployed, and contact information for the PSO providers;  
• Include measures for enhanced monitoring capabilities in the event that poor visibility conditions unexpectedly arise, and pile driving cannot be stopped.  
• Include an Alternative Monitoring Plan that provides for enhanced monitoring capabilities in the event that poor visibility conditions unexpectedly arise, and pile driving cannot be stopped. The Alternative Monitoring Plan must also include measures for deploying additional observers, using night vision goggles, or using PAM with the goal of ensuring the ability to maintain all clearance and shutdown zones in the event of unexpected poor visibility conditions. Describe a communication plan detailing the chain of command, mode of communication, and decision authority must be described. PSOs as determined by NMFS and BOEM must be used to monitor the area of the clearance and shutdown zones. Seasonal and species-specific clearance and shutdown zones must also be described in the PDM Plan including time-of-year requirements for NARWs. A copy of the approved PDM Plan must be in the possession of the lessee representative, the PSOs, impact-hammer operators, and any other relevant designees operating under the authority of the approved COP and carrying out the requirements on site. | C | Increase effectiveness of mitigations to avoid or minimize impacts on marine mammals and sea turtles from underwater noise |
<p>| BA-18 | Wind Turbine Foundations | The Lessee must implement soft start techniques for all impact pile-driving, both at the beginning of a monopile installation and at any time following the cessation of impact pile-driving of 30 minutes or longer. The soft start procedure must include a minimum of 20 minutes of 4-6 strikes/minute at 10-20 percent of the maximum hammer energy. | C | Increase effectiveness of mitigations to avoid or minimize impacts on ESA-listed species from underwater noise |
| BA-19 | Wind Turbine Foundations | The Lessee must ensure that the distance to the Level A harassment and Level B harassment thresholds, sea turtle injury and harassment thresholds, and Atlantic sturgeon injury and harassment thresholds are no larger than those modelled assuming 10 dB re 1 μPa noise attenuation is met by conducting field verification during pile-driving. At least 90 calendar days before beginning the first pile-driving activities for the Project, the Lessee must submit a Sound Field Verification Plan (SFVP) for review and comment to the USACE, BOEM (at <a href="mailto:renewable_reporting@boem.gov">renewable_reporting@boem.gov</a>), and NMFS (at <a href="mailto:nmfs.gar.incidental-take@noaa.gov">nmfs.gar.incidental-take@noaa.gov</a>). DOI will review the SFVP and provide any comments on the plan within 30 calendar days of its submittal. The Lessee must resolve all comments on the SFVP to DOI's satisfaction before implementing the plan. The Lessee may conclusively presume DOI’s concurrence with the SFVP if DOI provides no comments on the plan within 90 calendar days of its submittal. The Lessee must execute the SFVP and report the associated findings to BOEM for 3 monopile foundations, or as specified under the corresponding LOA for this action. The Lessee must conduct additional field measurements if it installs piles with a diameter greater than the initial piles, if it uses a greater hammer size or energy, or if it measures any additional foundations to support any request to decrease the distances specified for the clearance and shutdown zones. The Lessee must implement the SFVP requirements for verification of noise attenuation for at least 3 foundations for BOEM, in consultation | C | Increase effectiveness of mitigations to avoid or minimize impacts on ESA-listed species from underwater noise |</p>
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<td>BA-20</td>
<td>Wind Turbine Foundations Pile Driving/Impact Hammer Activity: Adaptive Refinement of Clearance Zones, Shutdown Zones, and Monitoring Protocols</td>
<td>The Lessee must reduce any unanticipated impacts on marine mammals and sea turtles by adjusting pile-driving monitoring protocols for clearance and shutdown zones, taking into account weekly monitoring results (see BA-28). Any proposed changes to monitoring protocols must be concurred with by DOI and NMFS before those protocols are implemented. Any reduction in the size of the clearance and shutdown zones for each foundation type must be based on at least 3 measurements submitted to BOEM and NMFS for review. For each 1,500 meters that a clearance or shutdown zone is increased based on the results from SFVP, the Lessee must deploy additional platforms and must deploy additional observers on those platforms. Should the shutdown zone for sea, fin, humpback, and sperm whales be decreased the full extent of the Level B harassment distance must be monitored using PAM and visual observations. Decreases in the distance of the clearance or shutdown zones for NARW and sea turtles are not permitted.</td>
<td>C</td>
<td>Increase effectiveness of mitigations to avoid or minimize impacts on marine mammals and sea turtles from underwater noise</td>
</tr>
<tr>
<td>BA-21</td>
<td>Wind Turbine Foundations Pile Driving/Impact Hammer Activity: Pile Driving Clearance Zones (No-go Zones) for Sea Turtles</td>
<td>The Lessee must minimize the exposure of ESA-listed sea turtles to noise that may result in injury or behavioral disturbance during pile-driving operations by tasking the PSOs to establish a clearance and shutdown zone for sea turtles during all pile-driving activities that is no less than 1,640 feet (500 meters) between 60 minutes before pile-driving activities, during pile driving and 30 minutes post-completion of pile-driving activity. Adherence to the 1,640-foot (500-meter) clearance and shutdown zones must be confirmed in the PSO reports.</td>
<td>C</td>
<td>Increase effectiveness of mitigations to avoid or minimize impacts on sea turtles from underwater noise</td>
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<tr>
<td>BA-22</td>
<td>Wind Turbine Foundations Pile Driving/Impact Hammer Activity: Impact Pile-Driving Clearance Zones (No-go Zones) for Marine Mammals</td>
<td>The Lessee must use visual monitoring by at least two PSOs and PAM during impact pile-driving activities following the standard protocols and data collection requirements. The Lessee must ensure that at least two PSOs are on duty on the impact pile driving platform and at least two PSO are on duty on a dedicated PSO vessel and establish the following clearance zones for NARWs to be used between 60 minutes before pile-driving activities and 30 minutes post-completion of pile-driving activity. Impact pile driving activity must be delayed when a NARW is visually observed by PSOs at any distance from the pile. Impact pile driving for all foundations must be delayed upon a confirmed PAM detection of a NARW, if the detection is confirmed to have been located within the 5 km clearance zone. No pile driving may begin unless all clearance zones have been free of NARW for 30 minutes immediately before pile driving. The Lessee must deploy a real-time PAM system designed and verified to maintain a PAM clearance zone of 3.1 miles (5 km) and a shutdown zone of 1.23 miles (2 km) for all monopile foundations. Real-time PAM must begin at least 60 minutes before pile driving to monitor a 3.1 mile (5 km) clearance zone. The real-time PAM system must be configured to ensure that the PAM operator is able to review acoustic detections within approximately 15 minutes of the original detection in order to verify whether a NARW has been detected. Impact pile driving must be suspended upon a confirmed PAM NARW vocalization within the PAM shutdown Zone detected and identified as a NARW. The detection will be treated as a NARW and trigger any required pre-construction delay or shutdowns during pile installation.</td>
<td>C</td>
<td>Increase effectiveness of mitigations to avoid or minimize impacts on marine mammals from underwater noise</td>
</tr>
<tr>
<td>BA-23</td>
<td>Wind Turbine Foundations Pile Driving/Impact Hammer Activity: Vibratory Pile-Driving Clearance Zones (No-go Zones) for ESA-listed Species and Marine Mammals</td>
<td>The Lessee must use visual monitoring by at least two PSOs during vibratory pile-driving activities. The Lessee must ensure that PSOs are on a dedicated PSO vessel and establish clearance zones for NARWs to be used between 30 minutes before pile-driving activities and 30 minutes post-completion of pile-driving activity. Vibratory pile driving may begin only after PSOs have confirmed all clearance zones are clear of marine mammals. Vibratory pile driving must be suspended if a marine mammal is visually observed by PSOs within the shutdown zone in the above table. At all times of the year, any unidentified whale sighted by a PSO within 6,562 feet (2,000 meters) of the pile must be treated as if it were a NARW and trigger any required pre-construction delay or shutdowns during pile installation.</td>
<td>C</td>
<td>Increase effectiveness of mitigations to avoid or minimize impacts on ESA-listed species from underwater noise</td>
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<tr>
<td>No</td>
<td>Measure Description</td>
<td>Project Phase</td>
<td>Expected Effects</td>
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<tr>
<td>BA-24 Wind Turbine Foundations</td>
<td>Pile Driving/Impact Hammer Activity: Noise Mitigation for Impact Pile Driving</td>
<td>C</td>
<td>Increase effectiveness of mitigations to avoid or minimize impacts on ESA-listed species from underwater noise</td>
<td></td>
</tr>
<tr>
<td>BA-25 Wind Turbine Foundations</td>
<td>Pile Driving/Impact Hammer Activity: Pile-Driving Noise Reporting and Clearance or Shutdown Zone Adjustment</td>
<td>C</td>
<td>Increase effectiveness of mitigations to avoid or minimize impacts on ESA-listed species from underwater noise</td>
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</tr>
<tr>
<td>BA-26 Wind Turbine Foundations</td>
<td>Pile Driving/Impact Hammer Activity: Pile-Driving Work Within a Slow Zone</td>
<td>C</td>
<td>Increase effectiveness of mitigations to avoid or minimize impacts on NARW from underwater noise</td>
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<tr>
<td>BA-27 Wind Turbine Foundations</td>
<td>Pile Driving/Impact Hammer Activity: Submittal of Raw Field Data Collected for Marine Mammals and Sea Turtles in the Pile-Driving Shutdown Zone</td>
<td>C</td>
<td>Record the effectiveness of mitigations to avoid or minimize impacts on ESA-listed species from underwater noise</td>
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<tr>
<td>BA-28 Wind Turbine Foundations</td>
<td>Pile Driving/Impact Hammer Activity: Weekly and Final Pile-Driving Reports</td>
<td>C</td>
<td>Record the effectiveness of mitigations to avoid or minimize impacts on ESA-listed species from underwater noise</td>
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<td>No</td>
<td>Measure and Elimination: Marine Debris Awareness and Elimination: Marine Debris Awareness Training</td>
<td>Description</td>
<td>Project Phase</td>
<td>Expected Effects</td>
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<tr>
<td>BA-20</td>
<td>Marine Debris Awareness Training</td>
<td>The Lessee must ensure that vessel operators, employees, and contractors engaged in offshore activities pursuant to the approved COP complete marine trash and debris awareness training annually. The training consists of two parts: (1) viewing a marine trash and debris training video or slide show (described below); and (2) receiving an explanation from management personnel that emphasizes their commitment to the requirements. The marine trash and debris training videos, training slide packs, and other marine debris related educational material may be obtained at <a href="https://www.bsee.gov/debris">https://www.bsee.gov/debris</a> or by contacting BSEE. The training videos, slides, and related material may be downloaded directly from the website. Operators engaged in marine survey activities must continue to develop and use a marine trash and debris awareness training and certification process that reasonably assures that their employees and contractors are in fact trained. The training process would include the following elements: Viewing of either a video or slide show by the personnel specified above; An explanation from management personnel that emphasizes their commitment to the requirements; Attendance measures (initial and annual); and Recordkeeping and the availability of records for inspection by DOI. By January 31 of each year, the Lessee would submit to DOI an annual report that describes its marine trash and debris awareness training process and certifies that the training process has been followed for the previous calendar year. The Lessee would send the reports via email to BOEM (at <a href="mailto:renewable_reporting@boem.gov">renewable_reporting@boem.gov</a>) and to BSEE (at <a href="mailto:OSWsubmittals@bsee.gov">OSWsubmittals@bsee.gov</a>). The Lessee must report to DOI (using the email address listed on DOI’s most recent incident reporting guidance) all lost or discarded marine trash and debris. This report must be made monthly and submitted no later than the fifth day of the following month. The Lessee is not required to submit a report for those months in which no marine trash and debris was lost or discarded. In addition, 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 biologic components, with particular attention to marine trash or debris that could entangle or be ingested by marine protected species; or (b) significantly interfere with OCS uses (e.g., because the marine trash or debris is likely to snag or damage fishing equipment or presents a hazard to navigation). The information in the 48-hour report must be the same as that listed for the monthly report, but only for the incident that triggered the 48-hour Report. The Lessee must report to DOI via email to BOEM (at <a href="mailto:renewable_reporting@boem.gov">renewable_reporting@boem.gov</a>) and to BSEE (at <a href="mailto:OSWsubmittals@bsee.gov">OSWsubmittals@bsee.gov</a>). The marine trash and debris reporting required is at 48-hour reporting rate. The Lessee must submit to DOI an annual report that describes its marine trash and debris awareness training process and certifies that the training process has been followed for the previous calendar year. The Lessee would send the reports via email to BOEM (at <a href="mailto:renewable_reporting@boem.gov">renewable_reporting@boem.gov</a>) and to BSEE (at <a href="mailto:OSWsubmittals@bsee.gov">OSWsubmittals@bsee.gov</a>).</td>
<td>Pre-C, C, O&amp;M, D</td>
<td>Increase the effectiveness of mitigations to avoid or minimize impacts on ESA-listed species from underwater noise</td>
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| BA-30 | Marine Debris Awareness and Elimination: Marine Debris Reporting | The Lessee must report to DOI (using the email address listed on DOI’s most recent incident reporting guidance) all lost or discarded marine trash and debris. This report must be made monthly and submitted no later than the fifth day of the following month. The Lessee is not required to submit a report for those months in which no marine trash and debris was lost or discarded. In addition, 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 marine trash or debris that could entangle or be ingested by marine protected species; or (b) significantly interfere with OCS uses (e.g., because the marine trash or debris is likely to snag or damage fishing equipment or presents a hazard to navigation). The information in the 48-hour report must be the same as that listed for the monthly report, but only for the incident that triggered the 48-hour Report. The Lessee must report to DOI via email to BOEM (at renewable_reporting@boem.gov) and to BSEE (at OSWsubmittals@bsee.gov). If the object is recovered and, as applicable, describe any substantial variance from the activities described in the Recovery Plan that were required during the recovery efforts. The Lessee must determine and address information on unrecouped marine trash and debris in the description of the site clearance activities provided in the decommissioning application required under 30 C.F.R. § 585.906. Materials, equipment, tools, containers, and other items used in OCS activities which are of such shape or 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. 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 marine trash or debris that could entangle or be ingested by marine protected species; or (b) significantly interfere with OCS uses (e.g., because the marine trash or debris is likely to snag or damage fishing equipment or presents a hazard to navigation). The information in the 48-hour report must be the same as that listed for the monthly report, but only for the incident that triggered the 48-hour Report. The Lessee must report to DOI via email to BOEM (at renewable_reporting@boem.gov) and to BSEE (at OSWsubmittals@bsee.gov). If the object is recovered and, as applicable, describe any substantial variance from the activities described in the Recovery Plan that were required during the recovery efforts. The Lessee must determine and address information on unrecouped marine trash and debris in the description of the site clearance activities provided in the decommissioning application required under 30 C.F.R. § 585.906. Materials, equipment, tools, containers, and other items used in OCS activities which are of such shape or 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. Materials, equipment, tools, containers, and other items used in OCS activities which are of such shape or 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. The Lessee must report to DOI (using the email address listed on DOI’s most recent incident reporting guidance) all lost or discarded marine trash and debris. This report must be made monthly and submitted no later than the fifth day of the following month. The Lessee is not required to submit a report for those months in which no marine trash and debris was lost or discarded. In addition, 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 marine trash or debris that could entangle or be ingested by marine protected species; or (b) significantly interfere with OCS uses (e.g., because the marine trash or debris is likely to snag or damage fishing equipment or presents a hazard to navigation). The information in the 48-hour report must be the same as that listed for the monthly report, but only for the incident that triggered the 48-hour Report. The Lessee must report to DOI via email to BOEM (at renewable_reporting@boem.gov) and to BSEE (at OSWsubmittals@bsee.gov). If the object is recovered and, as applicable, describe any substantial variance from the activities described in the Recovery Plan that were required during the recovery efforts. The Lessee must determine and address information on unrecouped marine trash and debris in the description of the site clearance activities provided in the decommissioning application required under 30 C.F.R. § 585.906. Materials, equipment, tools, containers, and other items used in OCS activities which are of such shape or 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. | Pre-C, C, O&M, D | Record the effectiveness of mitigations to avoid or minimize impacts on ESA-listed species from underwater noise |

<p>| BA-31 | Marine Debris: Periodic Underwater Surveys, Reporting of Monofilament and Other Fishing Gear Around WTG Foundations | The Lessee must monitor indirect impacts associated with charter and recreational fishing gear lost from expected increases in fishing around WTG foundations by surveying at least 10 different WTGs in the Mayflower Wind Lease Area annually. Survey design and effort may be modified based upon previous survey results with review and concurrence by DOI. The Lessee must conduct surveys by remotely operated vehicles, divers, or other means to determine the frequency and locations of marine debris. The Lessee must report the results of the surveys to BOEM (at <a href="mailto:renewable_reporting@boem.gov">renewable_reporting@boem.gov</a>) | O&amp;M, D | Record the effectiveness of mitigations to avoid or minimize impacts on ESA-listed species from marine debris, particularly ghost gear |</p>
<table>
<thead>
<tr>
<th>No</th>
<th>Measure Description</th>
<th>Project Phase</th>
<th>Expected Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>BA-32</td>
<td>Establishment of Shutdown Zones for Vibratory Pile Driving</td>
<td>C</td>
<td>Increase effectiveness of mitigations to avoid or minimize impacts on ESA-listed species from underwater noise</td>
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<td></td>
<td>Ensure that vibratory pile-driving operations are carried out in a way that minimizes the exposure of listed sea turtles to noise that may result in injury or behavioral disturbance. Pile-driving will establish a 1,640-foot (500-meter) shutdown zone for all pile-driving activities. Adherence to the 1,640-foot (500-meter) shutdown zones must be reflected in the PSO reports. Any visual detection of sea turtles during pile-driving, Mayflower Wind must shut down the pile-driving hammer (unless activities must proceed for human safety or for concerns of structural failure) from when the PSO observes, until: 1) The lead PSO verifies that the animal(s) voluntarily left and headed away from the clearance area; or 2) 30 minutes have elapsed without re-detection of the sea turtle(s) by the lead PSO. Additionally, if shutdown is called for but Mayflower Wind determines shutdown is not technically feasible due to human safety concerns or to maintain installation feasibility, reduced hammer energy must be implemented, when the lead engineer determines it is technically feasible to do so.</td>
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</tr>
<tr>
<td>BA-33</td>
<td>Sea turtle Disentanglement</td>
<td>C, O&amp;M, D</td>
<td>Increase effectiveness of mitigations to avoid or minimize impacts on sea turtles from marine debris</td>
</tr>
<tr>
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<td>Vessels deploying fixed gear (e.g., pots/traps) must have adequate disentanglement equipment onboard, such as a (i.e., knife and boathook) onboard. Any disentanglement must occur consistent with the Northeast Atlantic Coast STDN Disentanglement Guidelines at <a href="https://www.reginfo.gov/public/do/DownloadDocument?objectID=102486501">https://www.reginfo.gov/public/do/DownloadDocument?objectID=102486501</a> and the procedures described in “Careful Release Protocols for Sea Turtle Release with Minimal Injury” (NOAA Technical Memorandum 580; <a href="https://repository.library.noaa.gov/view/noaa/3773">https://repository.library.noaa.gov/view/noaa/3773</a>).</td>
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<tr>
<td>BA-34</td>
<td>Sea Turtle/Atlantic Sturgeon Identification and Data Collection</td>
<td>C, O&amp;M, D</td>
<td>Increase effectiveness of mitigations to avoid or minimize impacts on ESA-listed species by gathering biological data</td>
</tr>
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</table>
| | Any sea turtles or Atlantic sturgeon caught or retrieved in any fisheries survey gear must first be identified to species or species group. Each ESA-listed species caught or retrieved must then be documented using appropriate equipment and data collection forms. Biological data collection, sample collection, and tagging activities must be conducted 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://media.fisheries.noaa.gov/2021-02/Sturgeon%20%26%20Sea%20Turtle%20Take%20SOPs_external_11032021.pdf). b. Survey vessels must have a passive integrated transponder (PIT) tag reader onboard capable of reading 134.2 kHz and 125 kHz encrypted tags (e.g., Biomark GPR Plus Handheld PIT Tag Reader). This reader must be used to scan any captured sea turtles and sturgeon for tags, and any tags found must be recorded on the take reporting form (see below). c. Genetic samples must be taken from all captured Atlantic sturgeon (alive or dead) to allow for identification of the DPS of origin of captured individuals and tracking of the amount of incidental take. This must be done in accordance with the Procedures for Obtaining Sturgeon Fin Clips (https://media.fisheries.noaa.gov/dam-migration/sturgeon_genetics_sampling_revised_june_2019.pdf). i. Fin clips must be sent to a NMFS-approved laboratory capable of performing genetic analysis and assignment to DPS of origin. Mayflower Wind must cover all reasonable costs of the genetic analysis. Arrangements for shipping and analysis must be made before samples are submitted and confirmed in writing to NMFS within 60 days of the receipt of the Project BiOp with ITS. Results of genetic analyses, 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 forms must be held and submitted to a tissue repository (e.g., the Atlantic Coast Sturgeon Tissue Research Repository) on a quarterly basis. The Sturgeon Genetic Sample Submission Form is available for download at: https://media.fisheries.noaa.gov/2021-02/Sturgeon%20Genetic%20Sample%20Submission%20Sheet%20v07%20%207_v1.1_Form%2007%20
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. Particularly, a NMFS Take Report Form must be filled out for each individual sturgeon and sea turtle (download at: https://media.fisheries.noaa.gov/2021-07/take%20Report%20Form%202017-2021.pdf?null) and submitted to NMFS as described in the take notification measure below.

**BA-35**

Sea Turtle/Atlantic Sturgeon Handling and Resuscitation Guidelines

Any sea turtles or Atlantic sturgeon caught and retrieved in gear used in fisheries surveys must be handled and resuscitated (if unresponsive) according to established protocols provided 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. Handling times for these species must be minimized, and if possible, kept to 15 minutes or less to limit the amount of stress placed on the animals.

b. All survey vessels must have onboard copies of the sea turtle handling and resuscitation requirements (found at 50 CFR 223.206(d)(1)) before beginning 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 survey activities.

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 the handling, and potential coordination of transfer to a rehabilitation facility. If survey staff are 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 required, hard-shelled sea turtles (i.e., non-leatherbacks) may be held on board for up to 24 hours and managed in accordance with handling instructions provided by the Hotline before transfer to a rehabilitation facility.

d. Survey staff must attempt 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. If appropriate cold storage facilities are available on the survey vessel, any dead sea turtle or Atlantic sturgeon must be retained on board the survey vessel for transfer to an appropriately permitted partner or facility on shore unless NMFS indicates that storage is unnecessary, or storage is not safe.

f. Any live sea turtles or Atlantic sturgeon caught and retrieved in gear used in any fisheries survey must ultimately be released according to established protocols including safety considerations.

**BA-36**

Lost Survey Gear

If any survey gear is lost, all reasonable efforts that do not compromise human safety would be undertaken to recover the gear. All lost gear would be reported to NMFS (nmfs.gar.incidental-take@noaa.gov) and BSEE (OSWSubmittals@bsee.gov) within 24 hours of the documented time of missing or lost gear. This report would include information on any markings on the gear and any efforts undertaken or planned to recover the gear.

**AMP** = alternative monitoring plan; **BOI** = biological opinion; **BOEM** = Bureau of Ocean Energy Management; **BSEE** = Bureau of Safety and Environmental Enforcement; **C** = construction; **COP** = Construction and Operation plan; **dB** = decibel; **D** = Decommissioning; **DMA** = dynamic management area; **DOI** = Department of the Interior; **DPS** = distinct population segment; **ESA** = Endangered Species Act; **HVAC** = high voltage alternating current; **HVDC** = high voltage direct current; **ITA** = incidental take authorization; **JPEG** = joint photographic experts group; **km/hr** = kilometer per hour; **kHz** = kilohertz; **MMPA LOA** = Marine Mammal Protection Act Letter of Authorization; **mph** = miles per hour; **NARW** = north Atlantic right whale; **NAVTEX** = NAVigational TeleX; **NMFS** = National Marine Fisheries Service; **NOAA** = National Oceanic and Atmospheric Administration; **O&M** = operations & maintenance; **OCS** = outer continental shelf; **OSP** = offshore substation platform; **PAM** = Passive acoustic monitoring; **PDM** = Pile-Driving Monitoring; **PIT** = passive integrated transponder; **PSO** = protected species observer; **RWSAS** = Right Whale Sighting Advisory System; **SFVP** = sound field verification plan; **SMA** = seasonal management area; **STDN** = sea turtle disentanglement network; **USACE** = United States Army Corps of Engineers; **WTG** = wind turbine generator

Increase effectiveness of mitigations to avoid or minimize impacts on ESA listed species from unsafe handling

Increase effectiveness of mitigations to avoid or minimize impacts on sea turtles from marine debris
Figure 3.3-1. Enhanced mitigation area

Source: Mayflower Wind 2022.
4. **Environmental Baseline**

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

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

Mayflower Wind conducted detailed surveys of the Project area during COP development. Those surveys are the most current information available for characterizing baseline conditions within the Project area and are relied upon here and supported by other appropriate sources of information where available.

Marine ecosystems in the Action Area are described using the Coastal and Marine Ecological Classification Standard (CMECS), a classification system based on biogeographic setting for the area of interest (FGDC 2012). CMECS provides a comprehensive framework for characterizing ocean and coastal environments and living systems using categorical descriptors for physical, biological, and chemical parameters relevant to each specific environment type (FGDC 2012). The CMECS biogeographic setting for the entire Action Area is the Temperate Northern Atlantic Realm, Cold Temperate Northwest Atlantic Province, Virginian Ecoregion. The environmental baseline for benthic habitats also incorporates updated recommendations from the National Oceanic and Atmospheric Administration (NOAA) (2021) regarding mapping fish habitat.

The Action Area includes marine (i.e., subsurface), airborne (e.g., airborne noise), and the upland or terrestrial components of the Project footprint. However, the NMFS ESA-listed species considered in this BA do not occur within the terrestrial components of the Action Area, and the projected impacts on upland habitats resulting from the onshore components of the Proposed Action would have no measurable effect on aquatic habitats used by ESA-listed species. The following discussion provides information on those elements of the environment relevant to the species covered in this BA and the project related IPFs.

4.1 **Benthic Habitat**

Mayflower Wind collected Sediment Profile Imaging (SPI)/Plan View (PV) imagery data, benthic grab samples in addition to geophysical, geotechnical, and some submerged aquatic vegetation (SAV) survey data throughout the Project area. These data indicate that the seabed in the Lease Area is mostly flat with gentle slopes ranging from less than 1.0° to 4.9°. The central section of the Lease Area comprises ridges with moderate slopes (5.0° to 9.9°) and shallow channels. Sediments from grab samples within the Lease Area were largely classified as CMECS Subclass Fine Unconsolidated Substrate, or dominated by sand or finer sediment size (< 5 percent gravel). Only one sample was classified as Coarse Unconsolidated Substrate (≥ 5 percent gravel). The Lease Area was mainly soft bottom habitat with little relief and no complex habitat-forming features. Total organic carbon (TOC) was low with the majority of samples containing less than 1 percent TOC (Mayflower Wind 2022). Benthic epifauna were sampled by beam trawl across the Massachusetts offshore wind Lease Area with sand shrimp and sand dollars comprising 88 percent of individuals collected (Guida et al. 2017). Mobile crustaceans and mollusks were dominant in 2020 benthic samples and are commonly associated with the soft sediments of the Lease Area. Infraunal communities of the Lease Area consisted mainly of soft-sediment burrowing infauna, with the eastern portion consisting of clam beds and tube-building Ampelisca beds. The western portion of the Lease Area also contained Ampelisca beds, as well as small surface-burrowing polychaete worm beds. Results of a
seagrass and macroalgae evaluation of the Project area found no SAV in the Lease Area (Mayflower Wind 2022).

Similar to the Lease Area, the southern portion of the Falmouth ECC (between the Lease Area and the Muskeget Channel) consisted mainly of fine and soft sediments. Samples in this southern section were mainly Fine Unconsolidated sediment, with three samples of Coarse Unconsolidated sediment (≥ 5 percent gravel). Most samples (approximately 90 percent) were sand, with three samples consisting of Muddy Sand. Further sand classification indicated a transition of Fine/Very Fine Sand to Medium and Very Coarse/Coarse Sand as sampling occurred more north and away from the Lease Area. The only complex habitats observed were three gravelly samples. TOC was less than 1 percent in all samples. The infauna sampled along the southern Falmouth ECC closely matched the eastern Lease Area, dominated by clam beds and large tube-building fauna. The northern Falmouth ECC sediment samples were more variable, with a further transition to coarser sediments as the corridor proceeds north towards landfall. Gravelly samples dominated south of the Nantucket Sound Main Channel, with all samples within the Nantucket Sound Main Channel classified as sand. Complex habitat was observed in the remaining samples north of the Nantucket Main Channel, with two samples classified as Biogenic Shell Substrate (Crepidula reef). Some gravel pavement was noted in the SPI/PV images, and gravel/gravelly samples were observed throughout the northern section of the Falmouth ECC. TOC was undetectable in the majority of samples, with one sample containing slightly above 1 percent. The northern Falmouth ECC had a heterogenous array of species including soft-sediment bryozoans and mobile burrowing crustaceans (Mayflower Wind 2022).

Benthic surveys were conducted along the Brayton Point ECC in Summer 2021 and Spring 2022. Sediments followed similar patterns as the Falmouth ECC, with finer sediments in the southern section near the Lease Area becoming coarser as sampling proceeded north. In federal waters, over 90 percent of benthic habitat was mapped as sand or finer (Appendix M.3; Mayflower Wind 2022). Gravelly Sand to Sandy Gravel, including Boulders, were present in the Rhode Island Sound where an area of glacial till southwest of Martha’s Vineyard provides heterogenous substrate and hardbottom substrate. Sand or finer sediments dominated Rhode Island state waters as well with 88 percent of the benthic habitat, and coarse sediments consisting of 8.5 percent Mixed-Sized Gravel in Muddy Sand/Sand, 3.1 percent Glacial Moraine A, and 0.1 percent Bedrock. Additionally, 22.2 percent of the Rhode Island state waters had Crepidula Substrate as a CMECS Substrate classifier, and 3.1 percent had Boulder Field(s) as a Substrate classifier (Appendix M.3; Mayflower Wind 2022). Sediments in the Sakonnet River are finer sands to silts with areas of boulders, including anthropogenic rock dumps that provide hardbottom habitat, and isolated mounds associated with Crepidula reefs.

Submerged aquatic vegetation beds were identified at the Falmouth landfall areas from a review of eelgrass field surveys completed in August 2020. The seagrass and macroalgae characterization surveys did not identify SAV in the southern portion of the Falmouth ECC, but macroalgae was identified in approximately two-thirds of the survey locations during benthic grabs of the northern section of the Falmouth ECC. A previously unmapped section of interpreted SAV was identified near the Aquidneck Island landfall of the Brayton Point ECC. Sampling within the Brayton Point ECC showed soft sediment fauna was the dominant CMECS biotic subclass observed along the entire Brayton Point ECC, characterized by clam beds, larger tube-building, mobile crustaceans, and surface-burrowing fauna, with much more diversity in the southern portion of the ECC (Mayflower Wind 2022).

Analytical modeling and qualitative assessment were employed to investigate scour potential in the Project area. Geotechnical data, site-specific bathymetric data, publicly available data, and site-specific conditions from a high resolution model developed specifically for the Proposed Action revealed very limited potential for background sediment transport activity across the Lease Area and along the southern part of the ECCs. Bed shear stresses resulting from currents and waves exceed critical shear stresses for initiation of sediment movement during a very low percentage of the time, and no significant bedform or
other presently active geomorphological feature is observed from the review of the currently available data.

In the vicinity of the Vineyard and Nantucket Sounds and Muskeget Channel, much stronger currents and waves occur along the shallower sections of the export cable routes. These are associated with widespread evidence of sediment transport activity and bedforms such as megaripples and sand waves, with height locally reaching up to 13 feet (4 meters). Sediment mobility along the export cable routes varies over a wide range, with significant mobility associated with sand waves and shoals where strong tidal currents occur, especially in the vicinity of the Vineyard and Nantucket Sounds and Muskeget Channel. Scour is more likely to be associated with natural processes than caused by the cables themselves, provided the latter is buried such that it is not exposed to seabed currents. The burial depth will have to be determined to prevent the potential re-exposure of the cables in areas of migrating sand waves.

4.2 Pelagic Habitat

The Action Area includes coastal and offshore areas in the southern New England waters, as well as offshore and coastal areas utilized by vessels transiting to ports north to Canada and south to Virginia. This section presents water quality data for federal waters, mostly associated with the Lease Area, and offshore waters for the ECCs. The aquatic component of the Project area is located in transitional waters that separate Narragansett Bay and Long Island Sound from the Atlantic OCS. The Falmouth ECC state waters include Nantucket Sound, which is located between the south coast of Massachusetts and the Islands of Martha’s Vineyard and Nantucket. The Brayton Point ECC state waters include the Sakonnet River, located east of Narragansett Bay in Rhode Island, which connects Mount Hope Bay to the Rhode Island Sound. Mount Hope Bay is located between both Massachusetts and Rhode Island and is in the vicinity of the proposed export cable landfall locations at Brayton Point. Water quality of coastal marine waters in the region is summarized below, with more detailed water quality information and data sources included in the Mayflower COP Appendix H (Mayflower Wind 2022).

Within the Lease Area, water depths range from 122 to 208 feet (37.1 to 63.5 meters; Figure 4.2-1) (Mayflower Wind 2022). Along the Falmouth and Brayton Point export cable routes, water depths vary between 0 and 160 feet (0 and 49.8 meters) and 0 and 136 feet (0 and 41.5 meters), respectively. The Falmouth ECC is subject to strong ebb and flood tidal currents, from Falmouth, Massachusetts, to where it passes between Martha’s Vineyard and Nantucket Islands. Beyond the islands, and into the Lease Area, offshore hydrodynamic conditions are considered storm dominated with relatively weaker bottom currents driven by waves and circulation (Mayflower 2022). Circulation patterns in the region are influenced by water moving in from Block Island Sound and the colder water coming in from the Gulf of Maine with a net transport of water from Rhode Island Sound towards the southwest and west. While the net surface transport is to the southwest and west, bottom water may flow toward the north, particularly during the winter (Rhode Island Coastal Resources Management Council 2010). Currents generally flow westward across the shelf south of the islands, although a tidally driven anticyclonic flow encircles Nantucket Shoals, with tidal mixing maintaining cool water temperatures on the shoals throughout the year whereas the rest of the region becomes stratified during the summer months (Wilkin 2006).

The Project area 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). Weather-driven surface currents, tidal mixing, and estuarine outflow all contribute to driving water movement through the area (Kaplan 2011), which is subjected to highly seasonal variation in temperature, stratification, and productivity. There is a persistent frontal zone near Nantucket Shoals, which marine vertebrates often use for foraging and migration as they can aggregate prey (Scales et al. 2014). Overall, pelagic habitat quality within the Project area is considered fair to good (USEPA 2015). Surface Water temperatures in the Project area
range from approximately 39.0°F (3.9°C) to 69.6°F (20.9°C). The warmest temperatures occur from July through September and coldest temperatures occur from February through April. Surface waters experience the greatest temperature variation throughout the year while deeper waters maintain more consistent temperatures (Mayflower Wind 2022).

![Figure 4.2-1. WTG/OSP positions in the Lease Area relative to MLLW](attachment:image)

### 4.3 Water Quality

Surface waters in the Action Area include: (1) coastal onshore waterbodies that generally include freshwater ponds, streams, and rivers; and (2) coastal marine waters that generally include saline and tidal/estuarine waters, such as Nantucket Sound, Rhode Island Sound, Mount Hope Bay, Sakonnet River, and the Atlantic Ocean. Surface waters within most of the Action Area and all of the Onshore Project areas are coastal marine waters.

In federal waters, seasonal average turbidity ranges from 0.47 to 0.59 nephelometric turbidity units (NTU), seasonal average total nitrogen ranges from 10.1 to 11.7 micrometers (µm), seasonal average total phosphorus ranges from 0.61 to 0.76 µm, and seasonal average dissolved oxygen (DO) concentration ranges from 7.6 to 9.8 milligrams per liter (mg/L). Salinity averages remained fairly stable; ranging only from approximately 31.5 practical salinity units (psu) to 32.9 psu (Mayflower Wind 2022).
In coastal waters near the Falmouth ECC, seasonal average turbidity ranges from 2.2 to 2.8 NTU, seasonal average total nitrogen ranges from 35.0 to 42.3 µm, seasonal average total phosphorus is 1.4 µm, and seasonal average DO concentration ranges from 6.7 to 7.2 mg/L. Salinity averages remained fairly stable; ranging only from 21.1 to 21.8 psu (Mayflower Wind 2022). These water quality parameters were used to determine a Water Quality Index (WQI) for each sample characterized as Good, Fair, or Poor. In Nantucket Sound, 88 percent of the samples (seven of eight) received a WQI of Good and the remaining sample was Fair.

In coastal waters near the Brayton Point ECC by Gould Island, seasonal average turbidity ranges from 1.2 to 2.5 NTU, seasonal average total nitrogen ranges from 0.21 to 0.33 µm, seasonal average total phosphorus ranges from 0.04 to 0.08 µm, and seasonal average DO concentration ranges from 6.1 to 7.3 mg/L. Salinity averages range from approximately 28 psu to 30.3 psu (Mayflower Wind 2022). The Sakonnet River is a tidal straight flowing from Mt. Hope Bay to Rhode Island Sound and located east of Narragansett Bay in Rhode Island. Physical and chemical data were collected from the Sakonnet River United States Geological Survey (USGS) Buoy monitoring station to characterize its water quality conditions in 2018 and 2019. The Sakonnet River remains saline throughout the year due to tidal influence. Reaching peak temperatures in the summer months, the river also reaches its lowest dissolved oxygen levels. Seasonal algal growth, seen as increased Chlorophyll a, as well as low dissolved oxygen levels have raised concern for the ecological health of the river (USGS 2019). The primary causes of the observed water-quality impairments are the inputs of nutrients from wastewater management and stormwater runoff from the surrounding developed area (USGS 2019). The Sakonnet River is listed in the State of Rhode Island 2018-2020 Impaired Waters Report (RIDEM 2021). The waterbody is identified as Category 4A – Waterbodies for which a Total Maximum Daily Load (TMDL) has been developed. The TMDL for fecal coliform was published April 7, 2005 (RIDEM 2005). The TMDL indicates the impaired reach of the Sakonnet River includes “waters north of a line extending from the southwestern-most corner of the stone bridge in Tiverton to the eastern-most extension of Morningside Lane in Portsmouth.” The landfall for the offshore export cable on Aquidneck Island is within this reach. The 180-acre (73-hectare) area is closed to shellfishing due to the presence of fecal coliform.

In coastal waters near the Brayton Point ECC within Mount Hope Bay, seasonal average total nitrogen ranges from 0.12 to 0.18 mg/L, and seasonal average DO concentration ranges from 7.1 to 7.9 mg/L. Salinity averages range from approximately 27.2 psu to 27.9 psu (Mayflower Wind 2022). Other coastal waters near the Project area, including Buzzards Bay, Mount Hope Bay, Upper Narragansett, Providence River, Newport Harbor/Coddington Cove and associated tidal tributaries, are listed as 303(d) impaired. These waters are non-attaining for fish consumption, ecological or recreational use, with causes including metals other than Mercury, nutrients, oil and grease, trash, pathogens, total toxins, oxygen depletion, and PCBs (USEPA 2020).

4.4 Underwater Noise

Kraus et al. (2016) recorded ambient noise in the Massachusetts and Rhode Island WEA from 2011 to 2015 and found sound levels in the 70.8 to 224 Hertz (Hz) frequency band with variations between 96 and 103 dB re 1 µPa (decibel referenced to 1 microPascal) during 50 percent of the recording time.

4.5 EMFs

The natural magnetic field in the Action Area has a total intensity of approximately 512 to 514 milligauss (mG) at the seabed, based on modeled magnetic field strength from 2019 through 2021 (NOAA 2021). The marine environment continuously generates additional ambient EMF. The motion of electrically conductive seawater through the Earth’s magnetic field induces voltage potential, thereby creating electrical currents. Surface and internal waves, tides, and coastal ocean currents all create weak induced
electrical and magnetic fields. Their magnitude at a given time and location is dependent on the strength of the prevailing magnetic field, site, and time-specific ocean conditions. Other external factors like electrical storms and solar events can also cause variability in the baseline level of EMF naturally present in the environment (CSA Ocean Sciences 2019).

Following the methods described by Slater et al. (2010), a uniform current of 1 meter per second (m/s) flowing at right angles to the natural magnetic field in the Action Area could induce a steady-state electrical field on the order of 51.5 microVolts per meter (μV/m). Wave action will also induce electrical and magnetic fields at the water surface on the order of 10 to 100 μV/m and 1 to 10 mG, respectively, depending on wave height, period, and other factors. While these effects dissipate with depth, wave action will likely produce detectable EMF effects up to 185 feet (56 meters) below the surface (Slater et al. 2010).

Several existing cables intersect the Falmouth ECC. Cables supplying power and communication from the mainland to Martha’s Vineyard intersect the western edge of the surveyed ECC and the western alternative landfall approach to Falmouth. Crossing the Falmouth ECC just south of the entry to Muskeget Channel are three potential, out-of-service cables, of presently unknown origin. In the case of the Brayton Point ECC, a gas pipeline and two water pipelines cross the Sakonnet River, and therefore also the surveyed ECC. Three cables cross southern Mt. Hope Bay, close to and parallel with the Mt. Hope Bridge. Further details are provided in the Geohazard Report of each ECC in Appendix E of Mayflower Wind’s COP (Mayflower Wind 2022). There are no permanent seabed installations, such as telecommunications or naval cables, in the offshore portion of the Project area, including the Lease Area.

Though no submarine transmission or communication cables have been identified in the Project area, these can also contribute to EMF levels in an area. Electrical telecommunications cables are likely to induce a weak EMF in the immediate area along the cable path. Gill et al. (2005) observed electrical fields on the order of 1 to 6.3 μV/m within 3.3 feet (1 meter) of a typical cable of this type. The heat effects of communication cables on surrounding sediments are likely to be negligible given the limited transmission power levels involved. Fiber-optic cables with optical repeaters would not produce EMF or significant heat effects.

4.6 Artificial Light

Vessel traffic and safety lighting on marine structures (i.e., buoys and meteorological towers) are the only sources of artificial light in the offshore portion of the Action Area. The construction and O&M of WTG and OSP structures would introduce new short-term and long-term sources of artificial light to the offshore environment in the forms of vessel lighting and navigation and safety lighting on offshore WTGs and OSP foundations. Maintenance vessel lighting and operational lighting on WTG and OSP foundations, in the forms of navigation, aircraft safety, and work lighting, would produce long-term lighting effects over the life of planned offshore wind projects. BOEM has issued guidance for avoiding and minimizing artificial lighting impacts from offshore energy facilities and associated construction vessels (BOEM 2021g; Orr et al. 2013) and has concluded that adherence to these measures should effectively avoid adverse effects on marine mammals, sea turtles, fish, and other marine organisms (Orr et al. 2013). BOEM would require all future offshore energy projects to comply with this guidance. Land-based artificial light sources are generally predominant in nearshore areas with substantial residential, commercial, and industrial shoreline development, such as at the Falmouth and Brayton Point landfall locations.

4.7 Vessel Traffic

There is wide variance in traffic density, vessel types, and vessel sizes within the Project area. To quantify these variables, Mayflower Wind retained DNV Energy USA Inc. (DNV GL) to conduct an independent
Navigation Safety Risk Assessment (NSRA) of the proposed Mayflower Wind Project. The sources employed to identify vessel traffic patterns in the NSRA include Nationwide Automatic Identification System (AIS) data for 2019; 2016 vessel monitoring system data from NMFS; vessel trip report data from 2011 to 2015; the Massachusetts and Rhode Island Port Access Route Study (USCG 2020); and interactions with recreational boating, fishing, and towing industry organizations, agencies, and other stakeholders. The study area of the assessment consists of an area extending at least 20 nm (37 km) on all sides of the Project area (Figure 4.7-1). Based on the information in the NSRA, vessel traffic in the northern portion of the NSRA study area (within Nantucket Sound, the Sakonnet River, and Mount Hope Bay) comprises smaller vessels with a high seasonal activity. The vessel traffic in the southern portion of the study area—encompassing the Lease Area, other lease areas, Nantucket shoals, and the Nantucket Ambrose Fairway—is more varied, with a mixture of deep draft vessels and commercial fishing vessels engaged in fishing or transiting to fishing grounds outside the Project area. The number of vessel tracks in the study area is highest in the summer with a peak in July of over 21,000 tracks. The low is in January with less than 3,500 tracks. In 2019, summer increases were greatest for pleasure, fishing, passenger, and other vessel types. For the southern portion of the study area, where the Lease Area is located, the vast majority of the seasonal increase is from fishing vessels in the summer. Non-fishing vessels show a seasonal effect, but to a much lower extent. Summer is the peak for passenger, pleasure, and tug/service vessels; fall is the peak for tankers with non-oil cargoes; and spring and fall are peaks for cargo/carrier and tanks with oil cargoes. The total AIS traffic density for 2019 is shown on Figure 4.7-2, and Table 4.7-1 shows the average vessel details from the study area assessment and the vessel tracks that intersect the Lease Area and offshore ECCs derived from the NSRA study area.
Most cargo, carrier, and tanker vessel traffic near the study area use the Nantucket Ambrose Fairway and Narragansett Bay traffic separation scheme (TSS), located south and west of the Lease Area, respectively. The highest density of vessel traffic is within the Nantucket Ambrose Fairway, located between the approaches to New York and waters south of Nantucket, south of the Lease Area. Some deep draft vessels cross the Lease Area when transiting between the Nantucket Ambrose Fairway and the Narragansett Bay TSS. Minimal cargo and tanker activity occurs within the Sakonnet River and Rhode Island Sound with slightly higher activity within Mount Hope Bay (COP Volume 2, Section 13.1.1; Mayflower Wind 2022).

Within the study area, the area with the most commercial fishing vessel traffic is in the northwest-southeast corridor from Martha’s Vineyard and along Nantucket Shoals intersecting the Falmouth ECC. Near the Brayton Point ECC, the most commercial fishing activity occurs in Rhode Island Sound with limited activity within Mount Hope Bay and the Sakonnet River, with the exception of high levels of monkfish fishing and limited gillnet fishing (COP Volume 2, Section 13.1.1; Mayflower Wind 2022).

Most passenger vessels present in the study area occur in the area between Cape Cod, Martha’s Vineyard, and Nantucket. There are also cruise ships that transit the Nantucket Ambrose Fairway, and some pleasure vessel transits within Nantucket Sound and Rhode Island Sound, the Sakonnet River, and Mount Hope Bay (COP Volume 2, Section 13.1.1; Mayflower Wind 2022).

Size distributions for length overall (LOA), beam, and dead weight tonnage (DWT) for vessels in the NRSA study area (Table 4.7-1) are based on unadjusted AIS data. The average cargo/carrier vessel is 823 feet (251 meters) LOA. Oil tankers and other tankers average 633 feet (193 meters) and 564 feet (172 meters) LOA, respectively. Fishing, pleasure and tugs all average less than 82 feet (25 meters) LOA. Beam and DWT show similar patterns.

Vessel sizes and even some vessel types were present only in the northern or southern portion of the study area. Cargo and carrier vessels transited both in the north and south study areas, but no cargo/carrier vessel tracks crossed from one area into the other. Cargo/carrier vessels in the North study area had an average LOA of 295 feet (90 meters), while vessels in the southern portion of the study area were more than twice as large, averaging 827 feet (252 meters) LOA primarily because of the Nantucket Ambrose Fairway south of the Lease Area. Fishing, other, pleasure vessels, and tugs transited in and between the northern and southern study areas, and had fairly consistent LOA across the study area.

There were no tanker tracks in the northern portion of the study area. Passenger vessels in the southern portion of the study area were nearly four times as long as their counterparts in the northern portion of the study area. This is because the ferries crossing Nantucket Sound and the cruise ships transiting in the Nantucket Ambrose Fairway are both categorized as passenger vessels.
Figure 4.7-2. AIS traffic density in the NRSA study area (January to December 2019)

Table 4.7-1. Vessel details in the NSRA study area and vessel tracks that intersect the Project area (January 1 to December 31, 2019)

<table>
<thead>
<tr>
<th>Vessel Type</th>
<th>Draft</th>
<th>Average Speed</th>
<th>Average DWT</th>
<th>Average Beam (meters)</th>
<th>Average LOA (meters)</th>
<th>Vessel Tracks</th>
<th>Percent of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cargo</td>
<td>Deep</td>
<td>13.7</td>
<td>59,862</td>
<td>35</td>
<td>251</td>
<td>163</td>
<td>1%</td>
</tr>
<tr>
<td>Fishing&lt;sup&gt;1&lt;/sup&gt;</td>
<td>Shallow</td>
<td>4.7</td>
<td>N/A</td>
<td>7</td>
<td>25</td>
<td>11,303</td>
<td>38%</td>
</tr>
<tr>
<td>Passenger</td>
<td>Shallow</td>
<td>15.0</td>
<td>731</td>
<td>14</td>
<td>64</td>
<td>2,803</td>
<td>9%</td>
</tr>
<tr>
<td>Pleasure Craft/ Sailing&lt;sup&gt;2&lt;/sup&gt;</td>
<td>Shallow</td>
<td>10.4</td>
<td>167</td>
<td>5</td>
<td>18</td>
<td>11,251</td>
<td>38%</td>
</tr>
<tr>
<td>Tanker</td>
<td>Shallow</td>
<td>11.8</td>
<td>36,919</td>
<td>28</td>
<td>172</td>
<td>180</td>
<td>1%</td>
</tr>
<tr>
<td>Tug/Tow</td>
<td>Shallow</td>
<td>4.9</td>
<td>522</td>
<td>6</td>
<td>19</td>
<td>1,708</td>
<td>6%</td>
</tr>
<tr>
<td>Other/Not Available&lt;sup&gt;2&lt;/sup&gt;</td>
<td>Shallow</td>
<td>4.1</td>
<td>495</td>
<td>11</td>
<td>46</td>
<td>2,326</td>
<td>8%</td>
</tr>
</tbody>
</table>

Total 29,734 100%

Source: Office for Coastal Management 2022.

<sup>1</sup> AIS track counts for fishing and pleasure vessels underrepresent these vessel types, as not all of these vessel types are required to have AIS on board per USCG regulations.

<sup>2</sup> Other/Not Available vessel types include research, military, law enforcement, and unspecified vessels.
4.8 Description of Critical Habitat in the Action Area

There is no critical habitat designated for any ESA-listed species within the Project area. Critical habitat is found in the Action Area in the Gulf of Maine, Cape Cod Bay, and the James River. The Unit 1 Northeastern U.S. Foraging Area for NARWs (Eubalaena glacialis) (Figure 4.8-1) is the northernmost critical habitat area considered, and would only be impacted by vessel traffic from Salem, Massachusetts, transiting through Cape Cod Bay, and potentially from vessels that transit from the Port of Sheet Harbor in Canada that could potentially travel through the southermmost portions of the Unit 1 foraging area. The southernmost critical habitat considered is the Chesapeake Bay Distinct Population Segment (DPS) of Atlantic sturgeon (Acipenser oxyrhynchus oxyrhynchus). There are several rivers within the Chesapeake Bay DPS that are critical habitat for Atlantic sturgeon. The only critical habitat in the Chesapeake Bay DPS that occurs in the Action Area is the James River. The Port of Virginia, one of the ports proposed by Mayflower Wind for construction activity, is located near the mouth of the James River.

4.8.1 Critical Habitat for North Atlantic Right Whale

NMFS designated critical habitat for the NARW on January 27, 2016 (NMFS 2016a). This designation included two units: a foraging area in the Gulf of Maine and Georges Bank region (Unit 1, Figure 4.8-1, inside the Action Area) and a calving area off the southeastern coast of the United States (Unit 2 outside the Action Area). The northeast critical habitat area is located to the north and west of the Project area. Unit 1 is an important area for NARW foraging because of the prevalence of the copepod, Calanus finmarchicus. Given a NARW’s size in relation to its prey, high densities of copepods are required to meet a NARW’s energetic demands. The physical and biological features of foraging habitat (Unit 1), that contribute to these high-density copepod areas, that are essential to conservation of the species include:

- The physical oceanographic conditions and structures of the Gulf of Maine and Georges Bank region that combine to distribute and aggregate the Calanus 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 Calanus finmarchicus to aggregate passively below the convective layer so that the copepods are retained in the basins;
- Late stage Calanus finmarchicus in dense aggregations in the Gulf of Maine and Georges Bank region; and
- Diapausing Calanus finmarchicus in aggregations in the Gulf of Maine and Georges Bank region.

The physical oceanographic conditions, late stage Calanus finmarchicus aggregations, and aggregations of diapausing Calanus finmarchicus that have been identified as essential features are dynamically distributed throughout this specific area. The specific area includes the large embayments of Cape Cod Bay and Massachusetts Bay and deep underwater basins. The area incorporates state waters from Maine through Massachusetts as well as federal waters, but does not include inshore areas, bays, harbors, and inlets (NOAA 2015).

While the Project area does not directly overlap designated critical and core habitat areas for NARW, it is adjacent to and slightly overlaps the Nantucket Shoals. The shoals are an important area for NARW feeding given its unique oceanographic and bathymetric features that allow for year-round high phytoplankton biomass, likely contributing to increased availability of zooplankton prey for NARWs (Quintana-Rizzo et al. 2021).
Source: NMFS 2015a.

Figure 4.8-1. North Atlantic right whale critical habitat in the Action Area
4.8.2 Critical Habitat for the Chesapeake Bay DPS of Atlantic Sturgeon

NMFS listed the Chesapeake Bay DPS of Atlantic sturgeon (Figure 4.8-2) as endangered on February 6, 2012 (NMFS 2017). Subsequently, critical habitat was designated for the DPS. The following physical features are essential to the conservation of the species and may require special management considerations or protection (82 FR 39160):

- Hard bottom substrate (e.g., rock, cobble, gravel, limestone, boulder) in low salinity waters (i.e., 0.0–0.5 parts per thousand range) for settlement of fertilized eggs, refuge, growth, and development of early life stages.

- Aquatic habitat with a gradual downstream salinity gradient of 0.5 up to as high as 30 parts per thousand and soft substrate (e.g., sand, mud) between the river mouth and spawning sites for juvenile foraging and physiological development.

- Water of appropriate depth and absent physical barriers to passage (e.g., locks, dams, thermal plumes, turbidity, sound, reservoirs, gear) between the river mouth and spawning sites necessary to support: (1) unimpeded movements of adults to and from spawning sites; (2) seasonal and physiologically dependent movement of juvenile Atlantic sturgeon to appropriate salinity zones within the river estuary; and (3) 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 3.9 feet [1.2 meters]) to ensure continuous flow in the main channel at all times when any sturgeon life stage would be in the river.

- 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: (1) spawning; (2) annual and interannual adult, subadult, larval, and juvenile survival; and (3) larval, juvenile, and subadult growth, development, and recruitment (e.g., 55.4°F to 78.8°F [13°C to 26°C] for spawning habitat and no more than 86°F [30°C] for juvenile rearing habitat, and 6 mg/L or greater dissolved oxygen for juvenile rearing habitat).

Vessel traffic and associated impacts from vessels, such as vessel strikes, noise and accidental spills/releases, could potentially impact critical habitat for Atlantic sturgeon. The majority of the James River is upriver of the Port of Virginia and would not be affected by vessel traffic and associated impacts from vessels.
Figure 4.8-2. Critical habitat for Chesapeake Bay DPS of Atlantic sturgeon, specifically the James River, where the Port of Virginia is located

Source: NMFS 2017.
4.9 Description of ESA-listed Species in the Action Area

The best available information on the occurrence and distribution of ESA-listed species in the Action Area is provided by a combination of visual sighting, acoustic, stranding, bycatch, and fisheries survey data, including:

- Site-specific monthly aerial survey data collected by Mayflower Wind (Mayflower Wind 2022).
- Protected Species Observer data collected in the Project area (Mayflower Wind 2022).
- Sighting data retrieved from the Marine Life Data and Analysis Team (Curtice et al. 2019; Roberts 2018).
- Data from NOAA’s Atlantic Marine Assessment Program for Protected Species surveys (AMAPPS) (2011–2018).
- Fisheries data collected by federal and state agencies, including BOEM (Guida et al. 2017), the Northeast Fisheries Science Center the Northeast Area Monitoring and Assessment Program, Southeast Fisheries Science Center, Rhode Island Department of Environmental Management, and Massachusetts Division of Marine Fisheries.

Based on this information, 15 ESA-listed species may occur in the Action Area (Table 4.9-1): 5 marine mammal species, 5 sea turtle species, and 5 fish species. The West Indian manatee (*Trichechus manatus*) is under the jurisdiction of the USFWS and will therefore not be addressed in this BA. Several species that could occur in the Action Area are either unlikely to occur or the occurrence would be limited to a portion of the Action Area outside of the impact area of most Project activities. For species unlikely to occur, the potential for adverse effects is discountable. For these species, potential effects of the Proposed action are limited to interactions with vessels outside the Project area. Brief descriptions of each of these species are provided in Section 4.9.1. Species that are likely to occur in the Action Area are discussed in more detail in Sections 4.9.2, 4.9.3, and 4.9.4 for marine mammals, sea turtles, and fish, respectively.

Table 4.9-1. ESA-listed species in the Action Area

<table>
<thead>
<tr>
<th>Species</th>
<th>District Population Segment</th>
<th>ESA Status</th>
<th>Listing Date</th>
<th>Critical Habitat Status</th>
<th>Critical Habitat Occurrence in Action Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marine Mammals</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blue whale</td>
<td>N/A</td>
<td>Endangered</td>
<td>1970</td>
<td>Not designated</td>
<td>N/A</td>
</tr>
<tr>
<td>Fin whale</td>
<td>N/A</td>
<td>Endangered</td>
<td>1970</td>
<td>Not designated</td>
<td>N/A</td>
</tr>
<tr>
<td>North Atlantic right whale</td>
<td>N/A</td>
<td>Endangered</td>
<td>1970</td>
<td>Designated</td>
<td>Yes</td>
</tr>
<tr>
<td>Sei whale</td>
<td>N/A</td>
<td>Endangered</td>
<td>1970</td>
<td>Not designated</td>
<td>N/A</td>
</tr>
<tr>
<td>Sperm whale</td>
<td>N/A</td>
<td>Endangered</td>
<td>1970</td>
<td>Not designated</td>
<td>N/A</td>
</tr>
<tr>
<td>Species</td>
<td>District Population Segment</td>
<td>ESA Status</td>
<td>Listing Date</td>
<td>Critical Habitat Status</td>
<td>Critical Habitat Occurrence in Action Area</td>
</tr>
<tr>
<td>-------------------------</td>
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<td>-------------------------------------------</td>
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<tr>
<td><strong>Sea Turtles</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Green sea turtle</td>
<td>North Atlantic</td>
<td>Threatened</td>
<td>2016</td>
<td>Designated</td>
<td>N/A</td>
</tr>
<tr>
<td>Hawksbill sea turtle</td>
<td>N/A</td>
<td>Endangered</td>
<td>1970</td>
<td>Designated</td>
<td>No</td>
</tr>
<tr>
<td>Kemp’s ridley sea turtle</td>
<td>N/A</td>
<td>Endangered</td>
<td>1970</td>
<td>Not Designated</td>
<td>N/A</td>
</tr>
<tr>
<td>Leatherback sea turtle</td>
<td>N/A</td>
<td>Endangered</td>
<td>1970</td>
<td>Designated</td>
<td>No</td>
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<tr>
<td>Loggerhead sea turtle</td>
<td>Northwest Atlantic Ocean</td>
<td>Threatened</td>
<td>2011</td>
<td>Designated</td>
<td>No</td>
</tr>
<tr>
<td><strong>Fish</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Atlantic Salmon</td>
<td>Gulf of Maine</td>
<td>Endangered</td>
<td>2009</td>
<td>Designated</td>
<td>No</td>
</tr>
<tr>
<td>Atlantic sturgeon</td>
<td>New York Bight, Chesapeake Bay, South Atlantic, Carolina, Gulf of Maine</td>
<td>Threatened, Endangered</td>
<td>2012</td>
<td>Designated</td>
<td>Yes</td>
</tr>
<tr>
<td>Giant manta ray</td>
<td>N/A</td>
<td>Threatened</td>
<td>2018</td>
<td>Not designated</td>
<td>N/A</td>
</tr>
<tr>
<td>Oceanic whitetip shark</td>
<td>N/A</td>
<td>Threatened</td>
<td>2018</td>
<td>Not designated</td>
<td>N/A</td>
</tr>
<tr>
<td>Shortnose sturgeon</td>
<td>N/A</td>
<td>Endangered</td>
<td>1967</td>
<td>Not designated</td>
<td>N/A</td>
</tr>
</tbody>
</table>

N/A = not applicable indicates no distinct population segment or critical habitat has been designated

4.9.1 Species Considered but Discounted from Further Analysis

4.9.1.1 Atlantic Salmon

The endangered Gulf of Maine DPS of Atlantic salmon (*Salmo salar*) has not been found to occur in the Project area (BOEM 2018a). Gulf of Maine Atlantic Salmon are not expected to occur south of central New England, and the population forages primarily between West Greenland and the Labrador Sea. Significant spawning rivers for this species are the Penobscot River, Kennebec River, and Sheepscot River in Maine (Rikardsen 2021; USASAC 2020). Smolts migrate from their natal river to foraging grounds in the Western North Atlantic, and after one or more winters at sea, adults return to their natal river to spawn (Fay et al. 2006). Additionally, the Proposed Action vessel transit route from Canada would not overlap the critical habitat of Atlantic Salmon. It is noted that even if Atlantic salmon presence overlapped with vessel transit routes, vessel strikes are not an identified threat to the species (74 FR 29344) or their recovery (USFWS and NMFS 2019). Therefore, the Proposed Action is **Not Likely to Adversely Affect** Atlantic salmon.

4.9.1.2 Hawksbill Sea Turtle

The hawksbill sea turtle (*Eretmochelys imbricata*) is listed as endangered throughout its range (USFWS 1970). Though hawksbill sea turtles have been documented in OCS waters of the northwest Atlantic Ocean, they are very rarely seen in Massachusetts and Rhode Island waters, and observations are typically the result of cold-stun strandings (Lutz and Musick 1997; NMFS and USFWS 1993). Therefore, this species is considered unlikely to occur in the Project area or the portion of the Action Area associated with vessel transits to local ports.
Given the rarity of hawksbill turtle in the Action Area, vessels are not expected to encounter hawksbill sea turtles. Therefore, the Proposed Action is **Not Likely to Adversely Affect** hawksbill sea turtle.

### 4.9.1.3 Giant Manta Ray

The giant manta ray (*Manta birostris*) is listed as threatened throughout its range (NMFS 2018a). This highly migratory species is found in temperate, subtropical, and tropical oceans worldwide. Sightings of giant manta rays in New England are rare, though individuals have been documented as far north as New Jersey and Block Island (BOEM 2021 citing Gudger 1922; BOEM 2021 citing Miller and Klimovich 2017). In sightings compiled from 1925 to 2020 by Farmer et al. (2021) all sightings of giant manta rays, north of New Jersey, occurred along the boundary of the Atlantic OCS. Giant manta rays may overlap in areas traversed by vessels from New Jersey and farther south, however, interactions between transiting vessels and giant manta ray would be unlikely. This species could transit through the Project area but is considered unlikely due to its rarity.

Given the rarity of giant manta ray in Action Area, the Proposed Action is **Not Likely to Adversely Affect** giant manta ray.

### 4.9.1.4 Oceanic Whitetip Shark

The oceanic whitetip shark (*Carcharhinus longimanus*) is listed as threatened throughout its range (NMFS 2018b). This species is generally found in tropical and subtropical oceans worldwide, inhabiting deep, offshore waters (NMFS 2022). In the western Atlantic, oceanic whitetips occur as far north as Maine (NMFS 2016b). Given the species’ preference for deep, offshore waters, it is possible but unlikely that they will transit through the Action Area or Project area.

Transiting vessels are unlikely to encounter oceanic whitetip sharks and vessel strikes have not been identified as a threat to the species (NMFS 2016b), and there is no information to indicate that vessels have adverse effects on this species (BOEM 2021). Therefore, the Proposed Action is **Not Likely to Adversely Affect** oceanic whitetip shark.

### 4.9.1.5 Shortnose Sturgeon

The shortnose sturgeon (*Acipenser brevirostrum*) is listed as endangered throughout its range (USFWS 1967). It is an anadromous finfish species found mainly in large freshwater rivers and coastal estuaries located along the east coast of North America, from New Brunswick to Florida. Based on its habitat preferences, shortnose sturgeon may occur in nearshore waters and rivers (Bemis and Kynard 1997; Zydlewski et al. 2011). Shortnose sturgeon exhibit variable site fidelity. For example, the Hudson River population (outside of the Action Area) is almost exclusively confined to the river (Kynard et al. 2016; Pendleton et al. 2019), differing from other populations that may use coastal waters to move into smaller coastal rivers nearby.

The 41 rivers where shortnose sturgeon are currently found are all outside of the Project area and the Action Area. The rivers known to have shortnose sturgeon nearest the Project area are the Connecticut and Housatonic rivers, approximately 16 miles and 55 miles, respectively, west of the Port of New London, Connecticut (NOAA 2023). The next closest river would be the Merrimack River, which is approximately 20 miles north of the Port of Salem, Massachusetts (NOAA 2023).

There is a dearth of recent shortnose sturgeon distribution and density data for areas where shortnose sturgeon could occur in the Project area, such as Mount Hope Bay and the rivers that drain into it, such as the Lee River (near Brayton Point landfall location) and the Taunton River. A survey conducted by Buerkett and Kynard (1993) caught no shortnose sturgeon in Mount Hope Bay and the Taunton River, and ultimately concluded shortnose sturgeon are not present in the river. Therefore, this species is
unlikely to occur in the Project area or in the Action Area. Given the low likelihood of occurrence, the Proposed Action is **Not Likely to Adversely Affect** shortnose sturgeon.

### 4.9.2 Marine Mammals

The fin whale (*Balaenoptera physalus*), NARW, sei whale (*Balaenoptera borealis*) and sperm whale (*Physeter macrocephalus*), are listed as endangered, and are likely to occur in the Action Area. Blue whales (*Balaenoptera musculus*) are considered rare migrants to the Project area but have been sighted in the Project area (Stone et al. 2017; Kraus et al. 2016). As noted in Section 4.8, there is designated critical habitat for NARW within the Action Area. Critical habitat has not been designated for other ESA-listed marine mammals. Mean monthly whale density estimates in the Lease Area are shown in Table 4.9-2.

**Table 4.9-2. Mean monthly marine mammal density estimates for ESA-listed species within 5 km of the Mayflower Wind Lease Area**

<table>
<thead>
<tr>
<th>Month</th>
<th>Blue Whale Density (number / 100 km²)</th>
<th>Fin Whale Density (number / 100 km²)</th>
<th>NARW Density (number / 100 km²)</th>
<th>Sei Whale Density (number / 100 km²)</th>
<th>Sperm Whale Density (number / 100 km²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>N/A</td>
<td>0.218</td>
<td>0.422</td>
<td>0.038</td>
<td>0.045</td>
</tr>
<tr>
<td>February</td>
<td>N/A</td>
<td>0.175</td>
<td>0.478</td>
<td>0.025</td>
<td>0.016</td>
</tr>
<tr>
<td>March</td>
<td>N/A</td>
<td>0.144</td>
<td>0.430</td>
<td>0.050</td>
<td>0.016</td>
</tr>
<tr>
<td>April</td>
<td>N/A</td>
<td>0.149</td>
<td>0.424</td>
<td>0.119</td>
<td>0.004</td>
</tr>
<tr>
<td>May</td>
<td>N/A</td>
<td>0.302</td>
<td>0.323</td>
<td>0.193</td>
<td>0.017</td>
</tr>
<tr>
<td>June</td>
<td>N/A</td>
<td>0.292</td>
<td>0.059</td>
<td>0.064</td>
<td>0.031</td>
</tr>
<tr>
<td>July</td>
<td>N/A</td>
<td>0.474</td>
<td>0.032</td>
<td>0.016</td>
<td>0.056</td>
</tr>
<tr>
<td>August</td>
<td>N/A</td>
<td>0.360</td>
<td>0.020</td>
<td>0.012</td>
<td>0.170</td>
</tr>
<tr>
<td>September</td>
<td>N/A</td>
<td>0.269</td>
<td>0.031</td>
<td>0.019</td>
<td>0.100</td>
</tr>
<tr>
<td>October</td>
<td>N/A</td>
<td>0.081</td>
<td>0.050</td>
<td>0.040</td>
<td>0.072</td>
</tr>
<tr>
<td>November</td>
<td>N/A</td>
<td>0.052</td>
<td>0.081</td>
<td>0.089</td>
<td>0.043</td>
</tr>
<tr>
<td>December</td>
<td>N/A</td>
<td>0.142</td>
<td>0.246</td>
<td>0.067</td>
<td>0.029</td>
</tr>
<tr>
<td>Annual Mean</td>
<td>0.001</td>
<td>0.222</td>
<td>0.216</td>
<td>0.061</td>
<td>0.050</td>
</tr>
<tr>
<td>May to December Mean</td>
<td>N/A</td>
<td>0.247</td>
<td>0.105</td>
<td>0.063</td>
<td>0.065</td>
</tr>
</tbody>
</table>

Source: Density estimates are from habitat-based density modeling of the entire Atlantic Exclusive Economic Zone (EEZ) from Roberts et al. (2016, 2022).

#### 4.9.2.1 Blue Whale

**4.9.2.1.1 Description and Life History**

In the North Atlantic Ocean, the range of blue whales (*Balaenoptera musculus*) extends from the sub-tropics to the Greenland Sea. As described in 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 (Hayes et al. 2020). Photo-identification in eastern Canadian waters indicates that blue whales from the St. Lawrence River, Newfoundland; Nova Scotia; New England; and Greenland all belong to the same stock, whereas blue whales photographed off Iceland and the Azores appear to be part of a separate population (CETAP 1982; Sears and Calambokidis 2002; Sears and Larsen 2002; Wenzel et al. 1988). The largest
concentrations of blue whales are found in the lower St. Lawrence Estuary (Comtois et al. 2010; Lesage et al. 2007), which is outside of the Action Area (most northern port is located in Sheet Harbor, Nova Scotia). Blue whales do not regularly occur within the United States Exclusive Economic Zone (EEZ) and typically occur farther offshore in areas with depths of 328 feet (100 meters) or more (Waring et al. 2011).

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 and 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 deepwater areas near the shelf break west of the British Isles (Charif and 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). This hearing group has a generalized hearing range of 7 Hz to 35 kilohertz (kHz).

### 4.9.2.1.2 Status and Population Trend

Blue whales have been listed as endangered under the ESA Endangered Species Conservation Act of 1969, with a recovery plan published under 63 FR 56911 (*Federal Register* 2018). No critical habitat has been designated for the blue whale. Blue whales are separated into two major populations (the north Pacific and north Atlantic population) and further subdivided in stocks. The North Atlantic Stock includes mid-latitude (North Carolina coastal and open ocean) to Arctic (Newfoundland and Labrador) waters. However, historical observations indicate that the blue whale has a wide range of distribution from warm temperate latitudes typically in the winter months and northerly distribution in the summer months. Blue whales are known to be an occasional visitor to U.S. Atlantic EEZ waters, with limited sightings. Population size of blue whales off the eastern coast of the United States is not known; however, a catalogue count of 402 individuals from the Gulf of St. Lawrence is the minimum population estimate (NOAA Fisheries 2020).

### 4.9.2.1.3 Distribution and Habitat Use

Blue whales were detected acoustically during the Northeast Large Pelagic Survey (NLPS) but were never visually observed in the Massachusetts and Rhode Island WEA between 2011 and 2015 (Kraus et al. 2016). Three blue whale observations were recorded in the northeast U.S. Atlantic during the 2010–2013 AMAPPS summer/fall shipboard surveys, all of which occurred during the summer months (Palka et al. 2017). No blue whale observations were recorded during visual or acoustic surveys conducted in the Project area (Mayflower Wind 2022). This species is expected to occur in deeper waters (at least 328 feet [100 meters]) than those found in the Lease Area (BOEM 2021 citing Waring et al. 2010).

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

The mean abundance of blue whales in the Project area from 1998 to 2020 is estimated at less than one individual (0.000–0.016 / 29.15 nm² [100 km²]) (Roberts et al. 2022).

### 4.9.2.2 Fin Whale

#### 4.9.2.2.1 Description and Life History

The fin whale is the second-largest species of whale, reaching a maximum weight of 40 to 80 tons (36 to 73 metric tons) and a maximum length of 75 to 85 feet (23 to 26 meters) (NMFS 2020a). This species reaches physical maturity at 25 years of age. Age of sexual maturity varies between sexes; males reach sexual maturity at 6 to 10 years of age, and females mature between the age of 7 and 12 years. The
gestation period for fin whales is 11 to 12 months, and females give birth in tropical and subtropical areas in midwinter (NMFS 2020a).

Fin whales are mysticetes (i.e., baleen whales) and forage using lunge or skim feeding. This species feeds during summer and fasts during the winter migration (NMFS 2020a). Primary prey species include krill, squid, herring, sand lance, and copepods (Kenney and Vigness-Raposa 2010).

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

### 4.9.2.2.2 Status and Population Trend

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

Threats to fin whales include vessel strikes, entanglement, anthropogenic noise, and climate change. This species is likely the second most vulnerable species to vessel strikes following NARW (NMFS 2020a). In a study evaluating historic and recent vessel strike reports, fin whales were involved in collisions the most frequently of the 11 large species evaluated (Laist et al. 2001). Though entanglement can result in injury or mortality in this species, fin whales may be less susceptible to entanglement than other large whale species (Glass et al. 2010; Nelson et al. 2007).

### 4.9.2.2.3 Distribution and Habitat Use

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

Fin whales may occur in the Action Area year-round. Surveys have documented the species in the Action Area in all seasons, and fin whales have been sighted in the Project area most commonly from late winter through summer (Mayflower Wind 2022). Fin whale densities are expected to be highest in the spring and summer months. The Marine-life Data and Analysis Team (MDAT) models estimated a monthly average of 0.1 to 0.5 fin whales occurring per 24,710 acres (10,000 hectares) in the Lease Area (Roberts et al. 2018).

Modeled fin whale abundance from 1998 to 2020 shows peak abundances in the Project area occurring from April to August, at approximately 0.40-0.63 fin whales/29.15 nm² (100 km²) (Roberts et al. 2022). Fin whales also use the nearby Nantucket Shoals, with modeled density peaks in June and July at approximately 1 to 1.6 fin whales/29.15 nm² (100 km²) (Roberts et al. 2022).
4.9.2.3  North Atlantic Right Whale

4.9.2.3.1  Description and Life History

The NARW is a large mysticete that can reach lengths up to 52 feet (16 meters) and weights up to 70 tons (64 metric tons) (NMFS 2020g). This species may live to 70 years of age or more. Female NARWs reach sexual maturity at approximately age 10 and have a calf every 3 to 4 years, though in recent years the time span between calvings has increased to 6 to 10 years (NMFS 2020g). The gestation period is approximately 1 year, and calves are born in the coastal waters of South Carolina, Georgia, and Florida.

NARWs feed throughout the water column and may skim feed through dense patches of prey at the surface (NMFS 2020g). This species feeds primarily on copepods belonging to the Calanus and Pseudocalanus genera (McKinstry et al. 2013).

Marine mammals are organized into groups based on their hearing physiology and sensitivity (NMFS 2018). All mysticetes, including NARWs, are classified as low-frequency cetaceans. This hearing group has a generalized hearing range of 7 Hz to 35 kHz. A study of the inner ear anatomy of NARWs estimated a hearing range of 10 Hz to 22 kHz (Parks et al. 2007).

4.9.2.3.2  Status and Population Trend

The NARW was listed as endangered in 1970, as part of a precursor to the ESA (USFWS 1970). The status of this species was most recently reviewed during 2012 as part of the species’ 5-year status review, and its endangered status remains unchanged (NMFS 2012). NARWs found in the Project area belong to the Western North Atlantic stock. The most recent stock assessment for NARW was conducted in 2021. The best abundance estimate for the Western North Atlantic stock is fewer than 350 individuals (Pettis et al. 2022). The species is considered critically endangered, and the Western North Atlantic stock experienced a decline in abundance between 2011 and 2019 with an overall decline of 23.5 percent.

Threats to NARW include vessel strikes, entanglement, anthropogenic noise, and climate change. NARW has been undergoing an unusual mortality event since 2017, attributed to vessel strikes and entanglement in fisheries gear (NMFS 2022a). Vessel strike and entanglement are leading causes of death in this species (Kite-Powell et al. 2007; Knowlton et al. 2012). From 2002 to 2006, NARW was subject to the highest proportion of vessel strikes and entanglements of any species evaluated (Glass et al. 2010). As this species spends a relatively high proportion of time at the surface and is a slow swimmer, NARW are particularly vulnerable to vessel strike, and most strikes are fatal to this species (Jensen and Silber 2004). A total of 83 percent of NARWs show evidence of past entanglements, and entanglement may be limiting population recovery (Knowlton et al. 2012).

4.9.2.3.3  Distribution and Habitat Use

NARW is found primarily in coastal waters, though the species also occurs in deep, offshore waters (NMFS 2021e). In the U.S. Atlantic, NARW range extends from Florida to Maine. This species exhibits strong migratory patterns between high-latitude summer feeding grounds in New England and Canada and low-latitude winter calving and breeding grounds in shallow, coastal waters off South Carolina, Georgia, and northern Florida.

During the NLPS, 77 individual NARWs were observed in the Massachusetts and Rhode Island WEA over the duration of the survey period (October 2011–June 2015). NARW were acoustically detected on approximately 443 of the 1,020 days of recording in the Massachusetts and Rhode Island WEA (Leiter et al. 2017; Kraus et al. 2016). Peak NARW observations were recorded in the winter and spring in the northeastern portion of the Massachusetts and Rhode Island WEA, near Muskeget Channel and south of Nantucket (Stone et al. 2017). Most NARW observations during the NLPS occurred outside of the Lease.
Mayflower Wind
Chapter 4
Biological Assessment

Area, but there were some observations recorded in the northeastern portion of the Lease Area and near the proposed ECC routes. Four NARW observations were recorded in the northeast U.S. Atlantic during the 2010–2013 AMAPPS summer/fall shipboard surveys, and five NARW observations were recorded during the 2010–2013 AMAPPS aerial surveys (Palka et al. 2017). No NARW observations were recorded in the northeast U.S. Atlantic region during AMAPPS II surveys in winter 2017–2018 (NEFSC 2018). Fourteen NARWs were observed in the Massachusetts and Rhode Island WEA during aerial surveys conducted by the New England Aquarium in between July and October 2020 (NEAq 2020c–2020h): one in July, two in August, eight in September, and three in October. All NARW observations occurred northeast of the Lease Area in the Nantucket Shoals. One NARW was observed in the western portion of the Lease Area in November 2020 and six NARW observations occurred in December 2020 northeast of the Lease Area (NEAq 2020j-l). Four NARW observations occurred east of the Lease Area during the January 2021 NEAq survey period (NEAq 2020m). The MDAT models estimated a monthly average of 0 to 0.1 NARW occurring per 20 nm² (100 km²) in the Lease Area (Roberts et al. 2018).

One potential NARW observation was recorded in January 2020 during aerial surveys of the Lease Area from November 2019 to October 2020 (Mayflower Wind 2022). No further NARW observations were recorded during visual surveys conducted in the Project area between February and October 2020 (Mayflower Wind 2022). Given the abundance and distribution of NARW in the Massachusetts and Rhode Island WEA, there is the potential for NARWs to co-occur with activities in the Project area, particularly in the proposed ECCs during the winter and spring.

NARWs were observed during the NLPS between October 2011 and June 2015 (Leiter et al. 2017; Kraus et al. 2016) and are considered common visitors to the Project area with hotspots consistently observed in the northeastern portion of the Lease Area, adjacent to the shoals, during spring 2011–2015, spring 2017–2019, and winter 2017–2019 (Quintana-Rizzo et al. 2021). There is further potential for occurrence in the proposed ECCs during spring migration and winter months; specifically, areas of the Brayton Point ECC while traveling northward to forage in the spring during the breeding period. During 2020–2021 NLPS sampling activities, NARWs were the most observed whale species in the study area, with 184 whales recorded across the Massachusetts and Rhode Island Lease Areas and Nantucket Shoals. In winter 2021, two to five NARW were observed in the northeastern portion of the Lease Area, and in Spring 2021, two to five NARW were observed in the southwest portion of the Lease Area (O’Brien et al. 2021, 2022). Most NARW observations recorded during the NLPS were outside of the Lease Area, with some recorded in the northeastern portion of the Lease Area and near the proposed ECC. The highest monthly acoustic presence detected was during the late winter and early spring months (Kaus et al. 2016).

The NARW population is estimated to number between approximately 350 (NOAA 2022a) to 428 (Hayes et al. 2020) individuals. In 2017, an Unusual Mortality Event (UME) began for NARW, totaling 34 dead stranded whales: 21 in Canada and 13 in the United States (NMFS 2022a). Entanglement in fishing gear and ship strikes were the causes of mortality during the UME. In addition, 16 live free-swimming non-stranded whales have been documented with serious injuries from entanglements or vessel strikes since 2017, bringing the preliminary cumulative total number of animals in the NARW UME up to 50 individuals, which represents a substantial loss considering the total population size of ~350 to 428 NARW remaining.

NARW observations made outside the Lease Area consistently occurred in the nearby Nantucket Shoals primarily during winter, summer, and fall (Quintana-Rizzo 2021; O’Brien et al. 2022). Generally, NARW occur over Nantucket Shoals during these seasons and over portions of the Massachusetts and Rhode Island Lease Areas during the spring. Overall, NARWs are likely to occur in and near the Project area year-around, as only a portion of the population migrates, with abundances peaking from winter through early spring. Recently, the presence of NARWs has also increased in the summer and fall, which overlaps with the current schedule for pile-driving for projects in the Rhode Island and Massachusetts WEAs (Quintana-Rizzo et al. 2021). In earlier years (2012–2015), NARW sighting rates were zero from May
through November, but in later years (2017–2019) right whales were cited in all months except October (Quintana-Rizzo 2021). NARWs have become more common in southern New England waters likely due to prey items shifting northward and finding favorable conditions in Nantucket Shoals; NARW feeding has been observed in all seasons in southern New England waters. This increasing occurrence trend could mean an extension of critical habitat into southern New England waters (Quintana-Rizzo 2021).

The NARW is also a Massachusetts state-listed endangered species, and the Massachusetts Ocean Management Plan established a core habitat Special, Sensitive, or Unique resource area for NARW 0.5 mile (0.8 km) west of the central portion of the Falmouth ECC based on data that identified statistically significant use for feeding by NARW (MassGIS 2020; COP Appendix L1, Figure 3-3; Mayflower Wind 2022). These critical and core habitat areas do not directly overlap with the Project area. The northeast critical habitat area is located to the north and east of the Massachusetts and Rhode Island Lease Areas, but vessel operations may occur through these areas. Additionally, the Brayton Point ECC runs through approximately 18 miles (29 km) of the corner of the NARW Seasonal Management Area, off the west coast of Martha’s Vineyard. This area encompasses NARW migratory routes and calving grounds and indicates where all vessels 65 feet (19.8 meters) or longer must reduce speed to no more than 10 nm per hour from November 1 through April 30 (COP Appendix L1, Figure 3-1; Mayflower Wind 2022). Finally, a Biological Important Area for NARW migration runs along the eastern U.S. coastline and includes the Massachusetts and Rhode Island lease areas.

4.9.2.4  Sei Whale

4.9.2.4.1  Description and Life History

Sei whales occur in all the world’s oceans and migrate between feeding grounds in temperate and sub-polar regions to wintering grounds in lower latitudes (Kenney and Vigness-Raposa 2010; Hayes et al. 2020). In the Western North Atlantic, most of the population is concentrated in northerly waters along the Scotian Shelf. Sei whales are observed in the spring and summer, utilizing the northern portions of the U.S. Atlantic EEZ as feeding grounds, including the Gulf of Maine and Georges Bank. The highest concentration is observed during the spring along the eastern margin of Georges Bank and in the Northeast Channel area along the southwestern edge of Georges Bank. Passive acoustic monitoring (PAM) conducted along the Atlantic Continental Shelf and Slope in 2004–2014 detected sei whales calls from south of Cape Hatteras to the Davis Strait with evidence of distinct seasonal and geographic patterns. Davis et al. (2020) detected peak call occurrence in northern latitudes during summer indicating feeding grounds ranging from Southern New England (SNE) through the Scotian Shelf. Sei whales were recorded in the southeast on Blake’s Plateau in the winter months, but only on the offshore recorders indicating a more pelagic distribution in this region. Persistent year-round detections in SNE and the New York Bight highlight this as an important region for the species (Hayes et al. 2021). In general, sei whales are observed offshore with periodic incursions into more shallow waters for foraging (Hayes et al. 2020). Between April 2020 and December 2021, there were four sightings of six individual sei whales recorded during HRG surveys conducted within the area surrounding the Lease Area and Falmouth ECC (Milne 2020). Kraus et al. (2016) observed sei whales in the Rhode Island/Massachusetts and Massachusetts WEAs and surrounding areas only between the months of March and June during the 2011–2015 NLPSC aerial survey. The number of sei whale observations was less than half that of other baleen whale species in the two seasons in which sei whales were observed (spring and summer). This species demonstrated a distinct seasonal habitat use pattern that was consistent throughout the study. Calves were observed three times and feeding was observed four times during the Kraus et al. (2016) study. Sei whales were not observed in the Massachusetts WEA and nearby waters during the 2010–2017 AMAPPS surveys (NEFSC and SEFSC 2012, 2013, 2014, 2015, 2016, 2017, 2018). However, there were observations during the 2016 and 2017 summer surveys that were identified as being either a fin or sei whale. Sei whales are expected to be present in the Lease Area and surrounding waters but much less common than the NARW and fin whale.
Marine mammals are organized into groups based on their hearing physiology and sensitivity (NMFS 2018). All mysticetes, including sei whales, are classified as low-frequency cetaceans. This hearing group has a generalized hearing range of 7 Hz to 35 kHz.

### 4.9.2.4.2 Status and Population Trend

There are two stocks of sei whales, Nova Scotia stock and Labrador Sea stock. Only the Nova Scotia stock can be found in U.S. waters, and the current abundance estimate for this population is 6,292 derived from recent surveys conducted between Halifax, Nova Scotia, and Florida (Hayes et al. 2020). Population trends are not available for this stock because of insufficient data (Hayes et al. 2020). Sei whales are listed as Endangered under the ESA and by the IUCN Red list (Hayes et al. 2020; IUCN 2020). This stock is listed as strategic and depleted under the MMPA due to its Endangered status (Hayes et al. 2020). Annual human-caused mortality and serious injury from 2015 to 2019 was estimated to be 0.8 per year (Hayes et al. 2021). The potential biological removal level (PBR) for this stock is 6.2 (Hayes et al. 2020). Like fin whales, major threats to sei whales include fishery interactions, vessel collisions, contaminants, and climate-related shifts in prey species (Hayes et al. 2020). There are no critical habitat areas designated for the sei whale under the ESA. A Biologically Important Area for feeding for sei whales occurs east of the Lease Area from May through November (LaBrecque et al. 2015).

### 4.9.2.4.3 Distribution and Habitat Use

The sei whale (*Physeter macrocephalus*) is listed as Endangered throughout its range (USFWS 1970). A total of 25 sei whales were observed in the Massachusetts and Rhode Island WEAs and surrounding areas during the NLPS, and observations only occurred between the months of March and June (Kraus et al. 2016). A total of 10 sei whale observations were recorded in the northeast U.S. Atlantic during the 2010–2013 AMAPPS summer/fall shipboard surveys, and 23 sei whale observations were recorded during the 2010–2013 AMAPPS aerial surveys (Palka et al. 2017). No sei whales were observed visually or detected acoustically during surveys of the Project area (Mayflower Wind 2022). The MDAT models estimated a monthly average of 0 to 0.05 sei whales occurring per 24,710 acres (10,000 hectares) in the Lease Area (Roberts et al. 2018). This species is generally expected to occur around the continental shelf edge beyond the Lease Area (Hayes et al. 2021 citing Michel 1975; Hayes et al. 2021 citing Michel 1975).

Sei whale modeled density from 1999 to 2020 showed a peak in abundance from April to June, with highest densities in May at approximately 0.16 to 0.25 sei whales/29.15 nm² (100 km²) in the Project area. (Roberts et al. 2022). Sei whale modeled density in the Nantucket Shoals was highest from April to May at 0.040 to 0.63 sei whales/29.15 nm² (100 km²), but also peaked, to a lesser degree, in November and December (Roberts et al. 2022).

### 4.9.2.5 Sperm Whale

#### 4.9.2.5.1 Description and Life History

The sperm whale (*Physeter macrocephalus*) is the largest odontocete, reaching lengths of up to 52 feet (16 meters) and weighing up to 45 tons. Sperm whales are predatory specialists known for hunting prey in deep water. The species is among the deepest diving of all marine mammals. Males have been known to dive 3,936 feet (1,200 meters), whereas females dive to at least 3,280 feet (1,000 meters); both can continuously dive for more than 1 hour. Their diet includes squid, sharks, skates, and fish that occupy deep waters. Sperm whales are the only mid-frequency ESA-listed marine mammal considered, and have a generalized hearing range of 150 Hz to 160 kHz.
4.9.2.5.2 Status and Population Trend

This species is listed as Endangered throughout its range (USFWS 1970). The most recent abundance estimate for the North Atlantic stock is 4,349; between 1,000 to 3,400 Of these individuals occur in U.S. (Hayes et al. 2020). However, this group is likely part of a larger western North Atlantic population, and that population may or may not be distinct from the eastern North Atlantic population (Hayes et al. 2020).

The NLPS recorded limited sightings of sperm whales in the Massachusetts and Rhode Island WEA (Stone et al. 2017; Kraus et al. 2016). Nine sperm whales, traveling alone or in groups of three or four, were observed in 2012 and 2015; six individuals were observed in August and September of 2012, and three individuals were observed in June 2015. The MDAT models estimated a monthly average of 0 to 0.1 sperm whales occurring per 24,710 acres (10,000 hectares) in the Lease Area (Roberts et al. 2018). Sperm whales were not observed visually or detected acoustically during surveys of the Project area (AIS Inc. 2020; Mayflower-APEM 2020a–2020m; TerraSond 2019). Given the location of its general range and lack of recorded sightings in the Massachusetts and Rhode Island WEA, sperm whales are unlikely to co-occur with activities in the Project area.

4.9.2.5.3 Distribution and Habitat Use

Sperm whale is expected to occur year-round in deeper waters near the shelf break (Tetra Tech and SES 2018; Tetra Tech and LGL 2019, 2020). Water depths in the Lease Area are generally too shallow for sperm whales. Species densities in the Project area are expected to be low, ranging from 0.04 animals per 29.15 nm² (100 km²) from December through April to 0.01 animals per 29.15 nm² (100 km²) in July (Table 4.9-2).

Modeled density of sperm whales from 1998 to 2019 peaked in August and September at approximately 0.16 to 0.25 sperm whale/29.15 nm² (100 km²) in the Project area (Roberts et al. 2022). Modeled density of sperm whales peaked in October at 0.63 to 1 sperm whale/29.15 nm² (100 km²) in the nearby Nantucket Shoals (Roberts et al. 2022).

4.9.3 Sea Turtles

Four federally listed species of sea turtle are likely to occur in the Action Area: green sea turtle (Chelonia mydas), Kemp’s ridley sea turtle (Lepidochelys kempii), leatherback sea turtle (Dermochelys coriacea), and loggerhead sea turtle (Careta caretta). The green sea turtle DPS present in the area is the North Atlantic DPS, which is listed as threatened (Seminoff et al. 2015). The loggerhead sea turtles in the area are part of the Northwest Atlantic Ocean DPS and are listed as threatened (Conant et al. 2009). Kemp’s ridley and leatherback sea turtles are listed as endangered. As noted in Section 4.8, there is not designated critical habitat for loggerhead sea turtle within the Action Area. Critical habitat has been designated for green and leatherback sea turtles but it lies outside the Action Area. Critical habitat has not been designated for Kemp’s ridley sea turtles. Sea turtle densities are shown in Table 4.9-3.
Table 4.9.3. Sea turtle density estimates within 10 km of the Mayflower Lease Area

<table>
<thead>
<tr>
<th>Species</th>
<th>Density (number/100 km²)¹</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Spring</td>
</tr>
<tr>
<td>Kemp’s ridley sea turtle</td>
<td>0.007</td>
</tr>
<tr>
<td>Leatherback sea turtle</td>
<td>0.023</td>
</tr>
<tr>
<td>Loggerhead sea turtle</td>
<td>0.083</td>
</tr>
<tr>
<td>Green sea turtle²</td>
<td>0.007</td>
</tr>
</tbody>
</table>

¹ Density estimates are derived from Strategic Environmental Research and Development Program Spatial Decision Support System US Navy Operating Area Density Estimate database within a 10-km buffer of the Project area.
² Kraus et al. 2016 did not observe any green sea turtles in the Rhode Island/Massachusetts WEA. Densities of Kemp’s ridley sea turtles are used as a conservation estimate.
³ Densities calculated as averaged seasonal densities from 2011 to 2015 (Kraus et al. 2016).
⁴ Densities calculated as the averaged seasonal leatherback sea turtle densities scaled by the relative, seasonal sighting rates of loggerhead and leatherback sea turtles (Kraus et al. 2016).

4.9.3.1 Green Sea Turtle

4.9.3.1.1 Description and Life History

The green sea turtle is the largest hard-shelled sea turtle, reaching a maximum weight of 350 pounds (150 kilograms) and having a carapace length of up to 3.3 feet (1 meter) (NMFS 2020b). Green sea turtles generally reach sexual maturity between the ages of 25 and 35. Female green sea turtles nest every 2 to 5 years while males breed annually (NMFS 2020b). In the United States, breeding occurs in late spring and early summer, and nesting occurs in the Southeast between June and September, peaking in June and July (NOAA 2010b, as cited in USNRC 2010; NMFS 2020b). During the nesting season, females come ashore to nest approximately every 2 weeks with clutch sizes of approximately 100 eggs (NMFS 2020b). Hatchlings emerge after approximately 2 months and swim to offshore, pelagic habitats. Young green sea turtles remain in these pelagic habitats for 5 to 7 years before returning to coastal habitats as juveniles (NMFS 2020b).

During their pelagic phase, green sea turtles are omnivorous, foraging in drift communities. Once juveniles return to coastal habitats, they become benthic foragers. As benthic foragers, this species is primarily herbivorous, consuming mostly algae and seagrasses, though sponges and other invertebrates may also contribute to their diet (NMFS 2020b).

Sea turtles possess auditory organs that are adapted for underwater hearing. The hearing range of sea turtles is limited to low frequencies, typically below 1,600 Hz. The hearing range for green sea turtles is from 50 to 1,600 Hz, with peak sensitivity between 200 and 400 Hz underwater and 300 and 400 HZ in the air (Piniak et al. 2016).

4.9.3.1.2 Status and Population Trend

Green sea turtles were originally listed under the ESA in 1978. In 2016, the species was divided into 11 DPSs. Green sea turtles found in the Action Area most likely belong to the North Atlantic DPS, which is listed as Threatened (NMFS and USFWS 2016). The status of this DPS was most recently reviewed as part of the 2016 DPS determination and ESA listing. There is no population estimate for the North Atlantic DPS of green sea turtles. However, nester abundance for this DPS is estimated at 167,234 (Seminoff et al. 2015). All major nesting populations in this DPS have shown long-term increases in abundance (Seminoff et al. 2015).

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

4.9.3.1.3 Distribution and Habitat Use

Green sea turtles inhabit tropical and subtropical waters around the globe. In the United States, green sea
turtles occur from Texas to Maine, as well as the Caribbean. Hatchling and early juvenile sea turtles
inhabit open waters of the Atlantic Ocean. Late juveniles and adults are typically found in nearshore
waters of shallow coastal habitats (NMFS and USFWS 2007a). Seasonal distribution is governed by
water temperatures (NMFS 2018b). As temperatures warm in the spring, sea turtles migrate into southern
New England waters. This seasonal movement is reversed as water temperatures cool in the fall and sea
turtles migrate to warm waters farther south. In southern New England, juvenile and adult green sea
turtles occur in shallow, estuarine waters to forage between May and November (NMFS 2019c).

Green sea turtles have the potential to occur in the Action Area seasonally. This species generally occurs
seasonally in the Project area with the highest densities observed between June and November. In the
Massachusetts and Rhode Island WEA, no green turtles were identified during the NLPS conducted from
2011–2015. Unidentified juvenile sea turtles encountered in the survey may be either green sea turtles or
Kemp’s ridley juveniles (Kraus et al. 2016). There were also no recorded observations of green turtles in
northeastern U.S. waters during AMAPPS I surveys or AMAPPS II surveys conducted from 2010–2016
and 2017–2018, respectively (NEFSC and SEFSC 2018; Palka et al. 2017). Four green sea turtle
observations were recorded in Sea Turtle Stranding and Salvage Network (STSSN) reports of
Massachusetts waters from 2015–2021 (NMFS 2021b). Observations included three stranding events in
August and October of 2016 and one stranding event in October 2018. Due to a lack of historic and recent
records of green sea turtle occurrence in the Massachusetts and Rhode Island WEA and their preference
for warmer waters, the species is considered to be uncommon to the Project area, primarily in summer
months.

4.9.3.2 Kemp’s Ridley Sea Turtle

4.9.3.2.1 Description and Life History

The Kemp’s ridley sea turtle is a hard-shelled turtle and the smallest of all sea turtle species. The species
reaches a maximum weight of 100 pounds (45 kilograms) and grows to 2.3 feet (0.7 meter) in length
(NMFS 2020d). Kemp’s ridley sea turtles reach sexual maturity at approximately 13 years of age. This
species exhibits synchronized nesting behavior, coming ashore during daylight hours in large groups
called arribadas. Females nest every 1 to 3 years and will lay two to three clutches over the course of the
nesting season from May to July. Average clutch size is 100 eggs (NMFS 2020d). Hatchlings emerge
after 1.5 to 2 months and enter the ocean, traveling to deep, offshore habitats where they will drift in
Sargassum for 1 to 2 years. After completing their oceanic phase, juvenile Kemp’s ridley sea turtles move
to nearshore waters to mature (NMFS 2020d).
In their oceanic phase, early life stage Kemp’s ridley sea turtles are omnivorous, foraging on floating plants and animals near the surface. Once they recruit to nearshore waters, juveniles and adults consume primarily crabs; mollusks, shrimp, fish, and vegetation also contribute to their diet (Ernst et al. 1994; NMFS 2020d). This species is also known to scavenge on dead fish and discarded bycatch (NMFS 2020d).

Though sea turtles possess auditory organs that are adapted for underwater hearing, their hearing range is limited to low frequencies, typically below 1,600 Hz. The Kemp’s ridley hearing range extends from 100 to 500 Hz, with peak sensitivity between 100 and 200 Hz (Bartol and Ketten 2006).

### 4.9.3.2.2 Status and Population Trend

The Kemp’s ridley sea turtle is one of the least abundant sea turtle species in the world. This species was listed as Endangered in 1970, as part of a precursor to the ESA (USFWS 1970). The status of this species was most recently assessed for its 5-year status review completed in 2015, and its Endangered status remained unchanged (NMFS and USFWS 2015). In 2012, the population of individuals age 2 years and up was estimated at 248,307 turtles (NMFS and USFWS 2015 citing Gallaway et al. 2013). Based on hatching releases in 2011 and 2012, Galloway et al. (2013, as cited in NMFS and USFWS 2015) postulated that the total population size, including turtles younger than 2 years of age, could exceed 1,000,000. However, the number of nests recorded in 2012 was the highest of any year in the monitoring period, and the number of nests declined by almost 50 percent between 2012 and 2014. Therefore, the current population may be significantly lower than the population estimate from 2012 (NMFS and USFWS 2015). The status review also included an updated age-based model to evaluate trends in the Kemp’s ridley population. Results of the model indicated that the population is not recovering and suggested there is a persistent reduction in survival and/or recruitment to the nesting population (Heppell S., Oregon State University, unpublished data 2015, as cited in NMFS and USFWS 2015).

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

### 4.9.3.2.3 Distribution and Habitat Use

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

Kemp’s ridley sea turtles could occur in the Action Area seasonally. They are mainly in the Project area during the summer and fall (Mayflower Wind 2022). Kemp’s ridley sea turtles were rarely observed in

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2 Another 5-year status review was initiated in June 2021, but this review has not been completed.
the Massachusetts and Rhode Island WEA during the NLPS (Kraus et al. 2016). Six Kemp’s ridley sea turtle observations were recorded; one in August 2012 and five in September 2012. No Kemp’s ridley sea turtles were observed in the Massachusetts and Rhode Island WEA during the 2009–2015 AMAPPS or 2017–2018 AMAPPS II northeast aerial surveys (NEFSC and SEFSC 2018; Palka et al. 2017). A total of 28 Kemp’s ridley sea turtle observations were recorded in STSSN reports of Massachusetts waters from 2021 (NMFS 2021b). Observations included 19 stranding observations in the summer and fall of 2015–2019 and 1 incidental capture in October 2017. Two Kemp’s ridley sea turtles were observed during visual surveys conducted in the Project area between May and July 2020. One Kemp’s ridley sea turtle was observed surfacing in May 2020 and the other Kemp’s ridley sea turtle was observed surfacing in July 2020. No Kemp’s ridley sea turtles were observed during PSO surveys or aerial surveys conducted for the proposed Project (Mayflower Wind 2022).

4.9.3.3 Leatherback Sea Turtle

4.9.3.3.1 Description and Life History

The leatherback sea turtle is the largest sea turtle species and the only one lacking a hard shell. They can grow to 5.5 feet (1.7 meters) in length and weigh up to 2,200 pounds (998 kilograms) (NMFS 2020e). This species reaches sexual maturity between 9 and 29 years of age. The inter-nesting period for leatherback sea turtles is 2 to 3 years. In the United States, the nesting season extends from March to July. In a single nesting season, females will lay an average of five to seven clutches of eggs with an average clutch size of 100 eggs (Eckert et al. 2015, as cited in NMFS and USFWS 2020b; NOAA Fisheries 2020c). Hatchlings emerge from the nest after approximately 2 months and disperse into offshore habitats (NMFS and USFWS 2020b). Unlike other sea turtle species, juvenile leatherback sea turtles do not undergo an ontogenetic shift in distribution to shallower habitats and continue to use mid-ocean and continental shelf habitats (NMFS and USFWS 2020b), though older life stages may occur in nearshore waters (NMFS and USFWS 1992b).

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

Though sea turtles possess auditory organs that are adapted for underwater hearing, their hearing range is limited to low frequencies, typically below 1,600 Hz. The leatherback sea turtle’s hearing range extends from approximately 50 to 1,200 Hz, with peak sensitivity between 100 and 400 Hz (Piniak et al. 2012).

4.9.3.3.2 Status and Population Trend

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

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

4.9.3.3 Distribution and Habitat Use

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

Leatherback sea turtles could occur in the Action Area seasonally. Species densities in the Project area are highest in the summer and fall with a few sightings in the spring. Leatherback turtles were seen more frequently than other sea turtle species in the Massachusetts and Rhode Island WEA during the NLPS (Kraus et al. 2016). Leatherback sea turtles were also the primary sea turtle species identified during follow-up surveys conducted in 2018–2019, though these sightings mainly occurred south of Nantucket Island (O’Brien et al. 2021). The majority of observations occurred in the summer and fall, followed by two sightings in spring and none in the winter. No leatherback sea turtles were observed during PSO surveys or aerial surveys conducted for the proposed Project (Mayflower Wind 2022).

4.9.3.4 Loggerhead Sea Turtle

4.9.3.4.1 Description and Life History

The loggerhead sea turtle is a large, hard-shelled sea turtle that can reach 3 feet (1 meter) in carapace length and weigh up to 250 pounds (113 kilograms) (NMFS 2020f). Adults reach sexual maturity at approximately 35 years of age. This species nests every 2 to 3 years on ocean beaches. Nesting occurs in the southeastern United States between April and September, peaking in June and July (Hopkins and Richardson 1984; Dodd 1988). During the nesting season, females will lay two to three clutches of eggs, with each clutch containing 35 to 180 eggs. After approximately 1.5 to 2 months, hatchlings emerge from the nests (Hopkins and Richardson 1984). Hatchlings travel offshore and remain in the open ocean until they return to coastal and continental shelf waters as juveniles. Loggerheads continue to use the same coastal and oceanic waters through adulthood.

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

Though sea turtles possess auditory organs that are adapted for underwater hearing, their hearing range is limited to low frequencies, typically below 1,600 Hz. The loggerhead sea turtle’s hearing range extends from approximately 50 to 100 Hz up to 800 to 1,120 Hz (Martin et al. 2012).
4.9.3.4.2 Status and Population Trend

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

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

4.9.3.4.3 Distribution and Habitat Use

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

Loggerhead sea turtles could occur in the Action Area seasonally. The NLPS recorded 78 loggerhead sea turtle individuals in the Massachusetts and Rhode Island WEA (Kraus et al. 2016); 2 observations were recorded in the spring, 31 in the summer, and 45 in the fall (which all occurred in the month of September). There were no loggerhead sea turtles observed in the winter. In the Massachusetts and Rhode Island WEA, two Loggerheads were observed during follow-up surveys conducted in 2018–2019 (O’Brien et al. 2021) and one was observed in surveys conducted in 2020-2021 (O’Brien et al. 2022). Recorded observations were spread evenly across the Massachusetts and Rhode Island WEA in the summer, and some individuals were observed in the Project area; there was a higher concentration of individuals in the Project area in September, likely due to turtles migrating south through the Massachusetts and Rhode Island WEA. Loggerhead sea turtle observations were recorded just northeast of the Massachusetts and Rhode Island WEA in the spring and fall.
4.9.4 Fish

One ESA-listed fish species, Atlantic sturgeon (*A. oxyrinchus oxyrinchus*), is likely to occur in the Action Area. Critical habitat has been designated for this species but lies outside the Action Area. In addition, at this time, the shortfin mako is considered a candidate species under the ESA and is under review.

4.9.4.1 Atlantic Sturgeon

4.9.4.1.1 Description and Life History

Atlantic sturgeon is an anadromous species. This species is benthic-oriented and large-bodied, reaching a maximum total length of approximately 13.1 feet (4 meters) (Bain 1997). Atlantic sturgeon is also long-lived, reaching a maximum age of approximately 60 years (Gilbert 1989). Males reach sexual maturity at about 12 years of age, and females spawn for the first time at 15 years of age or older (Able and Fahay 2010; Bain 1997). Atlantic sturgeon spawn interannually, and spawning periods vary between sexes. Males spawn every 1 to 5 years while females spawn every 2 to 5 years (Vladykov and Greeley 1963). During spawning, females deposit eggs over hard substrate (e.g., gravel, cobble, and rock) where they are fertilized externally by the males.

Atlantic sturgeon eggs are adhesive and remain attached to hard substrate on the spawning grounds during incubation. Larvae hatch approximately 4 to 6 days after fertilization (ASSRT 2007; Mohler 2003). Yolk-sac larvae remain closely associated with benthic substrate on spawning areas (Bain et al. 2000). Yolk-sac absorption occurs over 8 to 12 days. Post yolk-sac larvae are active swimmers but continue to remain closely associated with benthic substrate for approximately 2 weeks following yolk-sac absorption (ASMFC 2012). Following yolk-sac absorption, juvenile Atlantic sturgeon emerge from the substrate to begin foraging and start their downstream migration (Kynard and Horgan 2002). Juveniles generally remain in their natal river for at least 2 years (ASMFC 2012). Subadults make their first migration into marine habitats at 4 to 8 years of age (ASSRT 2007). Prior to reaching sexual maturity, subadults return to their natal rivers to forage in the spring and summer months. Adult Atlantic sturgeon spend a majority of their time in marine habitats, often undertaking long-distance migrations along the Atlantic coast, and return to freshwater habitats in their natal rivers to spawn (Bain 1997).

Atlantic sturgeon undergo an ontogenetic shift in diet as they age. Post yolk-sac larvae feed on plankton then transition to benthic omnivores at older life stages. Juvenile diets include aquatic insects and other invertebrates. Subadults and adults consume bivalves, gastropods, amphipods, isopods, polychaete and oligochaete worms, and demersal fish (Able and Fahay 2010; ASSRT 2007; Bigelow and Schroeder 1953). Foraging studies indicate that larger Atlantic sturgeon have a strong preference for polychaetes; these data also show that isopods make up a larger portion of Atlantic sturgeon diets than amphipods (Dadswell 2006; Guilbard et al. 2007; Haley 1999; Johnson et al. 1997; Krebs et al. 2017; McLean et al. 2013; Savoy 2007). Though Atlantic sturgeon are known to forage on small fish, including sand lance (*Ammodytes* spp.), Atlantic tomcod (*Microgadus tomcod*), and American eel (*Anguilla rostrata*), the importance of fish in Atlantic sturgeon diet may vary with body size and location (Guilbard et al. 2007; Johnson et al. 1997; Krebs et al. 2017; McLean et al. 2013; Scott and Crossman 1973).

There are few published studies on the hearing ability of sturgeon. A study on the hearing abilities of paddlefish (*Polyodon spathula*) and lake sturgeon (*Acipenser fulvescens*) found that both species responded to sounds ranging from 100 to 500 Hz (Lovell et al. 2005). Based on preliminary physiological analysis, Atlantic sturgeon may be able to detect sounds from below 100 Hz to perhaps 1,000 Hz and should possess the ability to localize sound sources (Meyer and Popper unpublished cited in Popper 2005). Although no data are available on Atlantic sturgeon vocalizations, other sturgeon have been found to produce sounds (Popper 2005).
4.9.4.1.2 Status and Population Trend

Atlantic sturgeon in the United States are divided into five DPSs: Gulf of Maine, New York Bight, Chesapeake Bay, Carolina, and South Atlantic. In 2012, the New York Bight, Chesapeake Bay, Carolina, and South Atlantic DPSs were listed as endangered, and the Gulf of Maine DPS was listed as threatened (NMFS 2012a, 2012b). The only DPS considered in this BA is the Chesapeake Bay DPS.

Chesapeake DPS

The Chesapeake DPS is composed of all Atlantic sturgeon spawned in Chesapeake Bay watersheds as well as coastal watersheds from Fenwick Island at the Delaware-Maryland border to Cape Henry, Virginia. In the most recent 5-year status review, NMFS (2022d) estimated the oceanic population abundance of the Chesapeake DPS at 8,811 fish. This DPS has not shown any significant trend in abundance since 1998 and is depleted relative to historic levels (ASMFC 2017). Similar to the New York Bight DPS, impaired water quality, habitat disturbance, bycatch, and vessel strikes pose threats to the Chesapeake DPS (NMFS 2020).

4.9.4.1.3 Distribution and Habitat Use

Atlantic sturgeon are distributed from Labrador, Canada, to Cape Canaveral, Florida. In southern New England, spawning adults migrate upstream during April and May (Able and Fahay 2010). After spawning, females return to coastal waters within 4 to 6 weeks. Males may remain in freshwater habitats into the fall (Able and Fahay 2010).

Juvenile, subadult, and adult Atlantic sturgeon are expected to occur seasonally in the Action Area. Generally, this species is expected to migrate in spring from marine habitats to inshore coastal waters and return to marine habitats in the fall. Very few Atlantic sturgeon have been captured as bycatch in fisheries or in fisheries-independent surveys in the Massachusetts Lease Area (Stein et al. 2004; Dunton et al. 2011).

4.10 Climate Change Considerations

Climate change is an ongoing and developing phenomenon that has been shown to affect marine ecosystems. Warming sea temperature is a key feature of global climate change caused by atmospheric greenhouse effects from global greenhouse gas emissions including carbon dioxide (CO2). Warming water temperatures, in combination with sea level rise, could affect ESA-listed species in the Action Area. Warming and sea level rise could affect these species through increased storm frequency and severity, altered habitat/ecology, changes in prey distribution, altered migration patterns, increased disease incidence, increased erosion and sediment deposition, and development of protective measures (e.g., seawalls and barriers). Increased storm severity or frequency may result in increased energetic costs for marine mammals, particularly for young life stages, reducing individual fitness. Altered habitat/ecology associated with warming has resulting in northward distribution shifts for some prey species (Hayes et al. 2021); marine mammals are altering their behavior and distribution in response to these alterations (Davis et al. 2017, 2020; Hayes et al. 2020, 2021). Warming is also expected to influence the frequency of marine mammal diseases. Warming and sea level rise could lead to changes in sea turtle distribution, habitat use, migratory patterns, nesting periods, nesting sex ratios, nesting habitat quality or availability, prey distribution or abundance, and availability of foraging habitat (Fuentes and Abbs 2010; Janzen 1994; Newson et al. 2009; Witt et al. 2010). Northward shifts in fish communities, including demersal finfish and shellfish, have been documented to occur concurrently with rises in sea surface temperature (Gaichas et al. 2015; Hare et al. 2016; Lucey and Nye 2010).
Ocean acidification is another major problem caused by the release of anthropogenic CO2 into the atmosphere (Doney et al. 2020). The ocean serves as a major sink for anthropogenic CO2 (Doney et al. 2020). Once deposited in seawater, CO2 lowers pH levels, increasing its acidity. Ocean acidification may have negative impacts on zooplankton and benthic organisms, especially the many species that have calcareous shells or exoskeletons (e.g., shellfish, copepods) by reducing the growth of these species (PMEL 2020). Ocean acidification may affect ESA-listed marine mammal, sea turtle, and fish species through negative effects on their prey.

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

The effects of the Proposed Action are analyzed in this section based on the PDE described in Section 3. Effects of the Proposed Action include all consequences to ESA-listed species or designated critical habitat caused by the Proposed Action across all phases of the Project, including pre-construction, construction, O&M, and decommissioning. This includes consequences of other activities that would not occur but for the Proposed Action that are reasonably certain to occur. Effects are considered relative to the likelihood of species’ exposure to each effect and the biological significance of that exposure.

Biological significance is evaluated based on the extent and duration of exposure relative to established effects thresholds or relative to baseline conditions described in Section 4. Effects evaluated for the Proposed Action, including impacts from Underwater Noise (Sections 5.2), Other Noise Impacts (Section 5.3), Effects of Vessel Traffic (Section 5.4), Habitat Disturbance and Modification (Section 5.5), Air Emissions (Section 5.6), Port Modifications (Section 5.7), Repair and Maintenance Activities (Section 5.8), and Other Effects (Sections 5.9). Each of these impacts is evaluated separately for ESA-listed marine mammals, sea turtles, and fish.

5.1 Determination of Effects

Based on the analysis of the methods described in this section, potential effects from the proposed Project were determined using the criterion described as follows:

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

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

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

A determination for each species and designated critical habitat was made based on an analysis of potential consequences from each identified stressor. One of the following three determinations, as defined by the ESA, has been applied for listed species and critical habitat that have potential to be affected by the Project: no effect; may affect, not likely to adversely affect; may affect, likely to adversely affect.

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

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

- **A may affect, not likely to adversely affect** determination would be given if the Project’s effects are wholly beneficial, insignificant, or discountable.
- **Beneficial** effects have an immediate positive effect without any adverse effects on the species or habitat.

- **Insignificant** effects relate to the size or severity of the effect and include those effects that are undetectable, not measurable, or so minor that they cannot be meaningfully evaluated. *Insignificant* is the appropriate effect conclusion when plausible effects are going to happen but will not rise to the level of constituting an adverse effect.

- **Discountable** effects are those that are extremely unlikely to occur. For an effect to be discountable, there must be a plausible adverse effect (i.e., a credible effect that could result from the action and that would be an adverse effect if it did affect a listed species), but it is extremely unlikely to occur (USFWS and NMFS 1998).

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

### 5.2 Underwater Noise

High levels of underwater noise have the potential to result in take of ESA-listed species in the Action Area. The Proposed Action would generate temporary noise during pre-construction surveys, construction, and decommissioning phases while long-term noise would be generated during the O&M phase. Underwater noise sources associated with the Proposed Action would include impact pile driving, vibratory pile driving, geotechnical and geophysical surveys, cable laying, dredging, and UXO detonation, as discussed in the following subsections. Following the assessment of these noise sources, a summary of overall underwater noise effects to ESA-listed species is provided.

Underwater sound can be described through a source-path-receiver model. An acoustic source emits sound energy that radiates outward and travels through the water and the seafloor as pressure waves. The sound level decreases with increasing distance from the acoustic source as the sound pressure waves spread out under the influence of the surrounding receiving environment. The amount by which the sound levels decrease between a source and a receiver is called transmission loss. The amount of transmission loss that occurs depends on the source-receiver separation, the frequency of the sound, the properties of the water column, and the properties of the seafloor. Underwater sound levels are expressed in decibels (dB), which is a logarithmic ratio relative to a fixed reference pressure of 1 micropascal (μPa) (equal to \(10^{-6}\) pascals [Pa] or \(10^{-11}\) bar).

The efficiency of underwater sound propagation allows marine mammals to use underwater sound as a method of communication, navigation, and prey detection and predator avoidance (Richardson et al. 1995; Southall et al. 2007). Anthropogenic (i.e., human-introduced) noise has gained recognition as a potential stressor for marine mammals because of their reliance on underwater hearing for maintenance of these critical biological functions (Richardson et al. 1995; Ketten 1998). Underwater noise generated by human activities can often be detected by marine animals many kilometers from the source. With increasing distance from a noise source, potential acoustic impacts can range from physiological injury to permanent or temporary hearing loss, behavioral changes, and acoustic masking (i.e., communication interference). All the above impacts have the potential to induce stress on marine animals in their receiving environment (Erbe 2013).

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3 When the terms “discountable” or “discountable effects” appear in this document, they refer to potential effects that are found to support a “not likely to adversely affect” conclusion because they are extremely unlikely to occur. The use of these terms should not be interpreted as having any meaning inconsistent with the ESA regulatory definition of “effects of the action.”
Anthropogenic noise sources can be categorized generally as impulsive (e.g., impact pile driving, explosions) or continuous (e.g., vibratory pile-driving, vessel noise), especially in the context of evaluating noise-induced hearing loss. Sounds from moving sources such as ships are continuous noise sources, although transient relative to the receivers. Impulsive noises are characterized by broad frequencies, fast rise time, short durations, and a high peak sound pressure (Finneran 2016). Non-impulsive (i.e., continuous) noise is better described as a steady-state noise source.

For auditory effects underwater noise is less likely to disturb or injure an animal if it occurs at frequencies at which the animal cannot hear well. The importance of sound components at particular frequencies can be scaled by frequency weighting relative to an animal’s sensitivity to those frequencies (Nedwell and Turnpenny 1998; Nedwell et al. 2007). Regulatory-defined acoustic thresholds used for the purpose of predicting the extent of injury and behavioral disturbance for various marine fauna, including marine mammals, sea turtles, and fish (permanent threshold shift [PTS]/temporary threshold shift [TTS]), and the subsequent management of these impacts have recently been revised to account for the duration of exposure, incorporation of new hearing and TTS data, and the differences in hearing acuity in various marine animal species groups (Finneran 2016; Finneran 2017; NMFS 2018b).

Shock waves associated with underwater detonations (e.g., UXOs) can induce both auditory effects (PTS and TTS) and non-auditory physiological effects, including mortality and direct tissue damage known as primary blast injury. The magnitude of the acoustic impulse (which is the integral of the instantaneous sound pressure) of the underwater blast causes the most common injuries, and therefore its value is used to determine if mortality or non-auditory injury occurs (U.S. Navy 2017).

The auditory, non-auditory, and behavioral response thresholds used in this BA are:


- Injury, impairment, and behavioral response thresholds for sea turtles developed for use by the US Navy (Finneran et al. 2017) based on exposure studies (e.g., McCauley et al. 2000a). Dual criteria (PK and SEL) have been suggested for PTS, along with auditory weighting functions published by Finneran et al. (2017) used in conjunction with SEL thresholds for PTS for impulsive sounds.

Potential adverse auditory effects to marine mammals from Project-generated underwater noise includes PTS, TTS, behavioral disruption, and masking; potential non-auditory effects to marine mammals from Project-generated underwater noise (UXO detonations only) includes mortality, lung injury, and gastrointestinal injury.

The extent and severity of auditory, non-auditory, and behavioral effects from Project-generated underwater noise is dependent on the timing of activities relative to species occurrence, the type of noise
impact, and species-specific sensitivity. To support the underwater noise assessment for the Project, Mayflower Wind conducted Project-specific underwater noise modeling for the following Project activities: impact pile driving, vibratory sheet pile driving, UXO detonations, and HRG surveys. A summary of the reports used in the BA are provided below:


### 5.2.1 Impact and Vibratory Pile Driving

Impact pile driving would occur during construction to install WTG and OSP foundations (Section 3.1.2.3.2). Impact pile driving generates intense, impulsive underwater noise that may result in physiological or behavioral effects in aquatic species. The severity of the effect is dependent on the received sound level (i.e., the sound level to which the organism is exposed), which is a function of the sound level generated by the noise source, the distance between the source and the organism, and the duration of sound exposure.

Acoustic propagation modeling of the impact pile-driving activities for the Proposed Action was undertaken by JASCO Applied Sciences to determine distances to the established PTS and disturbance thresholds for marine mammals, sea turtles, and fish for both realistic and maximum-case scenarios (COP Appendix U2; Mayflower Wind 2022). Two types of piles were considered under the maximum-case scenario: 52-foot (16-meter) monopiles and 15-foot (4.5-meter) pin piles as part of the four-legged jacket foundations. Under the realistic scenario, two types of piles were considered: 36-foot (11-meter) monopiles and 9.5- foot (2.9-meter) pin piles as part of the three-legged jacket foundations. Modeling was done for 146 WTGs and three OSPs. Sound fields from monopiles and pin piles were modeled at two representative locations in the Project area representing the variation in water depth in the Lease Area using a Menck MHU 3500S impact hammer for the pin piles and theoretical 6,600- kilojoule impact hammer for the monopiles. The modeling also applied 0 dB, 6 dB, 10 dB, and 15 dB noise attenuation to incorporate the use of a noise-abatement system (e.g., one or multiple bubble curtain/s). The resulting values represent a radius extending around each pile where potential injurious levels or behavioral effects could occur.

Additional acoustic and animal exposure modeling was also performed for several different construction scenarios. The primary assumptions used in the modeling of each scenario are summarized in Table 5.2-1 and listed below. Scenarios 1 and 2 assume WTG foundation installations will use a combination of vibratory and impact pile driving. The scenarios also include concurrent installation of WTG foundations and OSP foundations during which only impact pile driving was assumed. Modeling was conducted
assuming installation from January through December; however, Mayflower Wind does not intend to conduct pile driving activity from January 1 through April 30.

5. Scenario 1 – WTG monopiles, vibratory and impact piling with concurrent OSP installations
   a. Consecutive installation of most WTG monopile foundations (9/16 m) using vibratory and impact piling (108 monopiles); concurrent installation of OSP jacket foundations (32, 4.5 m pin piles) and 16 monopiles using only impact pile driving; and consecutive installation using only impact pile driving of the remaining 22 WTG monopile foundations

6. Scenario 2 – WTG piled jackets, vibratory and impact piling with concurrent OSP installations
   a. Consecutive installation of most (120) WTG jacket foundations (4, 4.5 m pin piles per jacket) using vibratory and impact piling; concurrent installation of OSP jacket foundations (32, 4.5 m pin piles) and 8 WTG jacket foundations using only impact pile driving, and consecutive installation of the remaining 19 WTG jacket foundations using only impact piling.

Each of the scenarios developed included an assumed distribution of installation days per month. Both scenarios assumed foundation installations would occur across two separate years. Additional details regarding the two scenarios and associated assumptions are available in Mayflower Wind’s Petition for Incidental Take Regulations (LGL 2022) and mitigation measures are presented in Section 3.3. Noise-related effects on each species group are discussed in the following sections.

Table 5.2-1. Assumptions used in WTG and OSP foundation installation scenarios for which acoustic and sound exposure modeling was conducted to estimate potential incidental take of marine mammals.

<table>
<thead>
<tr>
<th>Scenario 1</th>
<th>Scenario 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>WTG Monopiles</td>
<td>OSP Jackets</td>
</tr>
<tr>
<td>Foundations</td>
<td>146</td>
</tr>
<tr>
<td>Piles per foundation</td>
<td>1</td>
</tr>
<tr>
<td>Pile Diameter (m)</td>
<td>9/16</td>
</tr>
<tr>
<td>Target Penetration Depth (m)</td>
<td>35</td>
</tr>
<tr>
<td>Maximum Hammer Energy (kJ)</td>
<td>6600</td>
</tr>
<tr>
<td>Impact or Vibratory</td>
<td>Both</td>
</tr>
<tr>
<td>Impact piling strikes per pile(^1)</td>
<td>7000/5000</td>
</tr>
<tr>
<td>Piles Per Day</td>
<td>2</td>
</tr>
<tr>
<td>Total Pile Installation Days</td>
<td>146</td>
</tr>
<tr>
<td>Installation Years</td>
<td>2</td>
</tr>
<tr>
<td>Installation Months</td>
<td>May-Dec</td>
</tr>
</tbody>
</table>

\(^1\) The first value shows the number of strikes if only impact pile driving is used while the second value shows the number of strikes if both vibratory and impact pile driving are used.

5.2.1.1 Marine Mammals

Cetaceans (i.e., mysticetes and odontocetes) rely heavily on sound for essential biological functions, including communication, mating, foraging, predator avoidance, and navigation (Madsen et al. 2006; Weilgart 2007). Anthropogenic underwater noise may have adverse impacts on marine mammals if the sound frequencies produced by the noise sources overlap with marine mammals’ hearing ranges (NSF and USGS 2011). If such overlap occurs, underwater noise can result in behavioral and/or physiological effects, potentially interfering with essential biological functions (Southall et al. 2007).
The intense, impulsive noise (i.e., noise with rapid changes in sound pressure) associated with impact pile driving can cause behavioral and physiological effects in marine mammals. Potential behavioral effects of pile-driving noise include avoidance and displacement (Dähne et al. 2013; Lindeboom et al. 2011; Russell et al. 2016; Scheidat et al. 2011). Potential physiological effects include temporary threshold shift (TTS) or permanent threshold shift (PTS) in an animal’s hearing ability. Literature indicates that marine mammals would avoid disturbing levels of noise. However, individual responses to pile-driving noise are unpredictable and likely context specific. Behavioral effects and most physiological effects (e.g., stress responses and TTS) are expected to be short term and limited to the duration of pile driving within a 160 dB RMS isopleth distance from the pile being driven. Given that pile driving would occur in the open waters of the OCS, marine mammals would be able to avoid disturbing levels of noise. Any disruptions to foraging or other normal behaviors would be short term, and increased energy expenditures associated with this displacement are expected to be small. PTS could permanently limit an individual’s ability to locate prey, detect predators, navigate, or find mates and could therefore have long-term effects on individual fitness.

Acoustic propagation modeling of the impact pile-driving activities for the Proposed Action was undertaken to determine radial distances to the established PTS and disturbance thresholds for marine mammals. NMFS (2018) hearing-group-specific, dual-metric thresholds for impulsive noise were used (Table 5.2-2) and marine mammal auditory weighting functions were applied. All ESA-listed marine mammals evaluated in this BA belong to the low-frequency cetacean (LFC) group, except for sperm whales which belong to the mid-frequency cetacean (MFC) group. For the installation of the WTGs, two scenarios were considered in the modeling of monopiles and pin-piles (used for jacket foundations). They both involve periods of vibratory and impact piling for WTGs, as well as periods of concurrent impact piling of WTGs and OSP jacket pin piles, and a period of impact-only WTG installation. The difference is that Scenario 1 employs monopile WTGs which will be installed at a rate of 2 piles per day, while Scenario 2 employs jacketed pin-pile WTGs which will be installed at a rate of 4 piles per day. Installation of WTGs for both scenarios was modeled between May – December of Year 1 and Year 2, with concurrent installation of four pin-piles per day for OSP jackets modeled in October of both years. Note the modeling also used a 10-dB-per-hammer-strike noise attenuation to incorporate the use of a single noise-abatement system$^4$ (e.g., bubble curtain system and an additional system). A 10 dB decrease means the sound energy level is reduced by 90 percent (Limpert et al. 2022). This attenuation is considered achievable with currently available technologies (Bellmann et al. 2020). The resulting values represent a radius extending around each pile where potential injurious-level or behavioral effects could occur and are presented in Table 5.2-3 for the 10 dB attenuation level, while results for the 0 dB, 6 dB, and 15 dB attenuation that were also calculated are available in the MMPA application (LGL 2022).

The ranges to threshold levels resulting from the acoustic modeling are reported using two different terminologies to reflect the underlying assumptions of the modeling. The term “acoustic range” is used to refer to acoustic modeling results that are based only on sound propagation modeling and not animal movement modeling. Acoustic ranges assume receivers of the sound energy (marine mammals) are stationary throughout the duration of the exposure. These are most applicable to thresholds where any single instantaneous exposure above the threshold is considered to cause a take, such as the Level A $\text{SPL}_{pk}$ thresholds and the Level B $\text{SPL}_{rms}$ threshold. The Level A $\text{SPL}_{pk}$ acoustic ranges from impact pile driving modeled in Scenarios 1 and 2 assuming 10 dB of attenuation in the summer and winter were calculated. Vibratory pile driving of 9/16 m WTG monopile foundations modeled as part of Scenarios 1 and 2 did not produce sounds above the $\text{SPL}_{pk}$ thresholds of any of the marine mammal functional hearing groups. The largest Level A $\text{SPL}_{pk}$ acoustic range for impact pile driving under Scenarios 1 and 2 was 0.27 km for the high-frequency cetacean group in summer. The modeling did not exceed $\text{SPL}_{pk}$ thresholds.

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$^4$ The noise-abatement system implemented must be chosen, tailored, and optimized for site-specific conditions.
for LFCs or MFCs indicating that noise from a single pile driving event would not cause PTS for ESA-listed marine mammals when mitigated with 10 dB broadband noise attenuation.

For SEL\textsubscript{cum} based thresholds, acoustic ranges represent the maximum distance at which a receiver would be exposed above the threshold level if it remained present during the entire sound producing event or 24 hours, whichever is less. Since receivers are likely to move in and out of the threshold distance over the course of an exposure, animal movement modeling are used to estimate an “exposure range”. This involves analyzing the movements and resulting accumulated sound energy during the exposure modeling and identifying the ranges within which most animals (95 percent) were exposed above the threshold level if they occurred within that range at any point in time, which provides a more realistic assessment of the distances within which animals would need to occur in order to accumulate enough sound energy to cross the applicable SEL\textsubscript{cum} threshold. The exposure range distances (in kilometers) to Level A cumulative sound exposure level (SEL\textsubscript{cum}) for combined vibratory pile driving with 10 dB of noise attenuation were zero for nearly all hearing groups in Scenario 2 (jacket pin piles). In Scenario 1 (monopiles), the exposure ranges to PTS for vibratory pile driving were 0.08 km for fin whale, 0.13 km for NARW, and zero for all other hearing groups/species. As such, a fin whale or NARW would need to remain within 80 m or 130 m of vibratory pile driving locations for 24 hours in order to accumulate enough sound exposure to exceed the Level A PTS threshold for injury, which is unlikely to happen.

For impact pile driving, the exposure ranges to Level A PTS thresholds varied by species for LFCs, sometimes up to 500 m, so each LFC species was evaluated separately. Individuals remaining within these distances from pile driving over 24 hours could experience Level A PTS without additional mitigation beyond the 10 dB noise attenuation assumption included in the modeling (LGL 2022). For these results, all winter exposure ranges were larger in the winter than in the summer estimates. For both fin whales and NARWs, the largest exposure ranges were 4.60 km and 3.28 km, respectively, under Scenario 1 (monopiles) with combined impact and vibratory piling installation methods (Table 5.2-3). The largest exposure range for sei whales was 3.56 km under Scenario 1 (monopiles) with sequential impact-only installation methods. For all three LFCs (fin, NARW, and sea), the smallest exposure ranges occurred under Scenario 2 (jacket pin piles) with combined impact and vibratory installation methods. The highest exposure range for each species was roughly double the size of the lowest exposure range for each species or hearing group. No Level A exposures were calculated for blue whales due to very low densities, and sperm whale didn’t accumulate enough exposure to reach the MFC threshold at any distance.

The acoustic ranges (i.e., where 95 percent of the individuals would be exposed to a threshold from one pile driving event) were calculated at Level B behavioral thresholds of 160 dB re 1 μPa sound pressure level (SPL\textsubscript{rms}) from impact pile driving and 120 dB re 1 μPa from vibratory pile driving, assuming 10 dB of noise attenuation (Table 5.2-4). Vibratory pile driving generates continuous underwater noise with lower source levels than impact pile driving. Noise impacts from continuous noise sources are generally less severe compared to impacts from impulsive noise sources, but physiological effects may still occur in proximity to the noise source if source levels are sufficiently high and/or if animals remain in the vicinity and are exposed to those levels for a sufficient duration. Vibratory hammering is accomplished by applying rapidly alternating (~250 Hz) forces to the pile. Vibratory pile driving produces non-impulsive, continuous sounds with lower acoustic pressure (Guan and Miner 2020). Although the overall sound levels associated with vibratory hammering are typically less than impact hammering, the lower disturbance threshold (120 dB re 1 μPa SPL\textsubscript{rms}) for continuous sounds means that vibratory pile driving activity will often result in a larger area ensonified above that threshold and therefore a larger number of potential Level B exposures. For vibratory pile driving, the largest unweighted acoustic range was 84.63 km under Scenario 1 (monopiles) in the winter, while the smallest unweighted acoustic range was 15.83 km under Scenario 2 (jacket pin piles) in the summer.
Given the large radial distances to PTS and behavioral thresholds, noise impacts associated with impact pile driving for the Proposed Action could occur. The numbers of individual marine mammals predicted to receive sound levels above thresholds were determined using animal movement modeling in the same modeling exercise (LGL 2022). Based on the modeling results (Table 5.2-5), it is estimated that 25 fin whales, 8 NARW, and 5 sei whales may be exposed to cumulative sound exposure levels over a period of 24 hours that exceed Level A injury thresholds during pile driving under Scenario 1 with 10 dB of noise attenuation. Estimates for individuals exposed to Level A injury thresholds under Scenario 2 were similar, with 20 fin whales, 8 NARW, and 5 sei whales exposed. In addition, under Scenario 1 (monopiles), it was estimated that 1 blue whale, 614 fin whales, 179 NARWs, 85 sei whales, and 150 sperm whales would be exposed to an individual sound pressure level (SPL$_\text{rms}$) that exceeded the Level B threshold for behavioral impacts. Exposure estimates under Scenario 2 were smaller for most species: 1 blue whale, 282 fin whales, 124 NARWs, 55 sei whales, and 85 sperm whales, suggesting that WTGs with jacket pin piling may cause reduced behavioral impacts vs. monopile WTGs.

Table 5.2-2. Marine mammal acoustic thresholds for impulsive noise sources

<table>
<thead>
<tr>
<th>Hearing Group</th>
<th>PTS Onset</th>
<th>Behavior</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SPL$_\text{pk}$(^1)</td>
<td>SEL$_\text{cum}$(^2)</td>
</tr>
<tr>
<td>Low-Frequency Cetaceans</td>
<td>219 dB</td>
<td>183 dB</td>
</tr>
<tr>
<td>Mid-Frequency Cetaceans</td>
<td>230 dB</td>
<td>185 dB</td>
</tr>
<tr>
<td>High-Frequency Cetaceans</td>
<td>202 dB</td>
<td>155 dB</td>
</tr>
<tr>
<td>Phocid Pinnipeds</td>
<td>218 dB</td>
<td>185 dB</td>
</tr>
</tbody>
</table>

Sources: GARFO 2020; NMFS 2018.

1 SPL$_\text{pk}$ = peak sound pressure level in decibels (dB) referenced to 1 microPascal squared; also written $L_p$

2 SEL$_\text{cum}$ = weighted cumulative sound exposure level in dB referenced to 1 microPascal squared second; also written $L_E$

3 SPL$_\text{RMS}$ = root mean squared sound pressure level in dB referenced to 1 microPascal squared; also written $L_p$ or $L_{\text{rms}}$
## Table 5.2-3. Exposure ranges to injury (Level A $SEL_{cum}$) thresholds for marine mammals during different scenarios of WTG and OSP impact pile driving assuming 10 dB of noise attenuation

<table>
<thead>
<tr>
<th>Species or Hearing Group</th>
<th>Exposure Ranges (km) during Winter</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Combined (impact + vibratory)</td>
<td>Concurrent (impact only)</td>
<td>Sequential (impact only)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>16 m WTG Monopile 2 piles/day</td>
<td>4.5 m WTG JPP 4 piles/day</td>
<td>16 m WTG Monopile and 4.5 m OSP JPP</td>
<td>4.5 m WTG JPP and 4.5 m OSP JPP</td>
<td>16 m WTG Monopile 2 piles/day</td>
<td>4.5 m WTG JPP 4 piles/day</td>
<td>4.5 m OSP JPP 4 piles/day</td>
</tr>
<tr>
<td>Fin whale</td>
<td>4.60</td>
<td>2.56</td>
<td>—</td>
<td>—</td>
<td>4.55</td>
<td>2.55</td>
<td>3.5</td>
</tr>
<tr>
<td>NARW</td>
<td>3.28</td>
<td>1.78</td>
<td>—</td>
<td>—</td>
<td>3.27</td>
<td>1.85</td>
<td>2.13</td>
</tr>
<tr>
<td>Sei whale (migrating)</td>
<td>3.52</td>
<td>2.07</td>
<td>—</td>
<td>—</td>
<td>3.56</td>
<td>2.22</td>
<td>2.72</td>
</tr>
<tr>
<td>MFC (e.g., sperm whale)</td>
<td>0</td>
<td>0</td>
<td>—</td>
<td>—</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

### Exposure Ranges (km) during Summer

<table>
<thead>
<tr>
<th>Species or Hearing Group</th>
<th>Exposure Ranges (km) during Summer</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>16 m WTG Monopile 2 piles/day</td>
<td>4.5 m WTG JPP 4 piles/day</td>
<td>16 m WTG Monopile and 4.5 m OSP JPP</td>
<td>4.5 m WTG JPP and 4.5 m OSP JPP</td>
<td>16 m WTG Monopile 2 piles/day</td>
<td>4.5 m WTG JPP 4 piles/day</td>
<td>4.5 m OSP JPP 4 piles/day</td>
</tr>
<tr>
<td>Fin whale</td>
<td>4.11</td>
<td>2.25</td>
<td>4.53</td>
<td>3.58</td>
<td>4.15</td>
<td>2.37</td>
<td>3.18</td>
</tr>
<tr>
<td>NARW</td>
<td>3.07</td>
<td>1.57</td>
<td>3.07</td>
<td>1.92</td>
<td>2.95</td>
<td>1.73</td>
<td>2.01</td>
</tr>
<tr>
<td>Sei whale (migrating)</td>
<td>3.13</td>
<td>1.84</td>
<td>3.44</td>
<td>2.41</td>
<td>3.19</td>
<td>1.96</td>
<td>2.59</td>
</tr>
<tr>
<td>MFC (e.g., sperm whale)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

dB = decibel; km = kilometer; m = meter; NARW = North Atlantic right whale; MFS = mid-frequency cetacean
dash (—) = no results because potential concurrent installation would only occur in the summer months
Source: Summarized from Tables 20 – 24 in MMPA Application (LGL 2022)
Table 5.2-4. Acoustic ranges (R95%) to the Level B, 160 dB re 1 μPa sound pressure level (SPL_{rms}) threshold from impact pile driving and Level B, 120 dB re 1 μPa SPL_{rms} from vibratory pile driving under Scenarios 1 and 2, assuming 10 dB of noise attenuation.

<table>
<thead>
<tr>
<th>Hearing Group</th>
<th>Acoustic Ranges (km) to Behavioral Thresholds during Winter</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Vibratory (120 dB SPL_{rms})</td>
<td>Impact (160 dB SPL_{rms})</td>
</tr>
<tr>
<td></td>
<td>16 m WTG Monopile 2 piles/day</td>
<td>4.5 m WTG JPP 4 piles/day</td>
</tr>
<tr>
<td>Unweighted</td>
<td>84.63</td>
<td>21.92</td>
</tr>
<tr>
<td>Low-Frequency (e.g., fin, sei, NARW)</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Mid-Frequency (e.g., sperm whale)</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

**Acoustic Ranges (km) to Behavioral Thresholds during Summer**

<table>
<thead>
<tr>
<th>Hearing Group</th>
<th>Acoustic Ranges (km) to Behavioral Thresholds during Summer</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unweighted</td>
<td>Low-Frequency (fin, sei, NARW)</td>
</tr>
<tr>
<td></td>
<td>42.02</td>
<td>15.83</td>
</tr>
<tr>
<td>Unweighted</td>
<td>7.36</td>
<td>4.37</td>
</tr>
<tr>
<td>Low-Frequency (fin, sei, NARW)</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Mid-Frequency (sperm whale)</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

dB = decibel; km = kilometer; m = meter; NARW = North Atlantic right whale; dash (—) = frequency weighted results for vibratory pile driving are not available.
Source: Summarized from Table 19 in MMPA Application (LGL 2022)

Table 5.2-5. Estimated Level A and Level B exposures from Scenarios 1 and 2 assuming 10 dB of noise attenuation. Level A exposure estimates assume no implementation of monitoring and mitigation measures. Level B exposure modeling take estimates are based on distances to the unweighted 160 dB threshold.

<table>
<thead>
<tr>
<th>Species</th>
<th>Exposure Estimates (# individuals)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Scenarios 1: 146 WTG Monopiles and 32 OSP Jacket pin piles</td>
<td>Scenarios 2: 147 WTG Jacket pin piles and 32 OSP Jacket pin piles</td>
</tr>
<tr>
<td></td>
<td>Total Level A (SEL_{cum})</td>
<td>Total Level B (SPL_{rms})</td>
</tr>
<tr>
<td>Blue whale</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Fin whale</td>
<td>25</td>
<td>614</td>
</tr>
<tr>
<td>NARW</td>
<td>8</td>
<td>179</td>
</tr>
<tr>
<td>Sei whale</td>
<td>5</td>
<td>85</td>
</tr>
<tr>
<td>Sperm whale</td>
<td>0</td>
<td>150</td>
</tr>
</tbody>
</table>

SEL_{cum} = weighted cumulative sound exposure level in decibels (dB) referenced to 1 microPascal squared second
SPL_{rms} = root mean squared sound pressure level in dB referenced to 1 microPascal squared
NARW = North Atlantic right whale
Source: Summarized from Tables 25 and 26 in MMPA Application (LGL 2022)

Mayflower Wind has proposed several measures to avoid, minimize, and mitigate impacts of pile driving noise on marine mammals (Section 3.3) including utilization of protected species observers to monitor and enforce appropriate monitoring and exclusion zones, soft-start procedures, noise-reduction technologies, and seasonal pile-driving restrictions with no pile driving occurring between January and April, with additional measures proposed by BOEM (Section 3.3, Table 3.3-2). Based on the anticipated
construction schedules provided in the Vineyard Wind Final EIS (BOEM 2021a), concurrent pile driving at other offshore wind Lease Areas in Massachusetts and Rhode Island is not anticipated during construction of the Proposed Action.

No peak PTS exposures are expected for fin, NARW, and sei whales for any Project activity; thus, the potential for PTS exposure to these ESA-listed species is considered extremely unlikely, given the mitigation measures and is **discountable**. Therefore, the effects of noise exposure from Project impact pile driving leading to PTS (peak threshold) **may affect, not likely to adversely affect** ESA-listed marine mammals.

Modeling indicates that up to 25 individual fin whales, 8 individual NARW, and 5 individual sei whales may be exposed to prolonged cumulative underwater noise levels above PTS thresholds from impact pile driving at 10 dB noise attenuation. The potential for serious injury is minimized by the implementation of pre-clearance, shutdown zones, and soft starts for impact pile driving operations that would facilitate a delay of pile driving if marine mammals were observed approaching or within areas that could be ensonified above sound levels that could result in auditory injury. These measures also make it unlikely that any ESA-listed cetacean will be exposed to pile driving that would result in severe hearing impairment and would more likely have the potential to result in slight PTS (i.e., minor, permanent degradation of hearing capabilities at some hearing thresholds). In addition, soft starts could be effective in deterring marine mammals from impact pile driving activities prior to exposure resulting in adverse effects. The potential for serious injury is also minimized through using a noise mitigation system during all impact pile driving operations. The proposed requirement that impact pile driving can only commence when the pre-clearance zones are fully visible to PSOs allows a high marine mammal detection capability and enables a high rate of success in implementing these zones to avoid serious injury. However, exposures leading to PTS are still possible, therefore, the effects of noise exposure from Project impact pile driving leading to PTS **may affect, likely to adversely affect** fin whales, NARWs, sei whales, and sperm whales.

Additional measures to minimize and avoid noise exposure from pile driving are included in the Project’s ITA application submitted to NMFS and are proposed by BOEM in this BA within the enhanced mitigation area where slightly higher densities of NARWs have been recorded (Section 3.3 and Figure 3.3-1). BOEM is considering a mitigation measure to require a real-time PAM system to further enhance the detection of NARWs in this enhanced mitigation area and cease pile driving until NARWs are not detected with PAM for at least 48 hours after the last detection.

Behavioral and masking effects are more difficult to mitigate and are, therefore, still considered likely for activities with large acoustic disturbance areas such as impact pile driving. Pile-driving activities have been shown to cause avoidance behaviors in most marine mammal species, although studies that specifically examine the behavioral responses of baleen whales to pile driving are absent from the literature. Behavioral avoidance of other impulsive noise sources has been documented and can be used as a proxy for impact pile driving. Malme et al. (1986) observed the responses of migrating gray whales to seismic exploration. At received levels of about 173 dB re 1 μPa, feeding gray whales had a 50 percent probability of stopping feeding and leaving the area. Some whales ceased to feed but remained in the area at received levels of 163 dB re 1 μPa. Individual responses were highly variable. Most whales resumed foraging activities once the air gun activities stopped. Dunlop et al. (2017) observed that migrating humpback whales would avoid air gun arrays up to 3 km away when received levels were over 140 dB re 1 μPa (Dunlop et al. 2017). Cetaceans showed varying levels of sensitivity to continuous noise sources (i.e., active sonar), with observed responses ranging from displacement (Maybaum 1993) to avoidance behavior (animals moving rapidly away from the source) (Watkins et al. 1993), decreased vocal activity, and disruption in foraging patterns (Goldbogen et al. 2013).
The Lease Area, where impact pile driving will occur, is near the Nantucket Shoals, an area important for NARW feeding. Fin and sei whales generally prefer the deeper waters of the continental slope and more often can be found in water > 90 meters deep (Hain et al. 1985; Hayes et al. 2020; Waring et al. 2011). Based on the literature outlined above, behavioral responses of LFCs to impact pile driving could include ceasing feeding and avoiding the ensonified area. To limit potential effects to NARWs, impact pile driving will not occur during January 1 through April 30, avoiding the times of year when NARWs are present in higher densities.

In addition, a 30-minute pre-start clearance period will be implemented where the shutdown zones are monitored to avoid any unnecessary takes related to behavioral disturbance, which will limit the potential for behavioral disturbance to all ESA-listed marine mammal species. If animals are exposed to underwater noise above behavioral thresholds, it could result in avoidance of a localized area around a pile (e.g., 3.5 km in the summer). However, this displacement would be temporary for the duration of activity, which would be a maximum of 4 hours per pile, for 2 piles per day, with a 4-hour break before another pile would be driven during monopile installation. NARW (and any LFCs) could be expected to resume their previous behavior (e.g., pre-construction activities) following this 12-hour period. The energetic consequences of any avoidance behavior and potential delay in resting or foraging are not expected to affect any individual’s ability to successfully obtain enough food to maintain their health or impact the ability of any individual to make seasonal migrations or participate in breeding or calving. Any physiological effects resulting from changes in behavior would be expected to resolve within hours to days of exposure and are not expected to affect the health of any individual whale or its ability to migrate, forage, breed, or calve.

Acoustic masking can occur if the frequencies of the activity overlap with the communication frequencies used by marine mammals. Modeling results indicate that dominant frequencies of impact pile-driving activities for the Proposed Action were concentrated below 1 kHz (LGL 2022). The short-term consequences of masking from Project activities range from temporary changes in vocalizations to avoidance (as outlined above). It is not known how often these types of vocal responses occur upon exposure to impulsive sounds, or what the long-term effects would be (LGL 2022). If marine mammals exposed to sounds sometimes respond by changing their vocal behavior, this adaptation, along with directional hearing and preadaptation to tolerate some masking by natural sounds (Richardson et al. 1995) would all reduce the importance of masking. In this Project, impact pile driving is not expected to occur for more than approximately 4 hours at one time for monopile foundation installation and 2 hours per foundation for piled jacket installation. As a result, a complete masking of LFC marine mammal communications would not be expected during a given day. In addition, the duty cycle of sound sources is also important when considering masking effects. Low-duty cycle sound sources such as impact pile driving are less likely to mask LFC communications, as the sound transmits less frequently with pauses or breaks between impacts, providing opportunities for communications to be heard.

Based on the mitigation and monitoring measures presented and discussed and the animal’s ability to move away from the noise, the potential for exposure of these ESA-listed species to noise levels leading to behavioral disruption would be reduced at the level of the individual animal and would not be expected to have population level effects. However, as described above, it is possible for an individual to experience a sound pressure level that exceeds behavioral thresholds if they are likely to occur near enough and be sensitive enough to the impact pile driving activity. Note that although 1 blue whale was included as a requested “take” in the MMPA application, this was based on increasing the density-based estimate to mean group size to account for a rare chance encounter. Since monthly average densities for blue whales within 10 km of the Lease Area were zero year-round, blue whales are likely to experience no effect. Therefore, the effects of noise exposure to Project impact and vibratory pile driving leading to behavioral disruption may affect, likely to adversely affect fin, NARW, sei, and sperm whales.
5.2.1.2 Sea Turtles

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

To estimate radial distances to injury and behavioral thresholds for impact pile driving, peak SPLs and frequency-weighted accumulated SELs for the onset of PTS in sea turtles from Finneran et al. (2017) and behavioral response thresholds from McCauley et al. (2000) were used (Table 5.2-6). As described in Section 5.2.1.1, modeling was performed under two scenarios, where Scenario 1 involved monopile WTGs and jacket pin pile OSPs, and Scenario 2 involved jacket pin piles for both WTG and OSP foundations. Under both scenarios, the modeling did not exceed SPL_{pk} thresholds for any sea turtles indicating that noise from a single pile driving event would not cause when mitigated with 10 dB broadband noise attenuation.

The cumulative exposure ranges to injury (SEL_{cum}) for all sea turtle species under all scenarios and combinations of vibratory and impact pile driving were less than 1 km. Exposure ranges were nearly identical between combined (impact plus vibratory) and sequential (impact only) installation scenarios, and between summer and winter scenarios. Exposure ranges for Scenario 1 (monopiles) were higher than for Scenario 2 (jacket pin piles), however, the concurrent (impact only) installation during summer under Scenario 1 had the largest exposure ranges overall. The leatherback turtle had the largest exposure ranges compare to the other sea turtle species, from 0.37 – 0.99 km. The next largest exposure ranges were calculated for the green turtle, with exposure to injury ranges from < 0.01 – 0.60 km. The Kemp’s ridley turtle had small exposure ranges, from 0 – 0.39 km, and the loggerhead turtle had the smallest exposure ranges from 0 – 0.22 km. Depending on species, sea turtles that remain within < 0.01 – 0.99 km of pile driving over 24 hours could experience PTS, assuming 10 dB of noise attenuation (Table 5.2-7).

Based on the same modeling results, 4 leatherback sea turtles and < 0.5 each of Kemp’s ridley, loggerhead, and green sea turtles will be exposed to sound levels exceeding recommended injury thresholds (L_{e}) under Scenario 1 (monopile WTGs) assuming 10 dB of noise attenuation (Table 5.2-8). Estimated exposures were even lower under Scenario 2 (jacket pine pile WTGs), with just 1 leatherback sea turtle, < 0.5 Kemp’s ridley and green sea turtles, and 0 leatherback sea turtles exposed to sound levels exceeding injury thresholds. For behavioral effects under Scenario 1 (monopiles), 7 leatherback turtles and 5 loggerhead turtles will be exposed to sound exceeding behavioral thresholds (L_{p}), while both Kemp’s ridley and green sea turtles will have < 0.5 individuals exposed. Under Scenario 2 (jacket pin piles), the exposure estimates to sounds that exceed behavioral thresholds for Kemp’s ridley and green sea turtles remain the same (< 0.5 individuals), while 3 leatherback and 6 loggerhead sea turtles will be exposed.

Modeling indicates that up to 4 individual leatherback turtles may be exposed to underwater noise levels above PTS thresholds from impact pile driving noise. The potential for injury is minimized by the implementation of pre-clearance, shutdown zones, and ramp-ups for impact pile driving operations that would facilitate a delay of pile driving if turtles were observed approaching or within areas that could be ensonified above sound levels that could result in auditory injury. As mentioned above, these measures also make it unlikely that any ESA-listed turtle will be exposed to impact pile driving noise that would result in severe hearing impairment or serious injury and would more likely have the potential to result in
slight PTS (i.e., minor, permanent degradation of hearing capabilities at some hearing thresholds). In addition, ramp-ups could be effective in deterring turtles from impact pile driving activities prior to exposure resulting in injury. The proposed requirement that impacts pile driving can only commence when the pre-clearance zones (Table 3.3-1) are fully visible to PSOs allows a high sea turtle detection capability and enables a high rate of success in implementation of these zones to avoid injury. However, exposures leading to PTS are still possible even with 10 dB of noise attenuation. Therefore, the effects of noise exposure from Project impact pile driving leading to PTS may affect, likely to adversely affect leatherback sea turtles.

Both injury and behavior exposures are expected to be less than 0.5 for Kemp’s ridley and green sea turtles for impact pile driving activities due to their rarity in the area, thus the potential for PTS is considered extremely unlikely to occur and is discountable. Therefore, the effects of noise exposure from Project pile driving leading to either PTS or behavioral change may affect, not likely to adversely affect Kemp’s ridley and green sea turtles.

While the mitigation and monitoring measures and the animal’s ability to avoid areas of loud construction noise are expected to decrease the potential exposure of these ESA-listed species to underwater noise above behavioral disturbance thresholds, the possibility still exists and cannot be discounted. Therefore, the effects of noise exposure from Project pile driving leading to behavioral disturbance may affect, likely to adversely affect leatherback and loggerhead sea turtles.

The developer’s proposed mitigation for pile driving includes pre-clearance and shutdown zones, and ramp-up procedures (Section 3.3). Pre-clearance and shutdown zones for sea turtles have conservatively been set at 500 meters and would capture the PTS zone of influence. Monitoring of this zone for sea turtles is considered highly effective in mitigating PTS effects. With the application of developer proposed mitigation, the potential for ESA-listed sea turtles to be exposed to noise above PTS thresholds is considered extremely unlikely to occur and is discountable. Therefore, the effects of noise exposure from Project vibratory pile driving leading to PTS may affect, not likely to adversely affect ESA-listed sea turtles.

As the source level assumed for vibratory pile driving (e.g., 165 dB re 1 µPa) would exceed the behavioral thresholds for sea turtles (e.g., 175 dB re 1 µPa) behavioral disturbance is considered possible. It is likely that the pre-clearance zone (e.g., 500 m) would cover the behavioral disturbance zone, so the potential for behavioral exposure to ESA-listed turtles is considered extremely unlikely to occur and is discountable. Therefore, the effects of noise exposure from Project vibratory pile driving leading to behavioral disturbance may affect, not likely to adversely affect ESA-listed sea turtles.

Table 5.2-6. Acoustic metrics and thresholds for sea turtles

<table>
<thead>
<tr>
<th>Faunal Group</th>
<th>Injury</th>
<th>Impairment</th>
<th>Behavior</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sea turtles</td>
<td>$L_{pk}^1$</td>
<td>$L_E^2$</td>
<td>$L_{pk}^1$</td>
</tr>
<tr>
<td></td>
<td>232</td>
<td>204</td>
<td>226</td>
</tr>
</tbody>
</table>

Sources: Finneran et al. 2017; McCauley et al. 2000

1 $L_{pk}$ = peak sound pressure level in decibels (dB) referenced to 1 microPascal squared; also SPLpk
2 $L_E$ = weighted cumulative sound exposure level in decibels referenced to 1 microPascal squared second; also SELcum
3 $L_p$ = root mean squared sound pressure level in dB referenced to 1 microPascal squared; also SPLrms or Lrms
Table 5.2-7. Exposure ranges to injury (SEL_{cum}) thresholds for sea turtles during different scenarios of impact pile driving assuming 10 dB of noise attenuation

<table>
<thead>
<tr>
<th>Species</th>
<th>Exposure Ranges (km) during Winter</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Combined (impact + vibratory)</td>
<td>Concurrent (impact only)</td>
<td>Sequential (impact only)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>16 m WTG Monopile 2 piles/day</td>
<td>16 m WTG Monopile and 4.5 m OSP JPP</td>
<td>4.5 m WTG JPP and 4.5 m OSP JPP</td>
<td>16 m WTG Monopile 2 piles/day</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kemp’s ridley turtle</td>
<td>0.39</td>
<td>0</td>
<td>—</td>
<td>—</td>
<td>0.39</td>
<td>0</td>
</tr>
<tr>
<td>Leatherback turtle</td>
<td>0.96</td>
<td>0.39</td>
<td>—</td>
<td>—</td>
<td>0.96</td>
<td>0.37</td>
</tr>
<tr>
<td>Loggerhead turtle</td>
<td>0.14</td>
<td>0</td>
<td>—</td>
<td>—</td>
<td>0.14</td>
<td>0</td>
</tr>
<tr>
<td>Green turtle</td>
<td>0.60</td>
<td>&lt; 0.01</td>
<td>—</td>
<td>—</td>
<td>0.55</td>
<td>0.15</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Species</th>
<th>Exposure Ranges (km) during Summer</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Combined (impact + vibratory)</td>
<td>Concurrent (impact only)</td>
<td>Sequential (impact only)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>16 m WTG Monopile 2 piles/day</td>
<td>16 m WTG Monopile and 4.5 m OSP JPP</td>
<td>4.5 m WTG JPP and 4.5 m OSP JPP</td>
<td>16 m WTG Monopile 2 piles/day</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kemp’s ridley turtle</td>
<td>0.39</td>
<td>0.45</td>
<td>0.03</td>
<td>0.39</td>
<td>0</td>
<td>0.13</td>
</tr>
<tr>
<td>Leatherback turtle</td>
<td>0.89</td>
<td>0.99</td>
<td>0.45</td>
<td>0.89</td>
<td>0.37</td>
<td>0.57</td>
</tr>
<tr>
<td>Loggerhead turtle</td>
<td>0.02</td>
<td>0</td>
<td>0.22</td>
<td>0</td>
<td>0.13</td>
<td>0</td>
</tr>
<tr>
<td>Green turtle</td>
<td>0.55</td>
<td>&lt; 0.01</td>
<td>0.57</td>
<td>0.20</td>
<td>0.55</td>
<td>0.15</td>
</tr>
</tbody>
</table>

dB = decibel; km = kilometer; m = meter; JPP = jacket pin piles; WTG = wind turbine generators; OSP = offshore service platform; dash (—) = no results because potential concurrent installation would only occur in the summer months. Source: Summarized from Tables 32 – 38 and H-43 through H-56 in Appendix A of the MMPA Application (Limpet et al. 2022)
Table 5.2.8. Estimated individuals exposed to injury and behavior threshold levels of sound from Scenarios 1 and 2 across two years assuming 10 dB of noise attenuation. Injury exposure estimates assume no implementation of monitoring and mitigation measures.

<table>
<thead>
<tr>
<th>Species</th>
<th>Exposure Estimates (# individuals)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Scenario 1: 146 WTG Monopiles and 32 OSP Jacket pin piles</td>
</tr>
<tr>
<td></td>
<td>Injury</td>
</tr>
<tr>
<td></td>
<td>$L_{pk}$</td>
</tr>
<tr>
<td>Kemp’s ridley turtle</td>
<td>0</td>
</tr>
<tr>
<td>Leatherback turtle</td>
<td>0</td>
</tr>
<tr>
<td>Loggerhead turtle</td>
<td>0</td>
</tr>
<tr>
<td>Green turtle</td>
<td>0</td>
</tr>
</tbody>
</table>

$L_{pk} =$ peak sound pressure level in decibels (dB) referenced to 1 microPascal squared; also written $SPL_{pk}$

$L_E =$ weighted cumulative sound exposure level in dB referenced to 1 microPascal squared second; also written $SEL_{cum}$

$L_P =$ root mean squared sound pressure level in dB referenced to 1 microPascal squared; also written $SPL_{rms}$ or $L_{rms}$

Source: Summarized from Tables 23 and 24 in Appendix A of the MMPA Application (Limpert et al. 2022). Values for Year 1 and Year 2 were summed and rounded up or down to the nearest whole number. A "< 0.5" to differentiate exposure values that should have rounded down to zero when summed from mean exposures that were truly zero.

5.2.1.3 Fish

Impact pile driving noise can cause behavioral changes, physiological effects (including TTS), or mortality in fish. Behavioral effects vary among individuals and include, but are not limited to, startle responses, cessation of activity, and avoidance. Extended exposure to mid-level noise or brief exposure to extremely loud sound can cause TTS, resulting in short-term, reversible loss of hearing acuity (Buehler et al. 2015). Fish are not known to develop PTS, potentially due to an ability to repair and regenerate hair cells in the inner ear damaged from sound exposure (Smith et al. 2006; Popper et al. 2007). Developmental abnormalities in early life stages of fishes resulting from pile-driving noise have been documented (Weilgart 2018; Hawkins and Popper 2017). Pile-driving noise could also result in reduced reproductive success while pile-driving is occurring, particularly in species that spawn in aggregate. Pile-driving noise may injure or kill early life stages of finfish and invertebrates at short distances (Weilgart 2018; Hawkins and Popper 2017).

To estimate radial distances to injury thresholds for impact pile driving, fish injury thresholds for different sized fish from the Fisheries Hydroacoustic Working Group (2008) and Stadler and Woodbury (2009) and for fish with different hearing capabilities (i.e., without swim bladder, with swim bladder not involved in hearing, and with swim bladder involved in hearing) from Popper et al. (2014) were used (Table 5.2-9). Fish with a swim bladder involved in hearing (e.g., herrings, gadids) are most susceptible to pile-driving noise while those without swim bladders (e.g., flatfish, rays, sharks) are least susceptible (Popper et al. 2014). ESA-listed fish evaluated in this BA (i.e., subadult and adult Atlantic sturgeon) would be larger than 2 grams and have a swim bladder not involved in hearing. To estimate radial distances to behavioral thresholds for fish, thresholds developed by the NMFS Greater Atlantic Regional Fisheries Office (Table 5.2-9; Mueller-Blenkle et al. 2010; Purser and Radford 2011; Wysocki et al. 2007) were used in a modeling study performed for this project (Limpert et al. 2022). Although some fish may move during pile driving, during modeling they were considered static receivers and acoustic distances where sound levels could exceed fish sound thresholds were determined using a maximum-over-depth approach and finding the distance that encompasses at least 95% of the horizontal area that would be exposed to sound at or above the specified level. Additional modeling details for scenarios can be found in Section 5.2.1.1.
Based on model results under Scenario 1 (monopiles), pile driving sound levels could exceed recommended injury thresholds for Atlantic sturgeon within up to 0.15 km for single strikes and within up to 9.68 km cumulative exposure over 24 hours, both with 10 dB of sound mitigation (Table 5.2-10). Sound levels could exceed recommended behavioral thresholds for Atlantic sturgeon within 8.34 – 17.22 km of pile driving with 10 dB of mitigation, depending on season and location (lower exposure ranges at L02 and in summer, and higher at L01 and in winter).

Table 5.2-9. Acoustic metrics and thresholds for fish

<table>
<thead>
<tr>
<th>Faunal Group</th>
<th>Injury</th>
<th>Behavior</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$L_{pk}^1$</td>
<td>$L_E^2$</td>
</tr>
<tr>
<td>Fish ≥ 2 grams</td>
<td>206</td>
<td>187</td>
</tr>
<tr>
<td>Fish less than 2 grams</td>
<td>183</td>
<td></td>
</tr>
<tr>
<td>Fish without swim bladder</td>
<td>213</td>
<td>216</td>
</tr>
<tr>
<td>Fish with swim bladder not involved in hearing</td>
<td>207</td>
<td>203</td>
</tr>
<tr>
<td>Fish with swim bladder involved in hearing</td>
<td>207</td>
<td>203</td>
</tr>
</tbody>
</table>

1 Measured in decibels referenced to 1 microPascal
2 Measured in decibels referenced to 1 microPascal squared second

Sources: Fisheries Hydroacoustic Working Group 2008; Mueller-Blenkle et al. 2010; Popper et al. 2014; Purser and Radford 2011; Stadler and Woodbury 2009; Wysocki et al. 2007

Table 5.2-10. Summary of acoustic radial distances ($R_{max}$ in kilometers) for fish during monopile impact pile installation at the higher impact of two modeled locations for both seasons, with 10 dB noise attenuation from a noise abatement system

<table>
<thead>
<tr>
<th>Faunal Group</th>
<th>Range (km) during Winter</th>
<th>Range (km) during Summer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Location 1</td>
<td>Location 2</td>
</tr>
<tr>
<td></td>
<td>Injury $^a$ $L_{pk}$</td>
<td>Injury $^a$ $L_E$</td>
</tr>
<tr>
<td>Fish ≥ 2 grams; 16 m Monopile Scenario, NNN 6600 (b) hammer</td>
<td>0.15 9.68 17.22</td>
<td>0.11 7.69 12.35</td>
</tr>
<tr>
<td>Fish ≥ 2 grams; 4.5 m Post-pile Jacket Scenario, MHU 3500S (b) hammer</td>
<td>0.06 8.21 13.02</td>
<td>0.06 6.30 11.07</td>
</tr>
</tbody>
</table>

km = kilometer; dB = decibel
$L_{pk} = $ unweighted peak sound pressure (dB re 1 μPa); $L_E = $ sound exposure level (dB re 1 μPa2·s); $L_p = $ unweighted sound pressure (dB re 1 μPa).
A dash indicates that distances could not be calculated because thresholds were not reached.

a NMFS recommended criteria adopted from the Fisheries Hydroacoustic Working Group (FHWG 2008).
c Popper et al. (2014).
Source: Summarized from Tables 39 – 44 in Limpert et al. (2022)
Mayflower Wind would implement measures to avoid, minimize, and mitigate impacts of pile-driving noise on fish, including using soft-start procedures and implementing seasonal work windows that avoid construction during periods when sensitive species and life stages would be present in the Project area. With these measures in place, injuries to fish are expected to be minimal. While some fish are expected to experience behavioral effects within the ensonified area, these effects would be temporary, as fish are expected to resume normal behaviors following the completion of pile driving (Jones et al. 2020; Shelledy et al. 2018). Impacts from injurious sound are expected to be short term and localized.

Atlantic sturgeon individuals present in the area will likely occur intermittently, moving through the Lease Area throughout their spring and fall migrations and may forage opportunistically in areas where benthic invertebrates are present. The area is not known to be a preferred foraging area and has not been identified as an aggregation area which reduced the potential for impact on this species from impact pile driving noise. Given the dispersed distribution of Atlantic sturgeon in the Lease Area, the potential for co-occurrence in time and space is considered extremely unlikely to occur given the small area where exposure to peak noise could occur and is therefore **discountable**. The effects of noise exposure from Project impact pile driving leading to physiological injury **may affect**, but are **not likely, to adversely affect** ESA-listed Atlantic sturgeon.

As stated above, the potential for Atlantic sturgeon to be present in the Lease Area is considered possible but would occur intermittently since no preferred foraging areas or aggregation areas have been identified in the Lease Area. Therefore, Atlantic sturgeon could be exposed to noises above behavioral threshold and may avoid the area, however, avoidance of preferred foraging areas and accessing of spawning or overwintering areas would not occur, and only cessation of opportunistic foraging areas during migration period is expected. Should an exposure occur, it would be temporary with effects dissipating once the activity had ceased or the individual had left the area. Potential effects would be brief (e.g., Atlantic sturgeon may approach the noisy area and divert away from it), and any effects from this brief exposure would be extremely unlikely to effect Atlantic sturgeon (**discountable**). Therefore, the effects of noise exposure from Project impact pile driving leading to TTS/behavioral disturbance **may affect**, but are **not likely, to adversely affect** ESA-listed Atlantic sturgeon.

### 5.2.2 Geotechnical and Geophysical Surveys

Geotechnical and geophysical (G&G) surveys for the Proposed Action would occur prior to installation of offshore cables and during the O&M phase of the Project (Section 3.1.2.7). Such surveys can generate high-intensity, impulsive or continuous noise that has the potential to result in physiological or behavioral effects in aquatic organisms. G&G surveys for the Proposed Action include HRG surveys. Compared to other G&G survey equipment, HRG survey equipment produces less-intense noise and operates in smaller areas.

#### 5.2.2.1 Marine Mammals

Geotechnical and geophysical survey noise may affect marine mammals through auditory injuries, stress, disturbance, and behavioral responses. Representative geophysical survey equipment that may be used by Mayflower Wind that reflects the largest horizontal impact distances in marine mammals are shown in Table 5.2-11.
Table 5.2-11. Summary of Level A (SEL<sub>cum</sub>) and Level B (SLP<sub>rms</sub>) horizontal impact distances

<table>
<thead>
<tr>
<th>Equipment</th>
<th>System</th>
<th>Level A horizontal impact distance (m) for LFC</th>
<th>Level A horizontal impact distance (m) for MFC</th>
<th>Level B horizontal impact distance (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>L&lt;sub&gt;pk&lt;/sub&gt; &amp; LE</td>
<td>L&lt;sub&gt;pk&lt;/sub&gt; &amp; LE</td>
<td></td>
</tr>
<tr>
<td>Sparker</td>
<td>SIG ELC 820 @ 750 J</td>
<td>-</td>
<td>1</td>
<td>&lt; 1</td>
</tr>
<tr>
<td>Sub-bottom profiler</td>
<td>Teledyne Benthos Chirp III</td>
<td>-</td>
<td>2</td>
<td>&lt; 1</td>
</tr>
<tr>
<td>Boomer</td>
<td>Applied Acoustics S-boom @ 700 J</td>
<td>-</td>
<td>&lt; 1</td>
<td>1</td>
</tr>
</tbody>
</table>

*"–" Indicates the HRG equipment source level is below the relevant threshold level

LFC = low frequency cetacean group; MFC = mid-frequency cetacean group; m = meters

Due to the range of frequencies emitted during HRG surveys, masking is considered possible in all functional hearing groups. It is, however, unlikely to occur due to the directionality (i.e., energy is pointed downwards) of the signals for most HRG survey equipment and the brief period when an individual mammal may be within its beam (NOAA 2021). Masking of LFC communications is considered more likely due to the overlap of these surveys with lower-frequency signals produced by these species. Masking of high-frequency echolocation clicks used by MFCs and HFCs is not anticipated; however, some masking of other communication used by these species is possible. Due to the number of survey days expected for the Proposed Action, masking is considered moderate for LFCs and minor for all other functional hearing groups. PTS could occur if marine mammals are close to survey activities. However, HRG survey equipment is unlikely to result in injury given that sound levels diminish rapidly with distance from the survey equipment (BOEM 2018). The Project’s LOA will include mitigation measures for HRG survey activities when operating equipment that produces sound within marine mammals’ hearing range (i.e., less than 180 kHz) (Section 3.3).

During HRG surveys, 1,640-foot (500-meter) monitoring zones for baleen whales, and 328-foot (100-meter) monitoring zones for other marine mammals would be used 30 minutes prior to noise-producing survey activities. Any marine mammals observed in these zones would pause the 30-minute observation period, which would resume only after confirmation from the observer that the animal has left the area. If the animal dives or visual contact is lost, the 30-minute observation period is reset (BOEM 2021c). During survey activities, 656-foot (200-meter) shutdown zones for baleen whales and 328-foot (100-meter) shutdown zones for all other marine mammals would be established. Observed animals occurring within these ranges would prompt a shutdown of boomers or sparkers until the animal leaves the area (BOEM 2021d).

These measures require the use of PSOs to monitor and enforce clearance and shut down zones around HRG survey activities and utilization of ramp-up procedures prior to commencement of survey activities, further reducing the likelihood of marine mammal injury. Any behavioral impacts on individual ESA-listed marine mammals associated with G&amp;G surveys for the Proposed Action would be temporary and are not expected to result in stock or population-level effects.

During construction, no PTS exposures are expected for any ESA-listed species during HRG surveys, thus there is no effect. The largest distance to a PTS threshold from a sparker, sub-bottom profiler, or boomer source for low frequency cetaceans is less than 10 m (33 ft). The largest modeled distance to the behavior harassment threshold was 141 m (463 ft) from a sparker. Although a sparker may not be used at all times during HRG surveys, this distance was used in calculating the area exposed to sounds above 160 dB SPL<sub>rms</sub> for all HRG survey activity. This was done by assuming an average of 80 km (50 mi) of survey...
activity would be completed daily by each survey vessel when active. A 141 m (463 ft) perimeter around 80 km (50 mi) of survey line was calculated to estimate a daily ensonified area of 22.6 km² (8.7 mi²).

During construction, it is estimated that 4,000 km (2,485.5 mi) of HRG surveys will occur within the Lease Area and 5,000 km (3,106.8 mi) will occur along the ECCs. Assuming 80 km (50 mi) is surveyed per day, that results in 50 days of survey activity in the Lease Area and 62.5 days of survey activity along the ECCs. Multiplying the daily ensonified area by the number of days of survey activity within each area results in a total ensonified area of 1,130 km² (702.1 mi²) in the Lease Area and 1,412.5 km² (877.7 mi²) along the ECCs.

HRG surveys will be carried out on a routine basis during the 3 years following the first 2 years of construction, which is termed the “operations phase” in the Project’s ITR (LGL 2022). This 3-year period differs from the operations and maintenance (O&M) phase of the Project that will follow for the remaining life of the Project. On an annual basis during construction operations period, it is estimated that 2,800 km (1,739.8 mi) of HRG surveys will occur within the Lease Area and 3,200 km (1,988.4 mi) will occur within the ECCs. Assuming 80 km (50 mi) is surveyed per day results in 35 days of survey activity in the Lease Area and 40 days of survey activity with the ECCs each year. Multiplying the daily ensonified area by the number of days of survey activity within each area results in an annual ensonified area of 791 km² (491.5 mi²) in the Lease Area and 904 km² (561.7 mi²) with the ECCs. Over the three years of construction operations that would occur during the five-year period covered by the requested regulations, the total ensonified area in the Lease Area would be 2,373 km² (1,474.5 mi²) and within the ECCs would be 2,712 km² (1,685.2 mi²).

Based on the mitigation and monitoring measures presented and discussed Section 3.3, the potential for exposure of these ESA-listed species to noise levels leading to behavioral disruption would be reduced at the level of the individual animal and would not be expected to have population level effects. The estimated exposure for ESA-listed whales is shown in Table 5.2-12. The greatest annual Level A exposure during the early construction is 1.8 for NARW in the Lease Area, with the highest total Level B exposure of 7 NARWs. Over the 3-year construction operations phase, up to 15 NARWs may be exposed to levels of sound inducing behavioral effects. Given these low numbers of potential exposures overall, the effects of noise exposure from Project HRG surveys leading to behavioral disturbance and masking may affect, not likely to adversely affect ESA-listed marine mammals.

**Table 5.2-12. Estimated Level B exposures for ESA-listed marine mammals during the 5-year period in mean number of individuals**

<table>
<thead>
<tr>
<th>Species</th>
<th>Construction Phase Take by Survey Area—Year 1</th>
<th>Construction Phase Take by Survey Area—Year 2</th>
<th>Total Density-based Exposure Estimates</th>
<th>PSO Data Exposure Estimate</th>
<th>Mean Group Size</th>
<th>Total Level B Take</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue whale</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>-</td>
<td>1.0</td>
<td>1</td>
</tr>
<tr>
<td>Fin whale</td>
<td>1.5</td>
<td>0.7</td>
<td>3.6</td>
<td>5.3</td>
<td>1.8</td>
<td>6</td>
</tr>
<tr>
<td>Sei whale</td>
<td>0.4</td>
<td>0.2</td>
<td>1.1</td>
<td>1.4</td>
<td>1.6</td>
<td>2</td>
</tr>
<tr>
<td>NARW</td>
<td>1.8</td>
<td>1.9</td>
<td>6.3</td>
<td>-</td>
<td>2.4</td>
<td>7</td>
</tr>
<tr>
<td>Sperm whale</td>
<td>0.3</td>
<td>0.1</td>
<td>0.7</td>
<td>0.4</td>
<td>1.5</td>
<td>2</td>
</tr>
</tbody>
</table>
### 5.2.2.2 Sea Turtles

Noise from G&G surveys has the potential to affect sea turtles through auditory injuries, stress, disturbance, and behavioral responses. However, PTS is considered unlikely, as sea turtles are expected to avoid survey activities and survey vessels would travel quickly (NSF and USGS 2011).

G&G surveys that use non-impulsive sources are not expected to affect sea turtles because they operate at frequencies above the sea turtle hearing range (e.g., multibeam echosounders, side scan sonar). BOEM (2021) evaluated potential underwater noise effects on sea turtles from G&G surveys using impulsive sources (e.g., boomers, bubble guns, air guns, sparkers, etc.) and concluded that for an individual sea turtle to experience a behavioral response threshold of SPL greater than 175 dB re 1 µPa, it would have to be within 90 meters of a sparker or the loudest G&G sound source. In fact, NMFS (2021) states that none of the equipment being operated for HRG surveys—with frequencies that overlap with sea turtles’ hearing—has source levels loud enough to result in permanent PTS. However, noise from impulsive sources used during HRG surveys could exceed the behavioral effects threshold (SPL: 175 dB re 1 µPa) up to 90 meters from the source, depending on the type of equipment used. Given the limited extent of potential noise effects, injury-level exposure (PTS) is unlikely to occur.

Based on expected sea turtle avoidance, the speed of the survey vessels, and the lower noise levels and smaller operational scales of G&G survey equipment, G&G surveys associated with the Proposed Action are unlikely to result in injury of any ESA-listed sea turtles in the Action Area. Should an exposure occur, the potential effects would be brief (e.g., a sea turtle may approach the noisy area and divert away from it), and any effects to this brief exposure would be so small that they could not be measured, detected, or evaluated and are therefore insignificant.

The developer’s proposed mitigation for HRG surveys includes pre-clearance and shutdown zones, and ramp-up procedures (Section 3.3). Pre-clearance and shutdown zones for sea are 100 meters and would capture the PTS zone of influence. Monitoring of this zone for sea turtles is considered highly effective in mitigating PTS effects. With the application of developer proposed mitigation, the potential for ESA-listed sea turtles to be exposed to noise above PTS thresholds is considered extremely unlikely to occur and is discountable. Therefore, the effects of noise exposure from Project HRG surveys leading to PTS may affect, not likely to adversely affect ESA-listed sea turtles.

As the source level assumed for HRG surveys could exceed the behavioral thresholds for sea turtles (e.g., 175 dB re 1 µPa) behavioral disturbance is considered possible. It is likely that the pre-clearance zone (e.g., 100 m) would cover the behavioral disturbance zone of influence. In addition, the effects are transient and would dissipate as the vessel move away from the receiver (e.g., turtle). With the application of monitoring measures and the transient nature of the effect, the potential for behavioral exposure to

<table>
<thead>
<tr>
<th>Species</th>
<th>LA</th>
<th>ECC</th>
<th>Annual Total Density-based Exposure Estimates</th>
<th>Annual PSO Data Exposure Estimate</th>
<th>Highest Annual Level B Exposure</th>
<th>3-Year Level B Exposure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue whale</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>-</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Fin whale</td>
<td>1.8</td>
<td>0.7</td>
<td>2.5</td>
<td>3.6</td>
<td>4</td>
<td>12</td>
</tr>
<tr>
<td>Sei whale</td>
<td>0.5</td>
<td>0.3</td>
<td>0.7</td>
<td>0.9</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>NARW</td>
<td>2.1</td>
<td>2.1</td>
<td>4.2</td>
<td>-</td>
<td>5</td>
<td>15</td>
</tr>
<tr>
<td>Sperm whale</td>
<td>0.4</td>
<td>0.1</td>
<td>0.5</td>
<td>0.3</td>
<td>2</td>
<td>6</td>
</tr>
</tbody>
</table>
ESA-listed turtles is considered extremely unlikely to occur and is insignificant. Therefore, the effects of noise exposure from Project HRG surveys leading to behavioral disturbance may affect, not likely to adversely affect ESA-listed sea turtles.

5.2.2.3 Fish

Seismic noise from G&G surveys has been shown to create varying behavioral responses in fish. These responses in fishes have been documented but careful evaluations of their impacts and examinations of physiological injury are lacking (Carroll et al. 2016). Given that HRG survey equipment produces less-intense noise, HRG surveys for the Proposed Action are not expected to exceed the threshold for injury to finfish. Behavioral impacts on Atlantic sturgeon from Project-related G&G surveys would be localized and temporary.

During HRG survey activities, finfish and invertebrates close to sparkers and boomers may experience short-term and very localized impacts that could include displacement. These impacts would be highly localized around the sound source and would be short-term in duration. Finfish and invertebrates in the general area but not in the immediate vicinity of the sound source could experience short-term stress and temporary behavioral changes in a larger area affected by the sound.

Considering the relatively small injury zones, the implementation of ramp-up procedures and the transient nature of the effect, the potential for Atlantic sturgeon to be exposed to noise sources above physiological thresholds is considered extremely unlikely to occur and is discountable. Therefore, the effects of noise exposure from Project HRG surveys leading to physiological injury may affect, not likely to adversely affect ESA-listed Atlantic sturgeon.

Effects to this brief exposure could result in displacement of opportunistic feeding areas however any impacts associated with this avoidance would be so small that they could not be measured, detected, or evaluated and are therefore insignificant. Therefore, the effects of noise exposure from Project HRG surveys leading to behavioral disturbance may affect, not likely to adversely affect ESA-listed Atlantic sturgeon.

5.2.3 Cable Laying

Noise-producing activities associated with cable laying during construction include route identification surveys, trenching, jet plowing, backfilling, and installation of cable protection. Modeling based on noise data collected during cable laying operation in Europe estimates that underwater noise levels would exceed 120 decibels referenced to 1 microPascal in a 98,842-acre (400-square kilometer) area surrounding the source (Bald et al. 2015; Nedwell and Howell 2004; Taormina et al. 2018); the affected area associated with cable-laying activities is expected to be smaller than those modeled for other activities, including pile driving and G&G surveys. As the cable-laying vessel and equipment would be continually moving, the ensonified area would also move. Given the mobile nature of the ensonified area, a given location would not be ensonified for more than a few hours.

5.2.3.1 Marine Mammals

Foraging cetaceans are not expected to interrupt foraging activity when exposed to cable-laying noise but may forage less efficiently due to increased energy spent on vigilance behaviors (NMFS 2015). Decreased foraging efficiency could have short-term metabolic effects resulting in physiological stress, but these effects would dissipate once the prey distribution no longer overlaps the mobile ensonified area. Given the mobile nature of the ensonified area and associated temporary ensonification of a given habitat area, it is unlikely that cable-laying noise would result in adverse effects on ESA-listed marine mammals.
For example, during a similar type of underwater construction activity, Robinson et al. (2011) measured sound levels radiated from marine aggregate dredgers, mainly trailing suction hopper dredges during normal operation. Robinson et al. (2011) concluded that because of the operation of the propulsion system, noise radiated at less than 500 Hz, which is similar to that of a merchant vessel “traveling at modest speed (i.e., between 8 and 16 knots)” for self-propelled dredges. During dredging operations, additional sound energy generated by the impact and abrasion of the sediment passing through the draghead, suction pipe, and pump, is radiated in the 1 to 2 kHz frequency band. These acoustic components would not be present during cable laying operations, so these higher frequency sounds are not anticipated. Additionally, field studies conducted offshore New Jersey, Virginia, and Alaska show that noise generated by using vibracores and drilling boreholes diminishes below the National Marine Fisheries Service (NMFS) behavioral response thresholds (120 dB for continuous sound sources) relatively quickly and is unlikely to cause harassment to marine mammals (Reiser et al. 2010, 2011, TetraTech 2014).

Based on the mitigation measures presented and discussed (Section 3.3) the potential for exposure of these ESA-listed marine mammals to noise levels leading to behavioral disruption would be reduced at the level of the individual animal and would not be expected to have population level effects. As discussed above, NARW, fin whales and sei whales, may be exposed to noise above the behavioral thresholds depending on the type of the vessel and equipment used for cable laying operations. However, given the interim definition for ESA harassment, the animal’s ability to avoid harmful noises, and the established mitigation and monitoring measures being proposed (including vessel separation distances), the potential for ESA-listed marine mammals to be exposed to underwater noise exceeding behavioral disruption thresholds from cable laying operations would not rise to the level of take under the ESA is, therefore, considered insignificant. Therefore, the effects of noise exposure from Project cable laying and trenching operations leading to behavioral disturbance and masking may affect, not likely to adversely affect ESA-listed marine mammals.

5.2.3.2 Sea Turtles

As previously noted, the ensonified area associated with cable laying would be dynamic, and a given location would not be ensonified for more than a few hours. Any behavioral effects would be temporary, dissipating once the turtle is outside of the ensonified area. Therefore, it is unlikely that cable-laying noise would result in adverse effects on ESA-listed sea turtles.

If dredging occurs in one area for relatively long periods, behavioral thresholds are possible. There is very little information regarding the behavioral responses of sea turtles to underwater noise. Behavioral responses to vessel noise include avoidance behavior but only at very close range (10 m; Hazel et al. 2007). Popper et al. (2014) suggest that in response to continuous sounds, sea turtles have a high risk for behavioral disturbance in the near field (e.g., tens of meters), moderate risk in the intermediate field (hundreds of meters) and low risk in the far field (thousands of meters). The potential risk for injury is considered low at all distances for continuous noise (Popper et al. 2014).

Cable-laying noise sources associated with the Proposed Action were below the established PTS injury thresholds for all marine mammal hearing groups as outlined above. As turtles have a more reduced frequency range than marine mammals, it can be inferred that the potential for ESA-listed sea turtles to be exposed to noise above PTS thresholds from cable laying is extremely unlikely to occur and is discountable. Therefore, the effects of noise exposure from Project cable laying operations leading to PTS may affect, not likely to adversely affect ESA-listed sea turtles.

Behavioral effects are considered possible but would be temporary with effects dissipating once the activity has ceased or individual has left the area. Should an exposure occur, the potential effects would be brief (e.g., a sea turtle may approach the noisy area and divert away from it), and any effects to this
brief exposure would be so small that they could not be measured, detected, or evaluated and are therefore **insignificant**. Therefore, the effects of noise exposure from Project dredging operations leading to behavioral disturbance **may affect, not likely to adversely affect** ESA-listed sea turtles.

### 5.2.3.3 Fish

Noise levels associated with cable laying may cause temporary stress and behavioral changes in finfish in the ensonified area but are insufficient to pose a risk of injury or mortality. Because the cable-laying vessel and equipment would be continually moving and the ensonified area would move with it, any behavioral responses to cable-laying noise are expected to be temporary and localized. No significant impacts on ESA-listed Atlantic sturgeon are expected from noise generated by cable-laying activities.

The action of laying the cables on the seafloor itself is unlikely to generate high levels of underwater noise. Most of the noise energy would originate from the vessels themselves including propeller cavitation noise and noise generated by onboard thruster/stabilization systems and machinery (e.g., generators), including noise emitted by the tugs when moving the anchors.

There is limited information regarding underwater noise generated by cable-laying and burial activities in the literature. Johansson and Andersson (2012) recorded underwater noise levels generated during a comparable operation involving pipelaying and a fleet of nine vessels. Mean noise levels of 130.5 dB re 1 µPa were measured at 1,500 meters from the source. Reported noise levels generated during a jet trenching operation provided a source level estimate of 178 dB re 1 µPa measured at 1 meter from the source (Nedwell et al. 2003).

It is unlikely that received levels of underwater noise from cable-laying operations would exceed physiological injury thresholds for Atlantic sturgeon since the animals would move away from any noise that could result in injury. Thus, the potential for ESA-listed Atlantic sturgeon to be exposed to noise above physiological injury thresholds is considered extremely unlikely to occur and is **insignificant**. Therefore, the effects of noise exposure from Project cable-laying operations leading to physiological injury **may affect, not likely to adversely affect** ESA-listed Atlantic sturgeon.

Behavioral effects are considered possible but would be temporary with effects dissipating once the activity has ceased or individual has left the area. Should an exposure occur, the potential effects would be brief (e.g., Atlantic sturgeon may approach the area and divert away from it), and any effects to this brief exposure would be so small that they could not be measured, detected, or evaluated and are therefore **insignificant**. Therefore, the effects of noise exposure from Project dredging operations leading to behavioral disturbance **may affect, not likely to adversely affect** ESA-listed Atlantic sturgeon.

### 5.2.4 Dredging

Dredging is not anticipated for the interarray cable installation. For the export cable installation, dredging is anticipated for the purpose of seabed preparation (sand wave clearance) within five percent of the Falmouth ECC (associated with the Muskeget Channel and Nantucket Sound). Sand wave clearance would be accomplished with a trailing suction hopper dredger or water injection dredge (both hydraulic dredge types) (Section 3.1.2.4.2). Dredging is also expected at HDD offshore exit pits at landfall locations within the Falmouth ECC and Brayton Point ECC. In addition, dredging would also occur as part of seabed preparation of any foundation type and would be accomplished with trailing suction hopper dredgers (hydraulic), cutter suction dredgers (hydraulic), or mechanical dredging vessels (Section 3.1.2.3.2).

Mechanical clamshell dredging refers to grabs used to remove seafloor material. Noise produced by mechanical dredges is emitted from winches and derrick movement, bucket contact with the substrate, digging into substrate, bucket closing, and emptying of material into a barge or scow (Dickerson et al.
2001). Reported sound levels of clamshell dredges include 176 dB re 1 μPa Lrms (BC MoTI 2016) and 107 to 124 dB re 1 μPa at 505 feet (154 meters) from the source with peak frequencies of 162.8 Hz (Dickerson et al. 2001; McQueen et al. 2019). Maximum levels occurred when the dredge bucket made contact with the channel bottom in mixed coarse sand or gravel (Dickerson et al. 2001; McQueen et al. 2019). Hydraulic trailing suction hopper dredging and controlled-flow excavation dredging involve the use of a suction to either remove sediment from the seabed or relocate sediment from a particular location on the seafloor. The sound produced by hydraulic dredging results from the combination of sounds generated by the impact and abrasion of the sediment passing through the draghead, suction pipe, and pump. The frequency of the sounds produced by hydraulic suction dredging ranges from approximately 1 to 2 kilohertz, with reported source levels of 172 to 190 dB re 1 μPa at 3.3 feet (1 meter) (Robinson et al. 2011; Todd et al. 2015; McQueen et al. 2019). Robinson et al. (2011) noted that the level of broadband noise generated by suction dredging is dependent on the aggregate type being extracted, with coarse gravel generating higher noise levels than sand.

5.2.4.1 Marine Mammals

Based on the available source level information presented above, dredging by mechanical or hydraulic dredges is unlikely to exceed ESA-listed marine mammals PTS thresholds and therefore there is no effect. If dredging occurs in one area for relatively long periods, behavioral thresholds could be exceeded along with masking of marine mammal communications (Todd et al. 2015; NMFS 2018a).

Based on the available source level information presented above, dredging by mechanical or hydraulic dredges and if dredging occurs in one area for relatively long periods, behavioral thresholds could be exceeded along with masking of marine mammal communications.

Behavioral responses of marine mammals to dredging activities have included avoidance in bowhead whales, gray whales, minke whales, and gray seals (Bryant et al. 1984; Richardson et al. 1990; Anderwald et al. 2013). Diederichs et al. (2010) found short-term avoidance of dredging activities by harbor porpoises near breeding and calving areas in the North Sea. Pirotta et al. (2013) found that, despite a documented tolerance of high vessel presence, as well as high availability of food, bottlenose dolphins spent less time in the area during periods of dredging. The study also showed that with increasing intensity in the activity, bottlenose dolphins avoided the area for longer durations (with one instance being as long as 5 weeks; Pirotta et al. 2013).

Dredging that will occur in the Project area based on the above data would likely not extend into the Nantucket Shoals, the area where the greatest densities of ESA-listed marine mammals are found. Timing of NARW migrations includes a norward migration during March to April and a southward migration during November to December between summer feeding and winter calving grounds. During this migration period adults may be accompanied by calves and periodically feed and rest along their migration route. Fin whales are present in the area year-round. Fin whales, sei whales, and blue whales generally prefer the deeper waters of the continental slope and more often can be found in water greater than 295 feet (90 meters) deep (Hain et al. 1985; Waring et al. 2011; Hayes et al. 2020). The nearshore dredging activities are less likely to interact with blue and sei whales as these species are rarely observed in nearshore waters. Based on the literature, avoidance of dredging activities by LFCs is possible. However, any behavioral effects would be expected to dissipate once the activity ceases or individual has left the area and is therefore considered temporary. The exact duration or number of dredging events required to support the Project are unknown at this time. Behavioral disturbance from dredging is not expected to impede the migration of NARWs to critical habitats located to the north and south of the Project area as animals would be able to travel in areas undisturbed by Proposed Action activities. LFCs would be expected to resume pre-exposure activities once the activity stopped or the animal moved out of the disturbance zone.
Masking of LFC communications is considered possible; however, the effects of masking would be temporary for the duration of the activity. The potential for communications to be masked from cable laying operations is therefore considered temporary and transient.

The energetic consequences of any avoidance behavior or masking effects and potential delay in resting or foraging are not expected to affect any individual’s ability to successfully obtain enough food to maintain their health or impact the ability of any individual to make seasonal migrations or participate in breeding or calving. Any TTS effects would be expected to resolve within a few days to a week of exposure and are not expected to affect the health of any individual whale or its ability to migrate, forage, breed, or calve. Any TTS effects would be expected to resolve within a few days to a week of exposure and are not expected to affect the health of any individual whale or its ability to migrate, forage, breed, or calve.

Based on the mitigation measures presented and discussed (Table 3.3-1) the potential for exposure of these ESA-listed marine mammals to noise levels leading to behavioral disruption would be reduced at the level of the individual animal and would not be expected to have population-level effects. As discussed above, NARWs, blue whales, fin whales, sei whales, and sperm whales may be exposed to noise above the TTS and behavioral thresholds during dredging operations. However, given the animals ability to avoid harmful noises and the established mitigation and monitoring measures proposed the potential for ESA-listed marine mammals to be exposed to underwater noise exceeding behavioral disturbance thresholds from dredging operations is considered insignificant. Therefore, the effects of noise exposure from Project dredging leading to behavioral disturbance may affect, not likely to adversely affect ESA-listed marine mammals.

5.2.4.2 Sea Turtles

Based on the available source level information presented above, dredging by mechanical or hydraulic dredges is unlikely to exceed turtle PTS (injury) thresholds for sea turtles. Exposure of noises above PTS, thresholds from Proposed Action dredging for all sea turtles is extremely unlikely to occur and is discountable. Therefore, the effects of noise exposure from Proposed Action dredging operations leading to PTS may affect, not likely to adversely affect ESA-listed sea turtles.

If dredging occurs in one area for relatively long periods, behavioral thresholds are possible. As outlined above, there is very little information regarding the behavioral responses of sea turtles to underwater noise. Behavioral responses to vessel noise include avoidance behavior but only at very close range (32 feet [10 meters]; Hazel et al. 2007). Popper et al. (2014) suggests that in response to continuous sounds, sea turtles have a high risk for behavioral disturbance in the near field (e.g., tens of meters), moderate risk in the intermediate field (hundreds of meters) and low risk in the far field (thousands of meters). The potential risk for injury and TTS is considered low at all distances for continuous noise (Popper et al. 2014).

Behavioral effects are considered possible but would be temporary with effects dissipating once the activity has ceased or individual has left the area. Should an exposure occur, the potential effects would be brief (e.g., a sea turtle may approach the noisy area and divert away from it), and any effects to this brief exposure would be so small that they could not be measured, detected, or evaluated and are therefore insignificant. Therefore, the effects of noise exposure from Project dredging operations leading to behavioral disturbance may affect, not likely to adversely affect ESA-listed sea turtles.

5.2.4.3 Fish

It is unlikely that received levels of underwater noise from dredging operations would exceed physiological injury thresholds for Atlantic sturgeon since the animals would move away from any noise that could result in injury. Thus, the potential for ESA-listed Atlantic sturgeon to be exposed to noise above physiological injury thresholds is considered extremely unlikely to occur and is discountable.
Therefore, the effects of noise exposure from Project dredging leading to physiological injury may affect, not likely to adversely affect ESA-listed Atlantic sturgeon.

If dredging occurs in one area for relatively long periods, behavioral thresholds are possible. As outlined above. Behavioral responses of fish to vessel noises include changes swim speeds, direction, or depth, avoidance and alterations of schooling behaviors.

Behavioral effects are considered possible but would be temporary with effects dissipating once the activity has ceased or individual has left the area. Should an exposure occur, the potential effects would be brief (e.g., Atlantic sturgeon may approach the area and divert away from it), and any effects to this brief exposure would be so small that they could not be measured, detected, or evaluated and are therefore insignificant. Therefore, the effects of noise exposure from Proposed Action dredging operations leading to behavioral disturbance may affect, not likely to adversely affect ESA-listed Atlantic sturgeon.

5.2.5 UXO Detonation

To capture a range of potential UXOs, five categories or “bins” of net explosive weight established by the U.S. Navy (2017) were selected for acoustic modeling (Table 5.2-13). The calculation of SEL and SPL levels is dependent on the entire pressure waveform, including the initial shock pulse and the subsequent oscillation of the gas bubble. The negative phase pressure troughs and bubble pulse peaks following the shock pulse are responsible for most of the low frequency energy of the overall waveform. The SEL and SPL thresholds for injury and disturbance occur at distances of many water depths in the relatively shallow waters of the Proposed Action. As a result, the sound field becomes increasingly influenced by the contributions of sound energy reflected from the sea surface and sea bottom multiples times. To account for this, the modeling was carried out in decibel frequency bands using the marine operation noise model (Marine Operations Noise Model, JASCO Applied Sciences). This model applied a parabolic equation approach for frequencies below 4 kHz and a Gaussian beam ray trace model at higher frequencies. In this location, sound speed profiles change little with depth, so these environments do not have strong seasonal dependence. The propagation modeling was performed using a sound speed profile representative of September, which is slightly downward refracting and therefore conservative, and also represents the most likely time of year for UXO removal activities.

Table 5.2-13. Navy “bins” and corresponding maximum charge weights (equivalent TNT) modeled

<table>
<thead>
<tr>
<th>Navy Bin Designation</th>
<th>Maximum Equivalent Weight (TNT) in Kilograms</th>
<th>Maximum Equivalent Weight (TNT) in Pounds</th>
</tr>
</thead>
<tbody>
<tr>
<td>E4</td>
<td>2.3</td>
<td>5.1</td>
</tr>
<tr>
<td>E6</td>
<td>9.1</td>
<td>20.0</td>
</tr>
<tr>
<td>E8</td>
<td>45.5</td>
<td>100.3</td>
</tr>
<tr>
<td>E10</td>
<td>227.0</td>
<td>500.5</td>
</tr>
<tr>
<td>E12</td>
<td>454.0</td>
<td>1000.9</td>
</tr>
</tbody>
</table>

In the case of potential UXO detonations, additional thresholds for mortality and non-auditory injury to lung and gastrointestinal organs from the blast shock wave and/or onset of high peak pressures are also relevant (at relatively close ranges). These criteria have been developed by the U.S. Navy (2017) and are based on the mass of the animal and the depth at which it is present in the water column. This means that specific decibel levels for each hearing group are not provided and instead the criteria are presented as equations that allow for incorporation of specific mass and depth values. A conservative equation is available reflecting the onset (1 percent chance) of experiencing the potential effects (Table 5.2-14). The results from the equations in Table 5.2-14 were used in the subsequent analyses.
Table 5.2-14. Thresholds for Onset Effects for Mitigation Consideration

<table>
<thead>
<tr>
<th>Onset Effect for Mitigation Consideration</th>
<th>Threshold</th>
</tr>
</thead>
<tbody>
<tr>
<td>Onset Mortality-Impulse</td>
<td>103M^{1/3}(1+D/10.1)^{1/6} Pa-s</td>
</tr>
<tr>
<td>Onset Injury-Impulse (Non-auditory)</td>
<td>47.5M^{1/3}(1+D/10.1)^{1/6} Pa-s</td>
</tr>
<tr>
<td>Onset Injury-Peak Pressure (Non-auditory)</td>
<td>237 dB re 1 µPa peak</td>
</tr>
</tbody>
</table>

5.2.5.1 Marine Mammals

To avoid times when sensitive marine mammal species are more likely to be present, UXO detonations are only planned to occur during the months from May through November. UXO detonations would not occur during the months from December through April. Since detonations would likely occur within a relatively short period of time (e.g. one month), using the annual average densities calculated for HRG surveys may underestimate the actual densities of some species during the month that detonations actually take place. Instead, the highest average monthly density for each species from May through November from within 15 km (9.3 mi) of the ECCs and Lease Area was selected and used in the estimates of potential exposures. The type and net explosive weight of UXOs that may be detonated are not known at this time. To capture a range of potential UXOs, five categories or “bins” of net explosive weight established by the U.S. Navy were selected for acoustic modeling (Table 5.2-13). Estimated exposures of ESA-listed species for UXO detonations are shown in Table 5.2-15.

Sound propagation away from detonations is affected by acoustic reflections from the sea surface and seabed. Water depth and seabed properties will influence the sound exposure levels and sound pressure levels at distance from detonations. Their influence is complex but can be predicted accurately by acoustic models. Such modeling was conducted at five sites that are part of the Mayflower Wind Project (two along the eastern ECC, one on the western ECC, and two in the Lease Area). The modeled water depths at each site range from 45-60 m in the Lease Area and 10-30 m in the two ECCs.

A noise attenuation system (NAS) similar to those described for monopile foundation installations is planned to be used during any UXO detonations. Use of a NAS is expected to achieve at least the same 10 dB of attenuation assumed for foundation installation. This is based on an assessment of UXO-clearance activity in European waters summarized by Bellmann and Betke (2021) and has been assumed in the estimated distances to thresholds summarized below.

Since the size and type of UXOs that may be detonated are currently unknown, all area calculations were made using the largest UXO size class (E12). The E12 ranges to Level A and Level B thresholds within the ECC were used as radii to calculate the area of a circle (π × r² where r is the range to the threshold level) for each marine mammal hearing group. The results represent the largest area potentially ensonified above threshold levels from a single detonation within the ECC and are shown in Table 5.2-16. The same method was used to calculate the maximum area potentially ensonified above threshold levels from a single detonation in the Lease Area as shown in the final column of last row of Table 5.2-16.

The ranges for mortality, lung, and gastrointestinal injury are short distances, the greatest distance is 242 m (Table 5.2-17) which is in the range of all mitigation shutdown measures for cetaceans, and would be a distance easily monitored by PSOs. It is unlikely that mitigation measures would fail to detect an ESA-listed cetacean at the time of detonation. Given the uncertainty of the type of UXO encountered, however, and the difficulty in monitoring the single detonation maximum areas for an E12 detonation for both Level A and Level B exposures (Table 5.2-15), ESA-listed marine mammals could be exposed to both Level A and Level B harassment which may affect, likely to adversely affect ESA listed marine mammals.
Table 5.2-15. Estimated Level A and Level B exposures from potential UXO detonations for construction years 1 and 2 assuming 10 dB of attenuation. ECC=Export Cable Corridor, LA=Lease Area

<table>
<thead>
<tr>
<th>Species</th>
<th>Estimated Level A and Level B take from UXO detonations</th>
<th>PSO Data Exposure Estimate</th>
<th>Mean Group Size</th>
<th>Total Level A Take</th>
<th>Total Level B Take</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Year 1</td>
<td>Year 2</td>
<td>Year 1</td>
<td>Year 2</td>
<td>Year 1</td>
</tr>
<tr>
<td></td>
<td>ECC</td>
<td>LA</td>
<td>ECC</td>
<td>LA</td>
<td>ECC</td>
</tr>
<tr>
<td>Blue whale</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Fin whale</td>
<td>0.3</td>
<td>0.8</td>
<td>6.2</td>
<td>6.3</td>
<td>0.2</td>
</tr>
<tr>
<td>NARW</td>
<td>0.5</td>
<td>0.6</td>
<td>4.9</td>
<td>5.0</td>
<td>0.3</td>
</tr>
<tr>
<td>Sei whale</td>
<td>0.2</td>
<td>0.3</td>
<td>2.5</td>
<td>2.6</td>
<td>0.1</td>
</tr>
<tr>
<td>Sperm whale</td>
<td>0.0</td>
<td>0.0</td>
<td>0.1</td>
<td>0.1</td>
<td>0.0</td>
</tr>
</tbody>
</table>

Table 5.2-16. Range to Level A and Level B exposure SEL PTS-onset and SEL TTS-onset thresholds in the ECC and Lease Area for LFC(183 dB re 1 µPa·s) and MFC (Sperm whale)( 185 dB re 1 µPa·s) for five UXO charge sizes assuming 10 dB of noise attenuation, and the maximum area exposed above this threshold

<table>
<thead>
<tr>
<th>Range per UXO Charge Size</th>
<th>ECC (LFC)</th>
<th>Lease Area (LFC)</th>
<th>ECC (MFC)</th>
<th>Lease Area (MFC)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Level A</td>
<td>Level B</td>
<td>Level A</td>
<td>Level B</td>
</tr>
<tr>
<td>E4 R95% Distance (km)</td>
<td>0.72</td>
<td>2.74</td>
<td>0.34</td>
<td>2.82</td>
</tr>
<tr>
<td>E6 R95% Distance (km)</td>
<td>1.46</td>
<td>4.45</td>
<td>0.78</td>
<td>4.68</td>
</tr>
<tr>
<td>E8 R95% Distance (km)</td>
<td>2.86</td>
<td>7.21</td>
<td>1.75</td>
<td>7.49</td>
</tr>
<tr>
<td>E10 R95% Distance (km)</td>
<td>4.16</td>
<td>10.30</td>
<td>3.33</td>
<td>10.50</td>
</tr>
<tr>
<td>E12 R95% Distance (km)</td>
<td>4.84</td>
<td>11.80</td>
<td>4.30</td>
<td>11.90</td>
</tr>
<tr>
<td>Single Detonation Maximum Area (km²)</td>
<td>73.60</td>
<td>437.40</td>
<td>58.10</td>
<td>444.90</td>
</tr>
</tbody>
</table>
Table 5.2-17. Ranges (m) to the onset of mortality, non-auditory lung injury, and gastrointestinal (GI) injury thresholds in the Lease Area and ECCs for five UXO size classes assuming 10 dB of noise attenuation for Baleen and Sperm whales. GI injury combines ECC and Lease Area, Calf/Pup and Adult. Thresholds are based on animal mass and submersion depth.

<table>
<thead>
<tr>
<th>Range per UXO Charge Size</th>
<th>Mortality</th>
<th>Non-Auditory Lung Injury</th>
<th>GI Injury</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ECC</td>
<td>Lease Area</td>
<td>ECC</td>
</tr>
<tr>
<td></td>
<td>Calf/Pup</td>
<td>Adult</td>
<td>Calf/Pup</td>
</tr>
<tr>
<td>E4 R95% Distance (m)</td>
<td>5</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>E6 R95% Distance (m)</td>
<td>6</td>
<td>5</td>
<td>17</td>
</tr>
<tr>
<td>E8 R95% Distance (m)</td>
<td>23</td>
<td>6</td>
<td>54</td>
</tr>
<tr>
<td>E10 R95% Distance (m)</td>
<td>69</td>
<td>22</td>
<td>153</td>
</tr>
<tr>
<td>E12 R95% Distance (m)</td>
<td>108</td>
<td>34</td>
<td>132</td>
</tr>
</tbody>
</table>
5.2.5.2 Sea Turtle

UXO detonations could generate high pressure levels that could cause disturbance and injury to sea turtles. The Falmouth ECC does not overlap any UXO areas or Formerly Used Defense Sites (USACE 2019; AECOM 2020). The Brayton Point ECC intersects one land-based FUDS that is listed as closed out and complete but extends out into the Sakonnet River (USACE 2019). During BOEM’s pre-screening process for the selection of the Massachusetts/Rhode Island Wind Energy Areas, the nearest UXO site was found 10 miles (16 kilometers) west of the Massachusetts/Rhode Island Wind Energy Area (BOEM 2013). A desktop study by Mayflower Wind of UXO in the Project area concluded that there is a varying Low to Moderate risk from encountering UXO on site. The risk is Moderate throughout all of the Lease Area, and a relatively equal ratio between Low and Moderate within the ECCs (Mayflower Wind 2022).

If an animal is exposed to an explosive blast underwater, the likelihood of injury depends on the charge size, the geometry of the exposure (distance to the charge, depth of the animal and the charge), and the size of the animal. In general, an animal would be less susceptible to injury near the water surface because the pressure wave reflected from the water surface would interfere with the direct path pressure wave, reducing positive pressure exposure. However, rapid under-pressure phase caused by the negative surface-reflected pressure wave above an underwater detonation may create a zone of cavitation that may contribute to potential injury. In general, blast injury susceptibility would increase with depth, until normal lung collapse (due to increasing hydrostatic pressure) and increasing ambient pressures again reduce susceptibility.

Primary blast injury is injury that results from the compression of a body exposed to a blast wave. This is usually observed as barotrauma of gas-containing structures (e.g., lung and gut) and structural damage to the auditory system (Greaves et al., 1943; Office of the Surgeon General, 1991; Richmond et al., 1973). The lungs are typically the first site to show any damage, while the solid organs (e.g., liver, spleen, and kidney) are more resistant to blast injury (Clark & Ward, 1943). Recoverable injuries would include slight lung injury, such as capillary interstitial bleeding, and contusions to the gastrointestinal tract. More severe injuries would significantly reduce fitness and likely cause death in the wild. Rupture of the lung may also introduce air into the vascular system, producing air emboli that can cause a stroke or heart attack by restricting oxygen delivery to critical organs. In this discussion, primary blast injury to auditory tissues is considered gross structural tissue injury distinct from noise-induced hearing loss.

Data on observed injuries to sea turtles from explosives is generally limited to animals found following explosive removal of offshore structures (Viada et al., 2008), which can attract sea turtles for feeding opportunities or shelter. Klima et al. (1988) observed a turtle mortality subsequent to an oil platform removal blast, although sufficient information was not available to determine the animal’s exposure. Klima et al. (1988) also placed small sea turtles (less than 7 kg) at varying distances from piling detonations. Some of the turtles were immediately knocked unconscious or exhibited vasodilation over the following weeks, but others at the same exposure distance exhibited no effects. Incidental impacts on sea turtles were documented for exposure to a single 1200-lb (540 kg) underwater charge off Panama City, FL in 1981. The charge was detonated at mid-depth in water 120 feet (37 m) deep. Although details are limited, the following were recorded: at a distance of 500-700 ft. (150-200 m), a 400 lb. (180 kg) sea turtle was killed; at 1200 ft. (370 m), a 200-300 lb. (90-140 kg) sea turtle experienced “minor” injury; and at 2000 ft. (600 m) a 200-300 lb. (90-140 kg) sea turtle was not injured (O’Keeffe & Young, 1984).

The potential for serious injury is minimized by the implementation of pre-clearance and shutdown zones that would facilitate a delay in detonations if sea turtles were observed approaching or within areas that could be ensonified above sound levels that could result in auditory and non-auditory injury (Table 3.3-1). These measures also make it unlikely that any sea turtles will be exposed to UXO detonations that would result in mortality and slight lung injury as well as severe hearing impairment or serious injury and—if
The potential for PTS exposure to these sea turtle species is considered extremely unlikely to occur and is discountable. Therefore, the effects of noise exposure from Project UXO detonations leading to PTS/mortality/slight lung injury/gastrointestinal injury may affect, not likely to adversely affect ESA-listed sea turtles.

Reactions of sea turtles to explosives is absent from the literature. Finneran et al. (2017) assumed that sea turtles are likely to exhibit no more than a brief startle response to any individual explosive. Avoidance of the area is only considered likely if the event includes multiple explosives events. Popper et al. (2014) suggest that in response to explosions, sea turtles have a high risk for behavioral disturbance in the near and intermediate fields (e.g., tens of meters and hundreds of meters respectively), and low risk in the far field (thousands of meters). The risk for TTS and other recoverable injuries were considered high in near and intermediate fields, and low in the far field (Popper et al. 2014).

Should an exposure occur, the potential effects would be brief (e.g., a single noise exposure and the sea turtle would react to it), and any effects to this brief exposure would be so small that they could not be measured, detected, or evaluated and are therefore insignificant. Therefore, the effects of noise exposure from Project UXO detonations leading to TTS/behavioral disturbance may affect, not likely to adversely affect, ESA-listed sea turtles.

### 5.2.5.3 Fish

Injury to fish from exposures to blast pressure waves is attributed to compressive damage to tissue surrounding the swim bladder and gastrointestinal tract, which may contain small gas bubbles. Effects of detonation pressure exposures to fish have been assessed according to the Lpk limits for onset of mortality or injury leading to mortality due to explosives, as recommended by the American National Standards Institute (ANSI) expert working group (Popper et al. 2014) and provided in Table 5.2-18. The injurious effects thresholds for all fish species groups are the same: $L_{pk} = 229–234 \text{ dB re 1 } \mu \text{Pa}$. The present assessment has applied the lower range value of $L_{pk} = 229 \text{ dB re 1 } \mu \text{Pa}$ for potential mortal injury and mortality.

**Table 5.2-18. Effects of detonation pressure exposures**

<table>
<thead>
<tr>
<th>Type of Animal</th>
<th>Mortality and potential mortal injury</th>
<th>Recoverable injury</th>
<th>TTS</th>
<th>Masking</th>
<th>Behavior</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fish where swim bladder is not involved in hearing (particle motion detection)</td>
<td>229-234 dB</td>
<td>(Near field) High (Intermediate field) High (Far field) Low</td>
<td>(Near field) High (Intermediate field) Moderate (Far field) Low</td>
<td>NA</td>
<td>High (Intermediate field) High (Far field) Low</td>
</tr>
</tbody>
</table>

Reaction of fish to explosives is absent from the literature. Finneran et al. (2017) assume that sea turtles are likely to exhibit no more than a brief startle response to any individual explosive, which is likely similar to fish. Avoidance of the area is only considered likely if the event includes multiple explosives events, which is not part of the Proposed Action. Popper et al. (2014) suggest that in response to explosions, Atlantic sturgeon have a high risk for behavioral disturbance in the near and intermediate
fields (e.g., tens of meters and hundreds of meters respectively), and low risk in the far field (thousands of meters). The risk for TTS was considered high in near, moderate in the intermediate fields, and low in the far field. Recoverable injuries were considered high in near and intermediate fields, and low in the far field (Popper et al. 2014; Table 5.2-18).

The Project area has variable rates of Atlantic sturgeon bycatch with most bycatch near the northern portion of the Brayton Point ECC, and no bycatch recorded in the Falmouth ECC or Lease Area from 1989 to 2000 (Stein et al. 2004a). This suggests that most of the Project area has a low abundance of Atlantic sturgeon, further supported by the fact that one of the most impacted fisheries (Otter trawl targeting longfin squid) (NMFS 2022a,b) is one of the main gear types that fishes in the Project area and is one of the main gears associated with the bycatch of Atlantic sturgeon (Stein et al. 2004a), which further bolsters the idea that Atlantic sturgeon are not prevalent in the Project area. Further, most of the area, where bycatch rates are high for Atlantic sturgeon, have a low risk of encountering a UXO (Figure 3.1-15).

Given the dispersed distribution of Atlantic sturgeon in the Project area, the potential for co-occurrence in time and space is considered unlikely but possible. The developer is not planning to monitor for Atlantic sturgeon prior to detonations but has committed to the implementation of NAS during all detonation events. This, coupled with the unlikely detonation of UXO, the low number of potential detonations required for the Proposed Action (unknown, but modeled for no more than 10), and the commitment to a NAS, further reduces the potential for exposure to Atlantic sturgeon and is discountable, and not likely to adversely affect Atlantic sturgeon.

5.2.6 Summary of Underwater Noise Effects

5.2.6.1 Marine Mammals

Noise associated with vibratory pile driving, G&G surveys, and cable laying for the Proposed Action are not expected to result in injury of ESA-listed marine mammals based on the source levels or small ranges to injury thresholds. Therefore, the risk of injury associated with these noise sources is discountable. Impact pile driving has the potential to cause injury in ESA-listed marine mammals. However, the mitigation measures described in Section 3.3 and summarized in this section are expected to minimize injury risk for ESA-listed marine mammals. Impact pile driving, vibratory pile driving, G&G surveys, UXO detonations, and cable laying could all result in behavioral effects on ESA-listed marine mammals. These effects would be temporary but could occur over relatively large distances for some noise sources.

5.2.6.2 Sea Turtles

Noise associated with vibratory pile driving, G&G surveys, and cable laying for the Proposed Action are not expected to result in injury of ESA-listed sea turtles based on the source levels or small ranges to injury thresholds. Therefore, the risk of injury associated with these noise sources is discountable. Impact pile driving has the potential to cause injury in ESA-listed sea turtles. However, the mitigation measures described in Section 3.3 and summarized in this section, specifically the use of noise mitigation systems or techniques that achieve a 10-decibel reduction in sound levels, would make the risk of sea turtle injury associated with impact pile driving discountable. Impact pile driving, vibratory pile driving, G&G surveys, and cable laying could all result in behavioral effects on ESA-listed sea turtles. These effects would be temporary but could occur beyond a localized area for impact pile driving.

5.2.6.3 Fish

Noise associated with vibratory pile driving, G&G surveys, and cable laying for the Proposed Action are not expected to result in injury of ESA-listed fish species based on the source levels or small ranges to injury thresholds. Therefore, the risk of injury associated with these noise sources is discountable. Impact
pile driving has the potential to cause injury in ESA-listed fish species. However, the mitigation measures described in Section 3.3 and summarized in this section (e.g., soft start procedures) are expected to minimize injury risk for this species. Impact pile driving, vibratory pile driving, G&G surveys, and cable laying could all result in behavioral effects on ESA-listed fish species. These effects would be temporary but could occur over relatively large distances during impact pile driving.

5.3 Other Noise Impacts

In addition to the activities evaluated in Section 5.2, the Proposed Action includes other noise sources that have the potential to affect aquatic species during construction, O&M, and decommissioning. These additional noise sources would include vessels (Section 5.3.1), helicopters and drones (Section 5.3.2), and WTGs (Section 5.3.3). Following the assessment of these noise sources, a summary of overall noise effects to ESA-listed species is provided (Section 5.3.4).

5.3.1 Vessels

The Proposed Action includes the use of vessels during construction, O&M, and decommissioning, as described in Section 3.1.2.6. Vessels generate low-frequency (10 to 100 Hz) (MMS 2007), continuous noise that could affect aquatic species. There are several types of vessels that would be required throughout the life of the Project. Table 3.1-13 and Table 3.1-14 outlines the type of vessels that would be required for Project construction and operations as well as the maximum number of vessels required by vessel type. The size of these vessels range from 325 to 350 feet (99 to 107 meters) in length, from 60 to 100 feet (18 to 30 meters) in beam, and draft from 16 to 20 feet (5 to 6 meters). Source levels for large vessels range from 177 to 188 dB re 1 μPa SPLrms with frequencies between less than 40 Hz and 100 Hz (McKenna et al. 2012). Smaller support vessels typically produce higher-frequency sound concentrated in the 1,000 Hz to 5,000 Hz range, with source levels ranging from 150 to 180 dB re 1 μPa SPLrms (Kipple 2002; Kipple and Gabriele 2003).

5.3.1.1 Marine Mammals

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

A comprehensive review of the literature indicates no direct evidence of hearing impairment (either PTS or TTS) occurring in marine mammals as a consequence of exposure to vessel-generated sound. Adverse effects are more likely to be linked to behavior and acoustic communication. Research has demonstrated that vessel sound can elicit behavioral reactions in marine mammals and potentially result in masking of their communication space (Richardson et al. 1995). Acoustic responses to vessel sound include alteration of the composition of call types, rate and duration of call production, and actual acoustic structure of the calls. Observed behavioral responses include changes in respiration rates, dive patterns, and swim velocities. These responses have, in certain cases, been correlated with numbers of vessels and their proximity, speed, and directional changes. Responses have been shown to vary by gender and by individual.
Vessel activity associated with the Proposed Action is expected to cause repeated, intermittent impacts on ESA-listed marine mammals resulting from short-term, localized behavioral responses. These responses would dissipate once the vessel or individual leaves the area and are expected to be infrequent given the patchy distribution of marine mammals in the Action Area. Any behavioral effects in response to vessel noise are not expected to be biologically significant (Navy 2018). Therefore, no stock or population-level effects on ESA-listed species would be expected.

No PTS exposures are expected for all ESA-listed marine mammal species during Project vessel activities, thus there is no effect.

Based on the mitigation measures presented and discussed (Section 3.3) the potential for exposure of these ESA-listed marine mammal species to noise levels leading to behavioral disturbance would be reduced at the level of the individual animal and would not be expected to have population-level effects. As discussed above, NARW, fin whales, and sei whales, may be exposed to noise above the behavioral thresholds and masking effects depending on the type and speed of the vessel. However, given the interim definition for ESA harassment, the animals ability to avoid harmful noises, and the established mitigation and monitoring measures being proposed (including reduced vessel speeds), the exposure of ESA-listed marine mammals to vessel noise that results in behavioral disturbance or masking would not rise to the level of take under the ESA is, therefore, insignificant. Therefore, noise exposure from Project vessel operations leading to behavioral disturbance may affect, not likely to adversely affect ESA-listed marine mammals.

5.3.1.2 Sea Turtles

Vessel noise overlaps with the hearing range of sea turtles and may elicit behavioral responses, including startle responses and changes in diving patterns, or a temporary stress response (NSF and USGS 2011; Samuel et al. 2005). Vessel noise associated with the Proposed Action could cause repeated, intermittent impacts on sea turtles resulting from short-term, localized behavioral responses. These responses would dissipate once the vessel leaves the area. Behavioral effects are considered unlikely given the patchy distribution of sea turtles in the Action Area, and, therefore, no stock or population-level effects would be expected.

It is unlikely that received levels of underwater noise from vessel activities would exceed PTS thresholds for sea turtles, therefore, the potential for ESA-listed sea turtles to be exposed to noise above PTS thresholds is considered extremely unlikely to occur and is insignificant. Therefore, the effects of noise exposure from Project vessel operations leading to PTS may affect, not likely to adversely affect ESA-listed sea turtles.

There is very little information regarding the behavioral responses of sea turtles to underwater noise. A recent study suggests that sea turtles may exhibit TTS effects even before they show any behavioral response (Woods Hole Oceanographic Institution 2022). Hazel et al. (2007) demonstrated that sea turtles appear to respond behaviorally to vessels (avoidance behavior) at close range (approximately 10 meters or closer). Based on the source levels outlined above, the behavioral threshold for sea turtles is likely to be exceeded by Project vessels. Popper et al. (2014) suggests that in response to continuous shipping sounds, sea turtles have a high risk for behavioral disturbance in the near field (e.g., tens of meters), moderate risk in the intermediate field (hundreds of meters) and low risk in the far field (thousands of meters).

Behavioral effects are considered possible but would be temporary with effects dissipating once the vessel or individual has left the area. With the implementation of vessel separation distances outlined in Section 3.3, potential behavioral effects are further reduced. In addition, the BOEM proposed measures to reduce vessel strikes on sea turtles which includes slowing to 4 knots when sea turtle sighted within 100 meters of the forward path and avoiding transiting through areas of visible jellyfish aggregations or floating
sargassum) will reduce the potential for behavioral disturbance effects. Based on the proposed mitigation measures, sea turtles are expected to have a low probability of exposure to underwater noises above behavioral thresholds from vessel operations. Should an exposure occur, the potential effects would be brief (e.g., a sea turtle may approach the noisy area and divert away from it), and any effects to this brief exposure would be so small that they could not be measured, detected, or evaluated and are therefore insignificant. Therefore, the effects of noise exposure from Project vessel operations leading to behavioral disturbance may affect, not likely to adversely affect ESA-listed sea turtles.

5.3.1.3 Fish

Vessel noise may result in brief periods of exposure near the surface of the water column but is not expected to cause injury, hearing impairment, or long-term masking of biologically relevant cues in fish. Behavioral responses of fish to vessel noise are variable but include avoidance or scattering of schooling fishes (Misund and Aglen 1992). Impacts from vessel noise are expected to be temporary and localized. Adverse impacts on fish from noise generated by vessel transit and operations are unlikely (BOEM 2018).

Potential masking effects to fish from vessel noise has been reported (Vasconcelos et al. 2007), as well as behavioral effects from similar sources. Continuous sounds produced by marine vessels have been reported to change fish behavior, causing fish to change speed, direction, or depth; induce avoidance of impacted areas by fish; or alter fish schooling behavior (Engås et al. 1995, 1998; Sarà et al. 2007; De Robertis and Handegard 2013; Mitson and Knudsen 2003). It was observed that high levels of low-frequency noise (from 10 to 1,000 Hz) may be responsible for inducing an avoidance reaction (Sand et al. 2008). Popper et al. (2014) suggest that in response to continuous sounds, Atlantic sturgeon have a moderate risk for behavioral disturbance in the near field (e.g., tens of meters) and intermediate field (hundreds of meters) and low risk in the far field (thousands of meters). Masking effects are considered high risk in the near and intermediate field and moderate in the far field and TTS effects are considered of moderate risk in the near field and low in the intermediate and far fields.

It is unlikely that received levels of underwater noise from vessel activities would exceed physiological injury thresholds for Atlantic sturgeon, therefore, the potential for ESA-listed Atlantic sturgeon to be exposed to noise above physiological injury thresholds is considered extremely unlikely to occur and is discountable. Therefore, the effects of noise exposure from Project vessel operations leading to physiological injury may affect, not likely to adversely affect ESA-listed Atlantic sturgeon.

Behavioral effects are considered possible but would be temporary with effects dissipating once the vessel or individual has left the area. In addition, Atlantic sturgeon are benthic feeders and therefore, are unlikely to be affected while foraging by a transient vessel noise source. Should an exposure occur, the potential effects would be brief (e.g., Atlantic sturgeon may approach the vessel and divert away from it), and any effects to this brief exposure would be so small that they could not be measured, detected, or evaluated and are therefore insignificant. Therefore, the effects of noise exposure from Project vessel operations leading to behavioral disturbance may affect, not likely to adversely affect ESA-listed Atlantic sturgeon.

5.3.2 Helicopters and Drones

Helicopters may be used to support construction or O&M of the Proposed Action. Though helicopters produce in-air noise, a small portion of the produced sound can be transmitted through the water surface and propagate in the aquatic environment. Underwater sound produced by helicopters is generally low frequency (less than 500 Hz) and continuous with sound levels at or below 160 decibels referenced to 1 micropascal (Richardson et al. 1995). Underwater helicopter noise has the potential to elicit behavioral responses in aquatic species. The drones that would be used to support construction and O&M of the Proposed Action are a fraction of the size of and much quieter than helicopters, and as such, would fall
well within the noise analysis described below for helicopters. Therefore, drones will be dismissed from further discussion.

### 5.3.2.1 Marine Mammals

In general, marine mammal behavioral responses to aircraft most commonly occur at distances of less than 1,000 feet (less than 305 meters) (Patenaude et al. 2002). BOEM would require all aircraft operations to comply with current approach regulations for NARWs or unidentified large whales (50 CFR 222.32). These include the prohibition of aircraft from approaching within 1,500 feet (457 meters). This BA anticipates that most aircraft operations would occur above this altitude except under specific circumstances (e.g., helicopter landings on the service operations vessel or visual inspections of WTGs). Aircraft operations could result in temporary, minor behavioral responses, including short surface durations, abrupt dives, and percussive behaviors (i.e., breaching and tail slapping) (Patenaude et al. 2002). When traveling at relatively low altitude, helicopter noise that propagates underwater has the potential to elicit short-term behavioral responses in marine mammals, including altered dive patterns, percussive behaviors (i.e., breaching or tail slapping), and disturbance at haul-out sites (Efroymson et al. 2000; Patenaude et al. 2002). Helicopters transiting to and from the Action Area are expected to fly at sufficiently high altitudes to avoid behavioral effects on marine mammals, with the exception of WTG inspections, take-off, and landing. Additionally, Project aircraft would comply with current approach regulations for NARWs. Any behavioral responses elicited during low-altitude flight would be temporary, dissipating once the aircraft leave the area, and are not expected to be biologically significant.

With the implementation of these mitigation measures, exposure of noises above PTS, TTS, and behavioral thresholds for all ESA-listed marine mammal species is considered extremely unlikely to occur and insignificant. Therefore, noise exposure from Project aircraft activities leading to PTS/TTS/behavioral disturbance or masking may affect, not likely to adversely affect ESA-listed marine mammals.

### 5.3.2.2 Sea Turtles

When traveling at relatively low altitude, helicopter noise that propagates underwater has the potential to elicit stress or behavioral responses in sea turtles (e.g., diving or swimming away or altered dive patterns) (BOEM 2017; NSF and USGS 2011; Samuel et al. 2005). Helicopters transiting to and from the Action Area are expected to fly at sufficiently high altitudes to avoid behavioral effects on sea turtles, with the exception of WTG inspections, take-off, and landing. Any behavioral responses elicited during low-altitude flight would be temporary, dissipating once the aircraft leave the area. These temporary behavioral responses are not expected to be biologically significant.

Helicopter support would be required during several Project activities through construction, O&M, and decommissioning. The number of helicopter trips required for construction is provided in Table 3.1-13. Patenaude et al. (2002) showed that aircraft operations could result in temporary behavioral responses to marine mammals, however, similar studies on sea turtles is not available in the literature. Kuehne et al. (2020) demonstrated that underwater noise from large Boeing EA-18G Growler aircrafts and determined that sound signatures of aircraft at a depth of 30 meters below the sea surface had underwater noise levels of 134 (± 3) dB re 1 µPa SPLrms. Noise from helicopters required for the Project are expected to be less than those generate by these larger aircrafts.

Popper et al. (2014) suggest that in response to continuous sounds (e.g., aircraft operations), sea turtles have a high risk for behavioral disturbance in the near field (e.g., tens of meters), moderate risk in the intermediate field (hundreds of meters) and low risk in the far field (thousands of meters). The potential risk for injury and TTS are considered low at all distances (Popper et al. 2014). BOEM expects that most aircraft operations would occur above 1,500 feet (457 meters; NARW aircraft approach regulation) except
under specific circumstances (e.g., helicopter landings on the service operation vessel or visual inspections of WTGs). Exposure of noises above PTS, TTS, and behavioral thresholds from Project aircrafts for all ESA-listed sea turtles is extremely unlikely to occur and is insignificant. Therefore, the effects of noise exposure from Project aircraft activities leading to PTS/TTS/behavioral disturbance may affect, not likely to adversely affect ESA-listed sea turtles.

5.3.2.3 Fish

Noise from helicopters may cause behavioral changes in fish in the immediate vicinity of the noise source. Near-surface pelagic fish may detect helicopter noise that has transmitted through the water surface, but noise levels from aircraft would be greatly diminished when they reach benthic/demersal habitats and may be at least partially masked by ambient ocean noise. Helicopters transiting to and from the Action Area are expected to fly at sufficient altitudes to avoid behavioral effects on fish, with the exception of WTG inspections, take-off, and landing. Any behavioral responses that occur during low-altitude flight would be temporary, dissipating once the aircraft leave the area, and are not expected to be biologically significant. However, as Atlantic sturgeon are demersal, they are unlikely to experience behavioral effects of helicopter noise.

Exposure of noises above physiological injury, TTS, and behavioral thresholds from Project aircraft for Atlantic sturgeon is extremely unlikely to occur and is insignificant. Therefore, the effects of noise exposure from Project aircraft activities leading to physiological injury/TTS/behavioral disturbance may affect, not likely to adversely affect ESA-listed Atlantic sturgeon.

5.3.3 Wind Turbine Generators

WTGs operating during the O&M phase of the Proposed Action would generate non-impulsive, underwater noise. Monitoring data indicate that $SPL_{RMS}$ produced by operating WTGs generally ranges from 110 to 125 decibels referenced to 1 microPascal in the 10-Hz to 8-kHz frequency range (Tougaard et al. 2020). Noise levels produced by WTGs are only expected to exceed ambient levels at frequencies below 500 Hz (Tougaard et al. 2009a) and are expected to decrease to ambient levels within a relatively short distance from the turbine foundations (Kraus et al. 2016; Thomsen et al. 2015). At Block Island Wind Farm, turbine noise reached ambient noise levels within 164 feet (50 meters) of the turbine foundations (Miller and Potty 2017).

Sound is generated by operating WTGs due to pressure differentials across the airfoils of moving turbine blades and from mechanical noise of bearings and the generator converting kinetic energy to electricity. Sound generated by the airfoils, like aircraft, is produced in the air and can enter the water through the air-water interface. However, acoustic energy from in-air noise does not effectively cross the air/water interface; therefore, most of the noise is reflected off the water surface (Richardson et al. 1995). Mechanical noise associated with the operating WTG is transmitted into the water as vibration through the foundation and subsea cable. While airfoil sounds are unlikely to effectively cross the air-water interface, mechanical vibration may result in long-term, continuous noise in the offshore environment. Field measurements have documented that during offshore wind operations, sound levels are much lower than during construction activities. SPLs measured 164 feet (50 meters) from a BIWF turbine on average were 119 dB re 1 µPa and tonal peaks were observed at 30, 60, 70, and 120 Hz (Elliott et al. 2019). The turbines at the BIWF are 6 MW, direct-drive, 4-legged jacket-pile structures. During the winter, a 71 Hz constant tone was recorded 100 meters from a BIWF turbine, and during the summer, sound levels increased between 70 Hz and 120 Hz. During operations, the maximum particle velocity (as measured 100 meters from the turbine, just above the seafloor) during winter was 40 dB re 1 nm/sec. While in summer it was closer to 90 dB re 1 nm/sec, most of the energy was below 25 Hz (Elliott et al. 2019). Overall, the results from this study indicated that there is a correlation between underwater sound levels and increasing wind speed, but this is not clearly predominantly influenced by turbine machinery; rather it...
may be the natural effects that wind and sea state have on underwater sound (Elliott et al. 2019; Urick 1983).

### 5.3.3.1 Marine Mammals

WTG noise would be audible to marine mammals and therefore could affect ESA-listed marine mammal species. However, noise levels are expected to reach ambient levels within a short distance from turbine foundations (Kraus et al. 2016; Thomsen et al. 2015). Therefore, WTG noise impacts on marine mammals are expected to be too small to be meaningfully measured.

There are several studies that present sound properties of similar turbines in environments comparable to that of the Proposed Action. Field measurements during offshore wind operations have indicated that sound levels are much lower than during construction activities (Elliot et al. 2019). Additionally, Tougaard et al. (2020) summarized available monitoring data on wind farm operational noise and modeled correlations between estimated total sound pressure level and distance, wind speed, and turbine size. Their study included both older-generation, geared turbine designs and quieter, modern, direct-drive systems like those likely to be used for the Project. Their results showed that operational noise generally attenuates rapidly with distance from the turbines (falling below normal ocean ambient noise within 0.6 mile (1 kilometer) from the source), and the combined noise level from multiple turbines is lower or comparable to that generated by a small cargo ship. More recently, Stöber and Thomsen (2021) used monitoring data and modeling to estimate operational noise from larger (10 MW), current-generation, direct-drive WTGs and concluded that these designs could generate higher operational noise levels than those reported in earlier research. Stöber and Thomsen (2021) attempted to fill this knowledge gap by extracting a strictly defined subset of the data used by Tougaard et al. (2020) to extrapolate sound levels to larger turbine sizes and to direct-drive turbines. However, the small size of their data subset greatly increased the already considerable uncertainty of the modeling results. Both studies found sounds to generally be louder for higher-powered WTGs and, thus, distances to a given sound threshold are likely to be greater for higher-powered WTGs. However, as Stöber and Thomsen (2021) point out, direct-drive technology could reduce these distances substantially.

Marine mammals would be able to hear the continuous underwater noise of operational WTGs. As measured at the BIWF, this low-frequency noise barely exceeds ambient levels at 164 feet (50 meters) from the WTG base. Based on the results of Thomsen et al. 2015 and Kraus et al. 2016, SPLs would be expected to be at or below ambient levels at relatively short distances from the WTG foundations. More specifically, based on the least squares fits in Tougaard et al. 2020, SPL from a 10 MW turbine in 10 m/s (19 knot) winds would reach 120 dB re 1 µPa at 410 feet (125 meters) from the turbine.

However, it is also probable that operational noise would change the ambient sound environment within the wind farm environment in ways that could affect habitat suitability. This impact can be evaluated by estimating the area exposed to operational noise above the existing environmental baseline. Kraus et al. (2016) measured ambient noise conditions at three locations adjacent to the proposed South Fork Wind Farm over a 3-year period and identified baseline levels of 102 to 110 dB re 1 µPa. Maximum operational noise levels typically occur at higher wind speeds when baseline noise levels are higher due to wave action. Again, using equations from Tougaard et al. 2020, SPL measured from the same 10 MW turbine in the same 10 m/s (19 knot) winds would reach 110 dB re 1 µPa at about 1,150 feet (350 meters) from the turbine.

Operational noise could interfere with communication, reducing feeding efficiency in the areas within a few hundred feet of the foundations under some conditions. Any such effects would likely be dependent

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5 These are 50th and 90th percentile levels in the 20–447 Hz frequency band for monitoring locations RI-1, RI-2, and RI-3, as reported by Kraus et al. (2016).
on hearing sensitivity and the ability to adapt to low-intensity changes in the noise environment. For example, based on known hearing sensitivity (Johnson 1967), MFC like dolphins are likely to be less sensitive to the low-frequency sounds generated by operational WTGs. Dolphins vocalize in low to mid frequencies, suggesting the possibility of partial masking effects, but these species are also known to shift vocalization frequencies to adapt to natural and anthropogenic conditions (David 2006; Quintana-Rizzo et al. 2006) and this masking would only occur very close to individual WTGs.

On balance, any operational noise effects from the Lease Area are likely to be of low intensity and highly localized. Tougaard et al. (2009b) concluded that marine mammals would be able to detect operational noise within a few thousand feet of WTGs. This suggests the potential for a reduction in effective communication space within the wind farm environment for marine mammals that communicate primarily in frequency bands below 8 kHz. This localized, long-term impact would constitute a minor effect on marine mammals belonging to the LFC hearing group (COP Appendix U2, Table 7; Mayflower Wind 2022).

Based on the current available data, underwater noise from WTG operations from offshore wind activities is unlikely to cause PTS in ESA-listed marine mammals. Therefore, exposure of noises above PTS thresholds from WTG operations and for all ESA-listed marine mammals is considered extremely unlikely to occur and discountable. Therefore, the effects of noise exposure from Project WTG operations leading to PTS may affect, not likely to adversely affect any ESA-listed marine mammals.

Based on the available source level and modeling information presented above, underwater noise from WTG operations could exceed TTS and behavioral thresholds and cause masking of communications. Foraging cetaceans are not expected to be significantly interrupted foraging if exposed to underwater noise from WTG operations but may forage less efficiently due to increased energy spent due to avoidance behavior. Decreased foraging efficiency, especially if individuals move away from Nantucket Shoals, could have short-term metabolic effects resulting in physiological stress, but these effects would dissipate once the prey distribution no longer overlaps the underwater noise. Jansen and de Jong (2016) and Tougaard et al. (2009a) concluded that marine mammals would be able to detect operational noise within a few thousand feet of 2 MW WTGs, but the effects would have no significant impacts on individual survival, population viability, distribution, or behavior. Lucke et al. (2007) exposed harbor porpoise to simulated noise from operational wind turbines and found masking effects at 128 dB re 1 µPa in the frequencies 0.7, 1,000, and 2,000 Hz. This suggests the potential for a reduction in effective communication space within the wind farm environment for marine mammals that communicate primarily in frequency bands below 2,000 Hz. Any such effects would likely be dependent on hearing sensitivity of the individual and the ability to adapt to low-intensity changes in the noise environment. However, more acoustic research is warranted to characterize SLs originating from large direct-drive turbines, the potential for those turbines to cause TTS effects, and to what distance behavioral and masking effects are likely.

5.3.3.2 Sea Turtles

Maximum noise levels anticipated from operating WTGs are below recommended thresholds for sea turtle injury and behavioral effects. Additionally, noise levels are expected to reach ambient levels within a short distance of turbine foundations (Kraus et al. 2016; Thomsen et al. 2015) and studies suggest that sea turtles may acclimate to repetitive underwater noise in the absence of an accompanying threat (Bartol and Bartol 2011; Hazel et al. 2007; Navy 2018). Therefore, no WTG noise impacts on ESA-listed sea turtles are anticipated.

Although some noise associated with operation of WTGs would be audible to sea turtles in wind energy areas, measurable impacts from this noise are not expected because it is likely to be at or below ambient levels only a short distance from the WTG. Sound generated by WTG aerodynamics and mechanical
Mayflower Wind
Biological Assessment
Chapter 5
Effects of the Proposed Action

Vibration may result in long-term, continuous underwater noise in the offshore environment. Underwater operational noise generated by offshore WTGs less than 6.15 MW has been measured to have SPLs ranging from around 80 to 135 dB re 1 μPa at various distances with frequencies between 10 Hz and 8 kHz, and the combined noise levels from multiple turbines would be lower or comparable to those of a small cargo ship (Tougaard et al. 2020). Operational noise from larger WTGs on the order of 15 MW would generate higher SPL levels of 125 dB re 1 μPa measured 100 m from the turbine during 10 meter per second (22 miles per hour) wind speeds (Tougaard et al. 2020). Stöber and Thomsen (2021) created a linear model based on the maximum received wind levels from operational wind farms and estimated that a 10 MW wind turbine could yield broadband SPL source levels of 170 dB re 1 µPa-m, respectively. However, this would only be expected during extreme weather events, and Stöber and Thomsen expect that the industry shift from using gear boxes to direct-drive technology will reduce the sound level by 10 dB. Based on the current available data, underwater noise from turbine operations is unlikely to cause PTS or TTS in sea turtles but could cause behavioral effects. It is expected that these effects would be at relatively short distances from the foundations and as the sound would reach ambient underwater noise levels within 50 meters of the foundations (Miller and Potty 2017; Tougaard et al. 2009). Sea turtles would be expected to habituate to the noise.

Based on the source levels presented above, it is unlikely that received levels of underwater noise from WTG operations would exceed PTS or TTS thresholds for sea turtles, therefore, the potential for ESA-listed sea turtles to be exposed to noise above PTS or TTS thresholds is considered extremely unlikely to occur and is **discountable**. The effects of noise exposure from Project WTG operations leading to PTS or TTS may affect, not likely to adversely affect ESA-listed sea turtles.

Underwater noise from WTG operations could exceed behavioral thresholds and cause masking of communications. However, more acoustic research is warranted to characterize sound levels originating from large direct-drive turbines, the potential for those turbines to cause behavioral effects, and to what distance behavioral and masking effects are likely. Popper et al. (2014) suggest that in response to continuous sounds, sea turtles have a high risk for behavioral disturbance in the near field (e.g., tens of meters), moderate risk in the intermediate field (hundreds of meters) and low risk in the far field (thousands of meters).

Sea turtles may be exposed to noise levels that exceed behavioral thresholds during WTG operations, particularly during high wind events when ambient underwater noise levels are also elevated and behavioral reactions may include avoidance of the area (Hazel et al. 2007). Foraging sea turtles are not expected to be significantly interrupted foraging if exposed to underwater noise from WTG operations but may forage less efficiently due to increased energy spent due to avoidance behavior. Decreased foraging efficiency, especially if individuals move away from Nantucket Shoals, could have short-term metabolic effects resulting in physiological stress, but these effects would dissipate once the prey distribution no longer overlaps the underwater noise. Given the interim definition for ESA harassment, the animals ability to avoid harmful noises, the potential for ESA-listed sea turtles to be exposed to underwater noise exceeding behavioral thresholds from WTG operations would not rise to the level of take under the ESA and is therefore considered **insignificant**. Therefore, the effects of noise exposure from Project WTG operations leading to behavioral disturbance may affect, not likely to adversely affect ESA-listed sea turtles.

### 5.3.3.3 Fish

Maximum noise levels anticipated from operating WTGs are below injury and behavioral thresholds for fish. Additionally, noise levels are expected to reach ambient levels within a short distance of turbine foundations (Kraus et al. 2016; Thomsen et al. 2015), and no studies have found behavioral impacts from WTG noise (Thomsen et al. 2015). Therefore, no WTG noise impacts on ESA-listed fish species are expected.
Available data on large direct-drive turbines are sparse. Direct-drive turbine design eliminates the gears of a conventional wind turbine, which increases the speed at which the generator spins. Direct-drive generators are larger generators that produce the same amount of power at slower rotational speeds. Only one study of direct-drive turbines presented in Elliott et al. (2019) was available in the literature. The study measured SPLs of 114 to 121 dB re 1 μPa SPL_{rms} at 50 meters for a 6 MW direct-drive turbine.

Recent modeling conducted by Stöber and Thomsen (2021) and Tougaard et al. (2020) has suggested that operational noise from larger, current-generation WTGs would generate higher source levels (170 to 177 dB re 1 μPa SPL_{rms} for a 10-MW WTG) than the range noted above from earlier research. However, the models were based on a small sample size, which adds uncertainty to the modeling results. In addition, modeling results were based on measured SPLs from geared turbines. Even though current turbine engines are larger, WTGs with direct-drive technology could reduce SPLs because they eliminate gears and rotate at a slower speed than the conventional geared generators.

Based on the source levels presented above, it is unlikely that received levels of underwater noise from WTG operations would exceed physiological injury thresholds for Atlantic sturgeon, therefore, the potential for ESA-listed Atlantic sturgeon to be exposed to noise above physiological injury thresholds is considered extremely unlikely to occur and is insignificant. The effects of noise exposure from Project WTG operations leading to PTS may affect, not likely to adversely affect ESA-listed Atlantic sturgeon.

Based on the available source levels and modeling information presented above, underwater noise from WTG operations could exceed TTS and behavioral thresholds and cause masking of communications. However, more acoustic research is warranted to characterize SLs originating from large direct-drive turbines, the potential for those turbines to cause TTS effects, and to what distance behavioral and masking effects are likely.

Atlantic sturgeon may be exposed to noise levels that exceed TTS and behavioral thresholds during WTG operations, particularly during high wind events when ambient underwater noise levels are also elevated and behavioral reactions may include avoidance of the area. As described above, it is expected that Atlantic sturgeon would occur intermittently in the Lease Area throughout their spring and fall migrations and may be forage opportunistically in areas where benthic invertebrates are present. The area is not known to be a preferred foraging area and has not been identified as an aggregation area which reduced the potential for impact on this species from long-term operation noise. Given the interim definition for ESA harassment, the animals ability to avoid harmful noises, the lack of preferred foraging area and known aggregations in the Lease Area, the potential for ESA-listed Atlantic sturgeon to be exposed to underwater noise exceeding TTS/behavioral thresholds or masking effects from WTG operations would not rise to the level of take under the ESA and is therefore considered insignificant. Therefore, the effects of noise exposure from Project WTG operations leading to TTS/behavioral disturbance and masking may affect, not likely to adversely affect ESA-listed Atlantic sturgeon.

5.3.4 Summary of Other Noise Effects

5.3.4.1 Marine Mammals

Underwater noise generated by vessels, helicopters, and WTGs associated with the Proposed Action would not result in injury to ESA-listed marine mammals, but these noise sources do have the potential to elicit behavioral responses in these species. Based on the low source levels and rapid attenuation of WTG noise, associated behavioral effects on marine mammals are expected to be too small to be meaningfully measured. Any behavioral effects associated with vessel or helicopter noise would be temporary and are not expected to be biologically significant. Vessel noise may also result in temporary stress responses and masking, which could affect individual ESA-listed species but are not expected to result in stock or population-level effects based on the small number of Project vessels anticipated for the Proposed Action.
5.3.4.2 Sea Turtles

Underwater noise generated by vessels, helicopters, and WTGs associated with the Proposed Action would not result in injury to ESA-listed sea turtles. Based on the low source levels, WTG noise would also not result in behavioral effects on sea turtles. Vessel and helicopter noise may result in behavioral effects. However, these effects are considered unlikely given the patchy distribution of sea turtles in the Action Area and the relatively small number of vessels and aircraft associated with the Proposed Action. Any behavioral effects associated with vessel or aircraft noise would be temporary and localized and are not expected to result in stock or population-level effects.

5.3.4.3 Fish

Underwater noise generated by vessels, helicopters, and WTGs associated with the Proposed Action would not result in injury to ESA-listed fish species. Based on the low source levels, WTG noise would also not result in behavioral effects on ESA-listed fish species. Helicopter noise has the potential to result in behavioral effects, but such effects are unlikely given Atlantic sturgeon’s demersal life history. Therefore, the risk of behavioral effects associated with helicopter noise is discountable. Vessel noise may cause behavioral effects, but such effects would be most likely to occur in the upper portion of the water column where demersal Atlantic sturgeon are unlikely to occur. Any behavioral effects on ESA-listed fish species would be temporary and localized, and these impacts are unlikely to adversely affect individuals.

5.4 Effects of Vessel Traffic

As detailed in Section 3.1.2.6, a variety of vessels would be used to construct, operate, and decommission the Proposed Action. Mayflower Wind expects a daily average of 15-35 vessels depending on construction activities with a maximum peak of 50 vessels in the Lease Area at one time. Vessels are expected to be in use during any phase of the Proposed Action. Vessel traffic associated with the Proposed Action could affect ESA-listed species through vessel strikes (Section 5.4.1) or discharges of fuel, fluids, hazardous material, trash, or debris from Proposed Action vessels (Section 5.4.2). Following the assessment of these effects, a summary of overall vessel traffic effects on ESA-listed species is provided (Section 5.4.3). In addition to increased risk of vessel strike and accidental vessel discharges, vessels produce underwater noise, which was evaluated in Section 5.3.1. Vessels would also produce artificial lighting, which is addressed in Section 5.5.10, and air emissions, which are addressed in Section 5.6.

5.4.1 Risk of Vessel Strike

The Proposed Action would result in increased risk of vessel encounters for some ESA-listed species as a result of Project vessel traffic during the construction, O&M, and decommissioning phases of the Project. Vessel strikes are a known source of injury and mortality for marine mammals, sea turtles, and Atlantic sturgeon.

Based on the vessel traffic generated by the proposed Project, 15 to 35 vessels with up to 50 simultaneous construction vessels may operate in the Project area during the construction phase. The presence of these vessels could cause delays for non-Proposed Action vessels and could cause some fishing or recreational vessel operators to change routes or use an alternative port.

5.4.1.1 Marine Mammals

Vessel strikes are a significant concern for marine mammals, including NARWs, which are relatively slow swimmers and inhabit areas of high vessel traffic. Vessel strikes are relatively common for marine
mammals (Rockwood et al. 2017; Kraus et al. 2005) and are a known or suspected cause of the three active unusual mortality events in the Atlantic Ocean for marine mammals (humpback whale, minke whale, and NARW). Vessel strikes may be particularly significant for NARWs, for which vessel strikes are a primary cause of death (Kite-Powell et al. 2007; Garrison et al. 2022). Vessels of all sizes have the potential to cause lethal injury to large whales during a strike. Larger vessels may be able to produce enough force to cause lethal strikes even at reduced speeds (10 knots) (Kelley et al. 2021). Marine mammals are expected to be most vulnerable to vessel strikes when within the vessel’s draft and not detectable by visual observers (e.g., animal below the surface or poor visibility conditions such rough sea state or low light), and probability of vessel strike increases with increasing vessel speed (Pace and Silber 2005; Vanderlaan and Taggart 2007). NARWs are at highest risk for vessel strike when vessels travel in excess of 10 knots (Kelley et al. 2021; Vanderlaan and Taggart 2007); serious injury to marine mammals due to vessel collision rarely occurs when vessels travel below 10 knots (Laist et al. 2001).

A vessel strike on a marine mammal may result in either injury or mortality. Injuries are typically the result of one of two mechanisms: blunt force trauma from impact with the vessel or lacerations from contact with the propellers (Wiley et al. 2016). Depending on the severity of the strike and the injuries inflicted, the mammal may or may not recover (Wiley et al. 2016). The orientation of the marine mammal with respect to vessel trajectory will affect the severity of the injury (Martin et al. 2016; Vanderlaan and Taggart 2007). Other factors that affect the probability of a marine mammal-vessel strike and its severity include:

- Number, species, age, size, speed, health, and behavior of animal(s) (Martin et al. 2016; Vanderlaan and Taggart 2007);
- Number, speed, and size of vessel(s) (Martin et al. 2016; Vanderlaan and Taggart 2007);
- Habitat type characteristics (Gerstein et al.; Blue 2005; Vanderlaan and Taggart 2007);
- Operator’s ability to avoid collisions (Martin et al. 2016); and
- Vessel path (Martin et al. 2016; Vanderlaan and Taggart 2007).

The following factors can also impair the ability of a marine mammal to detect and locate the sound of an approaching vessel:

- Attenuation of low frequency vessel sound near the surface (i.e., Lloyd mirror effect);
- Decreased propeller sound at the bow as a vessel’s length increases (i.e., spreading loss);
- Impedance of forward-projecting propeller sound due to hull shape and relative placement of keel (above-keel propeller location resulting in acoustic shadowing); and
- Ambient (background) sound interfering with the sound of an approaching vessel (i.e., acoustic masking).

Vessel speed and size are also important factors for determining the probability and severity of vessel strikes. The size and bulk of the large vessels inhibits the ability for crew to detect and react to marine mammals along the vessel’s transit route. In 93 percent of marine mammal collisions with large vessels reported in Laist et al. (2001), whales were either not seen beforehand, or were seen too late to be avoided. Laist et al. (2001) reported that the most lethal or severe injuries are caused by ships 80 meters or longer travelling at speeds greater than 13 knots. A more recent analysis conducted by Conn and Silber (2013) built upon collision data collected by Vanderlaan and Taggart (2007) and Pace and Silber (2005) and included new observations of serious injury to marine mammals as a result of vessel strikes at lower speeds (e.g., 2 and 5.5 knots). The relationship between lethality and strike speed was still evident; however, the speeds at which 50 percent probability of lethality occurred was approximately 9 knots (10.4 miles per hour [4.6 meters per second]). Smaller vessels have also been involved in marine mammal
collisions. Minke, humpback, and fin whales have been killed or fatally wounded by whale-watching vessels around the world (Jensen and Silber 2004). Strikes have occurred when whale watching boats were actively watching whales as well as when they were transiting through an area, with the majority of reported incidences occurring during active whale watching activities (Laist et al. 2001 and Jensen and Silber 2004). However, Mayflower Wind has committed to a range of AMMs to minimize the potential for vessel collisions and impacts on marine mammals (Section 3.3, Table 3.3-1). These include strict adherence to NMFS Regional Viewing Guidelines for vessel strike avoidance.

Vessels of all sizes may pose a risk, but larger vessels may produce lethal strikes at speeds as low as 10 knots (Kelley et al. 2021). Large vessels that would be used for the Proposed Action include heavy lift vessels, monopile supply vessels, WTG installation vessels, heavy transport vessels, cable lay vessels, pre-lay grapple run vessels, construction support vessels, and tugs and barges (Table 3.1-13). The other Project vessels (i.e., crew transfer vessels safety vessels) would be smaller and more maneuverable, with smaller in-water hulls relative to larger construction vessels. However, maximum vessel speeds may be as fast as 35 knots and these higher speeds allow less reaction time for both the marine mammal and for the vessel operator conducting a maneuver to avoid the marine mammal. During both the construction and O&M phase, CTVs will be subject to the mitigation measures listed above, as well as those outlined in Section 3.3.

Vessel collision risk is expected to be highest during construction, when traffic volumes would be greatest. Risk of collisions is expected to be highest when vessels are transiting to and from the Lease Area. During construction, within the Lease Area, vessels actively engaged in construction (i.e. jack-up vessels), are expected to be largely stationary and to travel at slow speeds when transiting between locations within the offshore wind Lease Area.

Mayflower Wind has proposed measures to avoid, minimize, and mitigate impacts associated with vessel traffic (Section 3.3), including vessel speed restrictions and collision avoidance measures. These collision avoidance measures include maintaining separation distances for marine mammals; reporting as part of the Mandatory Ship Reporting System for NARWs; checking for active Dynamic Management Areas or Slow Zones daily; reporting NARW sightings to the North Atlantic Right Whale Sighting Advisory System; implementing crew member training on vessel strike avoidance measures; and using a dedicated lookout to reduce collision risk. Additional measures to address vessel strike are included in the Project’s LOA and are proposed by BOEM in this BA (Section 3.3) for an enhanced mitigation area where slightly higher densities of NARWs have been reported (Section 3.3 and Figure 3.3-1). BOEM is considering a measure to require a real-time PAM system to further enhance the detection of ESA-listed whales in this area (similar to the real-time PAM system use for impact pile driving) and to share its data with NMFS, and to require reduced vessel speeds upon a confirmed detection of a NARW (Section 3.3). The real-time detection and reporting PAM system during the construction period would help to detect the presence of marine mammals and avoid vessel strikes, minimizing the potential for impacts on marine mammals. Upon a confirmed detection of a NARW, all Project construction and crew transfer vessels of all sizes must travel at 10 knots or less in a 10-km² area around the location of the detection. Speed restriction must remain in place until there are no PAM detections within 48 hours of implementation of the speed restrictions, or daily aerial surveys result in no NARW sightings within 48 hours of implementation of the speed restrictions. This precautionary measure would be in place during offshore construction no matter the time of year when such work is being conducted. While NARW occurrence around Nantucket Shoals is greatest in the fall and winter, this measure addresses avoidance during offshore construction throughout the year to reduce the potential of any interaction between vessels and NARWs.

Vessel strikes are not anticipated when mitigation measures are effectively implemented; thus, the potential for vessel strikes to ESA-listed marine mammals is extremely unlikely. Given the low likelihood
of vessel strikes, the effects of Project vessel activities is **not likely to adversely affect (discountable)** ESA-listed marine mammals.

### 5.4.1.2 Sea Turtles

Vessel strikes are an increasing concern for sea turtles. A study of stranded sea turtles in Florida found that third of loggerhead sea turtles and leatherback sea turtles had suffered a vessel strike injury. A quarter of Kemp’s Ridley Sea turtles had suffered a vessel strike injury (Foley et al. 2019). The percentage of stranded loggerhead sea turtles with injuries that were apparently caused by vessel strikes increased from approximately 10 percent in the 1980s to over 20 percent in 2004, although some stranded turtles may have been struck post-mortem (NMFS and USFWS 2007a). Sea turtles are expected to be most vulnerable to vessel strikes in coastal foraging areas and may not be able to avoid collisions when vessel speeds exceed 2 knots (Hazel et al. 2007).

Although a vessel strike is a major source of human-caused sea turtle mortality, the above measures (Table 3.3-1 and Table 3.3-2) would reduce the probability of a vessel strike resulting from the Proposed Action. Although construction will occur over a period of seven years, the Proposed Action would have a period of peak vessel activity lasting approximately one year when multiple phases of construction will be happening simultaneously (during construction and installation of offshore export cables, WTGs, OSP, and interarray cables). However, avoidance measures would be designed to avoid vessel strikes on sea turtles by reducing vessel speed and maintaining a distance of 164 feet (50 meters) or greater from sighted turtles. The additional measure of training personnel to watch for and report sea turtles would further increase vigilance to avoid striking sea turtles (Table 3.3-1 and Table 3.3-2). Lookouts can advise vessel operators to slow the vessel or maneuver safely away from sea turtles, as well as observing for indicators of sea turtle presence such as drifting algal mats. Sea turtle exposure would be expected to be minor and risk localized to surface habitats in the transit path between ports and the Lease Area.

Fifty to 500 loggerhead sea turtles and five to 50 Kemp’s ridley sea turtles are estimated to be killed by vessel traffic per year in the U.S. (NRC 1990). This report is dated and also indicates that this estimate is highly uncertain and could be a large overestimate or underestimate. The Recovery Plan for loggerhead sea turtles (NMFS and USFWS 2008) notes that, from 1997 to 2005, 14.9 percent of all stranded loggerheads in the U.S. Atlantic and Gulf of Mexico were documented as having some type of propeller or collision injuries although it is not known what proportion of these injuries occurred before or after the turtle died. Therefore, increased vessel traffic associated with the Proposed Action will increase the potential for impacts from vessel strikes.

Several factors contribute to the probability of vessel strikes, including the sea turtle density, time of year, sea turtle submergence rates, vessel type and speed, vessel trip numbers, and vessel trip distances. Sea turtles, with the exception of hatchlings and pre-recruitment juveniles, spend a majority of their time submerged, during which time they may not be susceptible to vessel strikes. Sea turtles spend at least 20 to 30 percent of their time at the ocean surface (Lutcavage and Lutz 1997) during which time they would be vulnerable to being struck by vessels or struck by vessel propellers. However, with the exception of leatherbacks, sea turtles prefer to stay within the first few meters of the water’s surface. Information on swim depth are provided in the Navy Undersea Warfare Center’s dive distribution and group size parameter reports (Borcuk et al., 2017; Watwood and Buonantony, 2012). These data suggest loggerhead and green sea turtles spend 60 to 75 percent of their time within 10 meters of the surface; leatherback sea turtles spend about 20 percent of their time within 10 meters of the water surface, and there is insufficient data to quantify Kemp’s ridley sea turtle activity. Any sea turtle found in the Action Area could thus occur at or near the surface, whether resting, feeding or periodically surfacing to breathe.

Sea turtle density estimates are available from the U.S. Navy Operating Area Density Estimates (NODE) for the Atlantic Ocean (Navy 2007) through the Duke University Strategic Environmental Research and
Development Program Spatial Decision Support System Marine Animal Model Mapper. These NODE data indicate leatherback sea turtle density in the Project vicinity during fall ranges from 0.0093 to 0.0171 turtles per 38.6 square miles (100 km²), which translates to higher density estimate of approximately 0.04 to 0.09 leatherback sea turtles within the Project area at a given time. The NODEs data estimate a summer density of loggerhead sea turtles ranging from 0.0588 to 0.1234 turtles per 38.6 square miles (100 km²), which equates to approximately 0.3 to 0.6 loggerhead sea turtles within the Lease Area at a given time. The NODE data indicate the summer density of Kemp’s ridley sea turtles in the Project vicinity ranges from 0 to 0.02 turtles per 38.6 square miles (100 km²), which equates to approximately 0 to 0.09 Kemp’s ridley sea turtle within the Lease Area at a given time. Lastly, the NODEs data modeled estimate the density of green sea turtles in the Project vicinity during summer ranges from 0 to 0.09 turtles per 38.6 square miles (100 km²), which translates to approximately 0 to 0.02 green sea turtles within the Lease Area at a given time. Sea turtle densities in the Action Area are mainly driven by forage availability and measures to avoid transiting through areas of visible jellyfish aggregations or floating sargassum lines or mats would effectively reduce collision risk.

The latest reports compiled by O’Brien et al. (2021;2022) from survey campaigns 6A (March-October 2020) and campaign 6B (November 2020-October 2021) recorded 15 detections of 20 turtles (campaign 6A) and 45 detections of 51 sea turtles (campaign 6B). During campaign 6A, three leatherback sea turtles, two loggerhead sea turtles, and one unidentified sea turtle were observed. The majority of sightings occurred in the fall and only three sightings occurred in the summer (all in July). Leatherback turtles were sighted on four separate days, and all sightings except one were over the Nantucket Shoals. Seasonal sighting rates were higher in the fall (5.81 turtles/km) than in the summer (0.19 turtles/km). Only two loggerhead turtles were detected during campaign 6A; one was in the central part of OCS-A-0501 and one in OCS-A 0486.

During campaign 6B, eighteen sightings of 19 leatherback turtles were observed during general surveys. Sea turtles were sighted in five months in both summer (25 sightings of 26 individuals) and fall (20 sightings of 25 individuals). Leatherback turtles were predominantly sighted over the Nantucket Shoals. Seasonal sighting rates were 3.3 turtles/km (fall 2020), 5.3 turtles/km (summer), and 2.9 turtles/km (fall 2021). No turtles were sighted in winter or spring. One loggerhead turtle and one unidentified sea turtle were detected during campaign 6B, and both of these sightings were in the Nantucket Shoals area. For leatherbacks in particular, the greatest residency times (derived from analyzed tagging data of 20 leatherbacks) in Southern New England waters that encompass the Project area were up to 60 days in the summer. By fall, leatherbacks were no longer present in the Project area or Nantucket Shoals. Leatherbacks spent time in Cape Cod Bay and in the Mid-Atlantic bight, for up to 60 days, by the winter and spring leatherbacks were located far offshore and in southwestern Atlantic waters from roughly the DelMarVa region to South America (Dodge et al. 2014).

The only vessels that would potentially transit across the Nantucket Shoals, where the most turtles were observed, would be vessels transiting from the Port of Sheet Harbour, Canada. Vessels transiting from the Port of Salem, Massachusetts would be able to avoid the Nantucket Shoals via the Cape Cod Canal or by transiting through the Vineyard Sound.

Based on this analysis, the effects of the Proposed Action’s traffic leading to collisions with sea turtles are unlikely given that sea turtles only seasonally occur in typically small numbers with a dispersed distribution. The species and age classes most likely to be affected are adults, sub-adults, and juveniles of leatherback sea turtles, Northwest Atlantic Ocean DPS of loggerhead sea turtles, and the North Atlantic DPS of green sea turtles. Due to their low density in the Action Area, vessel collisions with Kemp’s ridley sea turtles would be extremely unlikely. While the effect of adding the vessels to the baseline cannot be meaningfully measured, detected, or evaluated, the effects are also discountable. Therefore, the effects of vessel traffic resulting in vessel strike due to the Proposed Action may affect, not likely to
adversely affect ESA-listed sea turtles.

5.4.1.3 Fish

Vessel strikes are a documented source of mortality for Atlantic sturgeon in riverine habitats (Brown and Murphy 2010; Balazik et al. 2012). Specifically, Balazik et al. (2012) assessed the potential for vessel interactions with adult Atlantic sturgeon in the James River. Carcasses from 2007 to 2010 were recovered with obvious signs of vessel strike mortality, in the tidal freshwater portion of the river, upriver of the Port of Virginia. The Port of Virginia is located near the mouth of the river and is roughly at river kilometer 0, whereas the carcasses were recovered from river kilometers 70 to 127. Importantly, these mortalities are likely the result of deep draft (≤ 7.3 m) ocean cargo vessels traveling to the Port of Richmond. The greatest number of vessel strike mortality carcasses recovered from 2007 to 2010, converge in an area of the river comparatively narrower and shallower than the waters near the Port of Virginia, over habitat types conducive to adult Atlantic sturgeon, where the draft and propeller of ocean cargo vessels corresponds with the depth preference of Atlantic sturgeon (Balazik et al., 2012). Further, Balazik et al. (2012) demonstrated that Atlantic sturgeon in this area spent 69 percent of their time in the navigation channel. While deep-draft vessels may be most likely to result in sturgeon injury or mortality in these habitats, vessel interactions are not limited to deep-draft vessels (NMFS 2018c). In the marine environment, however, where demersal Atlantic sturgeon would have much more separation from vessel hulls due to deeper water and less constrained ability to avoid vessels (i.e., as opposed to within the confines of a shallower river), the risk of vessel strike may be significantly lower.

Mayflower Wind has proposed measures to avoid or reduce vessel strike risk for marine mammals and sea turtles, some of which may also benefit ESA-listed fish species (Table 3.3-1). Given the low likelihood of vessel strike, the effects of vessel strikes from Project vessel activities is not likely to adversely affect (discountable) ESA-listed Atlantic sturgeon.

5.4.2 Vessel Discharges

The Proposed Action may increase accidental releases of fuels, fluids, and hazardous materials and trash and debris due to increased vessel traffic. The risk of accidental releases is expected to be highest during construction, but accidental releases could also occur to some extent during O&M and decommissioning.

5.4.2.1 Marine Mammals

Marine mammal exposure to fuel, fluid, or hazardous material releases through aquatic contact or inhalation of fumes can result in death or sublethal effects, including but not limited to adrenal effects, hematological effects, hepatological effects, poor body condition, and dermal effects (Kellar et al. 2017; Mazet et al. 2001; Mohr et al. 2008; Smith et al. 2017; Sullivan et al. 2019; Takeshita et al. 2017). In addition to direct effects on marine mammals, accidental releases can indirectly affect these species through impacts on prey species. Given the relatively small volumes of fuels, fluids, and hazardous materials potentially involved in vessel discharges and the likelihood of release occurrence, the increase in accidental releases associated with the Project vessel discharges is expected to fall below the range of releases that occur on an ongoing basis from other activities.

About half of all marine mammal species worldwide have been documented to ingest trash and debris (Werner et al. 2016), which can result in death. Based on stranding data, mortality rates associated with debris ingestion range from 0 to 22 percent (BOEM 2021a). Ingestion may also result in sublethal effects, including digestive track blockage, disease, injury, and malnutrition (Baulch and Perry 2014). Linkages between impacts on individual marine mammals associated with debris ingestion and population-level effects are difficult to establish (Brown et al. 2015). BOEM assumes that all vessels will comply with laws and regulations to minimize trash releases and expects such releases would be small and infrequent.
The amount of trash and debris accidentally discharged from Project vessels during construction, O&M, and decommissioning would be miniscule compared to other ongoing and future trash releases.

The Proposed Action would comply with all laws regulating at-sea discharges of vessel-generated waste further reducing the likelihood of an accidental release. Mayflower Wind has developed an OSRP (Mayflower Wind 2021, COP Appendix AA) with measures to avoid accidental releases and a protocol to respond to such a release if one occurs. Additional measures to address accidental releases are proposed by BOEM in this BA (Section 3.3). Therefore, accidental releases are considered unlikely. Based on the small contribution of Proposed Action vessel discharges to ongoing and future releases, the Proposed Action would not result in a measurable increase in accidental releases in the Action Area. Given the low likelihood of occurrence and the non-measurable increase in releases associated with the Proposed Action, effects of vessel discharges on ESA-listed marine mammals would be insignificant. Therefore, the effects of vessel discharges from the Project may affect, not likely to adversely affect ESA-listed marine mammals.

### 5.4.2.2 Sea Turtles

Sea turtle exposure to oil spills through aquatic contact or inhalation of fumes can result in death (NOAA 2010b) or sublethal effects, including but not limited to adrenal effects, dehydration, hematological effects, increased disease incidence, hepatological effects, poor body condition, and dermal and musculoskeletal effects (Bembenek-Bailey et al. 2019; Camacho et al. 2013; Mitchelmore et al. 2017; NOAA 2010b; Vargo et al. 1986). Such sublethal effects would affect individual fitness but are not expected to affect sea turtle populations. In addition to direct effects on sea turtles, accidental releases can indirectly affect sea turtles through impacts on prey species. Given the relatively small volumes of fuels, fluids, and hazardous materials potentially involved and the likelihood of release occurrence, the increase in accidental releases associated Project vessel discharges is expected to fall below the range of releases that occur on an ongoing basis from other activities.

All sea turtle species are known to ingest trash and debris, including plastic fragments, tar, paper, polystyrene foam, hooks, lines, and net fragments (Bugoni et al. 2001; Hoarau et al. 2014; Nelms et al. 2016; Schuyler et al. 2014; Thomás et al. 2002). Such ingestion can occur accidentally or intentionally when individuals mistake the debris for potential prey items (Gregory 2009; Hoarau et al. 2014; Thomás et al. 2002). Ingestion of trash and debris can result in death or sublethal effects, including but not limited to dietary dilution, chemical contamination, depressed immune system, poor body condition, reduced growth rates, reduced fecundity, and reduced reproductive success (Gall and Thompson 2015; Hoarau et al. 2014; Nelms et al. 2016; Schuyler et al. 2014). These sublethal effects would affect individual fitness, but mortality and sublethal effects associated with ingestion of trash and debris are not expected to have population-level effects. The amount of trash and debris accidentally discharged from Project vessels would be miniscule compared to trash releases associated with other ongoing and future activities.

The Proposed Action would comply with all laws regulating at-sea discharges of vessel-generated waste and Mayflower Wind has developed an OSRP with measures to avoid accidental releases and a protocol to respond to such a release if one occurs. Additional measures to address accidental releases are proposed by BOEM in this BA (Section 3.3). Therefore, accidental releases are considered unlikely. Given the low likelihood of a discharge and that the Proposed Action would not result in a measurable increase in accidental releases in the Action Area, effects of vessel discharges on ESA-listed sea turtles would be insignificant. Therefore, the effects of vessel discharges from the Project may affect, not likely to adversely affect ESA-listed turtles.
5.4.2.3 Fish

Accidental releases of fuel, fluids, and hazardous materials can cause temporary, localized impacts on finfish, including increased mortality, decreased fitness, and contamination of habitat. The Proposed Action would comply with all laws regulating at-sea discharges of vessel-generated waste and includes BOEM-proposed measures to address accidental releases (Section 3.3). Additionally, Mayflower Wind has developed an OSRP with measures to avoid accidental releases and a protocol to respond to such releases.

Therefore, accidental releases are considered unlikely. As noted in Section 5.4.2.1, the Proposed Action would not result in a measurable increase in accidental releases in the Action Area. Based on the low likelihood of discharge and the non-measurable increase in accidental releases associated with Project vessels, effects of vessel discharges on ESA-listed Atlantic sturgeon would be insignificant.

Air emissions from the proposed project would cumulatively add to the carbon dioxide and fossil fuel emissions. Impacts on CO₂ exposure to marine fish is limited. In lab-controlled settings, high concentrations of pCO₂ (> 30,000 µatm), have demonstrated to be lethal to many freshwater and marine fish. However, these levels far exceed the potential cumulative air emission resulting from project. Elevations of pCO₂ have demonstrated stress and increased energy spent on acid-base regulation and cardiorespiratory control (Ishimatsu et al. 2008).

As the National Ambient Air Quality Standards are designed to ensure that air quality does not significantly deteriorate from baseline levels, it is reasonable to conclude that any effects on listed Atlantic sturgeon from these emissions will be so small that they cannot be meaningfully measured, detected, or evaluated and, therefore, are insignificant. Therefore, the effects of air emissions from the Project may affect, not likely to adversely affect ESA-listed listed Atlantic sturgeon.

5.4.3 Summary of Vessel Traffic Effects

5.4.3.1 Marine Mammals

The increased risk of vessel strike for marine mammals associated with the Proposed Action would be discountable based on the small incremental increase in vessel traffic and the measures that would be undertaken to avoid or minimize vessel strike risk. Project vessel discharges are unlikely to occur given the measures in place to avoid or minimize accidental releases, and vessel traffic associated with the Proposed Action would not result in a measurable increase in discharges in the Action Area. Therefore, vessel discharges associated with the Proposed Action would have a discountable effect on ESA-listed marine mammals.

5.4.3.2 Sea Turtles

The increased risk of vessel strike for sea turtles associated with the Proposed Action would be discountable based on the small incremental increase in vessel traffic, the patchy distribution of sea turtles in the Action Area, and the measures that would be undertaken to avoid or minimize vessel strike risk. Project vessel discharges are unlikely to occur given the measures in place to avoid or minimize accidental releases, and vessel traffic associated with the Proposed Action would not result in a measurable increase in discharges in the Action Area. Therefore, vessel discharges associated with the Proposed Action would have a discountable effect on ESA-listed sea turtles.

5.4.3.3 Fish

Though vessel strike is a documented source of Atlantic sturgeon mortality in riverine habitats, the risks posed by vessel strike in oceanic habitats are uncertain, but are presumably less due to the deeper, more
open-water environment on the OCS. The increased risk of vessel strike for Atlantic sturgeon associated with the Proposed Action would be insignificant based on the small incremental increase in vessel traffic, the patchy distribution of sturgeon in the Action Area, and the measures that would be undertaken to avoid or minimize vessel strike risk. Project vessel discharges are unlikely to occur given the measures in place to avoid or minimize accidental releases, and vessel traffic associated with the Proposed Action would not result in a measurable increase in discharges in the Action Area. Therefore, vessel discharges associated with the Proposed Action would have an insignificant effect on ESA-listed Atlantic sturgeon.

5.5 Habitat Disturbance/Modifications

Activities included in the Proposed Action would result in habitat disturbance or modifications that may cause impacts on benthic and water column habitat. Anticipated habitat disturbance or alterations may result from geophysical and geotechnical surveys (Section 5.5.1); fisheries and habitat surveys and monitoring (Section 5.5.2); habitat conversion and loss associated with the placement of WTGs, OSPs, and submarine cables, and cable protection and scour protection (Section 5.5.3); turbidity (Section 5.5.4); dredging (Section 5.5.5), trenching (Section 5.5.6), the presence of offshore structures (Section 5.5.7 and 5.5.8); the addition of EMFs and heat (Section 5.5.9); lighting (Section 5.5.10); and the OSPs (Section 5.5.11). Individual activities and impacts are addressed in the following subsections. Following the assessment of these potential sources of habitat disturbance/modification, a summary of overall effects on ESA-listed species is provided (Section 5.5.12).

5.5.1 Geotechnical and Geophysical Surveys

As described in Section 3.1.2.7, HRG and geotechnical surveys would be conducted during the pre-construction and O&M phases of the Proposed Action. HRG surveys would not result in habitat disturbance or modification. Geotechnical surveys may cause benthic disturbance as a result of physical seafloor sampling. Geotechnical surveys would be limited to the pre-construction phase of the Project and would be conducted at specific WTG locations.

Each individual geotechnical sampling event would disturb a 10.8 to 107.6-square foot (1 to 10-square meter) area of seabed (BOEM 2014). Assuming all 147 WTG locations require geotechnical sampling, an area of up to 0.3 acres (1,470 square meters) would be disturbed.

BOEM and NMFS completed a programmatic consultation in compliance with section 7 of the ESA. This consultation resulted in Project Design Criteria (PDCs) and Best Management Practices (BMPs) for conducting HRG, geotechnical, and biological surveys in support of offshore wind development on the Atlantic OCS leases (GARFO PRD-BOEM 2021). There are eight PDCs;

1. Avoid Live Bottom Features
2. Avoid Spawning and Developmental Habitat of Sturgeon
3. Marine Debris Awareness and Elimination
4. Minimize Interactions with Protected Species during Geophysical Survey Operations
5. Minimize Vessel Interactions with Protected Species
6. Minimize Risk During Buoy Deployment, Operations, and Retrieval
7. Protected Species Observers
8. Reporting Requirements

These PDCs will be carried out through the implementation of the BMPs. The BMPs to minimize interactions with Protected Species during Geophysical Survey Operations include 500 m monitoring.
zones in all directions; 500 m shutdown zones (NARWs); 100 m shutdown (for all other ESA-listed whales); adherence to NMFS permit conditions under ITAs under the MMPA; preclearance observations before beginning noise producing activities, ramp-up, shutdown, and restart procedures; no surveys during peak NARW abundance (January 1 – May 15); separation distances between multiple surveys in the same area; loggerhead sea turtle protections when operating in nearshore critical habitat from April 1 to September 30; and all observations of listed species by crew or project personnel must be communicated to PSOs on-duty.

The geotechnical and geophysical surveys described in Section 3.1.2.7 and this section are consistent with the scope of activities covered in the programmatic consultation, further evidenced by the applicant mitigation measures for the construction and operation phases of the project (Section 3.3). Mayflower Wind is requesting incidental take under the MMPA, and no take under the ESA is expected with the required mitigation.

5.5.1.1 Marine Mammals

Benthic impacts associated with geotechnical surveys for the Proposed Action would not affect ESA-listed marine mammals, which do not forage on benthic prey species.

5.5.1.2 Sea Turtles

Benthic disturbance associated with geotechnical surveys for the Proposed Action has the potential to reduce foraging habitat or prey availability for ESA-listed sea turtle species that forage in soft bottom habitats (i.e., Kemp’s ridley sea turtle). These effects would be localized and short-term. Recolonization and recovery of prey species is expected to occur within 2 to 4 years (Van Dalfsen and Essink 2001) but could occur in as little time as 100 days (Dernie et al. 2003). Given the small size of individual disturbed areas and expected occurrence of similar, undisturbed benthic communities in the adjacent seabed, recolonization may occur relatively quickly following geotechnical surveys. Based on the short-term and localized nature of effects, the small area of disturbance, and the availability of similar foraging habitat throughout the Action Area, benthic habitat disturbance associated with geotechnical surveys for the Proposed Action would be insignificant, and not likely to adversely affect ESA-listed turtles.

5.5.1.3 Fish

Benthic disturbance associated with geotechnical surveys for the Proposed Action has the potential to reduce foraging habitat or prey availability for Atlantic sturgeon in the Action Area. These effects would be localized and short-term. Recolonization and recovery of prey species is expected to occur within 2 to 4 years (Van Dalfsen and Essink 2001) but could occur in as little as 100 days (Dernie et al. 2003). As noted in Section 5.5.1.2, recolonization may occur relatively quickly following geotechnical surveys. Based on the short-term and localized nature of effects, the small area of disturbance, and the availability of similar foraging habitat throughout the Action Area, benthic habitat disturbance associated with geotechnical surveys for the Proposed Action would be insignificant, and not likely to adversely affect Atlantic sturgeon.

5.5.2 Fisheries and Habitat Surveys and Monitoring

Mayflower Wind will be working with the University of Massachusetts Dartmouth’s School for Marine Science and Technology (MAST) and the Anderson Cabot Center of Ocean Life at the New England Aquarium to conduct baseline of existing fisheries information in and around the Lease Area and establish monitoring plans for pre-construction, construction, operations, and decommissioning phases of the Project area. Mayflower Wind is working with MAST, the Anderson Cabot Center, and federal and state agencies to prepare fisheries monitoring plans that are aligned with BOEM guidelines (BOEM, 2020a), and additional recommendations provided by the ROSA Fisheries Monitoring Working Group.
As discussed in Section 3.1.2.7, Mayflower Wind is in the planning stages of conducting fisheries and habitat surveys in the Project area. Open cod-end video surveys would be used to collect baseline data to evaluate changes to abundance and distribution of target fish and invertebrates in the Project area. Habitat surveys using sonar, video, and photographic imaging would be used to evaluate changes in benthic habitat structure and invertebrate community composition. Acoustic surveys would be used to collect data to evaluate changes to abundance and distribution of fish (pelagic and highly migratory species) around offshore structures. These surveys involve similar methods to, and would complement other survey efforts conducted by, various state, federal, and university entities supporting regional fisheries research and management. All requirements of the Proposed Action will follow BOEM’s 2021 Project Design Criteria and Best Management Practices (BOEM 2021) to limit interactions with protected species.

These plans will incorporate coordination with neighboring lease holders and agencies’ research and monitoring, leverage existing surveys and control sites based on previous work conducted by both institutes, and provide adaptability and flexibility to adjust as new information is learned and/or new regional programs are established.

Additionally, Mayflower Wind is working with adjoining lease holders to share fisheries survey data and is participating in the Commonwealth of Massachusetts Fisheries Working Group on Offshore Wind Energy to help establish state-wide offshore survey consistency for fisheries. Furthermore, Mayflower Wind plans financial and in-kind support to advance the collective understanding of Massachusetts fisheries ecology, ecosystems, and management.

5.5.2.1 Risk of Capture/Entanglement

5.5.2.1.1 Marine Mammals

Trawl surveys conducted by Mayflower Wind, will likely follow similar surveys for other wind farms. These tows are typically shorter in duration than conventional commercial trawl tows, and the frequency of tows on a trip-by-trip basis is much less for research fishing vs. commercial fishing, often spread out over a much larger area. Additionally, Mayflower Wind is proposing video trawls of finfish and squid resources. These video surveys will employ an open cod-end which would further reduce risk of capture of marine mammals. The slow speed of mobile gear and the short tow times further reduce the potential for entanglements or other interactions. Observations during mobile gear use have shown that entanglement or capture of large whale species is extremely rare and unlikely (NMFS 2016b). The likelihood of interactions with listed species of marine mammals is lower than commercial fishing activities. The potential for entanglement of ESA-listed marine mammals in bottom trawl equipment is, therefore, considered extremely unlikely to occur.

Acoustic telemetry would be conducted during pre-construction, construction, and O&M phases of the Project. Surveys would employ a combination of fixed hydrophone receivers attached to piers, bulkheads, and floating docks, deployed from a vessel during the structure associated fishes survey, and attached to a glider during the pelagic fish surveys. Continuous marine mammal observational periods will be implemented, and therefore, reduce the risk of entanglement and interactions to marine mammals. Hydrophones attached to the glider is considered non-extractive and would average 0.45 knots (0.83 kilometers per hour). The potential for entanglement of ESA-listed marine mammals in acoustic telemetry survey equipment is considered extremely unlikely to occur.

A PAM plan, as discussed in Section 3.1.2.7, will be submitted to NMFS and BOEM for review and concurrence 120 days prior to start of activities. BOEM anticipates requiring that moored and autonomous PAM systems that may be used for monitoring would either be stationary (e.g., moored) or mobile (e.g., towed, autonomous surface vehicle [ASVs], or autonomous underwater vehicle [AUVs]), respectively. PAM systems will use the best available technology to reduce any potential risks of
entanglement. Buoys attached to the seafloor will use buoys, lines (chains, cables, or coated rope systems), swivels, shackles, and anchor designs that prevent any potential entanglement of listed species while ensuring the safety and integrity of the structure or device. 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. 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. All buoys must be properly labeled with lessee and contact information. With the following mitigation measures, the potential for entanglement of ESA-listed marine mammals in PAM survey equipment is considered extremely unlikely to occur and is discountable.

Given the short survey times, the use of open cod-end video trawl surveys, the low-intensity and localized nature of the impact of gear used in fish and benthic habitat surveys, as well as the proposed mitigation and minimization measures, the risk of capture or entanglement may affect, but is not likely to adversely affect ESA-listed marine mammals.

5.5.2.1.2 Sea Turtles

The capture and mortality of sea turtles in bottom trawl fisheries is well documented (Henwood and Stuntz 1987; NMFS and USFWS 1991, 1992, 2008; NRC 1990; Murray 2006; Warden 2011; Murray 2015; Murray 2020). As discussed in recovery plans and 5-year status reviews for all sea turtle species, reduction of sea turtle interactions with fisheries is a priority where these species occur (NMFS and USFWS 1991, 1992, 2013, 2015a, 2015b, 2019, 2020, Conant et al. 2009, NMFS et al. 2011). Finkbeiner et al. (2011) compiled sea turtle bycatch in U.S. fisheries and found that in the Atlantic, a mean estimate of 137,700 interactions, of which 4,500 were lethal, occurred annually since the implementation of bycatch mitigation measures. However, a vast majority (98 percent) of the interactions and mortalities (80 percent) occurred in the Southeast/Gulf of Mexico shrimp trawl fishery, although sampling inconsistencies and limitations should be considered when interpreting this data (NMFS 2016b).

While sea turtles are capable of remaining submerged for long periods of time, they appear to rapidly consume oxygen stores when entangled and forcibly submerged in fishing gear (Lutcavage and Lutz 1997). However, the preponderance of available research (Epperly et al. 2002; Sasso and Epperly 2006) and anecdotal information from past trawl surveys indicates that limiting tow times to less than 30 minutes will likely eliminate the risk of death for incidentally captured sea turtles. Anticipated trawl surveys would be limited to tow times of 20 minutes or less. All tows would be completed during daylight hours, and trawling would be delayed if any protected species are sighted in the vicinity of the trawl tow. Additional mitigation measures would be expected to eliminate the risk of serious injury and mortality from forced submergence for sea turtles caught in bottom-trawl survey gear. Due to the low probability of interactions in the Project survey areas, and the negative impact of turtle exclusion devices (TEDs) on fish catch rates, TEDs will not be used on trawl surveys. All survey vessels, however, will have trained personnel (either dedicated protected species observers or trained crew members) conducting continuous monitoring of protected species during vessel operations and transits.

As with marine mammals, the reduced bottom-time and open cod-end survey proposed by Mayflower Wind would also reduce the likelihood of capture for sea turtles. While no mortality is expected from the trawl survey, incidentally captured individuals would likely suffer stress and potential injury. Metabolic changes that impair a sea turtle’s ability to function can occur within minutes of forced submergence, and in the event that forced submergence occurs, oxygen stores are rapidly consumed, anaerobic glycolysis is activated, and acid-base balance is disturbed, sometimes on lethal levels (NMFS 2012b).

As discussed in Section 5.5.2.1.1, acoustic telemetry to monitor for pelagic fish and highly migratory species would be conducted employing a combination of fixed and mobile hydrophone receivers. As with
marine mammals, continuous observational periods will be implemented to detect the presence of protected species in the area. Monitoring surveys are also expected to occur at short-term, regular intervals over the duration of the monitoring program. Therefore, the potential for entanglement of ESA-listed sea turtles in acoustic telemetry survey equipment is considered extremely unlikely to occur.

A PAM plan, as discussed in Section 5.5.2.1.1, will be submitted to NMFS and BOEM for review prior to the start of activities. Monitoring studies utilizing moored systems would be required to use the best available technology to reduce any potential risks of entanglement. Therefore, passive acoustic equipment is not expected to pose a meaningful risk of entanglement to sea turtles. Surveys are expected to occur at short-term, regular intervals over the duration of the monitoring program. Therefore, impacts of PAM survey equipment on ESA-listed sea turtles are expected to be negligible.

Based on the potential survey methods identified, and with effective implementation of mitigation measures to minimize impacts of fisheries and habitat surveys, mortality of sea turtles is not anticipated. However, there is still the likelihood for sea turtles to be captured or entangled during the anticipated surveys. This likelihood is greatly reduced for Kemp’s ridley and green sea turtles which have relatively low densities in the Project area compared to leatherback and loggerhead sea turtles. Therefore, the effects of fisheries and habitat surveys associated with the Proposed Action leading to injury due to capture or entanglement may affect, not likely to adversely affect Kemp’s ridley and green sea turtles and may affect, likely to adversely affect loggerhead and leatherback sea turtles.

5.5.2.1.3 Fish

Capture of Atlantic sturgeon in trawl gear has the potential to result in injury and mortality, reduced fecundity, and delayed or aborted spawning migrations (Collins et al. 2000; Moser et al. 2000; Moser and Ross 1995). However, the use of trawl gear has been employed as a safe and reliable method to capture sturgeon, provided that the tow time is limited. A review of eight long term trawl surveys recorded no injuries or mortalities among nearly 900 caught Atlantic and shortnose sturgeons when trawls were limited to tow times of thirty minutes or less (NMFS 2014).

Adverse impacts on sturgeon resulting from trawling capture are related to tow speed and duration (Moser et al. 2000). Northeast Fisheries Observer Program data from Miller and Shepherd (2011) indicate that mortality rates of Atlantic sturgeon caught in otter trawl gear is approximately 5 percent. Short tow durations and careful handling of individuals once on deck are likely to result in a very low risk of mortality to captured individuals (NMFS 2014, 2016b). The methods for the proposed trawl survey employ an open cod-end and a low tow duration, greatly reducing the likelihood of Atlantic sturgeon being caught during survey activities. A bycatch analysis estimated that up to 119 Atlantic sturgeons could be captured incidentally during NEFSC-affiliated research using bottom trawl gear (NMFS 2016). Northeast Fisheries Observer Program (NEFOP) data calculates mortality rates of Atlantic sturgeon caught in otter trawl gear are approximately 5 percent (Stein et al. 2004a; ASMFC TC 2007). In the Hudson River, a trawl survey that incidentally captures shortnose and Atlantic sturgeon has been ongoing since the late 1970s (NMFS 2016). To date, no serious injuries or mortalities of any sturgeon have been recorded in those surveys. Given the dispersed nature of Atlantic sturgeon, the limited number of open cod-end tows, and short tow duration, fisheries and habitat surveys are not expected to result in Atlantic sturgeon mortality. However, trawl surveys could still likely result in capture of some Atlantic sturgeon along with potential minor injuries associated with the action.

As discussed in Section 5.5.2.1.1, acoustic telemetry to monitor for pelagic fish and highly migratory species would be conducted employing a combination of fixed and mobile hydrophone receivers. As with marine mammals, continuous observational periods will be implemented to detect the presence of protected species in the area. Monitoring surveys are also expected to occur at short-term, regular
intervals over the duration of the monitoring program. Therefore, impacts of PAM survey equipment on the ESA-listed Atlantic salmon are expected to be negligible.

Based on the potential survey methods identified, and with effective implementation of mitigation measures to minimize impacts of fisheries and habitat surveys, mortality of the Atlantic sturgeon is not anticipated. However, minor injuries and/or capture of the Atlantic sturgeon in trawl surveys could not be discounted. Therefore, the effects of fisheries and habitat surveys associated with the Proposed Action leading to injury due to capture or entanglement may affect, likely to adversely affect the ESA-listed Atlantic sturgeon.

5.5.2.2 Effects on Prey and/or Habitat

5.5.2.2.1 Marine Mammals

After descending through the water column, the trawl gear used for these monitoring activities operates on or very near the bottom. Right whales feed on copepods and blue whales on krill exclusively, which are expected to pass through trawl gear used for the Project and not be impacted by turbidity created by the gear. Fin and sei whales consume prey species that have potential to be removed by trawl gear. However, the amount of prey species that may be removed is expected to be small. Effects from the proposed bottom trawl survey activities on the availability of prey of ESA-listed marine mammals are expected to be so small that they cannot be meaningfully measured, evaluated, or detected. Additionally, ESA-listed marine mammal species do not utilize benthic habitats which may be disturbed during monitoring efforts. Therefore, effects of fisheries and habitat surveys associated with the Proposed Action leading to impacts on prey or habitat may affect, but are not likely to adversely affect ESA-listed marine mammals.

5.5.2.2.2 Sea Turtles

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 Mayflower Wind trawl surveys would 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, no bycatch is expected as the trawl surveys will utilize cameras and open cod-ends. Given this information, the collection of potential sea turtle prey in the trawl gear will be so small that they cannot be meaningfully measured, detected, or evaluated. Disturbance of soft-bottom habitat in the Action Area during biological monitoring could potentially affect Kemp’s ridley sea turtles, which forage in this type of habitat. However, such disturbance would be temporary and would affect a relatively small area of available habitat in the Action Area. Therefore, effects of fisheries and habitat surveys associated with the Proposed Action leading to impacts on prey or habitat may affect, but are not likely to adversely affect ESA-listed sea turtles.

5.5.2.2.3 Fish

Mayflower Wind proposed open cod-end video trawl surveys which are not expected to retain bycatch. Atlantic salmon prey items such as sand lance are small enough to pass through the survey gears. Other infaunal prey items will not be retained. Given this information, any effects on Atlantic salmon from collection of potential Atlantic salmon prey in the trawl gear will be so small that they cannot be meaningfully measured, detected, or evaluated. Trawls have the potential to disturb benthic habitat. However, such disturbance would be temporary and would affect a relatively small area of available habitat in the Action Area. Therefore, effects of fisheries and habitat surveys associated with the Proposed
Action leading to impacts on prey or habitat may affect, but are not likely to adversely affect the ESA-listed Atlantic sturgeon.

### 5.5.3 Habitat Conversion and Loss

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

Seafloor habitats with the Lease Area and Southern portion of the ECC are homogenous sand plains, where are prevalent on the OCS. Greater habitat complexity, including hard bottom habitats, are found in the Northern portions of the ECC (Table 5.5-1). Communities well adapted to disturbance within their habitats (e.g., Soft Sediment Fauna dominant in sandy sediments in the Lease Area and Southern ECC) are expected to quickly recolonize a disturbed area, while communities less well adapted to frequent disturbance (e.g., attached fauna such as anemones and encrusting sponges associated with gravel, boulders, and cobble habitat noted in the Northern ECC) may take upwards of a year to begin recolonization (BERR, 2008; BOEM, 2013; Guarinello et al., 2017). Effects are expected to be temporary, short-term, and localized in the Lease Area and Southern ECC. In areas of more complex habitat (i.e., Northern ECC), recolonization is expected to occur over a longer period of time (1 to 3 years), though effects are still considered short-term, local, and direct (BERR, 2008; BOEM, 2012; Guarinello et al., 2017, HDR, 2020a). Foundations and scour protection/cable protection would create an artificial reef effect (Degraer et al. 2020), likely leading to enhanced biological productivity and increased abundance and concentration of fish and invertebrate resources (Hutchison et al. 2020).

Recent studies performed as part BOEM’s Real-time Opportunity for Development Environmental Observations (RODEO) program collected three years of benthic habitat data from the Block Island Wind Farm to assess the temporal and spatial changes in substrate characterization and benthos abundance and distribution near the WTG foundations during operations. Epifaunal monitoring data was collected using video analysis and benthic grab sampling from two of the five WTGs at various distances from the WTG foundations. Results of the RODEO program found that by year 2 of epifaunal monitoring, the foundations were primarily colonized by dense blue mussel aggregations; approximately 61-88 percent of epifauna observed were blue mussels (Hutchison et al., 2020). The epifaunal and sediment characteristics varied between WTGs and between survey years. These results are expected to be similar to those that may be observed during the operations phase of the proposed Project due to its close proximity to Block Island Wind Farm (located approximately 56.3 mi [90.6 km] southeast of the Block Island Wind Farm).

This habitat conversion and loss could alter predator–prey interactions in and around the foundations and cable protection areas, with uncertain and potentially beneficial or adverse effects on ESA-listed species. For example, foraging green and loggerhead sea turtles may benefit from increased biological productivity and abundant concentrations of prey(mollusks, crustaceans) generated by the reef effect (Russel et al. 2014).

<table>
<thead>
<tr>
<th>Habitat Types</th>
<th>Lease Area</th>
<th>Falmouth ECC Route – Federal</th>
<th>Falmouth ECC Route – MA State Waters</th>
<th>Brayton Point ECC Route – Federal</th>
<th>Brayton Point ECC Route – RI State Waters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glacial Moraine A</td>
<td>-</td>
<td>-</td>
<td>1,691</td>
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<tr>
<td>Bedrock</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
</tr>
</tbody>
</table>

Table 5.5-1. Area (acres) of different habitat types in the Project area
During geophysical surveys along the Brayton Point ECC, the risk to the cable due to sediment mobility along the corridor was found to be low. However, seabed preparation or alternate burial methods may be required in the northern portion of the Falmouth ECC in Muskeget Channel and Nantucket Sound, where surficial boulders, subsurface boulders, geological units representing hardgrounds or glacial tills, or shallowly buried channels with variable soil properties have been identified. The seabed preparation may include dredging or leveling steep and/or mobile seabed features to facilitate achieving the targeted depth of lowering to ensure adequate burial over the life of the Project. Additionally, dredging of cables may also be used for decommissioning of the Proposed Action.

The areas of impact for seafloor preparation during construction for OSP and WTG foundations are presented in Table 3.1-8. These values represent the area of benthic impact from seabed preparation activities which would be accomplished with dredges or excavators.

The area of impact for seafloor preparation during construction for export cable installation is presented in Table 3.1-11, and includes activities carried out by dredge. The anticipated volume of dredged material within the Falmouth ECC is approximately 807,597 cubic yards. The anticipated seabed area temporarily impacted by dredging within the Falmouth ECC is approximately 428.9 acres. The anticipated volume of dredged material within the Brayton Point ECC is approximately 22,398 cubic yards. The anticipated seabed area temporarily impacted by dredging within the Brayton Point ECC is approximately 1.2 acres.

The area of disturbance for HDD activities are shown in Table 3.1-12.

As described in Section 3.1.2.4, it is anticipated that a pre-lay grapnel run will be completed along the entire length of each export cable route (along the anticipated centerline) within the ECCs, and along the entire length of each interarray cable route within the Lease Area, shortly before cable installation. A pre-lay grapnel run will be conducted to clear the cable route of buried hazards along the installation route to remove obstacles that could impact cable installation, such as abandoned mooring lines, wires, or derelict fishing gear. Mayflower Wind will coordinate with relevant federal and state agencies in addition to Mayflower Wind’s other outreach efforts (i.e., direct outreach, outreach via Fisheries Representatives) to notify commercial and recreational fishermen prior to initiation of the pre-lay grapnel run.

**5.5.3.1 WTGs/OSPs Foundations and Scour Protection**

The installation of WTG and OSP foundations for the Proposed Action would result in the loss of soft-bottom habitat (the only habitat type in the Lease Area), including fine sand and silt/mud areas with little
relief, in the foundation footprints as shown in Table 3.1-8. Though the installation of WTGs and OSPs would result in the loss of soft-bottom habitat, it would also result in the conversion of open-water habitat to hard, vertical habitat, which would attract and aggregate prey species through the artificial reef effect (Causon and Gill 2018; Taormina et al. 2018). During decommissioning, foundations that required pile driving for installation i.e., monopiles and piled jacket, will be cut an approved depth within the subsurface and subsequently pulled out of the seabed. GBS sit on the seabed, and therefore will not be left within the subsurface. Suction-bucket foundations may require pumps to allow them to be more easily removed from their position suctioned to the seabed.

5.5.3.1.1 Marine Mammals

The WTG and OSP foundations would introduce complex three-dimensional structures to the water column that could potentially alter the normal behavior of aquatic organisms in the Project area (see Section 5.5.7).

Sperm whales are known to prey on bottom-oriented organisms including octopus, fish, shrimp, crab, and sharks, suggesting that short-term construction and installation disturbance could affect the prey base for this species. The baleen whale species addressed in this consultation are pelagic filter feeders that do not forage in or rely on benthic habitats, although it is recognized that species such as fin whales periodically prey on forage fish such as herring that rely on benthic/complex habitats. As such, the disturbance and modification of complex habitats could lead to subsequent effects on foraging opportunities for marine mammals that rely on these resources. However, observations of fish community response to the development of other offshore wind facilities suggest there is little basis to conclude that habitat disturbance and modification would lead to a measurable long-term adverse effect on the availability of fish and invertebrate prey organisms. For example, monitoring studies of the Block Island Wind Farm and other European wind energy (Hutchison et al. 2020a; Methratta and Dardick 2019; Guarinello and Carey 2021) have documented increased abundance of demersal fish species that also prey on forage fish, likely attracted by increased biological productivity created by the reef effect these structures generate. While seabed disturbance and habitat modification may result in changes in prey availability for some marine mammal species, these effects would be short-term and localized and unlikely to have a measurable effect on the ability of marine mammals to find suitable prey elsewhere within their seasonal range. Therefore, the effects of the action on ESA-listed whales resulting from benthic habitat alteration are likely to be insignificant.

5.5.3.1.2 Sea Turtles

The disturbance and alteration of the seabed is unlikely to measurably affect ESA-listed sea turtles. Leatherback sea turtles are dietary specialists, feeding almost exclusively on pelagic jellyfish, salps, and siphonophores, meaning they would not be measurably affected by benthic habitat alteration. While green, Kemp’s ridley, and loggerhead sea turtles all feed on benthic organisms, short-term benthic habitat disturbances are unlikely to have measurable adverse effects on prey resources for these species. The project would avoid impacting submerged aquatic vegetation and would therefore avoid adversely affecting forage resources for green and Kemp’s ridley turtles. The loss of soft-bottom habitat in the Action Area could potentially affect Kemp’s ridley sea turtles, which forage in this type of habitat on crabs, mollusks, and other invertebrates (NMFS and USFWS 2007c). However, the habitat loss would be small relative to similar habitat available in the Action Area. Therefore, habitat loss associated with WTGs and OSPs would have an insignificant effect on Kemp’s ridley sea turtles. No effects of habitat loss are expected for other ESA-listed sea turtle species.

While the project would have a short-term impact on benthic prey resources, those effects would be short-term and limited to a fraction of the overall Action Area and an even smaller fraction of suitable foraging habitat in nearshore and offshore areas of the Atlantic OCS. Further, aggregation of prey species at WTG
and OSP foundations, such as crustaceans attracted to the artificial reef or encrusting bivalves, may benefit ESA-listed sea turtles due to prey aggregation, which may result in increased foraging opportunities for these species, attracting them to the structures. In the Gulf of Mexico, green, Kemp’s ridley, leatherback, and loggerhead sea turtles have been documented in the presence of offshore oil and gas platforms (Gitschlag and Herczeg 1994; Gitschlag and Renaud 1989; Hastings et al. 1976; Rosman et al. 1987), indicating that sea turtles are likely to use habitat created by in-water structures to forage. However, increased foraging opportunities are not expected to be biologically significant given the broad geographic range used by sea turtles on their annual foraging migrations compared to the localized scale of artificial reef effects for the Proposed Action.

Given that the affected area is naturally dynamic and exposed to anthropogenic disturbance, the species that occur in this region already adjust foraging behavior based on prey availability. Kemp’s ridley and green sea turtles are omnivorous species with flexible diets, and loggerhead sea turtles readily target new prey species to adapt to changing conditions. Given the limited amount of foraging habitat exposed to construction and installation disturbance, the short-term nature of these effects, and the ability of these species to adjust their diet in response to resource availability, the resulting adverse effects of benthic disturbance on these species would be **discountable**.

### 5.5.3.1.3 Fish

Long-term habitat alterations from soft bottom to hardbottom will occur during O&M of the Proposed Action through placement of monopiles and jacketed piles, scour protection, and cable protection. Scour protection would only be added in areas where boulders or other hard substrates are present on or immediately below the bed surface.

Overall, construction of the WTGs, OSPs, and scour protection would transform potential foraging habitat for Atlantic sturgeon into coarse, hard-bottom habitat (see Table 3.1-8 for seabed disturbance and scour protection amount by foundation type). The addition of the WTGs and OSPs is expected to result in a habitat shift in the area immediately surrounding each foundation from soft-sediment, open-water habitat system to a structure-oriented system, including an increase in fouling organisms. Over time (weeks to months), the areas with scour protection are likely to be colonized by sessile or mobile organisms (e.g., sponges, hydroids, and crustaceans). This results in a modification of the benthic community in these areas from primarily infaunal organisms (e.g., amphipods, polychaetes, and bivalves). Hard-bottom habitat 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 sturgeon compared to the surrounding soft-bottom habitat. Studies have demonstrated that WTG foundations and scour protection acted as artificial reefs with high species diversity and abundance of epibenthic species, comparable to that of a natural rocky reef (Coolen et al. 2018). The only forage fish anticipated to be impacted by these habitat alterations would be sand lance, as they are the most dependent on soft bottom habitat among forage fish species (Staudinger et al. 2020). As sand lance are strongly associated with sandy substrate, and the Proposed Action 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, considering the size of the Action Area, which is dominated by sandy substrate (Table 5.5-1), the loss or conversion of soft-bottom habitat would be very small compared to the surrounding habitat area. Atlantic sturgeon may also experience a reduction in infaunal benthic organisms, such as polychaete worms, in areas where soft substrate is lost or converted to hard substrate. This represents a small portion of the soft-bottom habitat available in this region. However, it is expected that, due to the highly mobile behavior of the sturgeon, the large foraging areas over which sturgeon search and forage for food (Smith et al. 1985; Johnson et al. 1997; Dadswell 2006), the opportunistic nature of the Atlantic sturgeon diet (Smith 1985), and the relatively small area of habitat
conversion compared to the wider continental shelf, long-term habitat conversion from soft to hard bottom habitat is expected to be so small that it cannot be meaningfully measured. Therefore, the effects of conversion of soft-bottom habitat to hard-bottom habitat on Atlantic sturgeon and their prey are expected to be so small they cannot be meaningfully measured, evaluated or detected and are therefore insignificant.

5.5.3.2 Cable Emplacement/Maintenance

The Proposed Action would install interarray cables in the Lease Area and export cables within the Falmouth and Brayton Point ECCs, as described in Section 3.1.2.4. For the Brayton Point landfall locations where sea-to-shore transition activities (HDD) would occur, the 2 cable bundles will split to 4 HDD exit pits at each landfall: south of Aquidneck Island, north of Aquidneck Island, at Brayton Point. The Falmouth landfall location would have four HDD exit pits. At each landfall option, the four HDD exit pits would be arranged in a cluster; maximum potential area of impact described in the subsections below includes potential temporary disturbances inclusive of exit pit, cofferdam, and support vessels. The below analysis is based on information from COP Appendix M.3 (Mayflower Wind 2022), which was compiled to assess impacts to EFH. Thus, the areas of impact to the benthic habitat described in Appendix M.3 is more refined relative to COP Volume 1 and BA Section 3.1.2.4, which presents maximum potential impact, as it provides greater information on the heterogenous habitat types encountered in the ECCs relative to the homogenous soft-bottom habitat of the Lease Area.

Potential areas of sand wave clearance and boulder removal in the ECCs are shown in Figure 5.5-1.

Sand Wave Clearance

Sand wave clearance over approximately five percent of the Falmouth ECC is expected, primarily in Muskeget Channel and Nantucket Sound. Portions of the Falmouth ECC where sand waves were mapped may require sand wave removal, where micro-siting of the cables cannot avoid these features. Up to 428.9 acres (173.6 hectares) that may be temporarily impacted by sand wave removal. The potential affected habitat includes 51.9 acres (21 hectares) of large grained complex habitat, 140.3 acres (56.8 hectares) of complex habitat and 236.7 (95.8 hectares) acres of soft bottom habitat.
Figure 5.5-1. Map of ECCs depicting segments where various seafloor preparation and installation temporary disturbance activities would occur

**Boulder Removal**

Boulder removal and/or clearance will occur where boulders are present and cannot be avoided with micro-siting. For the Lease Area, boulder field removal is not expected.

Portions of the Brayton Point ECC where boulders were mapped may require boulder removal (by grab) or clearance (by plow), where micro-siting of the cable bundles cannot avoid these boulders. The boulder grab will be used to the extent possible, and the use of the 49.2 ft (15-m) wide boulder plow will be minimized. Up to 1,134.6 acres (459.2 hectares) may be temporarily impacted by boulder removal. Habitat types potentially impacted include 3.7 acres (1.4 hectares) of anthropogenic habitat, 31 acres (12.5 hectares) of large grained complex habitat, 149.7 acres (60.6 hectares) of complex habitat, 55.8 acres (22.6 hectares) of heterogeneous complex habitat, and 894.4 acres (362 hectares) of soft bottom habitat.

Portions of the Falmouth ECC where boulders were mapped may require boulder removal (by grab) or clearance (by plow), where micro-siting of the cable bundles cannot avoid these boulders. The boulder grab will be used to the extent possible, and the use of the (49.2 ft) 15-m wide boulder plow will be minimized. Up to 497.8 acres (201.5 hectares) may be temporarily impacted by boulder removal. Potential habitats impacted include 144.0 acres (58 hectares) of large-grained complex habitat, 220.0 acres (89 hectares) of complex habitat, 17.3 acres (7 hectares) of heterogenous habitat, and 116.6 acres (47.2 hectares) of soft bottom habitat.
Pre-lay Grapnel Run and Cable Installation

A pre-lay grapnel run is expected to occur over the entirety of the ECCs and the interarray cable location to remove any remaining obstructions prior to cable installation. Temporary disturbance related to installation of the interarray cable is anticipated along the entire length of the interarray network. Cable installation across the entire interarray network would temporarily impact a total of ~191 to 1,081 acres (77.3 to 437.5 hectares) (~71.4 acres [28.9 hectares] of temporary seafloor disturbance area around all 149 foundations is not included). Only soft-bottom habitat types would be impacted in the Lease Area.

Temporary disturbance related to installation of the Brayton Point cables is anticipated along the entire length of the Brayton Point ECC and would impact a total of 453.8 acres (183.6 hectares) and up to ~463 to 593 acres (187.4 to 240 hectares). Habitat types potentially impacted include 1.5 acres (0.6 hectares) of anthropogenic habitat, 12.5 acres (5.05 hectares) of large grained habitat, 59.8 acres (24.2 hectares) of complex habitat, 22.3 acres (9.02 hectares) of heterogeneous complex habitat, and 357.7 acres (144.8 hectares) of soft bottom habitat. Temporary disturbance related to installation of the Falmouth cables are anticipated along the entire length of the Falmouth ECC and would impact up to 1,038 acres (420 hectares). Habitat types potentially impacted include 57.6 acres (23.3 hectares) of large grained complex habitat, 162.8 acres (65.8 hectares) of complex habitat, 7.1 acres (2.87 hectares) of heterogeneous complex habitat, and 404.9 acres (163.9 hectares) of soft bottom habitat. Cable installation tools for all cables would measure up to 19.7 feet (6 m) wide for all cable installation.

Cable Protection

The majority of the habitat impacted by interarray and export cable installation and seabed preparation are expected to return to pre-construction baseline conditions when the target burial is achieved. When cable burial cannot be achieved, cable protection will be installed. For the Proposed Action, the installation of cable protection for the Falmouth export cables would result in habitat conversion and loss for 61.5 to 103.8 acres (24 to 42 hectares) for up to five export cables. Potential habitat types impacted would be 57.6 acres (23.3 hectares) of large grained complex habitat, 162.8 acres (65.8 hectares) of complex habitat, 7.1 acres (2.8 hectares) of heterogeneous complex habitat, and 404.9 acres (163.8 hectares) of soft bottom habitat type. The installation of cable protection for the Brayton Point export cable would result in habitat conversion and loss for 68.1 acres (27.6 hectares) to 89.0 acres (28 to 36 hectares) for up to two cable bundles for Brayton Point. Habitat types potentially impacted include 1.5 acres (0.6 hectares) of anthropogenic habitat, 12.5 acres (5.05 hectares) of large grained complex habitat, 59.8 acres (24.2 hectares) of complex habitat, 22.3 acres (9.02 hectares) of heterogeneous complex habitat, and 357.7 acres (144.7 hectares) of soft bottom habitat. For the interarray cable, 26.3 to 115.2 acres (10.6 to 46.6 hectares) may be subject to cable protection measures. In the Lease Area, any area that requires cable protection would convert soft bottom habitat to hard bottom habitat. Variable amounts of conversion are expected in the ECCs, as some areas that require cable protection would be hard bottom habitat types and others may be soft bottom habitat types (i.e. mixed habitat types in Falmouth ECC). Cable protection may attract and aggregate prey species through the artificial reef effect (Causon and Gill 2018; Taormina et al. 2018).

HDD Exit Pits

Disturbance impacts from HDD exit pits are identified in Table 3.1-12. For Aquidneck Island intermediate landfalls, all potential impacts at these landfall options are located entirely in habitats crosswalked to the NOAA Complexity Category of complex due to the presence of Crepidula Substrate, with the exception of the Roger Williams University landfall which measured as 70 percent complex and 30 percent soft bottom. At the Brayton Point landfalls, the total for the Taunton River (Western) landing is 0.3 acres (0.12 hectares) as this landfall is located within a dredged material deposit. Alternatively, 0.24 acres (0.09 hectares) of soft bottom would be the maximum potential impact at the Lee River (Eastern)
landfall. The total maximum potential area of temporary impact would be 0.4 acres (0.16 hectares) for the Falmouth landfall. The three landfall locations for Falmouth all occur within soft-bottom habitats. The HDD cable installation methodology would avoid direct impacts to documented SAV near the Falmouth landfall.

### 5.5.3.2.1 Marine Mammals

The habitat conversion and loss effects associated with cable emplacement and maintenance activities for the Proposed Action on ESA-listed marine mammals is expected to be similar to the effect of habitat conversion associated with WTGs and OSPs and scour protection, but greatly reduced in scope (Section 5.5.3.1). There would be very limited impacts on the water column during the O&M phase from conversion to hard bottom habitat from cable protection in the form of rock berms and concrete mattresses. Reef effects may be expected for anywhere cable protection is present and anywhere boulders are relocated. Some areas where cables cannot be buried would be hard bottom habitats thus the addition of cable protection would not change the sediment type greatly. Sand wave clearance is only expected for 5 percent of the Falmouth ECC and impacts on forage fish would be similar to Section 5.5.3.1.3. The habitat impacts from a pre-lay grapnel run are unlikely to impact marine mammals or the species they feed upon relatively to the area available for forage for prey species and marine mammals. Given the small area of expected HDD impacts the effects of habitat conversion and loss on marine mammals would be extremely unlikely. The only permanent effects of cable emplacement expected are from cable protection and sand wave clearance, all other habitat conversion and loss impacts are expected to be temporary. Any effects on ESA-listed marine mammals are expected to be so small that they cannot be meaningfully measured, evaluated or detected and are therefore insignificant.

### 5.5.3.2.2 Sea Turtles

The effect of habitat conversion associated with cable emplacement and maintenance for the Proposed Action on ESA-listed sea turtles is expected to be similar to the effect of habitat conversion associated with WTGs and OSPs and scour protection, but greatly reduced in scope (Section 5.5.3.1). There would be very limited impacts on the water column during the O&M phase from conversion to hard bottom habitat from cable protection in the form of rock berms and concrete mattresses. Reef effects may be expected for anywhere cable protection is present and anywhere boulders are relocated. Some areas where cables cannot be buried would be hard bottom habitats thus the addition of cable protection would not change the sediment type greatly. Sand wave clearance is only expected for 5 percent of the Falmouth ECC and impacts on forage fish would be similar to Section 5.5.3.1.3. Given the small area of expected HDD impacts the effects of habitat conversion and loss on ESA-listed sea turtles would be extremely unlikely. The only permanent effects of cable emplacement expected are from cable protection and sand wave clearance, all other habitat conversion and loss impacts are expected to be temporary. Any effects on ESA-listed sea turtles are expected to be so small that they cannot be meaningfully measured, evaluated or detected and are therefore insignificant.

### 5.5.3.2.3 Fish

The effect of habitat conversion associated with cable emplacement and maintenance for the Proposed Action on Atlantic sturgeon is expected to be similar to the effect of habitat conversion associated with WTGs and OSPs and scour protection, but greatly reduced in scope (Section 5.5.3.1). There would be very limited impacts on the water column during the O&M phase from conversion to hard bottom habitat from cable protection in the form of rock berms and concrete mattresses. Reef effects may be expected for anywhere cable protection is present and anywhere boulders are relocated. Some areas where cables cannot be buried would be hard bottom habitats thus the addition of cable protection would not change the sediment type greatly. Sand wave clearance is only expected for 5 percent of the Falmouth ECC and impacts on forage fish would be similar to Section 5.5.3.1.3. Given the small area of expected HDD
impacts the effects of habitat conversion and loss on Atlantic Sturgeon would be extremely unlikely. The only permanent effects of cable emplacement expected are from cable protection and sand wave clearance, all other habitat conversion and loss impacts are expected to be temporary. Any effects on Atlantic sturgeon are expected to be so small that they cannot be meaningfully measured, evaluated or detected and are therefore insignificant.

5.5.3.3 Spuds/Anchors

Dynamic positioning vessels will generally be used for cable burial activities; within segments of the ECCs where anchoring has been identified as a potential option, anchoring using moored spreads may be used. Anchoring is more likely to occur within soft bottom habitats.

Vessels required for the construction phase of the Proposed Action could anchor at various locations throughout the offshore ECCs (Figure 5.5-1). Anchoring, including anchor chain sweep, will result in shallow drags in seafloor sediment. Jack-up vessels and heavy-lift barges will also disturb the seafloor within the footprint of the spuds during foundation installation. Disturbances will vary in magnitude as a result of several factors including: wave and current conditions, anchor size, seafloor characteristics at the anchoring site, and vessel drag distances.

Vessel anchoring during construction of the Proposed Action may temporarily disturb approximately 441.8 acres of benthic habitat in the Lease Area at WTG positions and in the ECCs but is not expected to result in significant habitat loss or conversion in the Action Area as each anchor is estimated to be 5 meters in diameter. Although up to 203 anchor points could be used in the Brayton Point corridor, anchors will be spaced every 270 m totaling 0.98 acres of impact in largely soft-bottom habitats. This equates to 1 to 5 acres of temporary impact, to allow for length differences related to the full PDE, in the Brayton Point ECC over mostly soft-bottom habitat. In the Falmouth ECC, 211 anchor point would be used spaced every 270 meters for a total of 1.02 acres of impact, however, similar to the Brayton Point ECC a conservative estimate of 1 to 5 acres of impact is expected. Anchoring in the Falmouth ECC would occur in both soft-bottom habitats and heterogenous complex habitats. Vessel anchoring may result in temporary disturbance of bottom sediments during export cable installations. Temporary, short-term, direct effects associated with vessel anchoring include mortality or injury of slow-moving or sessile species within the affected area of spuds, vessel anchor, or anchor chain. The extent of the effects will vary based on vessel type, number, and duration.

The footprint of the jack-up vessel spuds on the seafloor is estimated at 0.37 ac (0.15 ha) per jack-up vessel (including all jack-up legs). During installation, there may be 6 to 8 vessel visits for the WTG locations and four visits to OSPs.

Seabed disturbance from vessel anchoring during the decommissioning phase is anticipated to be of the same magnitude as the construction phase when similar vessels will be required.

5.5.3.3.1 Marine Mammals

The effect of habitat conversion and loss associated with spuds/anchoring for the Proposed Action on ESA-listed marine mammals is relatively small compared to WTGs/OSP foundation and scour protection and cable presence/protection. The 441.8 acres impacted by spuds/anchoring includes the entire Project area. This means small, dispersed areas of benthic habitat will be impacted over the course of construction. Benthic habitats are expected to recover from far more invasive installation activities than anchoring (Section 5.5.3.2), thus there would be no expectation that benthic habitats temporarily impacted by anchoring would result in long-term habitat conversion or loss. Given this small, localized, temporary reduction in benthic habitat of vessel anchoring during construction any effects on ESA-listed marine
mammals are expected to be so small that they cannot be meaningfully measured, evaluated, or detected and are, therefore, insignificant.

**5.5.3.3.2 Sea Turtles**

The effect of habitat conversion and loss associated with mats/anchoring for the Proposed Action on ESA-listed sea turtles is expected to be greatly reduced from WTGs/OSPs foundation and scour protection and cable presence/protection. The 441.8 acres impacted by spuds/anchoring includes the entire Project area. This means small, dispersed areas of benthic habitat will be impacted over the course of construction. Benthic habitats are expected to recover from far more invasive installation activities than anchoring (Section 5.5.3.2, 5.5.4), thus there would be no expectation that benthic habitats temporarily impacted by anchoring would result in long-term habitat conversion or loss. Given this small, localized, temporary reduction in benthic habitat of vessel anchoring during construction any effects on ESA-listed sea turtle species are expected to be so small that they cannot be meaningfully measured, evaluated, or detected and are, therefore, insignificant.

**5.5.3.3.1 Fish**

The effect of habitat conversion associated with mats/anchoring for the Proposed Action on ESA-listed fish species is expected to be greatly reduced from WTGs/OSPs foundation and scour protection and cable presence/protection. The 441.8 acres impacted by spuds/anchoring includes the entire Project area. This means small, dispersed areas of benthic habitat will be impacted over the course of construction. Benthic habitats are expected to recover from far more deleterious impacts than anchoring (Section 5.5.3.2, 5.5.4), thus there would be no expectation that benthic habitats temporarily impacted by anchoring would result in long-term habitat conversion or loss. Given this small, localized, temporary reduction in benthic habitat during construction any effects on Atlantic sturgeon are expected to be so small that they cannot be meaningfully measured, evaluated, or detected and are, therefore, insignificant.

**5.5.4 Turbidity**

Construction activities with the potential to disturb bottom sediments include: vessel anchoring (including spuds), foundation and scour protection installation, installation of WTG, OSP, interarray, export, and sea-to-shore transition cables and any seafloor preparation activities. These activities would disturb bottom sediment, resulting in short-term increases in turbidity in the Action Area.

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

During cable installation, jet plowing is expected to produce maximum TSS concentrations of approximately 235.0 mg/L at 65 feet (20 meters) from the jet plow, with concentrations decreasing to 43.0 mg/L within 656 feet (200 meters) (NMFS 2020 citing ESS Group 2008). Further, jet plowing typically releases more turbidity than mechanical methods and is considered the worst-case installation method for this effects analysis. Sediment transport analysis conducted for the Proposed Action predicted that redeposition of suspended sediments occurs quickly before being transported long distances. Total suspended solid concentrations above 100 milligrams per liter (mg/L) (0.0008 pounds per gallon) extended a maximum of 1,214 feet (370 meters) for any scenario except for nearshore areas of the Brayton Point corridor, where they extended to just over 1 kilometer (0.62 mile). The maximum total suspended solid level dropped below 10 mg/L (0.00008 pounds per gallon) within 2 hours for all simulated scenarios and dropped below 1 mg/L (0.000008 pounds per gallon) within 4 hours for any
scenario except for nearshore areas of the Brayton Point corridor, where 100 mg/L and 10 mg/L concentrations lasted for less than 5 hours and a little over 2 days, respectively. Deposition thicknesses exceeding 0.20 inches (5 millimeters) were generally limited to a corridor with a maximum width of 79 feet (24 meters) around the cable routes but reached a maximum of 590 feet (180 meters) from the centerline for the interarray cables (COP Appendices F1 and F3; Mayflower Wind 2022).

Modeling results of suction dredging for the HDD exit pit indicate that elevated TSS levels will impact a limited area. For both neap and spring tides sediment concentrations exceeding 10 mg/l (0.00008 lb/gal) are found at a maximum distance of 230 meters (755 feet) and 150 meters (492 feet), the impacted areas are respectively 1.7 hectares (4.2 acres) and 1.5 hectares (3.7 acres). Similarly, deposited sediments, exceeding 5 mm, for the neap and spring tides are expected to occur 26 meters (85 feet) and 32 meters (105 feet) from the HDD exit location. Given the static nature of dredging at the HDD exit pit, sediment deposition is expected to be greater than deposition from jet plowing for cable installation.

During Project operation, routine maintenance activities, as described in Section 3.1.2.4, could result in short-term increases in turbidity in the Action Area. Any increases in TSS concentrations would occur in the Project area and are not expected to exceed background levels associated with natural events (Mayflower wind 2022).

Decommissioning activities would include removal and/or decommissioning of all Proposed Action infrastructure and clearance of the seabed of all obstructions at the end of the Proposed Action’s designed service life, as described in Section 3.1.2.9 Some activities would result in bottom disturbance, resulting in short-term increase in turbidity in the Action Area. Impacts during decommissioning, including turbidity impacts, are expected to be similar or less than those experienced during construction (Mayflower Wind 2022).

5.5.4.1 Marine Mammals

As marine mammals may occur within portion of the Action Area affected by pile driving, cable laying, and dredging during construction, as well as O&M and decommissioning activities, increased turbidity associated with the Proposed Action could potentially affect these species. There are no data on the physiological effects of suspended sediment on whales. However, elevated suspended sediment may cause these species to alter their normal movements. Such alterations are expected to be too small to be meaningfully measured or detected (Johnson 2018; Todd et al. 2015). No effects are anticipated if whales swim through the area of elevated suspended sediment. Suspended sediment is most likely to impact whales if the area of elevated concentrations acts as a barrier to normal behaviors. However, whales are expected to swim through sediment plumes or avoid the area of increased turbidity with no adverse effects. If elevated turbidity causes any behavioral responses, such behaviors would be temporary (Todd et al. 2015).

Sediment plumes associated with Project activities would be localized and short term. The plumes generated by pile driving are expected to extend up to 300 feet (91 meters). The plumes generated from the jet plow installation of the Falmouth ECC are expected to extend up to 3,126 feet (953 meters) to a depth of 0.02 inches (0.05 centimeters) sediment deposition thickness. The plumes generated from the jet plow installation of the Brayton Point ECC are expected to extend up to 267 meters to a depth of 0.02 inches (0.05 centimeters) sediment deposition thickness (Section 5.5.4). Given the limited spatial scale of the sediment plumes relative to the size of the Action Area, increased suspended sediment concentrations associated with Project activities are not expected to obstruct the movement of marine mammals in the Action Area.

As described in Johnson (2018), NMFS has determined that elevated TSS could result in effects on listed whale species under specific circumstances (e.g., high TSS levels over long periods during dredging
operations). In general, marine mammals are not subject to impact mechanisms that injure fish (e.g., gill clogging, smothering of eggs and larvae), so injury-level effects are unlikely. Behavioral impacts, including avoidance or changes in behavior, increased stress, and temporary loss of foraging opportunity, could occur but only at high TSS levels (Johnson 2018). Todd et al. (2015) postulated that dredging and related turbidity impacts could affect the prey base for marine mammals, but the significance of those effects would be highly dependent on site-specific factors. Given that presence of ESA-listed marine mammals is focused on offshore areas that may experience up to 100 mg/L 131 feet (40 meters) from the source for less than 20 minutes, the small-scale and short-term changes from construction and decommissioning activities that increase turbidity (e.g., interarray and export cable installation and vessel anchoring) are not likely to have measurable effects on ESA-listed whales and is insignificant.

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

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

NARWs feed almost exclusively on copepods. Of the different kinds of copepods, NARWs feed especially on late-stage Calanus finmarchicus, a large calanoid copepod (Baumgartner et al. 2007), as well as Pseudocalanus spp. and Centropages spp. (Pace and Merrick 2008). Because a right whale’s mass is 10 or 11 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 in the North Atlantic eat pelagic crustaceans (mainly euphausiids or krill) and schooling fish such as capelin, herring, and sand lance. 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. 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 hunt for food during deep dives, with feeding occurring at depths of 1,640 to 3,281 feet (500 to 1,000 meters) (NMFS 2010b). Deepwater squid make up the majority of their diet (NMFS 2010b). Given the shallow depths of the Project area where sedimentation would occur, it is extremely unlikely that any sperm whales would be foraging in the area affected by sedimentation and extremely unlikely that any potential sperm whale prey would be affected by sedimentation.
Copepods exhibit diel vertical migration; that is, they migrate downward out of the euphotic zone at dawn, presumably to avoid being eaten by visual predators, and they migrate upward into surface waters at dusk to graze on phytoplankton at night (Baumgartner and Fratantoni 2008; Baumgartner et al. 2011). Baumgartner et al. (2011) conclude that there is considerable variability in this behavior and that it may be related to stratification and presence of phytoplankton prey with some copepods in the Gulf of Maine remaining at the surface and some remaining at depth. Because copepods even at depth are not in contact with the substrate, no burial or loss of copepods is anticipated during installation of the cable. No scientific literature could be identified evaluated the effects on marine copepods resulting from exposure to TSS. Based on what is known about effects of TSS on other aquatic life, it is possible that high concentrations of TSS could negatively affect copepods. However, given that 1) the expected TSS levels are below those that are expected to result in effects on even the most sensitive species evaluated; 2) the sediment plume would be transient and temporary (i.e., persisting in any one area for no more than 3 hours); 3) elevated TSS is limited to the bottom 9.8 feet (3 meters) of the water column; and 4) elevated TSS plumes would occupy only a small portion of the Action Area at any given time, any effects on copepod availability, distribution, or abundance on foraging whales would be so small that they could not be meaningfully evaluated, measured, or detected.

As explained, elevated TSS would 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) reviewed available information on the effects of exposure of estuarine fish and shellfish to suspended sediment. In an assessment of available information on sublethal effects on non-salmonids, they report that the lowest observed concentration-duration combination eliciting a sublethal response in white perch (*Morone americana*) was 650 mg/L for 5 days, which increased blood hematocrit (Sherk et al. 1974, in Wilber and Clarke 2001).

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

Based on the anticipated non-detectable changes in marine mammal movements, the effects of elevated turbidity associated with the Proposed Action would be too small to be meaningfully measured, detected, or evaluated. Therefore, the effects of increased turbidity on marine mammals would be insignificant. Any effects from increased turbidity levels from construction activities on marine mammals or their prey is so small that they could not be measured, detected, or evaluated and are therefore insignificant. Therefore, the effects of increased turbidity levels from Project construction activities may affect, not likely to adversely affect ESA-listed marine mammals.

### 5.5.4.2 Sea Turtles

As sea turtles may occur within portions of the Action Area affected by pile driving, cable laying, and dredging during construction, as well as O&M and decommissioning activities, increased turbidity associated with Project activities could potentially affect these species. There are no data on the physiological effects of suspended sediment on sea turtles. However, elevated suspended sediment may cause sea turtles to alter their normal movements and behaviors as sea turtles would be expected to avoid the area of elevated suspended sediment. Such alterations are expected to be too small to be meaningfully measured or detected (NMFS 2020). No effects are anticipated if sea turtles swim through the area of elevated suspended sediment. Suspended sediment is most likely to impact sea turtles if the area of
elevated concentrations acts as a barrier to normal behaviors. However, no adverse effects are anticipated due to sea turtles swimming through the area of elevated suspended sediment or avoiding the area (NMFS 2020). In addition to direct effects on sea turtle behavior, suspended sediment can indirectly affect sea turtles through impacts on prey species, including benthic mollusks, crustaceans, sponges, and sea pens. Elevated suspended sediment concentrations are shown to have adverse effects on benthic communities when they exceed 390 mg/L (NMFS 2020 citing USEPA 1986).

As described in Section 5.5.4, the suspended sediment plumes associated with Project activities would be localized and short term. The maximum sediment plume radius generated by the Proposed Action would be 3,280 feet (1,000 meters), associated with jet plowing in high current areas. Given the limited spatial scale of the sediment plumes relative to the size of the Action Area, increased suspended sediment concentrations associated with Project activities are not expected to obstruct the movement of sea turtles in the Action Area.

The maximum suspended sediment concentrations (5 to 10 mg/L) associated with pile driving and jet plowing (235 mg/L) are below the threshold that could have negative impacts on benthic communities (390 mg/L). It is anticipated there would be a short-term impact on the availability of prey species within the area of direct impact; however, it is anticipated that this area would be recolonized within a short period of time after the completion dredging. Because the habitat disturbance would affect a relatively small amount of the Action Area and because of the short-term nature of the disturbance, the Project is expected to result in negligible reductions in benthic shellfish and infaunal organisms that serve as prey for ESA-listed species (NMFS 2020), including sea turtles.

Based on the anticipated non-detectable changes in sea turtle movements and the negligible reductions in prey species, the effects of elevated turbidity associated with the Proposed Action would be too small to be meaningfully measured, detected, or evaluated. Therefore, the effects of increased turbidity on sea turtles would be insignificant.

### 5.5.4.3 Fish

As ESA-listed fish species may occur within portions of the Action Area affected by pile driving, cable laying, and dredging during construction, as well as O&M and decommissioning activities, increased turbidity associated with Proposed Action activities could potentially affect this species. Studies of the effects of turbid water on fish suggest that concentrations of suspended sediment can reach thousands of milligrams per liter before an acute toxic reaction is expected (NMFS 2020 citing Burton 1993). TSS levels shown to have adverse effects on fish are typically above 1,000 mg/L (see summary of scientific literature in Burton 1993; Wilber and Clarke 2001). Potential physiological effects of suspended sediment on fish include gill clogging and increased stress (NMFS 2017). High TSS levels can cause a reduction in dissolved oxygen (DO) levels, and Atlantic sturgeon may become stressed when DO falls below certain levels (NMFS 2020). Increased turbidity can also result in behavioral effects in fish, such as foraging interference or inhibition of movement (NMFS 2017). However, increased turbidity is not expected to impact the ability of Atlantic sturgeon to forage as they are not visual foragers. Sturgeon rely on their barbels to detect prey and are known to forage during nighttime hours (NMFS 2017). Suspended sediment concentrations below those required for physiological impacts are not expected to inhabit sturgeon movement (NMFS 2017). While the increase in turbidity associated with the Proposed Action may cause Atlantic sturgeon to alter their normal movements, these minor movements would be too small to be meaningfully measured or detected. TSS is most likely to affect sturgeon if a plume causes a barrier to normal behaviors. However, Atlantic sturgeon are expected to swim through the plume and otherwise avoid the area with no adverse effects (NMFS 2020). Increased suspended sediment concentrations could also affect Atlantic sturgeon indirectly by affecting benthic prey species. TSS levels are shown to have adverse effects on benthic communities when they exceed 390.0 mg/L (NMFS 2020 citing USEPA 1986).
As described in Section 5.5.4, the suspended sediment plumes associated with Project activities would be localized and short term. The maximum sediment plume radius generated by the Proposed Action would be 3,280 feet (1,000 meters), associated with jet plowing in high current areas. Given the limited spatial scale of the sediment plumes relative to the size of the Action Area, increased suspended sediment concentrations associated with Project activities are not expected to obstruct the movement of Atlantic sturgeon in the Action Area.

It is anticipated that there will be a short-term impact on the availability of prey species within the area of direct impact; however, it is expected that this area will be recolonized within a short period of time after dredging is complete. Due to the small area in which benthic communities could be impacted relative the Action Area and the short-term nature of the impact, the Proposed Action is expected to result in negligible reductions in benthic shellfish and infaunal organisms that serve as prey for ESA-listed species (NMFS 2020), including Atlantic sturgeon.

Given that suspended sediment concentrations associated with the Proposed Action would be below physiological thresholds for sturgeon and reductions in foraging opportunities for Atlantic sturgeon would be negligible, the effects of increased turbidity are too small to be meaningfully measured, detected, or evaluated. Therefore, turbidity effects on ESA-listed Atlantic sturgeon would be insignificant.

5.5.5 Dredging

The short-term and long-term impacts of dredging to the benthic environment that have the potential to effect ESA-listed species are discussed in 5.5.3.1 and 5.5.3.2 and 5.5.4. During seabed preparation, mechanical dredges would be stationary during dredging activities, cutter suction dredges, trailing suction hopper dredges, and water injection dredges are expected to move at speeds between 1 to 3 knots while dredging (Reilly 1950).

The physical presence of dredging, during habitat disturbance/modifications activities on ESA-listed species is discussed below.

5.5.5.1 Marine Mammals

Marine mammals are not vulnerable to entrainment, impingement, or capture in dredge equipment, and ESA-listed marine mammals in the Project area, where dredging would occur, do not consume benthic prey species that may be captured in dredge equipment. Therefore, the effects of dredging associated with the Proposed Action leading to physical interactions with the dredge or reduction in prey availability would have no effect on ESA-listed whale species.

5.5.5.2 Sea Turtles

Mechanical dredging, including the use of a clamshell dredge, is not expected to capture, injure, or kill sea turtles (USACE 2020). Sea turtles are generally not vulnerable to entrainment in hydraulic dredges due to the small intake and relatively low intake velocity (NMFS 2018b). Hopper dredges may strike, impinge, or entrain sea turtles, which may result in injury or mortality (Ramirez et al. 2017 citing Dickerson et al. 1990; Ramirez et al. 2017 citing Dickerson et al. 1991; Ramirez et al. 2017 citing Reine et al. 1998; Ramirez et al. 2017 citing Richardson 1990). The sea turtle species most often affected by dredge interactions is loggerhead sea turtles, followed by green sea turtles, then Kemp’s ridley sea turtles (Ramirez et al. 2017).

Sea turtles are most vulnerable to interactions with dredges when foraging on or near the bottom. As Kemp’s ridley sea turtle is the only species that forages in soft bottom habitats where dredging for the Project would occur, this species is likely at the highest risk. However, other sea turtle species are also expected to occur in the dredge area and have the potential to interact with dredge equipment. The risk of
interactions between hopper dredges and sea turtles is expected to be low in the offshore environment where dredging for offshore seabed preparation would most likely occur (Michel et al. 2013; NMFS 2020b). Given the low likelihood of effects, the effects of physical interactions associated with dredging for the Proposed Action leading to injury or mortality is **not likely to adversely affect (discountable)** ESA-listed sea turtles.

Prey entrainment or benthic disturbance associated with dredging for the Proposed Action has the potential to reduce prey availability for ESA-listed sea turtle species that forage in soft bottom habitats (i.e., Kemp’s ridley sea turtle). These effects would be localized and short-term. Recolonization and recovery of prey species is expected to occur within 2 to 4 years (Van Dalfsen and Essink 2001) but could occur in as little time as 100 days (Dernie et al. 2003). Based on the short-term and localized nature of effects, the relatively small area affected, and the availability of similar foraging habitat throughout the Action Area, the effect of benthic habitat disturbance associated with dredging for the Proposed Action on Kemp's ridley sea turtles would be too small to be meaningfully measured or detected. Direct dredging impacts would be dispersed throughout the Project area directly impacting approximately 430 acres of 127,891 acres of Project area or approximately 0.3 percent of the Project area. Research on benthic recovery has found that shallow, sandy environments exposed to strong natural disturbances typically recover quickly as strong bottom currents and storms infill anthropogenically disturbed patches of sediment (Meyer et al. 1981; Dernie et al. 2003). Additionally, benthic communities in high energy, shallow areas with surficial sediment movement are thought to be disturbance-adapted and quicker to recover from anthropogenic disturbances (Collie et al. 2000). Given the small scale of anticipated effects, the effects of prey entrainment and benthic disturbance associated with dredging for the Proposed Action leading to reduced prey availability is **not likely to adversely affect (insignificant)** Kemp’s ridley sea turtle. As green, leatherback, and loggerhead sea turtles do not forage in soft bottom habitats, the effects of prey entrainment and benthic disturbance associated with dredging for the Proposed Action leading to reduced prey availability would have **no effect** on these species.

### 5.5.5.3 Fish

Impacts from dredging during construction, could affect ESA-listed marine fish through impingement, entrainment, and capture associated with hydraulic dredging techniques.

Dredging during construction could carry a variety of impacts on Atlantic sturgeon related to injury and mortality associated with dredging techniques as well as impacts on prey. Adult Atlantic sturgeon are thought to have low abundance in the Project area (Dunton et al. 2010). The risk of interactions between sturgeon and dredges is thought to be highest in areas where large numbers of sturgeon are known to aggregate. There are no known areas of sturgeon aggregations within the Project area for dredging for the Proposed Action. The risk of capture may also be related to the behavior of the sturgeon in the area. While foraging, sturgeon are at the bottom interacting with the sediment (Dadswell 2006). This behavior may increase the susceptibility of capture with a dredge bucket. For entrapment to occur, an individual sturgeon would have to be present directly below the dredge bucket at the time of operation. The risk of Atlantic sturgeon entrapment in mechanical dredges is low given the small area affected by the clamshell and the slow lowering speed of the bucket (NMFS 2018c).

Given the rarity of sturgeon in the areas to be dredged, the co-occurrence of an Atlantic sturgeon and the draghead is extremely unlikely. As such, entrapment of sturgeon during the temporary performance of dredging operations is also extremely unlikely. Due to their bottom foraging and swimming behavior, adult Atlantic sturgeon have been known to become entrained in hydraulic-cutterhead dredges as they move across the seabed (Novak et al. 2017; Balazik et al. 2020; NMFS 2022b). Studies of sturgeon vulnerability to hydraulic dredges have demonstrated that fish would have to be within 3.3 to 6.6 feet (1 to 2 meters) of the dredge head to be at risk of entrainment (Boysen and Hoover 2009; Clarke 2011; Hoover et al. 2011). Therefore, the overall risk of Atlantic sturgeon entrapment in a hydraulic cutterhead
dredge is low. Further, there is a lack of attraction or deterrence relationship observed between Atlantic sturgeon and dredges, the likelihood of effects on Atlantic sturgeon from dredging is low (Balazik et al. 2020; NMFS 2022b).

Sturgeon are vulnerable to entrainment in suction hopper dredges. However, this vulnerability is largely limited to juvenile sturgeon, which do not have the swimming capabilities of larger adults and are more likely to engage in bottom-holding behaviors (Hoover et al. 2011). Most Atlantic sturgeon in the offshore environment are expected to be larger subadults and adults, reducing sturgeon vulnerability to entrainment in suction hopper dredges in areas where dredging for the Proposed Action would occur. Given the life stages most likely to be present and the patchy distribution of Atlantic sturgeon in the offshore environment, interactions with suction hopper dredges are expected to be unlikely. Given the low likelihood of effects, the effects of physical interactions associated with dredging for the Proposed Action leading to injury or mortality is not likely to adversely affect (discountable) Atlantic sturgeon.

Juvenile Atlantic sturgeon are known to inhabit estuarine environments for up to a year before migrating out into the ocean (ASMFC 2012). Though the presence of SAV has been recorded in the Falmouth ECC that occurs in Massachusetts state waters, no known strong association has been documented between juvenile Atlantic sturgeon and SAV (ASMFC 1997). Additionally, only one Atlantic sturgeon was captured in a total of 5,563 bottom trawls in depths from 4 to 86 m occurring in the spring and fall from 1978 to 2007 (Dunton et al. 2010). It is not anticipated that dredging due to inshore export cable installation would impact juvenile Atlantic sturgeon.

Atlantic sturgeon prey upon small bottom-oriented fish such as the sand lance, mollusks, polychaete worms, amphipods, isopods, and shrimp, with polychaetes and isopods being the primary and important groups consumed in the Project area (Smith 1985, Johnson et al. 1997, Dadswell 2006). Sand lance could become entrained in a hydraulic dredge due to their bottom orientation and burrowing within sandy sediments that require clearing by the Proposed Action. Reine and Clarke (1998) found that not all fish entrained in a hydraulic dredge are expected to die. Studies summarized in Reine and Clarke (1998) indicate a mortality rate of 37.6 percent for entrained fish. It is expected that dredging in sand waves to allow for cable installation will result in the entrainment and mortality of some sand lance. Given the size of the area where dredging will occur and the short duration of dredging, Benthic infauna and epifauna will likely experience 100 percent mortality. However, given the size of the area where dredging will occur, the short duration of dredging, the loss of benthic invertebrates and sand lance will be small, temporary, and localized, and the opportunistic feeding nature of Atlantic sturgeon, it is expected any impact of the loss of Atlantic sturgeon prey items to be so small that it cannot be meaningfully measured, evaluated, or detected. Therefore, the effects of entrainment from the Project dredging leading to injury or mortality are discountable for ESA-listed Atlantic sturgeon.

### 5.5.6 Trenching

The noise and benthic effects for trenching are described in Sections 5.2.3, 5.2.4, 5.5.3.2, 5.5.3.3, and 5.5.4. For effect analysis purposes, trenching is defined here as any activity associated with cable burial/direct installation (i.e., trenching does not include seafloor preparation), seafloor preparation activities are achieved through dredging for seabed leveling and removal of sand waves and plows and grabbers for boulder removal. Dredging is expected primarily to occur in the Lease Area for foundation installation, with the exception of sand wave clearance described in Section 5.5.3.2 which will occur over 5 percent of the Falmouth ECC. The main seafloor preparation activity, for cable installation is boulder removal.

While there are six pieces of equipment potentially used for trenching in the ECCs and four pieces of trenching equipment for the interarray cables, equipment would either be mechanical or jetting (Section 3.1.2.4). All trenching activities are expected to be conducted during the summer months. From the
turbidity modeling conducted for the proposed action, trenching in the Falmouth ECC would take approximately 18.5 days, approximately 14.2 days would occur at distances 12 miles (20 km) to 55 miles (88 km) offshore in depths ranging from 69.26 feet (21.11 m) to 130.6 feet (39.81 m) the advance rate (movement of the equipment forward) is 0.1 mi/hr (200 m/hr). From the landfall location to 12 miles (20 km) offshore in depths ranging from 14.33 ft (4.37 m) to (20.06 m) trenching activities are expected to last 4.2 days at the same advance rate.

In the Brayton Point ECC, using the same jetting or mechanical trenching methods and the same advance rate the total duration of trenching activities is 30.3 days. Trenching activity in Mount Hope Bay is expected over 5.9 mi (9.5 km) for a duration of 47.5 hours at depths ranging from 3.2 ft -32 feet (1 to 10 m). Trenching activity in the Sakonnet River is expected over 11.2 mi (18 km) for a duration of 90 hours at depths ranging from 26.2 ft to 65.6 ft (8 m to 20 m). Trenching activity offshore is expected over 73.3 mi (118 km) for a duration of 590 hours at depths ranging from 26.25 ft to 65.6 ft (20 m to 40 m).

For trenching of the interarray cables in the Lease Area, a mechanical cutting or jetting ROV would be used. The advance rate is the same as export cable installation and trenching activity is expected over a maximum of 497.1 miles (800 km) in depths ranging from 124.6 ft to 206.69 (38 m to 63 m).

The physical presence of trenching equipment on ESA-listed species is discussed below.

### 5.5.6.1 Marine Mammals

Marine mammals are not vulnerable to entrainment, impingement, or capture in trenching equipment. ESA-listed marine mammals in the Project area, where trenching would occur, do not consume benthic prey species that may be killed by trenching equipment. Therefore, the effects of dredging associated with the Proposed Action leading to physical interactions with trenching equipment or reduction in prey availability would have **no effect** on ESA-listed whale species.

### 5.5.6.2 Sea Turtles

Sea turtles are not vulnerable to entrainment, impingement, or capture in trenching equipment, given the slow speeds of trenching equipment, it would be extremely unlikely that the effects of trenching leading to a physical interaction would occur. As discussed, earlier impacts on prey from cable laying are likely insignificant from turbidity effects. Further, the width of direct impacts from trenching (i.e. the area directly impacted by jetting/cutting), is expected to be 3.3 ft (1 m) in width, relative to the foraging area for sea turtles this amounts to a small area of potential direct mortality for prey items. Therefore, the effects of the physical interactions with trenching equipment would have **no effect** on sea turtles.

### 5.5.6.3 Fish

Atlantic sturgeon are not vulnerable to entrainment, impingement, or capture in trenching equipment, given the slow speeds of trenching equipment, it would be extremely unlikely that the effects of trenching leading to a physical interaction would occur. As discussed, impacts on prey from cable laying are likely insignificant from turbidity effects. Further, the width of direct impacts from trenching (i.e. the area directly impacted by jetting/cutting), is expected to be 3.3 ft (1 m) in width, relative to the foraging area for sea turtles this amounts to a small area of potential direct mortality for prey items. Therefore, the effects of the physical interactions with trenching equipment would have **no effect** on Atlantic sturgeon.

### 5.5.7 Presence of WTGs on Atmospheric/Oceanographic Conditions

Offshore wind facilities have the potential to impact atmospheric and oceanographic processes through the presence of structures and the extraction of energy from the wind. There has been extensive research into characterizing and modeling atmospheric wakes created by wind turbines in order to design the
layout of wind facilities and predict seabed scour but relatively few studies have analyzed the hydrodynamic wakes coupled with the interaction of atmospheric wakes with the sea surface. Further, even fewer studies have analyzed wakes and their impact on regional scale oceanographic processes and potential secondary changes to primary production and ecosystems. Studies thus far in this topic have focused on ocean modeling rather than field measurement campaigns.

**Oceanographic Effects due to Changes in Atmospheric Conditions**

Human-made structures, especially tall vertical structures such as foundations, alter local water flow at a fine scale by potentially reducing wind-driven mixing of surface waters or increasing vertical mixing as water flows around the structure (Carpenter et al. 2016; Cazenave et al. 2016; Segtnan and Christakos 2015). This atmospheric wake phenomenon affects hydrodynamic processes such as:

- Advection and Ekman transport are directly correlated with shear wind stress at the sea surface boundary. Vertical profiles from Christiansen et al. (2022) exhibited reduced mixing rates over the entire water column. As for the horizontal velocity, the deficits in mixing were more pronounced in deep waters than in well-mixed, shallow waters, which is likely favored by the influence of the bottom mixed layer in shallow depths. In both cases, the strongest deficits occur near the pycnocline depth.

- Additional mixing downstream has been documented from Kármán vortices and turbulent wakes due to the pile structures of wind turbines (Carpenter et al. 2016; Grashorn and Stanev 2016; Schultze et al. 2020).

- Up-welling and down-welling dipoles under contact of constant wind directions affecting average surface elevation of waters have been documented as the result of offshore wind farms (Brostörm 2008; Paskyabi and Fer 2012; Ludewig 2015). Mean surface variability was between 1 and 10 percent.

- With sufficient salinity stratification, vertical flow of colder/saltier water to the surface occurs in lower sea surface level dipoles and warmer/less saline water travels to deeper waters in elevated sea surface heights (Ludewig 2015; Christiansen et al. 2022). This observation also suggested impacts on seasonal stratification, as documented in Christiansen et al. (2022). However, the magnitude of salinity and temperature changes with respect to vertical structures is small compared to the long-term and interannual variability of temperature and salinity.

A study of atmospheric wake effects by Daewel et al. (2022) contains model results of a hypothetical build out of 24,000 5 MW WTGs at a hub height of 90 meters in the North Sea. The modeling results showed that extremely large clusters of offshore wind turbines provoke large scale changes in annual primary productivity. The model demonstrated that an extremely large cluster of 24,000 WTGs could result in a relatively strong increase in biomass in stratified seas and in less stratified and mixed seas. Despite the modeled changes in primary productivity, the authors state that “it is difficult to conclude on the overall trophic response, since the average fractional change in biomass is very small and shows a large regional variation” (Daewel et al. 2022). Therefore, this model showed that although very large numbers of WTGs may result in impacts on the forces driving the mixing of surface waters, only small changes in primary productivity may occur that may not be discernable from natural variation observed in the North Sea. Although detectable changes to the atmospheric forces that could affect surface mixing may occur, the influence of these impacts on biological productivity are likely minor, especially considering the much lower number of WTGs that are estimated to be built on the Atlantic OCS than were modeled by Daewel et al. (2022).

Another study of the potential impacts of atmospheric wind wakes of the larger-sized WTGs expected in U.S. waters (10–15 MW) (Golbazi et al. 2022) showed smaller surface effects from the wind wakes than
other modeling efforts on smaller turbines (5 MW) in the North Sea (Daewel et al. 2022). The authors state that the higher turbine hub heights are “key” to this difference and the research concludes “the results of this study indicate that, on average, meteorological changes at the surface induced by next-generation extreme-scale (diameter and hub height greater than 150 and 100 meters, respectively) offshore wind turbines will be nearly imperceptible.” These findings introduce uncertainty in interpretation of the scale of potential impacts reported from Daewel et al. (2022) on sea surface and stratification and, thus, on regional hydrodynamics due to the higher hub heights (130-150 meters) planned for use in U.S. projects than those studied in Europe (90 meters; Akhtar et al. 2022; Christiansen et al. 2022; Daewel et al. 2022).

The presence of a large number of smaller WTGs on the OCS may weaken the regional thermocline and affect heat storage, atmospheric CO₂ uptake, and benthic resupply of oxygen gas (Dorrell et al. 2022). This would reduce forces responsible for mixing surface waters, but as shown by Daewel et al. (2022), impacts on primary productivity are not expected to be different than natural variability. Additionally, the taller WTGs anticipated to be built in U.S. waters may have nearly imperceptible impacts on surface waters.

**Hydrodynamic Effects of In-Water Structures**

The general understanding of offshore wind–related impacts on hydrodynamics is derived primarily from European based studies. A synthesis of European studies by Van Berkel et al. (2020) summarized the potential effects of wind turbines on hydrodynamics, the wind field, and fisheries. Local to a wind facility, the range of potential impacts include increased turbulence downstream, remobilization of sediments, reduced flow inside wind farms, downstream changes in stratification, redistribution of water temperature, and changes in nutrient upwelling and primary productivity. When water flows around the structure, turbulence is introduced that influences local current speed and direction. Turbulent wakes have been observed and modeled at the kilometer scale (Cazenave et al. 2016; Vanhellemont and Ruddick 2014). While impacts on current speed and direction decrease rapidly around monopiles, there is a potential for hydrodynamic effects out to a kilometer from a monopile (Li et al. 2014). Direct observations of the influence of a monopile extended to at least 984 feet (300 meters); however, changes were indistinguishable from natural variability in a subsequent year (Schultze et al. 2020). Wakes from individual structures may persist for 100 meters to 1 kilometer downstream (Dorrell et al. 2022). However, biological changes in the demersal community have been observed over smaller distances of (<50 meters) due to increased local fecal pellet excretions from mussels on and around the structures (Maar et al. 2009). The range of observed changes in current speed and direction 984 to 3,281 feet (300 to 1,000 meters) from a monopile is likely related to local conditions, wind farm scale, and sensitivity of the analysis.

Results from a recent Johnson et al. (2021) hydrodynamic model of four different WTG build-out scenarios of the offshore Rhode Island and Massachusetts Lease Areas found that offshore wind projects have the potential to alter local and regional physical oceanic processes (e.g., currents, temperature stratification) via their influence on currents from WTG foundations and by extracting energy from the wind. The results of the hydrodynamic model study show that introduction of the offshore wind structures into the offshore WEA modifies the oceanic responses of current magnitude, temperature, and wave heights by (1) reducing the current magnitude through added flow resistance, (2) influencing the temperature stratification by introducing additional mixing, and (3) reducing current magnitude and wave height by extracting of energy from the wind by the offshore wind turbines. Alterations in currents and mixing would affect water quality parameters such as temperature, DO, and salinity, but would vary seasonally and regionally.

Water column impacts are heavily dependent on factors such as the hub height of the turbine, foundation type, and oceanographic conditions (e.g., currents, well-mixed to stratified waters, and depth). Many of
the modeling studies conducted to date note that there is uncertainty in whether impacts observed in the models would be distinguishable relative to natural variability in oceanographic conditions (Christiansen et al. 2022; Floeter et al. 2022; Schultze et al. 2020). In strongly stratified locations, the mixing seen at monopiles is often masked by processes forcing toward stratification (Schultze et al. 2020), but the introduction of nutrients from depth into the surface mixed layer can lead to a local increase in primary production (Floeter et al. 2017). Dorrell et al. (2022) state that offshore wind growth may fundamentally change shelf sea systems, particularly in seasonally stratified seas, but enhanced mixing could positively affect some marine ecosystems. The presence of foundations could increase vertical mixing driven by currents flowing around the foundations (Christiansen et al. 2022; Carpenter et al. 2016; Schultze et al. 2020). During times of stratification (summer), increased mixing due to the presence of structures could alter marine ecosystem processes by possibly increasing pelagic primary productivity in local areas (English et al. 2017; Degraer et al. 2020). That increased productivity could be partially offset by the formation of abundant colonies of filter feeders on the foundations (Maar et al. 2009). When the stratified water column is redirected around the structure, deeper, colder, nutrient-rich water mixes with warmer surficial nutrient-poor water. Installed structures pierce through separation barriers, such as the thermocline, increasing nutrient fluctuations similar to waves flowing over seafloor sand banks (Dorrell et al. 2021). The mass balance of the Lease Area will change as vertical mixing and transport will change nutrient cycling and energy flow around structures, such as the uptake and benthic resupply of oxygen (Dorrell et al. 2020).

5.5.7.1 Marine Mammals

In current shallow-water offshore wind farms, where levels of turbulence are high, wakes have been observed due to the presence of the monopiles as cylindrical structures that affect flow (Dorrell et al. 2022). At a regional level, Johnson et al. (2021) modeled the effects on larval transport from the full build out of the entire southern New England Lease Areas. This study showed that the changes to depth-averaged currents vary on the order of +11 percent to -8 percent, and many of the results on the higher ends of this range occurred in the regions north and south of the Lease Areas. Changes in currents east of the Lease Areas, in the region of Nantucket Shoals, were minor. Johnson et al. (2021) also showed a relative deepening in the thermocline of approximately 1 to 2 meters and a retention of colder water inside the Lease Areas through the summer months compared to the situation where turbines were not present. This is somewhat contrary to some of the results in European studies that suggest a loss of stratification due to the introduction of turbulence by wind wakes. Chen et al. (2016) assessed how wind turbines would affect oceanographic processes during storm events. The results showed that there would not be a significant influence on southward larval transport from Georges Bank and Nantucket Shoals to the Mid-Atlantic Bight due to the presence of turbine structures, although it could cause increased cross-shelf larval dispersion. Thus, the potential effects on marine mammal prey species, and therefore marine mammals, from changes to hydrodynamic conditions caused by the presence of offshore structures are not fully understood at this time but may conservatively range from 100 meters to 1 kilometer (Dorrell et al. 2022) and likely to vary seasonally and regionally.

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 (NMFS 2021a). Broadscale hydrodynamic impacts could alter zooplankton distribution and abundance (van Berkel et al. 2020). Wake effects from the turbine structures in water can induce mixing of stratified water columns especially in the summer months; this could mean more nutrients are available to surface waters or spread nutrient-poor surface water (Christiansen et al. 2022). With sufficient salinity stratification, vertical flow of colder/saltier water to the surface occurs in lower sea surface level dipoles and warmer/less saline water travels to deeper waters in elevated sea surface heights (Ludewig 2015; Christiansen et al. 2022). This observation also
suggested impacts on seasonal stratification, as documented in Christiansen et al. (2022). However, the magnitude of salinity and temperature changes with respect to vertical structures is small compared to the long-term and interannual variability of temperature and salinity.

A change in mixing is most relevant to NARWs, as they are the only listed species in the region specializing in prey (Calanoid copepods) whose aggregations are entirely driven by hydrodynamic processes, and have the lowest population numbers of all of the ESA-listed marine mammals. While fin and sei whales also feed on the copepod species *Calanus finmarchicus*, NARW are obligate feeders on *Calanus* and *Pseudocalanus* copepods, which are most abundant in the spring and summer. New England waters are an important feeding habitat for NARW after recent shifts in distribution have led to increases in documentation of NARW around Nantucket Shoals and areas east of the Massachusetts WEA, in particular (Hayes et al. 2020l; Quintana-Rizzo et al. 2021). Zooplankton abundance in the northeast US continental shelf has held at a consistent level over the past 20 years, with slight inter-annual variability (NEFSC 2018a); thus, since aggregations of plankton, which provide a dense food source for NARWs to efficiently feed upon, are concentrated by physical and oceanographic features, increased mixing may disperse aggregations and may decrease efficient foraging opportunities. In contrast, energy extraction (i.e., wind wake) effects on oceanographic processes may result in shallowing of the mixed layer or reduced mixing, which could concentrate aggregations of zooplankton and increase efficient foraging. The exact outcome is currently unknown.

There is considerable uncertainty as to how these broader ecological changes will affect marine mammals in the future, and how those changes will interact with other human-caused impacts. The effect of the increased presence of structures on marine mammals and their habitats is likely to be negative, varying by species, and their significance is unknown. For blue whales and sperm whales, which are very unlikely to occur near enough to Project activities to experience any changes in wake effects, there would be no effect. For fin whale, sei whale, and NARW, adverse effects could potentially occur depending on the significance of changes in hydrodynamics on distribution and availability of prey species. For fin and sei whales, this significance is likely to be low since they feed on other prey that are not dependent on frontal features / hydrodynamics, so these would be insignificant. For NARW, adverse effects may be greater because their population size is so small that loss of an individual could have a population effect; however, there is no empirical evidence that hydrodynamic changes would alter the aggregation of lipid-reach prey so much that NARWs could not adapt their foraging or relocate to an area with more concentrated prey if needed, as they have recently done in moving their foraging from Gulf of Maine back into New England Waters (O’Brien et al. 2022). Thus, while impacts on the environment and prey may be measurable, impacts on NARW individuals would likely still be insignificant.

### 5.5.7.2 Sea Turtles

Net primary productivity is driven by photosynthesis in marine phytoplankton and accounts for half of global-scale photosynthesis and supporting major ocean ecosystem services (Field et al. 1998). There are few empirical data showing the impact of WTGs on ocean stratification (Tagliabue et al. 2021), although recent models have demonstrated ocean mixing as a result of the wind-wake effect of WTGs in the North Sea (Carpenter et al. 2016; Floeter et al. 2017, Dorrell et al. 2022). However, interannual changes in net primary productivity in the North Atlantic are poorly correlated with parallel changes to stratification and emphasize the importance of other physical mechanisms, especially the Gulf Stream (Tagliabue et al. 2021). Potential impacts on net primary productivity in the North Atlantic from offshore wind projects may occur but, without additional data, impacts are considered negligible when compared with the effects of the Gulf Stream. Wake impacts would likely be permanent but variable, and because of the relatively low offshore wind blocking effect, impacts would be expected to be minor when compared to natural variability (Floeter et al. 2017). In addition, Golbazi et al. (2022) modeled surface effects of next-generation large turbines (more than 10 MW) along the Atlantic OCS and found that due to the higher hub heights of larger turbines, meteorological changes at the water surface would be nearly imperceptible.
The presence of in-water structures could reduce water flow immediately downstream of foundations but return to ambient levels within a relatively short distance (Miles et al. 2017). The downstream area affected by reduced flows is dependent on pile diameter. Fine-scale effects on water flow could have localized impacts on prey distribution and abundance. Regional hydrodynamic effects could affect prey species at a broader scale. Effects on surface currents could influence patterns of larval distribution (Johnson et al. 2021) and seasonal mixing regimes could influence primary productivity, both of which could, in turn, affect the distribution of fish and invertebrates on the OCS (Chen et al. 2018; Lentz 2017). Hydrodynamic alterations due to the presence of WTGs could increase primary productivity in the vicinity of the structures (Carpenter et al. 2016; Schultze et al. 2020). However, such an increase would be highly localized, and the increased productivity may be consumed by filter feeders colonizing the structures (Slavik et al. 2019) rather than leading to increased prey abundance for sea turtles.

While green sea turtles, loggerhead sea turtles, and Kemp’s ridley sea turtles consume prey not as closely impacted by physical oceanographic features such as currents and upwelling, leatherback sea turtles consume planktonic prey not able to move independently of normal ocean currents. Leatherback sea turtles are known to follow jellyfish aggregations, and thus forage around areas were the currents aggregate jellyfish, such as areas of upwellings (Bailey et al. 2012). Nantucket Shoals, along with areas on Georges Bank and the edge of the continental shelf, have been found to create hotspots of leatherback foraging. Areas such as Nantucket Shoals are important feeding areas due to tidal mixing and upwelling increasing productivity and gelatinous zooplankton numbers (Dodge et al. 2014). Since the leatherback sea turtle is the most pelagic of the turtles, it is expected to be the most affected by hydrodynamic effects if they occur. The presence of WTGs in the Project area may influence the distribution of jellyfish and, thus, affect the distribution of leatherback sea turtles.

In summary, the presence of WTGs is expected to result in wind-wake alterations in and around offshore wind Project areas. Some authors have suggested this could result in changes to ocean stratification that can reduce nutrient supplies to the surface ocean and alter net primary productivity. Wind wake may also disturb planktonic transport, and thus, prey availability for sea turtles (van Berkel et al. 2020). Structures may reduce wind-forced mixing of surface waters, whereas water flowing around the foundations may increase vertical mixing. During summer, when water is more stratified, increased mixing could result in localized increases in primary productivity near the structures. However, the increased productivity may be consumed by filter feeders colonizing the structures (Slavik et al. 2019) rather than leading to increased prey abundance for sea turtles. Project-specific effects would vary, recognizing that larger and contiguous projects could have more significant effects on prey and forage resources, but the extent and significance of these effects cannot be predicted based on currently available information.

Due to the uncertainty around regional effects post-construction, the possibility of both increasing and decreasing prey availability depending on multiple environmental and Project-specific factors, and the low density of sea turtle occurrence in the Project area (< 1 turtle per 100 km² was the highest seasonal averaged density of all sea turtles species [leatherback sea turtles in winter]), the overall impact of changes in oceanographic processes and hydrodynamics due to the presence of WTGs on sea turtles is insignificant.

5.5.7.3 Fish

As described in Section 5.5.7.2 for sea turtles, the presence of WTGs associated with the Proposed Action may lead to localized increases in primary productivity, but these increases may not translate to increases in prey for ESA-listed fish species. The presence of WTGs may reduce wind-forced mixing of surface waters, whereas water flowing around the foundations may increase vertical mixing (Carpenter et al. 2016). Increased mixing may result in warmer bottom temperatures, increasing stress on some shellfish and fish at the southern or inshore extent of the range of suitable temperatures. During summer, when water is more stratified, increased mixing could increase pelagic primary productivity near the structure,
increasing the algal food source for zooplankton and filter feeders. However, interannual changes in net primary productivity in the North Atlantic are poorly correlated with parallel changes to stratification and emphasize the importance of other physical mechanisms, especially the Gulf Stream (Tagliabue et al. 2021). In addition, Golbazi et al. (2022) modeled surface effects of next-generation large turbines (> 10 MW) along the Atlantic OCS and found that due to the higher hub heights of larger turbines, meteorological changes at the water surface would be nearly imperceptible.

The presence of WTGs is likely to create localized hydrodynamic effects that could have localized impacts on food web productivity and pelagic eggs and larvae. Addition of vertical structures that spans the water column could alter vertical and horizontal water velocity and circulation. The Project area is considered seasonally stratified, with warmer waters and high salinity leading to strong stratification in the late summer and early fall. Presence of the monopiles in the water column can introduce small-scale mixing and turbulence that also results in some loss of stratification (Carpenter et al. 2016; Floeter et al. 2017; Schultz et al. 2020). In strongly stratified locations, the mixing seen at monopiles is often masked by processes forcing toward stratification (Schultz et al. 2020), but the introduction of nutrients from depth into the surface mixed layer can lead to a local increase in primary production (Floeter et al. 2017).

Monopiles can also influence current speed and direction. Monopile wakes have been observed and modeled at the kilometer scale (Cazenave et al. 2016; Vanhellemont and Ruddick 2014). While impacts on current speed and direction decrease rapidly around monopiles, there is evidence of hydrodynamic effects out to a kilometer from a monopole (Li et al. 2014). However, other work suggests the influence of a monopile is primarily limited to within 328 to 656 feet (100 to 200 meters) of the pile (Schultz et al. 2020). The discrepancy is related to local conditions, wind farm scale, and sensitivity of the analysis. Here, the conservative assumption is made that wake effects could occur within 656 to 1,312.3 feet (200 to 400 meters) downstream of each monopile. Because the WTGs in the Proposed Action would be spaced by 1 nm (1.9 km), which is greater than the downstream extent of individual hydrodynamic effects, the hydrodynamic effects of one monopile are not expected to influence the effects of another. Thus, there are no anticipated hydrodynamic effects of the entire array, simply local effects of each individual monopile. Hydrodynamic effects could have localized effects on food web productivity and pelagic eggs and larvae. Given their planktonic nature, altered circulation patterns could transport pelagic eggs and larvae out of suitable habitat, altering their survivability. Additionally, pelagic juveniles and adults utilizing water column habitat may experience localized hydrodynamic effects down current of each monopile; however, adults and juveniles are expected to elicit an avoidance behavioral response away from potential unsuitable habitat due to hydrodynamic effects from monopiles.

Changes in hydrodynamics resulting from future activities, should they occur, could conceivably result in changes in habitat suitability and fish community structure, but the extent and significance of these potential effects are unknown. Any impacts on primary productivity associated with Project structures are expected to have an insignificant effect on ESA-listed fish species. Potential impacts on larval dispersion and survival of Atlantic sturgeon prey species from changes in hydrologic conditions are extremely unlikely to occur and are, therefore, discountable.

5.5.8 Physical Presence of WTGs on Listed Species

In addition to effects on oceanographic conditions (Section 5.5.7), the physical presence of WTGs during operation of the Proposed Action may have direct effects on ESA-listed species in the Action Area, including avoidance, displacement, or behavioral disruption. However, long-term, minor, indirect adverse impacts could also occur as a result of increased interaction with active or abandoned fishing gear encountered near the structures. BOEM proposes a monitoring condition that would alleviate potential impacts on marine mammals, including monofilament, and other fishing gear cleanup efforts around WTG foundations to inform any retrieval efforts that may be needed in the future.
5.5.8.1 Marine Mammals

The presence of structures associated with the Proposed Action over the life of the Project would modify pelagic habitats used by marine mammals, and their presence could affect marine mammal behavior; however, the likelihood and significance of these effects are difficult to determine.

The 149 foundations would be placed in a grid-like pattern with approximate spacing of 1 nm (1.9 km) between WTGs and OSPs. Based on documented lengths (Wynne and Schwartz 1999), the largest NARW (59 feet [18 meters]), fin whale (79 feet [24 meters]), sei whale (59 feet [18 meters]), and sperm whale (59 feet [18 meters]) would fit end to end between two foundations spaced at 1 nm (1.9 km) 100 times over. Although spacing between the structures would be sufficient to allow marine mammals to utilize habitat between and around structures, information about large whale responses to offshore wind structures is lacking. The presence of structures could have long-term, intermittent impacts on foraging, migration, and other normal behaviors.

The long-term presence of WTG structures could displace marine mammals from preferred habitats or alter movement patterns, potentially resulting in exposure to commercial and recreational fishing activity. Alternatively, displacement of fishing activity between WTG structures could potentially reduce interactions with commercial and recreational fishing gear within the project footprint. The evidence for long-term displacement is unclear and varies by species. For example, Teilmann and Carstensen (2012) observed clear long-term (greater than 10 years) displacement of harbor porpoise from commercial Lease Areas in Denmark. Displacement effects remain a focus of a study by Kraus et al. (2019). Other studies have documented apparent increases in marine mammal density around wind energy facilities. Russel et al. (2014) found clear evidence that seals were attracted to a European wind farm, apparently attracted by the abundant concentrations of prey created by the artificial reef effect. Gray seals are particularly susceptible to entrapment in trawl fisheries (Lyssikatos 2015). If commercial trawling were to occur near wind farms, increased interactions and resulting mortality of gray seals could occur.

The presence of structures could also concentrate recreational fishing around foundations, potentially increasing the risk of marine mammal entanglement in both lines and nets and increasing the risk of injury and mortality due to infection, starvation, or drowning (Moore and van de Hoop 2012). These structures could also result in fishing vessel displacement or gear shift. The potential impact on marine mammals from these changes is uncertain. However, if a shift from mobile gear to fixed gear occurs due to inability of the fishermen to maneuver mobile gear, there would be a potential increase in the number of vertical lines, resulting in an increased risk of marine mammal interactions with fishing gear. Entanglement in fishing gear has been identified as one of the leading causes of mortality in NARW and may be a limiting factor in the species’ recovery (Knowlton et al. 2012). Knowlton et al. (2012) reports 83 percent of NARWs show evidence of past entanglements. Additionally, recent literature indicates that the proportion of NARW mortality attributed to fishing gear entanglement is likely higher than previously estimated from recovered carcasses (Pace 2021). Entanglement may also be responsible for high mortality rates in other large whale species (Read et al. 2006). Abandoned or lost fishing gear may become tangled with foundations, reducing the chance that abandoned gear would cause additional harm to marine mammals and other wildlife, although debris tangled with WTG foundations may still pose a hazard to marine mammals. These potential long-term, intermittent impacts would be low intensity and persist until decommissioning is complete and structures are removed.

As discussed in Section 5.5.7.1, impacts from Proposed Action structures on hydrodynamic patterns in the nearby Nantucket Shoals are an important consideration for marine mammals and especially NARWs, which are known to forage in Nantucket Shoals. O’Brien et al. (2021) found that NARWs occurred in the greatest numbers in southern New England between December and February although they also occur in other months in lower numbers. The tidal currents on Nantucket Shoals are intense and the water column remains well mixed throughout the year (O’Brien et al. 2021), preventing the formation of thin, vertically
compressed layers of copepods that allow for efficient NARW feeding (Baumgartner and Mate 2003; Baumgartner et al. 2017). NARWs feed on copepods in well-mixed waters during winter, but during other times of the year when the larger and more nutritious *Calanus finmarchicus* is available, NARWs need to maximize their energy intake. To explain NARW presence near Nantucket Shoals when their preferred prey may be available elsewhere in more stratified waters, O’Brien et al. (2021) speculated NARWs are either feeding inefficiently on smaller copepod species or that they are feeding on a different non-copepod prey species that are more nutritious or can be ingested efficiently despite the strong tidal currents (e.g., a large-bodied bottom associated/clinging amphipod). Gammarid amphipods occur in abundant patches on the western edge of Nantucket Shoals where NARWs are also found (White and Veit 2020).

In-water structures result in the conversion of open-water and soft-bottom habitat to hard-bottom habitat. This habitat conversion attracts and aggregates prey species (i.e., fish and decapod crustaceans) (Causon and Gill 2018; Taormina et al. 2018). Foundations and scour protection would create an artificial reef effect (Degraer et al. 2020), likely leading to enhanced biological productivity and increased abundance and concentration of fish and invertebrate resources (Hutchison et al. 2020). This could alter predator–prey interactions in and around the facility, with uncertain and potentially beneficial or adverse effects on marine mammals. For example, fish predators like seals and porpoises could benefit from increased biological productivity and abundant concentrations of prey generated. However, any increase in biomass is anticipated to be small and localized, and it is not expected that reef effect would result in an increase in species preyed on by NARWs, fin whales, or sei whales (NMFS 2021). Mayflower Wind has committed to several AMMs that would alleviate potential impacts on marine mammals, including a requirement for annual remotely operated underwater vehicle surveys, reporting, monofilament, and other fishing gear cleanup efforts around WTG foundations, resulting in overall minor impacts.

Given the uncertainty regarding marine mammal responses to the presence of offshore wind structures, BOEM cannot discount the possibility that the presence of structures could have long-term, intermittent impacts on foraging, migration, and other normal behaviors.

### 5.5.8.2 Sea Turtles

In the Gulf of Mexico, loggerhead, leatherback, green, and Kemp’s ridley, have been documented in the vicinity of offshore oil and gas platforms, with the probability of occupation increasing with the age of the structures (Gitschlag and Herczeg 1994; Hastings et al. 1976). Sea turtles would be expected to use habitat in between the WTGs and around structures for feeding, breeding, resting, and migrating for short periods, but residency times around structures may increase with the age of structures if communities develop on and around foundations. Project-specific effects would vary, recognizing that larger and contiguous projects could have more significant effects on prey and forage resources, but the extent and significance of these effects cannot be predicted based on currently available information.

Impacts on sea turtles could result from the reef effect created by the presence of up to 149 foundations and between 390 acres (157 hectares) to greater than 1,700 (>686 hectares) of scour/cable protection. Studies have found increased biomass for benthic fish and invertebrates around artificial structures (Pezy et al. 2018; Raoux et al. 2017; Wang et al. 2019), indicating that offshore wind facilities could generate beneficial permanent impacts on local ecosystems, which may lead to behavioral changes related to foraging activities. The WTG and OSP foundations would provide some level of reef effect, likely increasing local prey availability, and may result in minor, long-term beneficial impacts on sea turtle foraging and sheltering.

While the anticipated reef effect may result in long-term beneficial impacts on sea turtles, some potential exists for increased exposure to fishing gear that could lead to entanglement, ingestion, injury, and death. The presence of structures may concentrate recreational fishing around foundations and would also increase the risk of gear loss or damage. This could cause entanglement, especially with monofilament
line, and increase the potential for entanglement in both lines and nets leading to injury and mortality due to abrasions, loss of limbs, and increased drag, resulting in reduced foraging efficiency and ability to avoid predators (Barnette 2017; Berreiros and Raykov 2014; Foley et al. 2008). The reef effect may attract recreational fishing effort from inshore areas and attract sea turtles for foraging opportunities, resulting in a small increase in risk of entanglement and hooking or ingestion of marine debris where fishers and turtles are concentrated around the same foundations. In addition to the risk of impacts from fishing gear, the artificial reef may also attract sea turtle predators to the area, increasing sea turtle predation risk.

The presence of WTG structures could result in sea turtle avoidance and displacement, which could potentially move sea turtles into areas with lower habitat value or with a higher risk of vessel collision or fisheries interactions. However, the habitat quality for sea turtles does not greatly vary within and around the Project area. Any avoidance or displacement is expected to be short term.

Structures may also reduce wind-forced mixing of surface waters, whereas water flowing around the foundations may increase vertical mixing. During summer, when water is more stratified, increased mixing could increase pelagic primary productivity near the structure, increasing the algal food source for zooplankton and filter feeders and further altering the prey availability to sea turtles. Leatherback sea turtles are known to forage around features, such as upwellings, that lead to an aggregation of jellyfish (Bailey et al. 2012). The Nantucket Shoals, located northeast of the Project area, provides a foraging ground for leatherback sea turtles. The addition of structures in the area has the potential to cause hydrodynamic effects on ocean currents, potentially affecting the distribution of the leatherback’s planktonic jellyfish prey, but there is uncertainty around potential effects.

These structures would also affect ocean mixing and alter thermal stratification, which although small compared to other naturally occurring mixing mechanisms (Schultze et al. 2020), could influence sea turtle dive behavior and thermoregulation.

Thus, exposure of Kemp’s ridley and green sea turtles to the physical presence of WTGs is discountable. Therefore, potential effects due to the presence of WTGS during operations may affect, not likely to adversely affect Kemp’s ridley and green sea turtles.

Based on available information, the physical presence of WTGs on leatherback or loggerhead sea turtles may result in an increased risk for entanglement. Therefore, the physical presence of WTGS during operations may affect, likely to adversely affect leatherback and loggerhead sea turtles.

5.5.8.3 Fish

The effects of WTG structures on fish movements and migrations are not yet known (Sparling et al. 2020). However, there is some evidence that offshore wind structures may create stopover locations for migratory fishes (Rothermel et al. 2020). Stopover locations may benefit migrating ESA-listed fish species by providing feeding opportunities but may also disrupt or slow migrations (Rothermel et al. 2020). Behavioral effects may affect the migrations of individual fish, but they are not expected to have broad impacts on Atlantic sturgeon migration.

The addition of new hard surfaces and structures, including WTG foundations, scour protection, and hard protection on top of cables, to a mostly sandy seafloor would create a more complex habitat. Structure-oriented finfish species such as black sea bass, striped bass, and Atlantic cod (among others) would be attracted to these more complex structures. The structures would create an artificial reef effect, whereby more sessile and benthic organisms would likely colonize the structures over time (e.g., sponges, algae, mussels, shellfish, sea anemones). Higher densities of filter feeders, such as mussels that colonize the structure surfaces, could consume much of the increased primary productivity but also provide a food source and habitat to crustaceans such as crabs (Dannheim et al. 2020). Mussels have been found to be the
preferred food source of Jonah crabs in the Gulf of Maine by Donahue et al. (2009). These impacts would likely be permanent or remain as long as the structure remains.

These increased fish aggregations may increase fishing activities (both commercial and recreational) in the vicinity of structures. Damaged and lost fishing gear caught on structures may result in ghost fishing or other disturbances, potentially leading to finfish mortality. Impacts from fishing gear would be localized; however, the risk of occurrence would remain as long as the structures are present. The presence of structures in an otherwise primarily sandy benthic environment would provide a more complex environment, likely to attract finfish and invertebrates such as mobile crustaceans of commercial value. As such, entanglement and gear loss may cause increased impacts on finfish, including mortality and alteration of habitats.

Disruption of normal behaviors, such as foraging and migration, could occur due to the presence of WTGs. Spacing between the Project WTGs would be sufficient to allow ESA-listed Atlantic sturgeon to utilize habitat between and around structures for foraging, resting, and migrating.

Johnson et al. (2021) determined that offshore wind development could affect larval dispersal patterns, leading to increases in larval settlement density in some areas and decreases in others. For Atlantic sturgeon, these changes are not anticipated to translate to measurable effects. While these changes could result in planktonic prey distribution for manta ray, any change in prey distribution is not anticipated to be biologically measurable.

The Project would be expected to produce measurable, localized hydrodynamic effects that would be expected to occur within 600 to 1,300 feet downcurrent of each monopile. Most research conducted to date has not been able to distinguish any hydrodynamic effects on fish populations from natural variability (van Berkel et al. 2020). While additional monitoring and research is needed, the likelihood of measurable regional effects on fish and fish populations from the Project is minimal. This conclusion is based on the location of the Project in an area dominated by strong seasonal stratification (van Berkel et al. 2020), the relatively small number of monopile foundations, and the fact that modeled cumulative effects across the action area are minor. In general, the potential effects to finfish resulting from the presence of structures are likely to vary by species. However, considerable uncertainty remains about the broader effects of this type of habitat alteration at population scales (Degraer et al. 2020). These effects could increase cumulatively when combined with those from other planned offshore energy developments in the future.

The presence of structures is not expected to result in measurable changes in ESA-listed Atlantic sturgeon migratory patterns, and effects are considered insignificant.

5.5.9 Electromagnetic Fields and Heat from Cables

The Proposed Action would include installation of up to 1,179 miles (1,897 kilometers) of export cables and 497 miles (800 kilometers) of interarray cables, increasing the production of EMF and heat in the Action Area. EMF and heat effects would be reduced by cable burial to an appropriate depth and the use of shielding, if necessary.

5.5.9.1 Marine Mammals

Marine mammals are capable of detecting magnetic field gradients of 0.1 percent of the Earth’s magnetic field (i.e., approximately 0.05 microtesla) (Kirschvink 1990). Based on this sensitivity, marine mammals are likely very sensitive to minor changes in magnetic fields (Walker et al. 2003) and may react to local...

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6 Ghost fishing refers to entrapment, entanglement, or mortality of marine life in discarded, lost, or abandoned fishing gear, which can also smother habitat and act as a hazard to navigation.
variation in geomagnetic fields associated with cable EMFs. These variations could result in short-term effects on swimming direction or migration detours (Gill et al. 2005). However, no EMF impacts on marine mammals associated with underwater cables have been documented. Mayflower Wind would bury cables to a target burial depth of 6 feet (1.8 meters) wherever possible (Mayflower 2022). In areas where sufficient cable burial is not feasible, surface cable protection would be utilized. Cable burial and surface protection, where necessary, would minimize EMF exposure for ESA-listed marine mammals. Any potential impacts on ESA-listed marine mammals from EMF associated with the Proposed Action are expected to be too small to be measured.

EMF levels were modeled that could be generated by the Mayflower Wind Farm submarine and onshore export cables (Mayflower Wind 2022, Appendix P1). The model estimated induced magnetic field levels ranging from 85 milligauss (6.6-foot [2-meter] burial depth) to 1,859 milligauss (unburied, covered with 1-foot-thick [0.3-meter-thick] concrete mattress) for Mayflower Wind export cables (COP Volume 1, Appendix P1, Table 3.3; Mayflower Wind 2022). Generally, the modeled EMF data are expected to over-predict magnetic field levels because of assumptions, such as no shielding of magnetic field from cable armorizing, and no self-cancellation of magnetic fields from twisting conductor bundles. Confirming this over-prediction, Exponent Engineering, P.C. (2018) modeled EMF levels that could be generated by the South Fork Wind Farm export cable and interarray cable. The model estimated induced magnetic field levels ranging from 13.7 to 76.6 milligauss on the bed surface above the buried and exposed South Fork Wind Farm export cable and 9.1 to 65.3 milligauss above the interarray cable, respectively. Induced field strength would decrease effectively to 0 milligauss within 25 feet (7.6 meters) of each cable. By comparison, Earth’s natural magnetic field produces more than five times the maximum potential EMF effect from projects similar to the Project (BOEM 2021b). Background magnetic field conditions would fluctuate by 1 to 10 milligauss from the natural field effects produced by waves and currents. The maximum induced electrical field experienced by any organism close to the exposed cable would be no greater than 0.48 millivolt per meter (Exponent Engineering, P.C. 2018). BOEM performed literature reviews and analyses of potential EMF effects from offshore renewable energy projects (CSA Ocean Sciences Inc. 2021; Normandeau et al. 2011). These reviews and other available reviews and studies (Gill et al. 2005; Kilfoyle et al. 2018) suggest that most marine species cannot sense low-intensity EMF generated by the HVAC power transmission cables commonly used in offshore wind energy projects. Normandeau et al. (2011) concluded that marine mammals are unlikely to detect magnetic field intensities below 50 milligauss, suggesting that these species would be insensitive to EMF effects from the Project’s electrical cables. Project-related EMFs would be below this threshold and, therefore, negligible, except in areas where the cables lie on the bed surface. The area exposed to magnetic field effects greater than 50 milligauss would be small, extending only a few feet from the cable. The 50-milligauss detection threshold is theoretical and an order of magnitude lower than the lowest observed magnetic field strength resulting in observed behavioral responses (Normandeau et al. 2011). These factors indicate that the likelihood of marine mammals encountering detectable EMF effects is low, and any exposure would be below levels associated with measurable biological effects. Therefore, EMF effects on marine mammals would be negligible.

Buried submarine cables can warm the surrounding sediment in contact with the cables up to tens of centimeters (Taormina et al. 2018). There are no data on cable heat effects on marine mammals (Taormina et al. 2018). However, increased heat in the sediment could affect benthic organisms that serve as prey for fish species that forage in the benthos, consequently impacting piscivorous marine mammals. Based on the narrowness of cable corridors and expected Lease Area of thermal radiation, impacts on benthic organisms are not expected to be significant (Taormina et al. 2018) and would be limited to a small area around the cable. Given the expected cable burial depths, thermal effects would not occur at the surface of the seabed. Therefore, any effects on marine mammal prey availability would be too small to be detected or meaningfully measured.
Given the low field intensities involved and the likely lack of interaction between ESA-listed whales and the benthos in the Project area, any EMF effects on marine mammals are expected to be so small that they cannot be meaningfully measured, evaluated, or detected and are, therefore, insignificant. Therefore, the effects of EMF from the Project may affect, not likely to adversely affect ESA-listed marine mammals.

5.5.9.2 Sea Turtles

Sea turtles are capable of detecting magnetic fields, and behavioral responses to such fields have been documented. The threshold for behavioral responses varies somewhat among species. Loggerhead sea turtles have exhibited responses to field intensities ranging from 0.0047 to 4,000 microteslas, and green sea turtles have responded to field intensities ranging from 29.3 to 200 microteslas (Normandeau et al. 2011); other species are expected to have similar thresholds due to similar anatomical features, behaviors, and life history characteristics. Juvenile and adult sea turtles may detect EMFs when foraging on benthic prey or resting on the bottom in relatively close proximity to cables. There are no data on EMF impacts on sea turtles associated with underwater cables. Migratory disruptions have been documented in sea turtles with magnets attached to their heads (Luschi et al. 2007), but evidence that EMF associated with future offshore wind activities would likely result in some deviations from direct migration routes is lacking (Snoek et al. 2016). Any deviations are expected to be minor (Normandeau et al. 2011), and any increased energy expenditure due to these deviations would not be biologically significant. Mayflower Wind would bury cables to a target burial depth of 6 feet (1.8 meters) wherever possible (Mayflower 2022). In areas where sufficient cable burial is not feasible, surface cable protection would be utilized. Any potential impacts on ESA-listed sea turtles from EMF associated with the Proposed Action are expected to be too small to be measured.

The available evidence indicates that sea turtles are magnetosensitive and orient to the Earth’s magnetic field for navigation, but they are unlikely to detect magnetic fields below 50 mG (5 µT). Normandeau (2011) summarized theoretical concerns in the literature that human-created EMF could disrupt adult migration to and juvenile migration from nesting beaches. Nesting beaches are not present within the Action Area. Although the Proposed Action would produce magnetic field effects above the 50-mG (µT) threshold at selected locations where transmission cables lie on the bed surface, the affected areas would be localized around unburied cable segments and limited to within 3.3 feet (1 meter) of the cable surface. Given the lack of sensitive sea turtle life stages to be present, the limited field strength involved, and limited potential for highly mobile species like sea turtles to encounter field levels above detectable thresholds, any disruptions to the navigational cues and migratory behavior of ESA-listed sea turtles are expected to be so small that they cannot be meaningfully measured, evaluated, or detected and are, therefore, insignificant.

Buried submarine cables can warm the surrounding sediment in contact with the cables up to tens of centimeters (Taormina et al. 2018). There are no data on cable heat effects on sea turtles (Taormina et al. 2018). However, increased heat in the sediment could affect benthic organisms which serve as prey for sea turtles that forage in the benthos. Based on the narrowness of cable corridors and expected Lease Area of thermal radiation, impacts on benthic organisms are not expected to be significant (Taormina et al. 2018) and would be limited to a small area around the cable. Given the expected cable burial depths, thermal effects would not occur at the surface of the seabed where benthic-feeding sea turtles would forage.

Magnetic fields associated with the operation of the transmission line could also impact benthic organisms that serve as sea turtle prey. Effects on 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. The survival and reproduction of benthic organisms are not thought to be affected by long-term exposure to static magnetic fields (Bochert and Zettler 2006; Normandeau 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 several 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 (NMFS 2021). Therefore, any effects from EMF leading to the reduction on sea turtle prey and prey availability would be too small to be detected or meaningfully measured.

Based on the analysis above, any potential impacts from EMF associated with the Proposed Action on are expected to be so small that they cannot be meaningfully measured, evaluated, or detected and, therefore, may affect, not likely to adversely affect ESA-listed sea turtles.

**5.5.9.3 Fish**

Electromagnetic-sensitive species (e.g., sharks, rays) have been shown to respond to HVAC, but adverse consequences have not been established (Gill et al. 2012). EMF from alternating current cables is not expected to adversely affect commercially and recreationally important species in the southern New England area (CSA Ocean Sciences, Inc. and Exponent 2019), and studies have shown that EMF would not interfere with movement or migration of marine species (Kavet et al. 2016). Mayflower Wind would bury cables to a target burial depth of 6 feet (1.8 meters) wherever possible (Mayflower 2022), which would minimize the strength of the EMF in the water column and cables would have industry standard electric shielding. Therefore, any potential impacts on ESA-listed fish species from EMF associated with the Proposed Action are expected to be too small to be measured.

During operation, powered transmission cables would produce EMFs (Taormina et al. 2018). The strength of the EMF rapidly decreases with distance from the cable (Taormina et al. 2018). The scientific literature provides some evidence of responses to EMFs by fish and mobile invertebrate species (Hutchison et al. 2018; Taormina et al. 2018; Normandeau Associates, Inc. et al. 2011), although recent reviews (CSA Ocean Sciences, Inc. and Exponent 2019; Gill and Desender 2020; Albert et al. 2020) indicate the relatively low intensity of the EMF associated with marine renewable projects would not result in impacts. Effects of an EMF may include interference with navigation that relies on natural magnetic fields, predator/prey interactions, avoidance or attraction behaviors, and physiological and developmental effects (Taormina et al. 2018). Review of responses to a direct current EMF found that there is inconsistent evidence of behavioral responses in some marine species and an absence of conclusive evidence supporting the observed behavioral responses as being indicative of potential population-level detrimental impacts (COP Appendix P2; Mayflower Wind 2022).

CSA Ocean Sciences, Inc. and Exponent (2019) found that offshore wind energy development as currently proposed would have negligible effects, if any, on bottom-dwelling finfish and invertebrates residing within the southern New England area. Although demersal biota would be most likely to be exposed to the EMF from power cables, potential exposure would be minimized because an EMF quickly decays with distance from the cable source (CSA Ocean Sciences, Inc. and Exponent 2019). Project-specific modeling confirmed that EMFs diminished rapidly (COP Appendix P1; Mayflower Wind 2022). In the case of mobile species, an individual exposed to an EMF would cease to be affected when it leaves the affected area. An individual may be affected more than once during long-distance movements; however, there is no information on whether previous exposure to an EMF would influence the impacts of future exposure. For pelagic species within the southern New England area, no negative effects were expected from offshore wind energy development as currently proposed because of their preference for habitats located at a distance from the seabed.

As described in Section 5.5.9.2, buried submarine cables can warm the surrounding sediment in contact with the cables up to tens of centimeters, but impacts on benthic organisms are expected to be insignificant (Taormina et al. 2018) and would be limited to a small area around the cable. Given the
expected cable burial depths, thermal effects would not occur at the surface of the seabed where Atlantic sturgeon forage. Therefore, any effects on sturgeon prey availability would be too small to be detected or meaningfully measured. Therefore, the effects of EMF from the Project may affect, not likely to adversely affect ESA-listed Atlantic sturgeon.

5.5.10 Lighting and Marking of Structures

Vessels and offshore structures associated with future offshore wind activity would have deck and safety lighting, producing artificial light during the construction, O&M, and decommissioning phases of the Proposed Action. Additional lighting for night operations may be necessary within the Lease Area and ECCs during construction and decommissioning. Lighting will follow IALA, USCG, and BOEM requirements for lighting during construction. These operations include installation and removal of WTGs, OSPs, interarray cables, and export cables. During construction, cranes and offshore structures will be illuminated and marked per applicable USCG, FAA, or local requirements. This magnitude of lighting is temporary and will not be present during the operational phase of the proposed Project. Offshore structures would have yellow flashing navigational lighting and red flashing FAA hazard lights, in accordance with BOEM’s (2021c) lighting and marking guidelines. Following these guidelines, direct lighting would be avoided, and indirect lighting of the water surface would be minimized to the greatest extent practicable.

5.5.10.1 Marine Mammals

Lighting is not expected to have direct effects on marine mammals. However, artificial light may indirectly impact marine mammals by disrupting the diel vertical patterns in zooplankton and fish, influencing prey location and density, and altering foraging behavior (Depledge et al. 2010; Gliwicz 1986; Orr et al. 2013). Blue whales, fin whales, NARW, and sei whales are thought to feed at night (Vikingsson 1997; Baumgartner et al. 2003; Baumgartner and Fratantoni 2008; Guilpin et al. 2019). Sperm whales also forage at night but are expected to feed in deeper waters outside the Project area. While the effects of artificial lighting on marine mammals themselves are largely unknown, impacts are anticipated to be negligible if appropriate design techniques and uses are employed (Orr et al. 2013). Mayflower Wind would light WTGs and OSPs in compliance with FAA and USCG standards and BOEM guidelines and would avoid intentionally illuminating the water surface. Mayflower Wind has additionally proposed the use of an ADLS to minimize the time that FAA-required lighting is illuminated on the offshore structures associated with the Proposed Action. Therefore, effects of lighting of vessels and offshore structures associated with the Proposed Action on ESA-listed marine mammals would be insignificant. Therefore, the effects of lighting of structures from the Project may affect, not likely to adversely affect ESA-listed marine mammals.

5.5.10.2 Sea Turtles

The flashing lights on offshore structures associated with the Proposed Action are unlikely to disorient juvenile or adult sea turtles, as they do not present a continuous light source (Orr et al. 2013). However, lighting on vessels and offshore structures could elicit attraction, avoidance, or other behavioral responses in sea turtles. In laboratory experiments, juvenile loggerhead sea turtles consistently oriented toward lightsticks of various colors and types used by pelagic longline fisheries (Wang et al. 2019), indicating that hard-shelled sea turtle species expected to occur in the vicinity of the Projects (i.e., green, Kemp’s ridley, and loggerhead) could be attracted to offshore light sources. In contrast, juvenile leatherback sea turtles failed to orient toward or oriented away from lights in laboratory experiments (Gless et al. 2008), indicating that this species may not be attracted to offshore lighting. There is no evidence that lighting on oil and gas platforms in the Gulf of Mexico, which may have considerably more lighting than offshore WTGs, has had any effect on sea turtles over decades of operation (BOEM 2019a). Any behavioral responses to offshore lighting are expected to be localized and temporary. Mayflower Wind would light
WTGs and OSPs in compliance with FAA and USCG standards and BOEM best practices and would avoid intentionally illuminating the water surface. Mayflower Wind has additionally proposed the use of an ADLS to minimize the time that FAA-required lighting is illuminated on the offshore structures associated with the Proposed Action. Therefore, effects of lighting of vessels and offshore structures associated with the Proposed Action on ESA-listed sea turtles would be insignificant. Therefore, the effects of lighting of structures from the Project may affect, not likely to adversely affect ESA-listed turtles.

5.5.10.3 Fish

Artificial lighting could elicit temporary attraction, avoidance, or other behavioral responses in some finfish, potentially affecting distributions near the light source. Atlantic sturgeon are demersal and forage on benthic prey. Therefore, neither the species nor its prey is likely to be exposed to artificial light associated with the Proposed Action. Mayflower Wind would use lighting on the WTGs and OSPs that complies with FAA and USCG standards and would follow BOEM best practices to minimize illumination of the water surface. Furthermore, Mayflower Wind has proposed the use of an ADLS to minimize the time that FAA-required lighting is illuminated on the offshore structures. Based on the habitat used by ESA-listed fish species and the measures in place to reduce artificial lighting of the water surface, lighting effects on Atlantic sturgeon are extremely unlikely to occur.

With the application of mitigation measures, the potential effects of artificial light to ESA-listed Atlantic sturgeon and their prey are likely so small that they cannot be meaningfully measured, detected, or evaluated and, therefore, are insignificant. Therefore, the effects of lighting of structures from the Project may affect, not likely to adversely affect ESA-listed Atlantic sturgeon.

5.5.11 Offshore Substations

The Proposed Action includes the installation and operation of up to five OSPs in the Lease Area. Potential impacts associated with impact pile driving and vessel traffic during foundation installation, and with the presence of the structure are discussed in previous sections. The potential effects related to cooling water withdrawals, thermal discharge, and impacts on prey species are discussed in this section.

5.5.11.1 Water Withdrawal/Risk of Impingement and/or Entrainment

Mayflower Wind has proposed the use of one or more HVDC converter OSPs, which would require seawater to be pumped in to cool the electrical equipment and then discharged back into the ocean. Potential impacts associated with HVDC converter OSPs include a temperature change at the heated effluent discharge site, impingement of fish, and entrainment of planktonic life stages of fish and invertebrate species. As reported in the Mayflower Wind Offshore Converter Station NPDES Permit Application (TetraTech and Normandeau Associates, Inc. 2022; Appendix A) for the HVDC converter OSP for Brayton Point, the CWIS is expected to withdraw cooling water from the ocean in the immediate vicinity of the HVDC converter OSP at rate of approximately 8 to 10 million gallons per day (MGD) and maintain an intake velocity of less than 0.5 feet second. The USEPA considers intake velocities less than 0.5 feet per second the best technology available to minimize impingement impacts. The design calls for a once-through cooling system because closed-cycle cooling is not a feasible option offshore. Since impingement compliance is obtained through meeting the 0.5 feet per second velocity requirement, and there are no traveling screens on which a fish could become impinged, potential impingement impacts at HVDC converter intake will no longer be included in the subsequent sections.

5.5.11.1.1 Marine Mammals

During operation, there would be increased intake and discharge from HVDC converter OSP(s) in the Lease Area, which requires continuous cooling water withdrawals and subsequent discharge of heated
effluent back into receiving waters. Marine mammals could experience indirect effects during water withdrawals if prey species become entrained in very large numbers. Marine mammal prey may be affected further due to thermal impacts from subsequent heated discharge effluent released back into receiving waters. To minimize potential impacts on zooplankton from entrainment, Mayflower Wind has committed to siting the northernmost HVDC converter OSP outside of a 10-kilometer buffer of the 30-meter isobath from Nantucket Shoals, an area of high productivity and foraging value for several marine species (Table 3.3-1).

In the absence of site-specific plankton densities, Mayflower Wind, in their NPDES permit application, evaluated an impact assessment for the Northeast Gateway Project where a bioenergetic model was used to address impacts of the removal of zooplankton and small fish. While the model was ultimately used to assess removal of excessive biomass of prey items beyond natural variability and recovery rates, the Northeast Gateway Project was expected to utilize up to 56 million gallons per day and was found to have negligible impacts on the entrainment of zooplankton. Therefore, Mayflower Wind OSP operations, which will use considerably less cooling water (up to ten million gallons per day), is expected to entrain proportionally lower numbers of zooplankton. Mayflower Wind further estimated entrainment abundance of ichthyoplankton from cooling water withdrawal at the OSP using EcoMon plankton data from 1977 through 2019. Given the limitations of recent data immediately in the vicinity of the intake location, the minimum, mean, and maximum larval densities observed within 10 miles (16 kilometers) of the OSP location over the full time series were used to extrapolate the range of entrainment abundance assuming a water withdrawal rate of 10 million gallons per day. The annual entrainment abundance of fish larvae was estimated to range from 8.4 million to 176.2 million with a mean estimate of 84.0 million. Based on monthly mean larval densities and excluding unidentified fish, the taxa with the highest estimated larval entrainment annually were hakes (*Urophycis* spp.: 3.94 million), Atlantic herring (*Clupea harengus*: 3.92 million), sand lances (*Ammodytes* spp.: 3.3 million), summer flounder (*Paralichthys dentatus*: 1.4 million) and silver hake (*Merluccius bilinearis*: 0.50 million (TetraTech and Normandeau Associates, Inc. 2022).  

In addition to entrainment impacts, the HVDC converter OSP would discharge warmer water into the surrounding ocean, which could have localized impacts on marine mammal prey. Mayflower Wind modeled thermal plumes from HVDC cooling water discharge to predict water temperature changes around the discharge location during critical tidal conditions in summer and winter months (TetraTech and Normandeau Associates, Inc. 2022; Appendix A). The physical mixing processes in a plume takes place in two regions: the near-field and far-field. The region influenced by the discharge conditions in a plume is the near-field region (NFR). As the plume travels further away from the source, the path and dilution of the plume is influenced by the ambient conditions. This region is called the far-field region (FFR). Results were analyzed at the edge of the NFR because this region is representative of strong initial mixing and is controlled by the discharge conditions. Four scenarios were modeled to provide the expected maximum extent of the plume (maximum tidal velocities) and maximum concentrations of the plume (minimum tidal velocities). Refer to Table 5.5-2 for results of plume modeling for each scenario.

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7 As further described in the NPDES application (TetraTech and Normandeau Associates, Inc. 2022), due to limitations in the available data, there are uncertainties in these results. For example, entrainment estimates do not fully capture the annual entrainment abundance of all fish and life stages, as all fish eggs and the larvae of less common taxa are excluded from the publicly available EcoMon data set. Additionally, the estimates assume the 1977–2019 time series is representative of the current and future species composition, and that abundance will remain constant each year. The data also represents sampling of ichthyoplankton at various depths, whereas the OSP intake would withdraw water from a discrete depth in the water column (32.8 feet [10 meters] above the seafloor). This may result in overestimation of larval entrainment, as individuals settling in demersal habitats or floating on the surface may not be susceptible to the intake flow.
Table 5.5-2. Results from thermal plume modeling conducted for Mayflower Wind HVDC OSP

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Atlantic Ocean Temperature at the edge of NFR, °F</td>
<td>54.4</td>
<td>39.6</td>
<td>60.8</td>
<td>60.8</td>
</tr>
<tr>
<td>Temperature change at the edge of NFR in the Atlantic Ocean, °F</td>
<td>0.3</td>
<td>0.0</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>Dilution ratio at the edge of NFR in the Atlantic Ocean</td>
<td>110.6</td>
<td>5,126.7</td>
<td>98.7</td>
<td>114.6</td>
</tr>
<tr>
<td>NFR distance, a feet</td>
<td>306</td>
<td>2,661</td>
<td>272</td>
<td>1,436</td>
</tr>
<tr>
<td>NFR distance when temperature change of 5°F is met, feet</td>
<td>43</td>
<td>-757b</td>
<td>36</td>
<td>2</td>
</tr>
</tbody>
</table>

Source: TetraTech and Normandeau Associates, Inc. 2022; Appendix A.

a Distance from the diffuser.
b Negative sign represents the plume moving against direction of ocean current.

The temperature change at the edge of the NFR ranged from 0.0 °F to 0.3 °F. During maximum current speeds in summer and winter months, the location of the NFR from the discharge point ranged from 272 to 306 feet (83 to 93 meters), and the edge of the NFR ranged from 1,436 to 2,661 feet (438 to 811 meters) during minimum current speeds. The width of thermal plumes in the NFR ranged from approximately 9.8 to 6,562 feet (3 to 2,000 meters). The largest potential impact based on size of the plume resulted from Scenario 4 where the area of the plume in the NFR was approximately 9,422,601 square feet (6,562 by 1,436 feet) or 216 acres. Considering the slight increases in water temperatures and small size of the thermal plume area (maximum of 216 acres), in the context of the overall size of the Lease Area (127,388 acres), minimal impacts on water temperature are anticipated. Based on results of the thermal plume modeling, impacts from the discharge are expected to be localized and minimal, especially where the plume is controlled by discharge characteristics (NFR). Bleach (sodium hypochlorite) would be used to inhibit marine growth in the HVDC cooling equipment. A hypochlorite generator would produce the bleach by seawater electrolysis. These generators are designed to achieve a hypochlorite solution flow rate of sufficient concentration, corresponding with a 0 to 2 parts per million equivalent free chlorine concentration in the seawater intake lines (TetraTech and Normandeau Associates, Inc. 2022; Appendix A). This concentration is small and is equivalent to 0.0002 percent per unit volume.

The ecological effects from entrainment and thermal discharge from HVDC converter may affect, not likely to adversely affect ESA-listed marine mammals.

5.5.11.1.2 Sea Turtles

As discussed previously, the Proposed Action would install an HDVC converter OSP, which would result in the intake and discharge of water. There is potential for entrapment of sea turtles within the vertical intake pipes of the CWIS, based on historical evidence of entrapment in cooling water intakes at other facilities. Sea turtles, especially smaller or less mobile individuals, in the vicinity of the OSPs may experience entrapment within intake pipes of the CWIS. Records of sea turtles becoming trapped within cooling water intakes from power plants have been common, though incidents are primarily located in warmer regions where sea turtles are likely to occur year-round and in higher-volume cooling water systems (i.e., those of nuclear power plants) (Florida Power and Light, 1995; Florida Power Corporation, n.d.). While the likelihood of sea turtle entrapment is low due to the seasonal nature and overall low sea turtle abundance in Project area waters (see Section 4.9.3), mitigation measures proposed to reduce overall entrapment (e.g., intake velocity of 0.5 ft/s and appropriately sized bar racks) are expected to
minimize these risks further. Mayflower Wind will consult with USEPA and NMFS to ensure appropriately sized bar racks are included in the engineering design to minimize the risk of entrapment at the CWIS. The thermal plume created by effluent from cooling water discharge may also affect sea turtles occurring near the OSPs. Behavioral and biological impacts of heated effluent from cooling water discharges have been studied, however are not well understood. Research suggests green sea turtles may use plumes from cooling water effluent as thermal refuge or foraging habitat, potentially resulting in extended residence times in areas outside natural movement or migratory periods (Crear et al., 2016; Turner-Tomaszewicz and Seminoff, 2012). Green sea turtles inhabiting areas downstream of warm effluent have also been observed to have increased growth rates relative to other individuals in similar regions (Eguchi et al., 2012). It may be unlikely for sea turtles to experience these thermal impacts from Mayflower Wind cooling operations due to the relatively small discharge plume and localized temperature increase within the mixing zone in comparison to other, larger CWIS at coastal facilities. The installation and operation of an HDVC converter OSP and associated CWIS intake pipes may affect, not likely to adversely affect ESA-listed sea turtles due to the mitigation measures in place and the overall low sea turtle abundance in the Project area.

5.5.11.1.3 Fish

Impacts of entrainment on finfish and invertebrates at HVDC converter intakes are anticipated to be limited to the immediate area of the OSP. To minimize potential impacts on zooplankton from entrainment, Mayflower Wind has committed to siting the northernmost HVDC converter OSP outside of a 10-kilometer buffer of the 30-meter isobath from Nantucket Shoals, an area of high productivity and foraging value for several marine species (Table 3.3-1). Given the limitations of recent data immediately in the vicinity of the intake location, Mayflower Wind’s NPDES permit application used EcoMon plankton data from 1977–2019 to estimate entrainment abundance from cooling water withdrawal at the OSP (TetraTech and Normandeau Associates, Inc. 2022; Appendix A). The minimum, mean, and maximum larval densities observed within 10 miles (16 kilometers) of the OSP location were used to extrapolate the range of entrainment abundance. The annual entrainment abundance of fish larvae was estimated to range from 8.4 million to 176.2 million with a mean estimate of 84.0 million. Based on monthly mean larval densities and excluding unidentified fish, the taxa with the highest estimated larval entrainment annually were hakes (3.94 million), Atlantic herring (3.92 million), sand lances (3.3 million), summer flounder (1.4 million) and silver hake (0.50 million) (TetraTech and Normandeau Associates, Inc. 2022; Appendix A). Impacts from entrainment of finfish and invertebrates associated with HVDC converter OSPs would be continuous during the O&M phase resulting in long-term and moderate impacts.

In addition to entrainment impacts, the HVDC converter OSP would discharge warmer water into the surrounding ocean, which could have localized impacts on fish species. The impact of raised water temperatures on living organisms is most frequently seen in the lowered dissolved oxygen saturation level of warmer water since dissolved oxygen levels are often a limiting factor for organism survival (Mel’nichenko et al. 2008). Further, temperature affects the speed of egg development and growth of offspring (Walkuska and Wilczek 2009). Mayflower Wind modeled thermal plumes of the discharged cooling seawater from the HVDC converter OSP. Four different thermal discharge scenarios were modeled, two in the winter and two in the summer, and the anticipated impacts on water temperature from the effluent discharge were found to be minimal. Thermal plumes up to 0.5°F above ambient sea temperatures extended from 75 meters to approximately 400 meters from the OSP, varying by seasonal ocean currents. The maximum plume range of seawater 5°F above ambient seawater conditions extended 43 meters in the winter with maximum current speeds (TetraTech and Normandeau Associates, Inc. 2022; Appendix A).

Because occurrence of Atlantic sturgeon in the Lease Area would be rare, Atlantic sturgeon are not susceptible to entrainment at an HVDC converter OSP in the Lease Area. Impingement of these sturgeon
species is improbable given the expected intake configuration and operation at Mayflower Wind’s offshore HVDC converter OSP.

The limited range of warmed water, local oceanographic conditions, the ability of fish to move out of the affected area, would likely result in long-term but minor impacts and thus may affect, not likely to adversely affect Atlantic sturgeon.

5.5.11.2 Impacts on Prey

In the context of regional abundances and species life histories, estimated losses of zooplankton and ichthyoplankton from entrainment by OSP HVDC converter platforms are small. The intake and discharge of seawater is expected to remove less than 40 m³ of seawater. When considering the high mortality rates for fish early life stages, the number of equivalent age-one fishes lost to entrainment are expected to be much lower than the annual commercial landings for most species. At this scale, the ecological effects from entrainment via the OSP intake will likely be insignificant for all ESA-listed species as discussed in the sections below.

5.5.11.2.1 Marine Mammals

In addition to threatened or endangered fish species, the OSP may result in entrainment of certain prey species (e.g., copepods [Calanus spp. and Pseudocalanus spp] and other zooplankton) important to the foraging base of marine mammals, such as the endangered NARW (Eubalaena glacialis) within the Project area. While copepods, like larval fishes, are subject to entrainment through the CWIS, they are not removed from the forage base, by the nature of the once-through cooling water intake/discharge system; any individuals entrained through the intake are returned to the source water via the discharge pipe, where they remain available as prey items to the NARW, and other marine organisms. As part of the impact assessment for the Northeast Gateway Project, Dr. Robert Kenney developed a bioenergetic model to address the impacts of the removal of zooplankton and small fish under the Proposed Action on marine mammals (Northeast Gateway 2012). The model was used to address concerns whether or not the Proposed Action could remove excessive biomass of prey items beyond natural variability and recovery rates. Kenney et al. (1986) estimated the minimum concentrations of zooplankton needed by NARWs to obtain a long-term net energetic benefit from feeding. While it is not possible to analyze the effects of the Northeast Gateway operations, nor that of the Mayflower OSP, on the concentration of prey at a scale that would be meaningful for whale feeding, the analysis provided in the Northeast Gateway Environmental Assessment (Northeast Gateway 2012) modeled the amount of food needed by one individual or a population of any of the endangered whales that occur in the region, based on the typical basal metabolic rate and active metabolic rates of an individual, estimated from the body mass (Kleiber 1975; Trites and Pauly 1998; Kenney et al. 1985; Kenney et al. 1997; Barlow et al. 2008; Laran et al. 2010).

Daily and annual consumption rates for an individual NARW were estimated at 642 kg/day and 46,587 kg/year, while present off the coast of Massachusetts on a seasonal basis (Northeast Gateway 2012). Those rates were expected to be orders of magnitude greater than any reasonable estimates of prey removals by Northeast Gateway operations (which utilizes up to 56 MGD), which was considered negligible. Therefore, the OSP operations (which utilizes considerably less cooling water, up to 10 MGD) would be expected to entrain proportionally lower numbers of copepods and zooplankton, which may affect, not likely adversely affect marine mammal prey availability.

5.5.11.2.2 Sea Turtles

As discussed in previous sections, the Proposed Action would install an HVDC converter OSP, which would result in the intake and discharge of water. While the risk of direct harm to sea turtles caused by heated effluent water or of entrainment or impingement is considered negligible, sea turtle prey in the
water column may still be susceptible to entrainment. With the application of mitigation measures to reduce entrainment, OSP operations are not expected to make any measurable difference in sea turtle foraging and prey availability and thus may affect, not likely adversely affect sea turtle prey.

5.5.11.2.3 Fish

The Atlantic sturgeon is a bottom feeder and typically feed on crustaceans, worms, and mollusks. The Mayflower Wind offshore converter station CWIS facility is designed to withdraw water from the middle of the water column at a depth of approximately 25 to 115 ft (7.6 to 35.0 m) below the surface and approximately 32.8 ft (10 m) above the seafloor. Due to the depth of water withdrawal, foraging and prey availability of ESA-listed Atlantic sturgeon may affect, not likely to be adversely affected by HVDC OSP and associated CWIS intake operations.

5.5.12 Summary of Habitat Disturbance Effects

5.5.12.1 Marine Mammals

Habitat disturbance or modifications associated with G&G surveys would have no effect on ESA-listed marine mammals. Habitat conversion and loss associated with WTGs, OSPs, scour protection, and cable protection is not expected to increase foraging opportunities for ESA-listed marine mammals but there may be an increase in entanglement risk due to increased recreational fishing activity. However, the increase in risk would be insignificant for these species. Increased turbidity associated with the Proposed Action may result in short-term localized effects on ESA-listed marine mammals, but these effects would be insignificant. The physical presence of WTGs in the Lease Area could directly affect ESA-listed marine mammals through avoidance, displacement, or behavioral disruption or indirectly through localized hydrodynamic effects. Any behavioral disruption or hydrodynamic changes are not expected to be significant for ESA-listed marine mammals. Effects of EMF associated with submarine cables and lighting of vessels and offshore structures are also expected to be discountable.

5.5.12.2 Sea Turtles

Habitat disturbance associated with G&G surveys would be short-term and localized to a small area. Therefore, associated impacts on Kemp’s ridley sea turtle would be insignificant. Other ESA-listed sea turtles do not use the affected habitat and would therefore not be affected by G&G survey habitat disturbance. Habitat conversion and loss associated with WTGs, OSPs, scour protection, and cable protection may increase foraging opportunities for ESA-listed sea turtles but may also increase entanglement risk due to increased recreational fishing activity. However, the increase in foraging opportunities and entanglement risk would be insignificant for these species. Increased turbidity associated with the Proposed Action may result in short-term localized effects on ESA-listed sea turtles, but these effects would be insignificant. The physical presence of WTGs in the Lease Area could directly affect ESA-listed sea turtles through avoidance, displacement, or behavioral disruption or indirectly through localized hydrodynamic effects. Any direct or indirect effects associated with the presence of WTGs are not expected to be significant for ESA-listed sea turtles. Effects of EMF and heat associated with submarine cables and lighting of vessels and offshore structures are also expected to be discountable.

5.5.12.3 Fish

Habitat disturbance associated with G&G surveys would be short-term and localized to a small area. Therefore, associated impacts on ESA-listed fish species would be insignificant. Habitat conversion and loss associated with WTGs, OSPs, scour protection, and cable protection may increase foraging opportunities for ESA-listed fish species but may also increase entanglement risk due to increased recreational fishing activity. However, the increase in foraging opportunities and entanglement risk would
be insignificant for these species. Increased turbidity associated with the Proposed Action may result in short-term localized effects on ESA-listed fish species, but these effects would be insignificant. The physical presence of WTGs in the Lease Area could directly affect ESA-listed fish species through avoidance, displacement, or behavioral disruption or indirectly through localized hydrodynamic effects. Any direct or indirect effects associated with the presence of WTGs are not expected to be significant for ESA-listed fish species. Effects of EMF and heat associated with submarine cables and lighting of vessels and offshore structures are also expected to be discountable.

5.5.12.4 Impacts on Prey

Impacts from G&G surveys may cause benthic habitat disturbance and reduce the availability of benthic invertebrates that serve as prey for Atlantic sturgeon or Kemp’s ridley sea turtles. These impacts are expected to be localized and short-term, with recolonization occurring quickly. Associated impacts would be insignificant. Habitat conversion due to the presence of structures is expected to lead to an increase in fish and crustacean biomass due to the reef effect of encrusting organisms colonizing the structures. This will also lead to a loss in soft bottom habitat, which may reduce the local abundance of infaunal organisms and sand lance, which are prey for Atlantic sturgeon. However, the loss of soft bottom habitat would be very small compared to the amount of soft bottom habitat in the surrounding region, therefore the impacts would be insignificant. Turbidity can have adverse effects on suspension feeding mollusks, crustacean, and sponges, which are prey for the benthic feeding sea turtles. The effects of suspended sediment from the Project are expected to be insignificant and result in negligible reductions in benthic prey species. Estimated losses of benthic organisms from dredging are expected to be small. The dredging paths are relatively narrow and are benthic-oriented, thus only benthic infauna or sessile organisms on the seafloor or near the seafloor would be impacted. Immobile life stages of fish and invertebrate species in or on benthic sediment in the direct path of the draghead would be at the most risk of direct injury or mortality. Trenching is expected to have similar impacts on prey species. At this scale, the ecological effects from loss of prey due to dredging and trenching will likely be insignificant for all ESA-listed species. Submarine cables may produce heat which would impact benthic and infaunal organisms in the immediate area, given the burial depths of the cables these effects would not reach the seabed surface. EMF is not expected to affect the survival of benthic organisms in the area. Effects of EMF and heat associated with submarine cables and lighting of vessels and offshore structures are therefore expected to be insignificant. The presence of structures in the area is likely to create hydrodynamic changes in the environment, which could lead to changes in zooplankton abundance and distribution. Impacts on zooplankton primarily effect whales, most notably the NARW, as it is an obligate feeder of copepods. Jellyfish, which are the primary prey of leatherback sea turtles, are expected to be similarly impacted by hydrodynamic change. Alterations in the plankton community will in turn influence the abundance and distribution of forage fish, which are preyed upon by fin and sei whales. Changes in primary productivity that may occur due to the presence of structures could potentially be small and not discernable from natural variations in primary productivity. Increased mixing may lead to the dispersal of plankton aggregations; however, it is also possible that wind wake effects lead to a shallowing of the mixed layer, leading to plankton concentration. The current effects are unknown. HVDC converter OSPs are expected to lead to the impingement and entrainment of plankton, including the planktonic larval stages of fish and crustaceans. Calanus spp. Copepods, the favored prey of the NARW, is likely to be subject to entrainment. The rates of prey removal due to OSP operations are expected to be small and therefore may affect, not likely adversely affect planktonic prey.

5.6 Air Emissions

Air emissions would be generated during the construction, O&M, and decommissioning phases of the Proposed Action. Emissions would primarily be generated by Proposed Action vessels (Section 5.6.1) and the installation equipment on board Proposed Action vessels (Section 5.6.2). Mayflower Wind has
conducted an air emissions inventory for the Proposed Action, provided in Appendix G, *Air Emissions Report*, of the COP (Mayflower Wind 2022). Following the assessment of these potential sources of air emissions, a summary of overall effects on ESA-listed species is provided (Section 5.6.3).

The “OCS Air Regulations,” presented in 40 CFR 55, establish the applicable air pollution control requirements, including provisions related to permitting, monitoring, reporting, fees, compliance, and enforcement, for facilities subject to Section 328 of the Clean Air Act; the USEPA issues OCS air permits. Emissions from Project activities on the OCS would be permitted as part of an OCS air permit and must demonstrate compliance with National Ambient Air Quality Standards (NAAQS). Mayflower Wind submitted an OCS Air Permit application to USEPA in November 2022.

5.6.1 Vessels

Operation of Project vessels during construction would result in short-term increases in Project-related air emissions. During O&M, operation of Project vessels would result in long-term increases in emissions related to the Proposed Action. However, estimated air emissions from O&M activities would generally be lower than emissions generated during construction activities and are not expected to have a significant effect on regional air quality. Air emissions during decommissioning are expected to be similar or less than emissions estimated for construction activities.

5.6.1.1 Marine Mammals

The effects of air pollution on marine mammals are not well-studied, and air emissions are not an IPF of concern for marine mammal species (BOEM 2019). Given that long-term effects on regional air quality are expected to be insignificant and that compliance with the NAAQS will ensure that air quality does not significantly deteriorate from baseline levels, the air emissions produced by Project vessels are expected to have no effect on ESA-listed marine mammals.

5.6.1.2 Sea Turtles

The impact from air pollutant emissions is anticipated to be minor and temporary. Since construction and decommissioning activities will likely require similar equipment such as vessels for transportation, driving and removing piles and laying and removing cable, it is assumed that air quality impacts would be similar. Although sea turtles are capable of diving for long periods and have different diving patterns, these animals respire air with very little cutaneous exchange (Jackson 1985, Hays et al. 2000). Not many studies have been conducted to assess air quality impacts on sea turtles, however the National Ambient Air Quality Standards are designed to ensure that air quality does not significantly deteriorate from baseline levels. Additionally, the Project’s use of SES or CTVs for crew transport have the potential to employ technology that reduces emissions compared to standard in-water hull and propeller vessels. It is reasonable to conclude that any effects on listed sea turtles from these emissions will be so small that they cannot be meaningfully measured, detected, or evaluated and, therefore, are insignificant. Therefore, the effects of air emissions from the Project may affect, not likely to adversely affect ESA-listed turtles.

5.6.1.3 Fish

As Atlantic sturgeon do not breathe air, Project vessel air emissions would have no effect on this ESA-listed fish species.
5.6.2 WTG Installation Equipment

Operation of WTG installation equipment during Project construction would result in short-term increases in air emissions during construction of the Proposed Action. Mayflower Wind has proposed measures to avoid and minimize air emissions effects, including the use of low-sulfur fuels and minimization of engine idling time.

5.6.2.1 Marine Mammals

As described in Section 5.6.1.1, air emissions associated with the Proposed Action are expected to have no effect on ESA-listed marine mammals.

5.6.2.2 Sea Turtles

As described in Section 5.6.1.2, air emissions associated with the Proposed Action are expected to have no effect on ESA-listed sea turtles.

5.6.2.3 Fish

As Atlantic sturgeon do not breathe air, air emissions associated with installation equipment would have no effect on this ESA-listed fish species.

5.6.3 Summary of Air Emissions Effects

5.6.3.1 Marine Mammals

There is a lack of information on the effects of air emissions on marine mammals. However, based on the compliance with NAAQS, as well as the avoidance and minimization measures proposed by Mayflower Wind, air emissions associated with the Proposed Action are expected to have no effect on ESA-listed marine mammals.

5.6.3.2 Sea Turtles

There is a lack of information on the effects of air emissions on sea turtles. However, based on the compliance with NAAQS, as well as the avoidance and minimization measures proposed by Mayflower Wind, air emissions associated with the Proposed Action are expected to be insignificant. Therefore, the effects of air emissions from the Project may affect, not likely to adversely affect ESA-listed turtles.

5.6.3.3 Fish

Air emissions would have no effect on ESA-listed Atlantic sturgeon.

5.7 Port Modifications

No port modifications are proposed as part of the Proposed Action.

5.8 Repair and Maintenance Activities

As described in Section 3.1.2, repair and maintenance activities during O&M of the Proposed Action would include inspections and any necessary repairs and replacements identified during inspections. Some inspections (e.g., surveys of submarine export cables) may generate noise which could affect ESA-listed species. Effects of these types of surveys on ESA-listed species were previously addressed in Section 5.2. Though not anticipated, repairs to faulty submarine cables may require additional cable laying activities that could result in noise and turbidity impacts on ESA-listed species in the Action Area.
These impacts were previously assessed in Sections 5.2.3 and 5.5.4, respectively, and the effects on ESA-listed species was determined to be insignificant.

5.9 Other Effects

5.9.1 Potential Shifts or Displacement of Ocean Users (vessel traffic, recreational and commercial fishing activity)

The presence of offshore structures associated with the Proposed Action could displace commercial or recreational fishing vessels to areas outside of the Lease Area or potentially lead to a shift in gear types due to displacement and introduction of structured habitat in the Lease Area. If displacement leads to an overall shift from mobile to fixed gear types, there could be an increased number of vertical lines in the water, increasing the risk of interactions between ESA-listed species and fixed fishing gear. Additional detail on the effects of the presence of WTGs on ESA-listed species from shifts or displacement is described in Section 5.5.8.

5.9.1.1 Marine Mammals

Another long-term impact of the presence of structures during O&M is the potential to concentrate recreational fishing around foundations, potentially increasing the risk of marine mammal entanglement in both lines and nets and increasing the risk of injury and mortality due to infection, starvation, or drowning (Moore and van der Hoop 2012). These structures could also result in fishing vessel displacement or gear shift. The potential impact on marine mammals from these changes is uncertain. However, if a shift from mobile gear to fixed gear occurs due to inability of fishermen to maneuver mobile gear, there would be a potential increase in the number of vertical lines, resulting in an increased risk of marine mammal interactions with fishing gear. Entanglement in fishing gear has been identified as one of the leading causes of mortality in NARWs and may be a limiting factor in the species’ recovery (Knowlton et al. 2012). Knowlton et al. (2012) reports that 83 percent of NARWs show evidence of past entanglements. Additionally, recent literature indicates that the proportion of NARW mortality attributed to fishing gear entanglement is likely higher than previously estimated from recovered carcasses (Pace 2021). Entanglement may also be responsible for high mortality rates in other large whale species (Read et al. 2006). Abandoned or lost fishing gear may become tangled with foundations, reducing the chance that abandoned gear would cause additional harm to marine mammals and other wildlife, although debris tangled with WTG foundations may still pose a hazard to marine mammals. These potential long-term, intermittent impacts would be low in intensity and persist until decommissioning is complete and structures are removed. As a result, any effects from the secondary entanglement due to an increased presence of recreational fishing in response to reef effect would be so small that they could not be measured, detected, or evaluated and are therefore insignificant. Therefore, the effects of secondary entanglement due to an increased presence of recreational fishing in response to the reef effect from Project structures may affect, not likely to adversely affect ESA-listed marine mammals.

5.9.1.2 Sea Turtles

Another long-term impact of the presence of structures during O&M is the potential to concentrate recreational fishing around foundations, potentially increasing the risk of sea turtle entanglement in both vertical and horizontal fishing lines and increasing the risk of injury and mortality due to infection, starvation, or drowning. A majority of the recreational and commercial prime fishing areas and fishing activity occurs outside of the Project area (DNV-GL 2021). If there is an increase in recreational fishing in the Project area, it is likely that this will represent a shift in fishing effort from areas outside the Lease Area to within the Lease Area and/or an increase in overall effort. These structures could also result in fishing vessel displacement or gear shift. The potential impact on sea turtles from these changes is uncertain. However, if a shift from mobile gear (trolling) to fixed gear (hook and line) occurs due to
inability of the fishermen to maneuver mobile gear, there would be a potential increase in the number of vertical lines, resulting in an increased risk of sea turtle interactions with fishing gear. Given vessel safety concerns regarding being too close to foundations and other vessels, the likelihood of recreational fishermen aggregating around the same turbine foundation at the same time is low. Due to foraging strategies, leatherback and loggerhead sea turtles are more likely to be exposed to recreational fishing lines in the pelagic Lease Area. Conversely, Kemp’s ridley and green sea turtles are less likely to be exposed to recreational fishing lines in the pelagic Lease Area.

Thus, exposure of Kemp’s ridley and green sea turtles to entanglement in fishing gear around WTGs is discountable. Therefore, potential entanglement due to increased presence of recreational fishing gear associated with WTGs during operations may affect, not likely to adversely affect Kemp’s ridley and green sea turtles.

Based on available information, secondary entanglement due to an increased presence of recreational fishing around the WTGs is possible and cannot be discounted for leatherback or loggerhead sea turtles. Therefore, the potential entanglement due to increased presence of recreational fishing gear associated with WTGs during operations may affect, likely to adversely affect leatherback and loggerhead sea turtles.

5.9.1.3 Fish

Another long-term impact of the presence of structures during O&M is the potential to concentrate recreational fishing around foundations, potentially increasing the risk of Atlantic sturgeon entanglement in both vertical and horizontal fishing lines and increasing the risk of injury and mortality due to infection and starvation. A majority of the recreational and commercial prime fishing areas and fishing activity occurs outside of the Project area (DNV-GL 2021). If there is an increase in recreational fishing in the Project area, it is likely that this will represent a shift in fishing effort from areas outside the Lease Area to within the Lease Area and/or an increase in overall effort. These structures could also result in fishing vessel displacement or gear shift. The potential impact on Atlantic sturgeon from these changes is uncertain. However, if a shift from mobile gear (trolling) to fixed gear (hook and line) occurs due to inability of the fishermen to maneuver mobile gear, there would be a potential increase in the number of vertical lines, resulting in an increased risk of sturgeon interactions with fishing gear. Given vessel safety concerns regarding being too close to foundations and other vessels, the likelihood of recreational fishermen aggregating around the same turbine foundation at the same time is low. Due to their benthic foraging strategy, Atlantic sturgeon have a reduced chance of being exposed to recreational fishing lines in the pelagic Lease Area. Thus, exposure of Atlantic sturgeon to entanglement in fishing gear around WTGs is discountable. Therefore, potential entanglement due to increased presence of recreational fishing gear associated with WTGs during operations may affect, not likely to adversely affect Atlantic sturgeon.

5.9.2 Unexpected/Unanticipated Events

Unexpected or unanticipated events with the potential to affect ESA-listed species could occur during the construction, O&M, or decommissioning phases of the Proposed Action. Such events would include vessel collisions or allisions (i.e., collisions with stationary structures) (Section 5.9.2.1), severe weather events resulting in equipment failure (Section 5.9.2.2), oil spills (Section 5.9.2.3), or encounters with unexploded ordnance (Section 5.9.2.4).

5.9.2.1 Vessel Collision/Allision with Foundation

Vessel collisions or allisions may result in oil spills, which are addressed in Sections 5.4. Such events are considered unlikely given the lighting requirements for Project vessels and offshore structures, vessel
speed restrictions, proposed spacing of Project structures, inclusion of Project structures on navigational charts, and Notices to Mariners issued by the U.S. Coast Guard. Therefore, effects on ESA-listed species due to vessel collisions or allisions are extremely unlikely to occur. Given the low likelihood of effects, the effects of oil spills associated with collisions or allisions leading to injury or mortality is not likely to adversely affect (discountable) any of the ESA-listed species considered.

### 5.9.2.2 Failure of WTGs due to Weather Events

The Lease Area may be affected by extratropical storms, which are common in the area between October and April, or hurricanes. The high winds associated with these events have the potential to result in the failure of WTGs. However, such a failure is highly unlikely, as these structures are designed to withstand significant storms, and effects on ESA-listed species associated with WTG failure are extremely unlikely to occur. Given the low likelihood of effects, the effects of catastrophic WTG failure leading to injury or mortality is not likely to adversely affect (discountable) any of the ESA-listed species considered.

### 5.9.2.3 Oil Spill/Chemical Release

Vessel traffic associated with the Proposed Action would increase the risk of accidental releases of fuels, fluids, and hazardous materials (Section 5.4.2). There would also be a low risk of leaks of fuel, fluid, or hazardous materials from any of the 149 WTGs/OSPs anticipated for the Project. The total volume of WTG and OSP fuels, fluids, and hazardous materials associated with the Proposed Action is identified in Table 3.1-1. BOEM has modeled the risk of spills associated with WTGs and determined that a release of 128,000 gallons is likely to occur no more frequently than once every 1,000 years and a release of 2,000 gallons or less is likely to occur every 5 to 20 years (Bejarano et al. 2013).

#### 5.9.2.3.1 Marine Mammals

Effects of oil spills from vessels was addressed in Section 5.4.2. Effects of oil spills from WTGs or OSPs would be similar. As noted in Section 5.4.2.1, Mayflower Wind has developed an OSRP (Mayflower Wind 2022) with measures to avoid accidental releases and a protocol to respond to such a release if one occurs. Given the low likelihood of occurrence, effects of oil spills on ESA-listed marine mammals are extremely unlikely to occur and are not likely to adversely affect (discountable) for ESA-listed marine mammals.

#### 5.9.2.3.2 Sea Turtles

Effects of oil spills from vessels was addressed in Section 5.4.2. Effects of oil spills from WTGs or OSPs would be similar. As noted in Section 5.4.2.1, Mayflower Wind has developed an OSRP (Mayflower Wind 2022) with measures to avoid accidental releases and a protocol to respond to such a release if one occurs. Given the low likelihood of occurrence, effects of oil spills on ESA-listed sea turtles are extremely unlikely to occur and are not likely to adversely affect (discountable) for ESA-listed sea turtles.

#### 5.9.2.3.3 Fish

Effects of oil spills from vessels was addressed in Section 5.4.2. Effects of oil spills from WTGs or OSPs would be similar. As noted in Section 5.4.2.1, Mayflower Wind has developed an OSRP (Mayflower Wind 2022) with measures to avoid accidental releases and a protocol to respond to such a release if one occurs. Given the low likelihood of occurrence, effects of oil spills on ESA-listed Atlantic sturgeon are extremely unlikely to occur and are not likely to adversely affect (discountable) for Atlantic sturgeon.
5.9.2.4 UXO Encounters/Response

As described in Section 3.1.2.5, Mayflower Wind is currently conducting a three-phase UXO risk assessment. Phase 1 determined that the risk level for UXO is low for most installation activities in the Project area and that there is a moderate risk of encountering UXO in the Lease Area and in certain portions of both ECCs. Mayflower Wind continues to evaluate the potential for UXO presence in the Project area. Avoidance is the preferred approach for UXO mitigation. When avoidance is not possible, UXO may be disposed of in place via low-noise methods, such as controlled deflagration or by opening the UXO and removing the explosive components, or it may be relocated to another safe location on the seafloor or to a designated disposal area. The choice of removal method and suitable safety measures would be made with the assistance of a UXO specialist and the appropriate agencies. The US Navy is the responsible agency for any UXO removal operations. Aa a conservative estimate, Mayflower Wind anticipates that up to 5 UXOs in the Lease Area and up to 5 along the ECCs may have to be detonated in place. Such unexpected or emergency actions may require independent consultation under section 7 of the ESA. Given that avoidance is the primary strategy under the Proposed Action and no UXO removal is proposed for any identified targets, effects of existing UXOs under the Proposed Action would be avoided and impacts on ESA-listed species are extremely unlikely to occur and will not affect any ESA-listed species or critical habitat. Given the low likelihood of effects, the effects of UXO encounters associated with the Proposed Action leading to injury or mortality is **not likely to adversely affect (discountable)** for ESA-listed marine mammals, sea turtles, and Atlantic sturgeon.
6. Other Relevant Action Alternatives

BOEM considered four relevant action alternatives to the Proposed Action (Alternatives C through F in the EIS). The impact analyses, effects determinations, and conclusions for Alternatives C through F would not be materially different from those of the Proposed Action.

Under Alternative C (Fisheries Habitat Impact Minimization), BOEM developed onshore cable route options that would avoid placing the Offshore Export Cable in the Sakonnet River. Under this alternative, the construction, O&M, and eventual decommissioning of the Project on the OCS offshore Massachusetts would occur within the range of the design parameters outlined in the Mayflower Wind COP, subject to applicable mitigation measures. BOEM worked with Mayflower Wind to identify feasible onshore cable routes to avoid the Sakonnet River and identified two onshore route alternatives: Aquidneck Island, Rhode Island Route and Little Compton/Tiverton, Rhode Island. The ESA-listed species that would potentially benefit from this are the sea turtles and Atlantic sturgeon. However, these species, in particular sea turtles, are uncommon in the river, and cable laying activities would still occur at all other project locations.

Alternative D (Nantucket Shoals) intends to address potential impacts on foraging habitat and potential displacement of protected species in the northeastern portion of the Lease Area by eliminating up to six WTG foundations. The six WTG foundations to be removed are located on the eastern edge of the Lease Area, which are near Nantucket Shoals (Figure 5.9-1). This area exhibits higher modeled relative abundance of gammarid amphipods and chlorophyll in the spring, which is correlated with increased NARW abundance in that area in the spring and winter. Potential impacts on ESA-listed species from noise, cable emplacement and maintenance, presence of structures, habitat alteration and EMF could be reduced by the removal of up to six WTGs in the northeastern portion of the Lease Area. Overall, Alternative D is expected to lessen the duration for the IPFs in comparison to those described for the Proposed Action.

Under Alternative E (Foundation Structures), the construction and installation, O&M, and eventual decommissioning of the Project on the OCS offshore Massachusetts would occur within the range of the design parameters, which includes a range of foundation types (monopile, piled jacket, suction bucket, and GBS), subject to applicable mitigation measures. This alternative includes three foundation options, which assume the maximum use of piled (monopile and piled jacket), suction bucket, and GBS foundations to assess the extent of potential impacts from each foundation type: Alternative E-1: Piled Foundations (monopile and piled jacket) only; Alternative E-2: Suction Bucket Foundations only; Alternative E-3: GBS Foundations only.

Alternative F (Muskeget Channel Cable Modification) was developed to minimize impacts on complex habitats and reduce seabed disturbance in the Muskeget Channel east of Martha’s Vineyard in response to concerns from NMFS. Under Alternative F, the construction, O&M, and eventual decommissioning of the Project on the OCS offshore Massachusetts would occur within the range of the design parameters outlined in the Mayflower Wind COP, subject to applicable mitigation measures. However, to minimize seabed disturbance in the Muskeget Channel, the Falmouth offshore export cable route would use ±525kV HVDC cables connected to one HVDC converter OSP, instead of HVAC cables connected to one or more HVAC OSPs as proposed under the Proposed Action. The OSP design for the offshore export cables connecting to Brayton Point would remain unchanged from the Proposed Action. As a result, there would be two HVDC converter OSPs under Alternative F – one HVDC converter OSP for Brayton Point and one HVDC converter OSP for Falmouth. In addition, Alternative F would install up to three offshore export cables to Falmouth, instead of up to five offshore export cables under the Proposed Action.
The impact of each IPF with consideration to each Proposed Action alternative is discussed below:

**Noise:** The roughly 4 percent reduction in the number of WTGs for Alternative D would reduce the overall number of impact pile-driving hours required for installation from 588–882 hours to 564–846 hours. Overall, the number of pile-driving hours under Alternative D would be reduced by 24–36 hours in comparison to the Proposed Action. The specific effects are likely to remain the same for marine mammals including masking, disturbance, and PTS. However, by limiting the duration of the effect, the number of marine mammals exposed to underwater sound in excess of acoustic thresholds could be reduced. This could be important for species who are sensitive to impact pile-driving activities including baleen whales, which are low-frequency specialists with known sensitivity to the low frequencies of pile-driving noise. A reduction of WTGs under Alternative D would also result in a reduction in the number of construction vessels or the duration of vessels in the Project area during construction activities that would be required for installation. The magnitude of the effects of underwater noise from Project vessels during construction would remain the same, but the duration of the effects would be reduced. Although certain impacts may be minimally decreased in duration and geographic extent, the differences between Alternative D and the Proposed Action do not have the potential to significantly reduce or increase impacts on ESA-listed species.

Alternative E includes the use of all piled (Alternative E-1), all suction bucket (Alternative E-2), or all GBS (Alternative E-3) foundations for WTGs and OSPs. Installation activities would not differ between the Proposed Action and Alternative E-1, which assumes pile driving would be used for all foundations with corresponding noise impacts. Under Alternatives E-2 and E-3, no pile driving would occur; therefore, there would be no underwater noise impacts on ESA-listed species due to pile driving. The avoidance of pile-driving noise impacts would reduce overall construction and installation impacts under Alternatives E-2 and E-3 compared to the Proposed Action. Construction, O&M, and decommissioning would still, however, result in impacts to ESA-listed marine mammals, sea turtles, and fish. Impacts are magnified in severity for the NARW due to low population numbers and the potential to compromise the viability of the species from the loss of a single individual. Overall, impacts of Alternative E would be similar to impacts of the Proposed Action with the most notable difference in the reduction of short-term impacts from avoidance of pile-driving noise and the increase in long-term impacts from larger foundation footprints.

**EMF:** Under Alternative D, a reduction in WTGs would result in a reduction of interarray cable, which would limit the footprint of potential EMF exposure, especially for ESA-listed species that forage on benthic prey species near the cable. A roughly 4 percent reduction in WTGs under Alternative D would result in 19.9 miles (32 kilometers) less interarray cable length within the Project area. Given that Alternative D only represents a reduction of up to six WTGs, impact levels would be the same as the Proposed Action.

Under Alternative F, the reduction in the number of cables in the Falmouth ECC could reduce the effects of EMF-sensitive species such as ESA-listed sea turtles. However, because impacts associated with cable installation and maintenance would still occur in the same corridor, the impacts on sea turtles under Alternative F would be slightly reduced but not materially different than those described for the Proposed Action.

**Presence of structures:** Under Alternative D, a reduction in WTGs potential impacts on marine mammals due to the presence of structures could be realized with the removal of up to six WTGs in the northern portion of the Lease Area. Northern portions of the Lease Area are frequented by NARWs (Figure 5.9-1), and a reduction in offshore wind development in this area may lessen the impacts on these species.
Nantucket Shoals is relatively shallow (< 50 meters) and an area of high biological productivity (Townsend et al. 2006). This broad area extends south, southeast and east of Nantucket and contains complex, dunelike topography which reflects the strong tidal currents (PCCS 2005). The shoals are known to be consistently colder than surrounding waters proven by satellite images of sea surface temperature and are tidally well mixed (Townsend et al. 2006). A trend of higher near surface chlorophyll is greater inshore than offshore (Townsend et al. 2006). The year-round productivity of Nantucket Shoals is known to attract primarily NARWs and fin whales, which may use the area for congregation, feeding, or passing through (PCCS 2005). The removal of six WTGs in this area may lessen the impacts on marine mammals by providing more area of open ocean nearest to Nantucket Shoals foraging habitat.

Additionally, the reduction of 6 WTGs near Nantucket Shoals, under this alternative, may lessen the impacts to marine mammals by providing more area of open ocean for foraging as well as allow some benefits to ESA-listed species by minimizing disturbance to important prey habitats. The removal of WTGs could, however, reduce reef and hydrodynamic effects, which may then reduce foraging opportunities for some ESA-listed species compared to the Proposed Action. The presence of vertical structures in the water column may influence primary and secondary productivity and the distribution and abundance of invertebrate and fish community structures within and in proximity to Project footprints; however, modeling of the full build-out of the entire southern New England lease areas indicate that only localized changes to the physical hydrodynamic features may occur on the western side of Nantucket Shoals adjacent to the Massachusetts and Rhode Island offshore wind lease areas (Johnson et al. 2021). There is a lack of conclusive evidence that removal of turbines in the northern portion of the Mayflower Wind Lease Area would measurably lessen the impacts on the hydrodynamic features associated with Nantucket Shoals. While BOEM expects small reductions in the presence of structures under Alternative D, impacts from the remaining 143 WTG/OSPs would still occur and would not change the overall impact magnitude of the Project and Proposed Action.

Alternative C would avoid EFH and HAPC by avoiding cable installation in the Sakonnet River through an onshore alternative route. Alternative C-1 would reduce the total offshore export cable route by 9 miles (14 kilometers) and Alternative C-2 would reduce the total offshore export cable route by 12 miles (19 kilometers). These reductions in offshore export cable length would eliminate the construction and installation impacts from cable emplacement and anchoring in the Sakonnet River compared to the Proposed Action. The Sakonnet River contains a mix of soft bottom and complex substrates, which can be important benthic habitats for fish and invertebrates. In a few locations, live Crepidula sp. reefs or Crepidula sp. shell hash were found on the sediment surface overlying reduced silt (COP Appendix M.2; Mayflower Wind 2022), which is a biogenic habitat that also adds complexity to the seafloor. This complex habitat, along with some boulder fields in Mount Hope Bay, are EFH for many species, and Alternative C will avoid the disturbance of this benthic habitat. Because the Sakonnet River is HAPC for juvenile Atlantic cod, there is a greater potential for Alternative C to avoid or minimize impacts on this species than the Proposed Action. As under the Proposed Action, Mayflower Wind would use HDD for the installation of the Alternative C offshore export cables beneath the shallower nearshore areas at all landfall locations. This is expected to substantially reduce impacts of sediment dispersion on sensitive habitats, such as SAV and wetlands, which could serve as EFH. BOEM anticipates that potential effects from avoiding the installation of export cables in the Sakonnet River would result in a reduced, but not measurably different, impact on ESA-listed species.

While sightings of sea turtles in the Project area are uncommon, Kemp’s Ridley sea turtle is associated with coastal habitats and is known to forage in bays and estuaries across Rhode Island in the summer months (Schwartz 2021). This particular species of sea turtle would then be expected to benefit the most from the prevention of construction in the Sakonnet River. However, no measurable difference in the impacts on sea turtles are expected between the Proposed Action and Alternative C. Therefore, BOEM
anticipates that impacts under Alternative C would not be measurably different from those anticipated under the Proposed Action.

Under Alternative E, the use of GBS foundations (E-3), would result in the greatest area of habitat conversion due to foundation footprint and scour protection. Alternative E-1 (piled foundations only) would result in at least a 77 percent reduction in footprint and scour protection, and Alternative E-2 (suction bucket foundations only) would result in at least a 58 percent reduction in footprint and scour protection, compared to Alternative E-3. Alternative E-2 and Alternative E-3 may have a greater artificial reef effect with increased surface area, which would benefit sea turtles, increase overall abundance and diversity of fish, and increase foraging opportunities for ESA-listed species. However, adverse impacts from these larger underwater structures may include entanglement in lost or discarded fishing gear, potential of vessel strike from increased recreational fishing vessel traffic, and incidental hooking. For example, the GBS of Alternative E-3 may have less entanglement potential as it has a smooth, sloping exterior in the water column compared to the suction bucket foundation of Alternative E-2 that has steel cross beams which may create more entanglement potential of marine debris and recreational fishing gear. Given that Alternative E includes increases in both beneficial and adverse impacts, there is not expected to be a measurable difference in impacts on ESA-listed species from those anticipated under the Proposed Action. BOEM anticipates that the impacts on ESA-listed species under Alternatives E-1, E-2, and E-3 would not be materially different from those anticipated under the Proposed Action.

Under Alternative F, to minimize seabed disturbance in the Muskeget Channel, the Falmouth offshore export cable route would use ±525kV HVDC cables connected to one HVDC converter OSP instead of HVAC cables connected to one or more HVAC OSPs as proposed under the Proposed Action. A 40 percent reduction in seabed disturbance from installation of the Falmouth offshore export cables would reduce impacts on benthic habitat, in particular some complex habitats found in the Muskeget Channel that may be important EFH. Conversely, during operation, there would be increased intake and discharge from the additional HVDC converter OSP, which could result in increased entrainment of marine mammal prey compared to the Proposed Action. Potential impacts, however, would remain localized near the OSP locations. Overall, due to both adverse and beneficial impacts associated with Alternative F and given that the overall magnitude would be the same as in the Proposed action, effects determination would likely not change.

**Cable emplacement and maintenance:** Alternative C would reduce cable-related impacts on fish within the Sakonnet River compared to the Proposed Action. The Sakonnet River is an important area for juvenile Atlantic cod and other species with EFH present, but overall impacts on this area under the Proposed Action area are anticipated to be small and make up a small portion of the overall Project impacts. The export cable reroute under Alternatives C-1 and Alternative C-2 would not cross other habitats important to ESA-Listed species, but it would have a reduced total length of offshore export cable installation, and is therefore, expected to have minimal impacts on ESA-listed species. Therefore, BOEM anticipates that impacts on ESA-listed species under Alternative C would not be measurably different from those anticipated under the Proposed Action.

Under Alternative D, a reduction in WTGs would result in less interarray cable within the Project area footprint and a reduction in area over which the emplacement disturbance and resulting impacts could occur. This would additionally limit short-term elevated turbidity in the Project area, reducing the number of ESA-listed species exposed to potentially adverse effects. Although certain impacts may be minimally decreased in duration and geographic extent, the differences between Alternative D and the Proposed Action do not have the potential to significantly reduce or increase impacts on ESA-listed species from the analyzed IPF. BOEM does not anticipate impacts to be measurably different from those described under the Proposed Action; thus, the effects determination would remain the same.
Under Alternative F, the Falmouth offshore export cable route would still be within the Proposed Action’s PDE but would use ±525kV HVDC cables connected to one HVDC converter OSP, instead of HVAC cables connected to one or more HVAC OSPs as proposed under the Proposed Action. During operation, there would be increased intake and discharge from the additional HVDC converter OSP, which could result in increased entrainment of ESA-listed prey and fish larvae compared to the Proposed Action. However, impacts would remain localized near the OSP locations, and the overall impact determination would be the same. Additionally, the Falmouth offshore export cable would include only three cables compared to five cables under the Proposed Action, which would reduce seafloor disturbance by approximately 700 acres. Because the offshore export cable footprint would be the same or slightly less, BOEM does not anticipate impacts to ESA-listed species to be materially different than those described under the Proposed Action.
Figure 5.9-1. Alternative D WTG Removal and NARW seasonal density
7. **Cumulative Effects**

Cumulative effects are defined as those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the Action Area (50 CFR 402.02). Those activities involving Federal activities are excluded from consideration as they would require separate consultation under Section 7 of the ESA. The majority of activities which may occur within the Action Area for the Proposed Action would involve Federal activities, thereby requiring future consultation under the ESA. Potential future activities without Federal involvement that could occur in the Action Area include recreational fishing, state-regulated fisheries, marine transportation, recreational boat traffic, discharge of wastewater, and state or locally authorized coastal development. Effects of such activities are not expected to differ from the current environmental baseline (Section 4).

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8 “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]
8.  Conclusion

8.1  Marine Mammals

Five ESA-listed marine mammal species under NMFS jurisdiction may occur in the Action Area for the Proposed Action. However, one of these species (blue whale) is unlikely to occur or their occurrence would be limited to a portion of the Action Area. Potential effects on this species would be limited to vessel traffic effects, and such effects would be extremely unlikely to occur (Table 8.4-1). One exposure was estimated for blue whale, however, this is considered extremely unlikely. Thus the Proposed Action may affect, not likely to adversely affect blue whales.

Fin whales, sei whales and NARWs are likely to occur in the Action Area, and sperm whale to a much lesser extent, and would be subject to effects associated with the Proposed Action, including effects of noise, vessel traffic, habitat disturbance/modifications, repair and maintenance activities, and unexpected/unanticipated events and other effects. Noise associated with the Proposed Action has the potential to result in injury or behavioral effects in these species. Project vessel traffic could increase vessel strike risk for ESA-listed marine mammals, but this increase would be insignificant given the measures in place to avoid or minimize vessel strikes. Habitat disturbance or modification could result in increased entanglement risk in recreational fishing gear, turbidity effects, species avoidance or displacement, behavioral disruption, or EMF effects. However, such effects are expected to be insignificant as they would be short-term, localized, or would not be measurable or measurably change risk. Repair and maintenance activities would be similar to activities evaluated for noise and habitat disturbance/modifications. Other effects (i.e., shifts or displacement of other ocean users) could result in displacement of fishing activity outside the Lease Area and may result in increased entanglement risk for ESA-listed marine mammals if shifts to fixed gear from mobile gear were to occur. However, such a gear shift is not expected, and effects of displacement would be insignificant. Unexpected/unanticipated events, including vessel collisions or allisions, WTG failure, oil spills, and UXO encounters, would be extremely unlikely to occur, making their effects extremely unlikely to occur. Given that underwater noise has the potential to result in injury or behavioral effects, the Proposed Action may affect and is likely to adversely affect fin whales, NARW, sei whales, and sperm whales.

8.2  Sea Turtles

Five ESA-listed sea turtle species may occur in the Action Area for the Proposed Action. However, hawksbill sea turtle occurrence would be limited to a portion of the Action Area. Potential effects on this species would be limited to vessel traffic effects, and such effects would be extremely unlikely to occur (Table 8.4-1). Therefore, the Proposed Action may affect but is not likely to adversely affect hawksbill sea turtle.

Green, Kemp’s ridley, leatherback, and loggerhead sea turtles are likely to occur in the Action Area and would be subject to effects associated with the Proposed Action, including effects of noise, vessel traffic, habitat disturbance/modifications, port modifications, repair and maintenance activities, and unexpected/unanticipated events and other effects (Table 8.4-1). Noise associated with the Proposed Action has the potential to result in injury or behavioral effects in these species. Project vessel traffic could increase vessel strike risk for sea turtles, but this increase may affect, not likely to adversely affect ESA-listed sea turtles given their patchy distribution and the measures in place to avoid or minimize vessel strikes. Habitat disturbance or modification could result in decreased foraging habitat for Kemp’s ridley sea turtle and increased foraging opportunities, increased entanglement risk in recreational fishing gear, turbidity effects, species avoidance or displacement, behavioral disruption, EMF and heat effects, or lighting effects in all ESA-listed sea turtles. However, such effects are expected to not likely adverse
Kemp’s ridley and green sea turtles, but would likely adversely impact leatherback and loggerhead sea turtles. Repair and maintenance activities would be similar to activities evaluated for noise and habitat disturbance/modifications. Other effects (i.e., shifts or displacement of other ocean users) could result in displacement of fishing activity outside the Lease Area and may result in increased entanglement risk for ESA-listed sea turtles if shifts to fixed gear from mobile gear were to occur. However, such a gear shift is not expected, and effects of displacement are not likely to affect Kemp’s ridley and green sea turtles, but are likely to adversely affect leatherback and loggerhead sea turtles. Unexpected/unanticipated events, including vessel collisions or allisions, WTG failure, oil spills, and UXO encounters, would be extremely unlikely to occur, making their effects extremely unlikely to occur. Given that underwater noise has the potential to result in injury or behavioral effects, the Proposed Action may affect and is likely to adversely affect leatherback and loggerhead sea turtles. The Proposed Action may affect, is not likely to adversely affect Kemp’s ridley and green sea turtles based on their comparatively lower abundances in the Project area.

8.3 Fish

Five ESA-listed fish species may occur in the Action Area of the Proposed Action. However, giant manta ray would be limited to the southern portion of the Action Area. Oceanic whitetip shark may occur infrequently as oceanic whitetip shark spend more time farther offshore. Potential effect son these species would be limited to those related to vessel traffic, and such effects would be extremely unlikely to occur. Shortnose sturgeon and Atlantic salmon are unlikely to occur in the Action Area, making potential effects on these species extremely unlikely to occur, and thus discountable. Therefore, the Proposed Action may affect but is not likely to adversely affect Atlantic salmon, giant manta ray, oceanic whitetip shark, and shortnose sturgeon.

Atlantic sturgeon is likely to occur in the Action Area and would be subject to effects associated with the Proposed Action, including effects of noise, vessel traffic, habitat disturbance/modifications, port modifications, repair and maintenance activities, and unexpected/unanticipated events and other effects (Table 8.4-1). Noise associated with the Proposed Action has the potential to result in injury or behavioral effects in Atlantic sturgeon. Project vessel traffic could increase vessel strike risk for Atlantic sturgeon, though strike risk in oceanic habitats is not well understood. Any increase in strike risk would be insignificant given their patchy distribution and the measures in place to avoid or minimize vessel strikes. Habitat disturbance or modification could result in decreased foraging habitat, turbidity effects, behavioral disruption, and EMF and heat effects. However, such effects are expected to be insignificant as they would be short-term, localized, or would not be measurable. Fisheries and habitat surveys, however, may impact Atlantic sturgeon and cannot be discounted. HRG surveys conducted during repair and maintenance activities would be similar to activities evaluated for noise and habitat disturbance/modifications. Other effects (i.e., shifts or displacement of other ocean users) could result in displacement of fishing activity outside the Lease Area or shifts from mobile to fixed gear. However, fishing displacement or gear shift would be insignificant for Atlantic sturgeon. Unexpected/unanticipated events, including vessel collisions or allisions, WTG failure, oil spills, and UXO encounters, would be extremely unlikely to occur, making their effects extremely unlikely to occur. Given that fishery/habitat surveys have the potential to result in injury or behavioral effects, the Proposed Action may affect and is likely to adversely affect Atlantic sturgeon.

8.4 Climate Change Considerations

As described in Section 4.10, climate change could affect ESA-listed species in the Action Area. Warming water temperatures associated with climate change could affect distribution of ESA-listed species or their prey, for species whose distribution is largely governed by water temperatures. Water temperature is generally not the most significant determinant of habitat usage for marine mammals.
However, prey species distribution for some marine mammal species are affected by water temperatures. Recent changes in NARW distribution may be attributed to changes in the distribution of copepod prey in response to changing climate (Record et al. 2019). Warming may negatively impact the abundance of *Calanus* copepods, primary prey for NARW, on the Northeast U.S. shelf in the coming decades (Grieve et al. 2017), which could potentially reduce NARW foraging in the Action Area. Climate change is not expected to affect NARW use of the Action Area for other critical functions and is not expected to reduce the overall effects on NARWs associated with the Proposed Action. Climate change is not expected to have a measurable effect on usage of the Action Area by other ESA-listed marine mammal species and is therefore not expected to change the effects of the Proposed Action on these species.

Seasonal usage of the Action Area by ESA-listed sea turtle species is largely governed by water temperatures. Warmer water temperatures could increase the period of time in which sea turtles are likely to occur in the Action Area. However, any increase in the likely period of habitat use is expected to be small. Therefore, climate change is not expected to change the effects of the Proposed Action on ESA-listed sea turtle species.

Atlantic sturgeon exhibit seasonal migrations that are influenced by water temperatures, among other environmental and biological cues. Based on the large geographic distribution for Atlantic sturgeon, anticipated changes in water temperatures over the life of the Proposed Action are not expected to result in changes in use of the Action Area by Atlantic sturgeon. Habitat use by other ESA-listed fish species in the Action Area is largely governed by factors other than temperature. Therefore, climate change is not expected to change the effects of the Proposed Action on ESA-listed fish species.
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Appendix A: Mayflower Wind National Pollutant Discharge Elimination System Permit Application
Mayflower Wind – National Pollutant Discharge Elimination System (NPDES) Permit Application

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