SouthCoast Wind Project Biological Assessment

For the National Marine Fisheries Service

March 2023 (Revised August 2023)

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

BOEM
BUREAU OF OCEAN ENERGY MANAGEMENT

CONTENTS

TABLES

FIGURES

1. Introduction

This document transmits the Bureau of Ocean Energy Management's (BOEM) biological assessment (BA) in accordance with Section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 United States Code [U.S.C.] 1531 et seq.), on the effects of the Proposed Action on ESA-listed species and designated critical habitat that occur in the Action Area.

The Proposed Action in this BA entails the construction, operation and maintenance (O&M), and decommissioning of the SouthCoast Wind Project in Lease Area OCS-A 0521 (the Project or Proposed Action).[1] SouthCoast Wind Energy LLC (hereafter SouthCoast 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 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 (48 kilometers) south of Martha's Vineyard and 20 nautical miles (37 kilometers) 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). SouthCoast Wind has submitted the construction and operations plan (COP) for the SouthCoast Wind Project to BOEM for review and approval. Consistent with the requirements of 30 Code of Federal Regulations (CFR) 585.620 to 585.635, 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.

[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 COP was submitted before the name change, references to the COP and other related documents still refer 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 SouthCoast 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 farm on the Lease Area (30 CFR 585.620 to 585.635). 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. SouthCoast Wind was the winner of Lease OCS-A 0521. On April 1, 2019, BOEM and SouthCoast Wind executed the lease agreement for Lease OCS-A 0521. On May 26, 2020, BOEM approved SouthCoast Wind's SAP.

As part of Phase 4, SouthCoast Wind has completed site characterization activities and has developed a COP in accordance with BOEM regulations. On February 15, 2021, SouthCoast Wind submitted its COP for the construction, operations, and conceptual decommissioning of the Project within the Lease Area. SouthCoast 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 SouthCoast 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 SouthCoast 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 SouthCoast 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. Section 2.1.6 provides a summary of required compliance actions and permits, current status, and anticipated dates of completion.

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 (U.S.) and structures or work in navigable waters of the U.S. 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. SouthCoast 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. SouthCoast 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. SouthCoast 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. SouthCoast 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 U.S. federal waters. SouthCoast Wind submitted an application to USEPA for a NPDES permit on October 31, 2022 and filed a revised application in April 2023. 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), SouthCoast 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 SouthCoast Wind's request for authorization to take marine mammals incidental to specified activities associated with the Project (e.g., pile driving)—is to evaluate SouthCoast 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, SouthCoast 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. SouthCoast 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.

2.1.6 Summary of Required Permits and Consultations

A summary of required compliance actions and permits, current status, and anticipated dates of completion is provided in Table 2.1-1.

Table 2.1-1. Summary and Status of Environmental Permits and Consultations for the Proposed Action

Agency/Regulatory Authority	Permit/Approval	Status
Federal (Portions of the Project within Federal Jurisdiction)		
Bureau of Ocean Energy Management (BOEM)	Construction and Operations Plan (COP) Approval	COP filed with BOEM on February 15, 2021. Updates to the COP were submitted on August 30, 2021, October 28, 2021, March 17, 2022, and December 22, 2022.
Department of Defense (DoD)	Informal Project Notification Form	Submitted May 2020
National Marine Fisheries Service (NMFS)	Marine Mammal Protection Act (MMPA) Incidental Take Regulations and Letter of Authorization	Application accepted as complete September 2022
U.S. Army Corps of Engineers (USACE)	Clean Water Act Section 404 and Rivers and Harbors Act Section 10 Individual Permit	Submitted December 2022
U.S. Coast Guard (USCG)	Private Aids to Navigation (PATON) authorization	Planned
USCG	Local Notice to Mariners per Ports and Waterways Safety Act	Planned
U.S. Environmental Protection Agency (USEPA)	Clean Air Act Outer Continental Shelf (OCS) Air Permit	Submitted November 2022
USEPA	National Pollutant Discharge Elimination System General Permit	Submitted October 2022, April 2023
Federal Aviation Administration	Determination of No Hazard, if required	Planned
Bureau of Safety and Environmental Enforcement (BSEE)	Oil Spill Response Plan	Planned

Agency/Regulatory Authority	Permit/Approval	Status
State (Portions of the Project within State Jurisdiction)		
Massachusetts Executive Office of Energy and Environmental Affairs	Massachusetts Environmental Policy Act (MEPA) Environmental Notification Form (ENF) or Environmental Impact Report (EIR) and Certificate of Secretary of Energy and Environmental Affairs	Falmouth ENF filed November 17, 2021. EIR planned for 2023. Brayton Point ENF filed August 12, 2022. EIR planned for 2023.
Massachusetts Energy Facility Siting Board (MA EFSB)	Siting Petition pursuant to G.L. c. 164, 69J and Certificate of Environmental and Public Need (Section 72 Approval Consolidated with MA EFSB)	Filed November 17, 2021 for Falmouth. Filed May 27, 2022 for Brayton Point.
Massachusetts Department of Environmental Protection (MassDEP)	Chapter 91 Waterways License/Permit for dredge, fill, or structures in waterways or tidelands	Planned
	Section 401 Water Quality Certification	Planned
Massachusetts Office of Coastal Zone Management	Coastal Zone Management Consistency Determination	Submitted February 15, 2021. Updates provided January 13, 2022.
Massachusetts Historical Commission	Project Notification Form/Field Investigation Permits (980 Code of Massachusetts Regulations 70.00)	Submitted February 14, 2020 for Falmouth and July 26, 2021 for Brayton Point.
	Section 106 Consultation	Initiated October 1, 2021. Notice of Intent (NOI) provided November 1, 2021.
Massachusetts Board of Underwater Archaeological Resources (BUAR)	Section 106 Consultation	Initiated September 29, 2021. NOI provided November 1, 2021.
Massachusetts Fisheries and Wildlife (MassWildlife) – Natural Heritage & Endangered Species Program (NHESP)	Endangered Species Act Checklist and Conservation and Management Permit (if needed) or No-Take Determination	Planned
Rhode Island Coastal Resources Management Council (RICRMC)	Coastal Zone Management Consistency Determination	Filed in 2021. Revised version filed March 16, 2022.
RICRMC	Freshwater Wetlands Permit	Planned
RICRMC	Category B Assent and Submerged Lands License	Planned
Rhode Island Energy Facility Siting Board (RI EFSB)	Certificate of necessity/public utility	Filed May 31, 2022.

Agency/Regulatory Authority	Permit/Approval	Status
Rhode Island Historical Preservation and Heritage Commission (RIHPHC)	Archaeological Permit	Phase 1 permit issued December 17, 2021. Marine Archaeological Resources Assessment submitted March 16, 2022.
RIHPHC	Section 106 Consultation	Initiated September 29, 2022. NOI provided November 1, 2021.
Rhode Island Department of Environment	Water Quality Certification and Dredging Permit	Planned
Rhode Island Department of Environment	Rhode Island Pollution Discharge Elimination System General Permit for Stormwater Discharge Associated with Construction Activity	Planned
Rhode Island Department of Transportation	Utility Permit/Physical Alteration Permit	Planned

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 U.S. 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 SouthCoast Wind Project. The Lease Area (OCS-A 0521) is sited 26 nautical miles (48 kilometers) south of Martha's Vineyard and 20 nautical miles (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 nautical mile x 1.0 nautical mile (1.9 kilometer x 1.9 kilometer) 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 (see Action 2.1.3 *in* USDOE and USDOI, 2016)). 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.

SouthCoast 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 SouthCoast 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 SouthCoast 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. 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).

Although the majority of activities associated with the Proposed Action would occur in the Project area, Project vessels would travel between the Project area and ports. Table 3.1-1 identifies the ports that may be used during construction, O&M, and decommissioning. The Action Area includes any vessel routes between these port locations and the Project area. While specific ports have not been identified where equipment and components may originate, SouthCoast Wind anticipates Project components (e.g., monopile foundations) could be fabricated in the U.S., Europe, Asia, and/or the Middle East. It is expected that components would typically first be shipped to ports in the U.S. or Canada for marshalling, identified in Table 3.1-1, before transiting to the Project area. For example, all WTG components are to be marshalled/staged in New Bedford, Massachusetts before being installed offshore.

Table 3.1-1 Potential Proposed Action ports and average transit distance between ports and the Lease Area

Ports	Distance (nautical miles) to Lease Area	Project Phase Use		
		C	O&M	D
Port of New Bedford, Massachusetts, USA	70	X	X	X
Port of Davisville, Rhode Island, USA	75	X		
Port of Providence, Rhode Island, USA	85	X		X
Port of New London, Connecticut, USA	90	X	X	X
Port of Fall River area, Massachusetts, USA	95	X	X	X
Port of Salem, Massachusetts, USA	170	X		X
Port of Coeymans, New York, USA	335	X		
NJ Wind Port, New Jersey, USA	360	X		
Port of Virginia, Virginia, USA	400	X		
Sparrows Point Port, Maryland, USA	490	X		
Port of Charleston, South Carolina, USA	690	X		
Port of Corpus Christi, Texas, USA	2450	X		
Port of Altamira, Tamaulipas, MEX	2470	X		
Port of Sheet Harbor, Nova Scotia, CAN	434	X		
Port of Sydney, Nova Scotia, CAN	625	X		
Port of Argentia, Newfoundland, CAN	940	X		

C = construction / marshalling port; O&M = operations and maintenance port; D = decommissioning port.

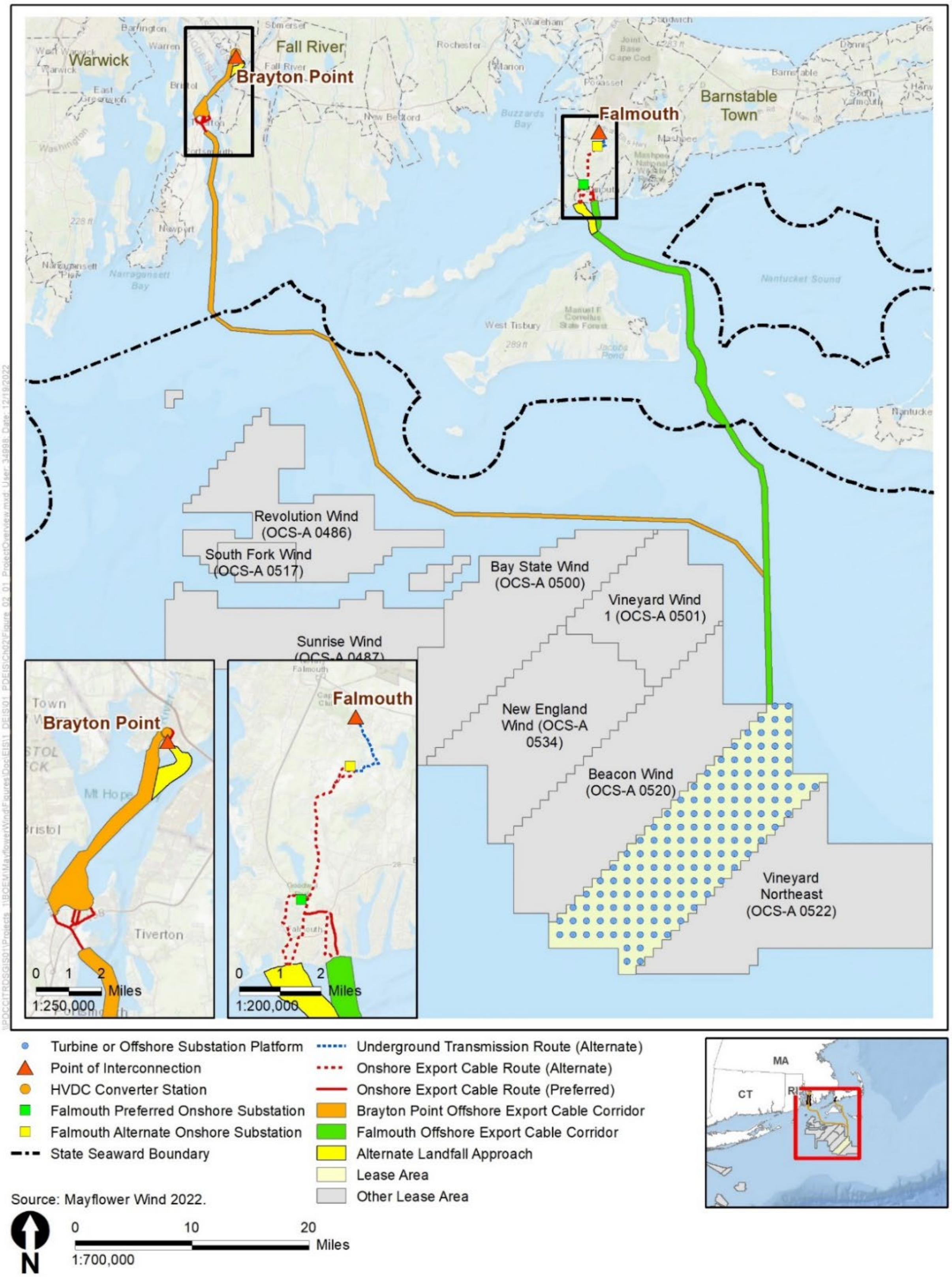


Figure 3.1-1. Project area

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, SouthCoast Wind has elected to use a PDE approach for the Proposed Action, which is reflected in the description of the activities in this BA. For the purpose of this ESA consultation, BOEM assumes that the Applicant may select the design alternative within the PDE resulting in the greatest potential impact to the environment.

Maximum PDE parameters for the SouthCoast Wind project are summarized in Table 3.1-2 and the general construction schedule is provided in Figure 3.1-2 and in Table 3.1-3. The SouthCoast Wind Lease Area will be developed in two phases or "projects". Project 1 includes Project activities associated with the Brayton Point interconnection in Somerset, Massachusetts while Project 2 includes Project activities associated with the Falmouth interconnection in Falmouth, Massachusetts (Figure 3.1-2). Figure 3.1-2, taken from SouthCoast Wind's Incidental Take Regulations (ITR) Application to NMFS, depicts nominal installation periods for the major Project components for Projects 1 and 2.

The lengths of each Project phase are as follows:

- Construction: approximately 7 years (Project 1 and Project 2 combined);
- Operations and Maintenance (O&M): approximately 35 years[2]; and
- Decommissioning: unless otherwise authorized by BOEM, pursuant to the applicable regulations in 30 CFR Part 585, SouthCoast Wind would be required to remove or dispose of all facilities within 2 years following termination of SouthCoast Wind's lease.

In May 2023, SouthCoast Wind informed BOEM that it was removing gravity-based structures (GBS) as a potential foundation from its PDE (from both Project 1 and Project 2) and that it would restrict possible locations of WTGs with suction-bucket jacket foundations to the southern portion of the Lease Area corresponding to Project 2.

The construction schedule (Figure 3.1-2) shows potential foundation installations occurring in more than one year for each project (Project 1 and Project 2) because the specific period in which foundation installations will commence is not currently known; however, it is expected that foundation installations would occur in a single year for each project. During the construction and installation period, some activities will occur 24-hours a day in order to minimize the overall duration of activities and the associated period of potential impact on marine mammals. This may include impact and/or vibratory pile driving of WTG and OSP foundations during nighttime hours. The total number of construction days will

[2] SouthCoast Wind's lease with BOEM (Lease OCS-A 0521) has an operational term of 33 years that commences on the date of COP approval. (https://www.boem.gov/sites/default/files/renewable-energy-program/State-Activities/MA/Lease-OCS-A-0521.pdf; see also 30 CFR 585.235(a)(3).) SouthCoast Wind would need to request an extension of its operational term from BOEM in order to operate the proposed Project for 35 years. The BA analyzes a 35-year operational term in case BOEM grants such an extension and for the purposes of maximum-case scenario.

be dependent on a number of factors, including environmental conditions, planning, construction, and installation logistics.

O&M of offshore wind facilities 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 3.1-2 SouthCoast Wind Project Design Envelope summary

Project Component	Location	Project Details and Envelope Characteristic(s)
Layout and Project Size	Offshore	• Up to 149 WTG/OSP positions • Up to 147 WTGs • Up to 5 OSPs • 1 nautical mile x 1 nautical mile (1.9 kilometer x 1.9 kilometer) grid layout with east-west and north-south orientation

Foundations	Offshore	• Monopile, piled jacket, and/or suction-bucket jacket for WTGs and monopile and piled jackets for OSP options
		• Seabed penetration: 65.6–295.3 feet (20.0–90.0 meters)
		• Foundation diameters
		  ○ monopiles: up to 52.5 feet (16.0 meters)
		  ○ piled jackets: up to 14.7 feet (4.5 meters)
		  ○ suction-bucket jackets: up to 65.6 feet (20.0 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 (from up to 147 WTGs) • Total oils and lubricants: 433,650 gallons (from up to 147 WTGs) • Total diesel fuel: 132,300 gallons (from up to 147 WTGs) • Gas insulated equipment will use Sulfur hexafluoride (SF6)
OSPs	Offshore	• Maximum structures envisaged located on grid positions: 5 • HVAC and HVDC converter OSP options • Top of topside height above MLLW: 160.8–344.5 feet (49.0–105.0 meters) • Scour protection for all positions • Total coolant: 1,500 gallons (from up to 5 OSPs) • Total oils and lubricants: 755,000 gallons (from up to 5 OSPs) • Total diesel fuel: 200,000 gallons (from up to 5 OSPs) • Gas insulated equipment will use Sulfur hexafluoride (SF6)
Interarray Cables	Offshore	• Nominal interarray cable voltage: 60 to 72.5 kV • Length of interarray cables beneath seafloor: Up to 497.1 miles (800 kilometers) • Target burial depth (below level seabed): 6 feet (1.8 meters) • Possible burial depth range (below level seabed): 3.2–8.2 feet (1.0–2.5 meters)

Project Component	Location	Project Details and Envelope Characteristic(s)
Falmouth Offshore Export Cables	Offshore, Nearshore	• Number of offshore export cables: up to 5 • Anticipated nominal export cable voltage (AC or DC): 200–345 kV (AC) or ±525 kV (DC) • Length per export cable beneath seabed: Up to 87.0 miles (140.0 kilometers) • Cable/pipeline crossings: up to 9 • Target burial depth (below level seabed): 6 feet (1.8 meters) • Possible burial depth range (below level seabed): 3.2–13.1 feet (1.0–4.0 meters)
Brayton Point Offshore Export Cables	Offshore, Nearshore	• Number of offshore export cables: up to 6 • Nominal export cable voltage (DC): ±320 kV • Length per export cable beneath seabed: Up to 124 miles (200 kilometers) • Cable/pipeline crossings: up to 16 • Target burial depth (below level seabed): 6 feet (1.8 meters) • Possible burial depth range (below level seabed): 3.2–13.1 feet (1.0–4.0 meters)
Aquidneck Island Onshore Export Cable Route (Intermediate landfall)	Nearshore, Onshore	• Portsmouth, Rhode Island • Nominal underground onshore export cable voltage for DC transmission: ±320 kV • Up to 4 onshore export cables and up to 2 communications cables • Up to 3 miles (4.8 kilometers) per cable
Falmouth Landfall Site	Nearshore, Onshore	• Three locations under consideration: Worcester Avenue, Central Park, and Shore Street • Installation methodology: HDD
Brayton Point Landfall Site	Nearshore, Onshore	• Brayton Point: Two locations under consideration: Eastern and Western shorelines of Brayton Point • Brayton Point: Installation methodology: HDD • Aquidneck Island: Several locations under consideration for the intermediate landfall across the island • Aquidneck Island: Installation methodology: HDD
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 kilometers) 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 kilometer) per cable

Project Component	Location	Project Details and Envelope Characteristic(s)
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 kilometers) 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 kilometer) 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 3.1-3. SouthCoast Wind Project schedule summary

Construction Activity	SouthCoast Wind Indicative Construction Schedule
Scour Protection, Seabed Preparation, and Substructure Installation	Q1 of 2025 to Q3 of 2030
Onshore Export Cables and Onshore Substations	Q3 of 2024 to Q4 of 2030
OSP Installation and Commissioning	Q3 of 2027 to Q3 of 2029
Offshore Export Cable Installation	Q4 of 2024 to Q2 of 2029
Interarray Cable Installation	Q2 of 2026 to Q3 of 2030
WTG Installation and Commissioning	Q2 of 2027 to Q4 of 2030

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

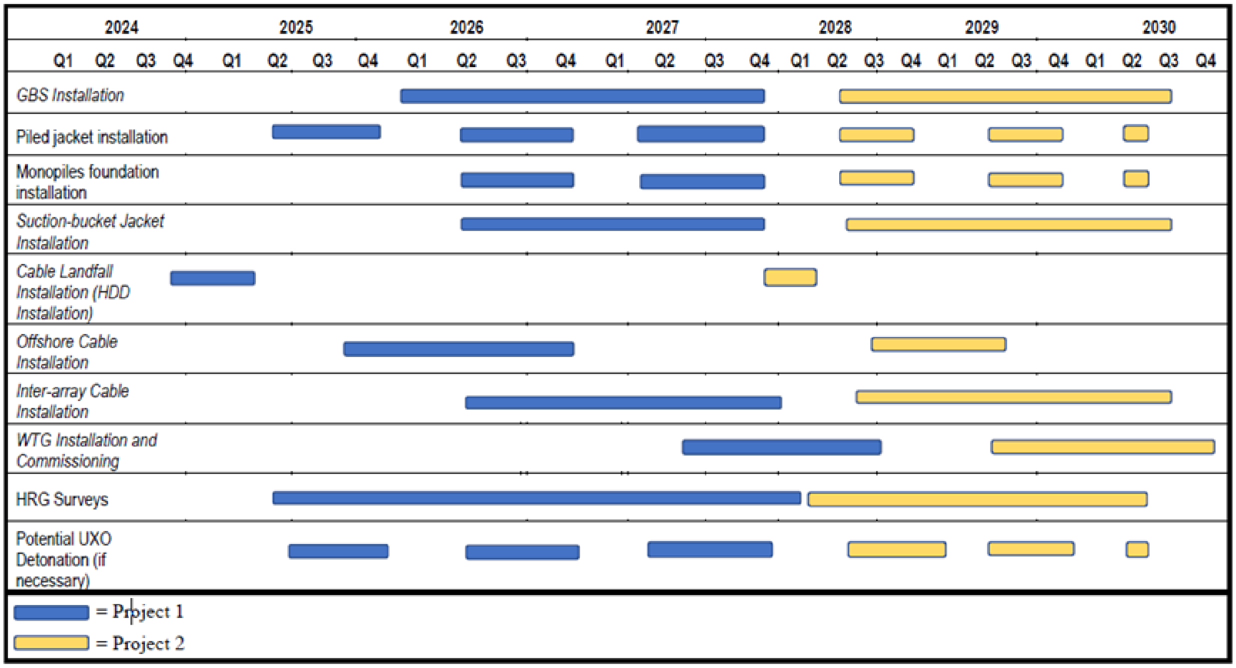


Figure 3.1-2. SouthCoast Wind indicative construction schedule

Source: SouthCoast Wind Construction ITR Application
Note: 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. In May 2023, SouthCoast Wind informed BOEM that it was removing GBS as a potential foundation from its PDE and that it would restrict possible locations of WTGs with suction-bucket jacket foundations to the southern portion of the Lease Area corresponding to Project 2. Installation of GBS and suction-bucket jacket foundations for Project 1 are no longer included in the anticipated 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 feet (325 meters) above mean lower low water (MLLW). Spacing between the WTGs would be 1 nautical mile (1.9 kilometers) 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*. The exact WTG type and supplier have not been finalized, and SouthCoast Wind is currently considering the use of both direct drive and gear-driven turbines.

Each WTG would contain oils, greases, and fuels used for lubrication, cooling, and hydraulic transmission. Indicative volumes are listed in Table 3.1-2. 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 3.1-4 lists the primary maintenance activities along with the potential frequency of visits.

Table 3.1-4. Indicative O&M WTG task and schedule

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

O&M = operations and maintenance; WTG = wind turbine generator
Source: COP Volume 1, Table 3-9; Mayflower Wind 2022.

During O&M, SouthCoast Wind will utilize lighting during operations as required by the USCG, FAA, and/or relevant regulatory body and abide by all applicable standards. This includes lighting to be placed on all offshore structures that will be visible throughout a 360-degree arc to aid in mariner navigation. SouthCoast Wind will implement an Aircraft Detection Lighting System (ADLS), which will activate the lighting system on WTGs based on approaching air traffic. SouthCoast Wind does not anticipate utilizing continuous lighting on the WTGs at the water's surface; however, SouthCoast Wind does plan to illuminate, at a minimum, the landing during crew transfers (specifically, the Walk to Work gate). The gangway from operations vessels will be fitted with necessary lighting that meets minimum requirements to assure safe transfers of technicians.

3.1.2.2 Offshore Substation Platforms

3.1.2.2.1 Description

The proposed Project would include up to five OSPs to collect the energy generated by the WTGs and would be located on the same 1 nautical mile x 1 nautical mile (1.9 kilometer x 1.9 kilometer) grid layout as the WTGs. OSPs help stabilize and maximize the voltage of power generated offshore, reduce potential electrical losses, and transmit energy to shore. Three OSP designs are under consideration: Option A – Modular, Option B – Integrated, Option C – HVDC Converter. Each OSP design would include a topside that houses electrical equipment and a foundation substructure to support the topside. Foundations under consideration for the OSPs are described in greater detail in Section 3.1.2.3. The smallest topside structure would be Option A – Modular and would likely hold a single alternating current (AC) transformer with a single export cable. It would sit on any type of substructure design considered for the WTGs; however, SouthCoast Wind is no longer considering suction-bucket jacket foundations for OSPs. Option B – Integrated is also an AC solution but is designed to support a high number of inter-array cable connections, as well as multiple export cable connections and would contain multiple transformers in a single topside structure. Depending on the weight of the topside structure and soil conditions, the jacket substructure may be four- or six-legged and require one to three piles per leg. Because of its larger size, if

Option B is selected, a smaller number of OSPs would be required to support the proposed Project. Option C – HVDC Converter would convert electric power from HVAC to HVDC for transmission to the onshore grid system and would serve as a gathering platform for inter-array cables or be connected to one or more HVAC gathering units, which would be similar to the Modular and Integrated OSP designs. Due to its size, the HVDC Converter OSP would be installed on piled jacket foundation. SouthCoast Wind's preferred OSP design is Option C – HVDC Converter with piled jacket foundations to meet the specific engineering requirements of this design.

While the PDE includes up to five OSPs, SouthCoast Wind's preference and the most likely scenario is two HVDC OSPs, one for Project 1 (Brayton Point) and one for Project 2 (Falmouth). SouthCoast Wind has already selected an HVDC converter OSP (Option C) for the Brayton Point interconnection (Project 1). For Falmouth (Project 2), SouthCoast Wind will select an OSP design based on future offtake agreements and through its supplier/equipment contracting process. If HVDC is selected for Project 2, which is the most likely scenario, there would be one HVDC OSP for Project 2 in addition to the HVDC OSP for Project 1 (for a total of two HVDC OSPs). While not SouthCoast Wind's preference, if HVAC is selected for Project 2, SouthCoast Wind anticipates there would be one HVAC OSP for Project 2 in addition to the HVDC OSP for Project 1 (for a total of two OSPs).

SouthCoast Wind filed a NPDES permit application for the HVDC converter OSP for Brayton Point (Project 1) on October 31, 2022 and submitted a revised application in April 2023. A copy of the NPDES permit application is provided as Appendix A, *SouthCoast Wind National Pollutant Discharge Elimination System Permit Application* of this BA (Tetra Tech and Normandeau Associates, Inc. 2023). If SouthCoast Wind uses HVDC technology for Project 2, the parameters and modeling results from the NPDES permit application are representative of a second HVDC converter OSP for Project 2 within the Lease Area. Currently, the only major anticipated difference would be the location of the second HVDC converter OSP, which would be at a deeper position in the southern portion of the Lease Area. Neither HVDC converter OSP would be placed in the enhanced mitigation area near Nantucket Shoals, in alignment with the NS-1 mitigation measure (see Section 3.3, Table 3.3-2).

Figure 3.1-3 shows the approximate location of the HVDC converter OSP for Project 1. The HVDC converter OSP would include a CWIS, requiring the use of up to 10.2 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. Seawater intake pipes are fitted with an inline seawater filter (mesh size ranging from 250 µm to 25 mm) that screens debris and organisms from the pump shaft. Discharged effluent is estimated to have a temperature of approximately 90°F (32.2°C). Hypochlorite solution is used as an antifouling agent at concentrations of 0 to 2 parts per million in the seawater intake lines. Residual free chlorine within the effluent would be negligible and oxidized in the water with no negative impact. Table 3.1-5 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*.

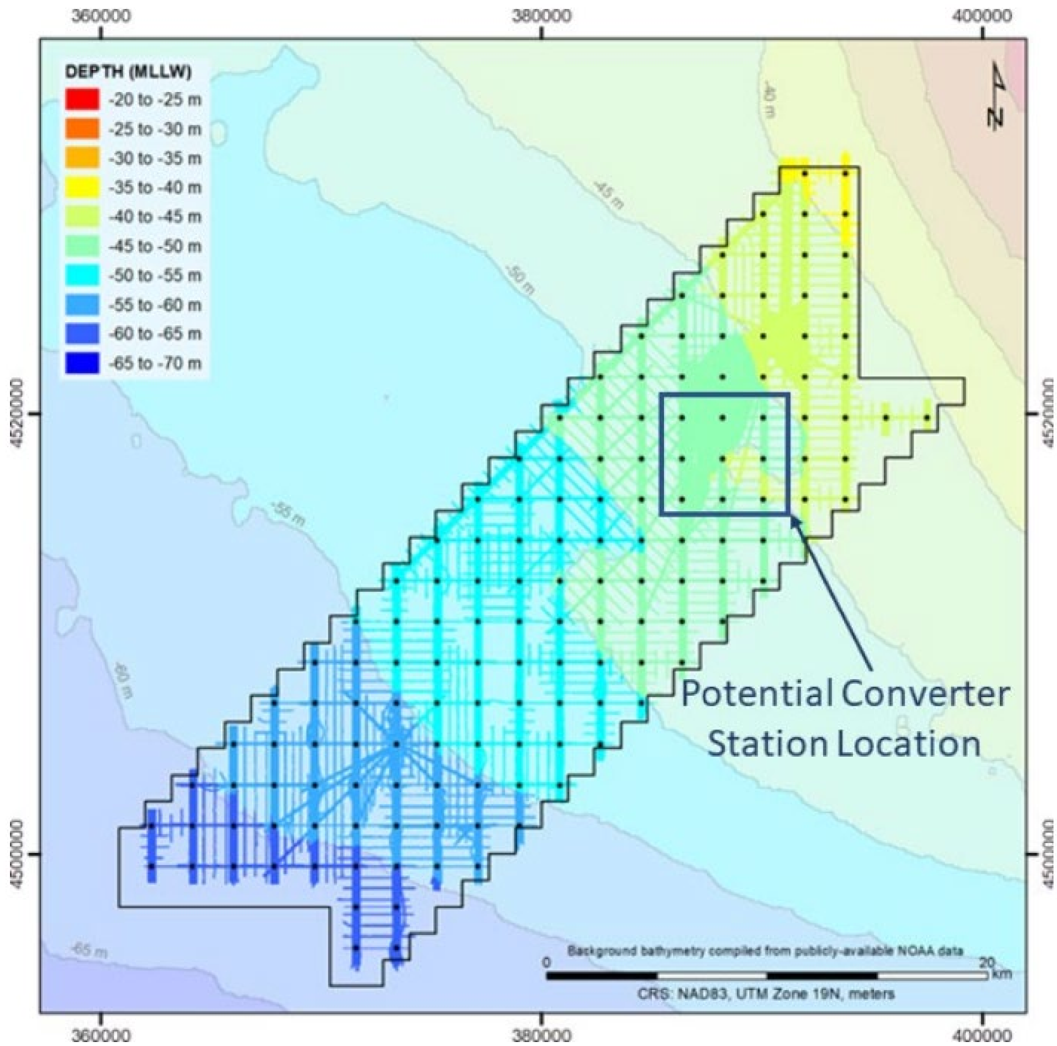


Figure 3.1-3. Approximate location of HVDC converter OSP for Project 1

Table 3.1-5. CWIS parameters for one HVDC converter OSP

Configuration Parameter	HVDC Converter OSP CWIS
Source water	Atlantic Ocean
CWIS	Non-contact, once-through cooling
Configuration of intake	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, located within the jacketed structure. The intake structure will include the following instrumentation: • temperature & water conductivity monitoring devices installed at the seawater lift pump intake. • the intake seawater flowline has an inline flow meter installed upstream of the seawater filter at the topside of the converter station. • temperature and flow monitoring devices are installed at the feed line and at the discharge outlet of the seawater heat exchanger. • mechanical sampling connections located at the return line of seawater. The samples are taken as required per NPDES permit conditions, to a laboratory for the analysis of pH and the total residual oxidant concentration.
Configuration of discharge	One or two, approximately 3.3-foot (1 meter)-diameter vertical-shaft discharge caisson, set perpendicular to the seafloor, located within the jacketed foundation structure. The exact depth and location of discharge will be based on the experience of previous projects in ensuring sufficient distance is maintained between the lift pump caisson and the overboard water caisson.
Trash/debris bar rack	Each intake pipe will be equipped with a bar rack (either super duplex stainless steel or plastic/composite) to minimize entrapment of debris or marine organisms within the intake pipe. SouthCoast Wind is considering a range of 6 to 10 inch (15.2 to 25.4 cm) spacing between bars. The configuration details will be refined during the detailed design stage, which will include consultations with EPA and other agencies to ensure appropriate spacing of bars is protective of marine organisms, as applicable within engineering constraints (e.g., flow velocity, biofouling, etc.). Design would include either parallel bars or perforated plate.
Pump screens/strainers	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
Number of traveling screens/ screen wells	N/A- no traveling screens
Water depth of withdrawal, below surface at MLLW	Ranges from approximately 25 to 115 feet (7.6 to 35.0 meters) below the surface
Water depth of withdrawal, above seafloor	Approximately 32.8 feet (10 meters) above the seafloor
Through-screen velocity (calculated from DIF)	Intake velocity will not exceed 0.5 feet (0.2 meters) per second for velocity-based impingement compliance option. A maximum velocity of 0.5 feet (0.2 meters) per second will be integrated into the engineering design of the CWIS to ensure compliance. The details of how the velocity is calculated will be determined during the detailed design phase and shared with EPA when available.

Configuration Parameter	HVDC Converter OSP CWIS
Circulating water intake pumps (seawater lift pumps)	Up to three approximately 5,315 GPM raw seawater vertical lift pumps, each with a rated design flow of 7.7 MGD (approx. 75% of total CWIS flow requirements). Only two of the three pumps would be used under normal operating conditions, with the third pump serving as a spare/backup. Internal cooling flow is controlled with the use of a 3-way valve while maintaining a constant speed with seawater open loop cooling.
Maximum Discharge Temperature	90°F (32.2°C), with maximum anticipated temperature change (ΔT) of 18°F (10°C) from ambient water.
Total Design Intake Flow (DIF)	The system will be designed for a maximum flow of 10.2 MGD (DIF). Two of the seawater lift pumps will each provide 50% of that capacity during normal operating conditions (e.g., 5.1 MGD each, or 50% each of DIF). The design capacity/rating of a single seawater lift pump is 7.7 MGD. During normal operating conditions, each individual seawater lift pump will provide a maximum of 5.1 MGD out of its 7.7 MGD capacity (approx. 66% of the design rated design capacity), to ensure reliable, safe operating conditions at the unmanned OSP. Since it is not recommended to run seawater lift pumps continuously at 100% rated capacity, SouthCoast Wind determined the 10.2 MGD flow rate to be the maximum DIF necessary to operate the OSP. Seawater Lift Pump settings can be controlled with or without a variable frequency drive (VFD). Internal cooling flow is controlled by use of a 3-way valve while maintaining a constant speed with the seawater open loop cooling. 7.7 MGD = rated design flow on each seawater lift pump (75% of total platform flow requirements). 10.2 MGD = max. average flow of 2 seawater lift pumps running at 50% each to provide the design 100% total platform flow (SouthCoast Wind is seeking 10.2 MGD maximum design intake flow in NPDES permit).
Actual intake flow (AIF)	To be determined based on average CWIS operational conditions. Per §125.92(a), AIF represents the average volume of water withdrawn on an annual basis by the cooling water intake structures over the past three years. After October 14, 2019, AIF means the average volume of water withdrawn on an annual basis by the cooling water intake structures over the previous five years.
Flow reduction from design capacity	While 10.2 MGD is the DIF, a 50% flow reduction potential from DIF could be achieved by use of single-pump operation (5.1 MGD), or dual-pumps each operating at reduced capacity during certain metocean conditions.
Closed-cycle recirculating cooling	None. Closed-cycle cooling utilizing air or seawater is not an available technology for this type of unmanned offshore facility
Chlorination system	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 (NaOCl) 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. This method of continuous injection into the pump caisson is preferred because at a low dosage of NaOCl (i.e., 2 milligrams per liter, 95 kilograms per day), the residual free chlorine at the outlet would be negligible and oxidized in the water with no negative impact.

Source: Tetra Tech and Normandeau Associates, Inc. 2023.
CWIS = cooling water intake structure; ; °F = degrees Fahrenheit; °C = degrees Celsius; cm = centimeter; MLLW = Mean Lower Low Water; GPM = gallons per minute; MGD = million gallons per day; NPDES = National Pollutant Discharge Elimination System; OSP = offshore service platform

Each OSP would contain oils, greases, and fuels used for lubrication, cooling, and hydraulic transmission. Indicative volumes are listed in Table 3.1-2. 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.

3.1.2.2.2 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 3.1-6 for general list of O&M activities and timeframes).

Table 3.1-6. OSP O&M schedule

O&M Task	Inspection Cycle
Routine inspections	As required based on final OSP design
Maintenance of switchgear and equipment	Annually
Transformer oil sample and targeted maintenance	Every 3 years
Extended maintenance routines	Every 5 and 10 years
Unplanned maintenance	As needed

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. Foundation concepts considered for WTGs include monopile, piled jacket, and suction-bucket jacket. Foundation concepts considered for OSPs include monopile and piled jacket. Suction-bucket jacket foundations would be restricted to up to 85 WTG positions in the southern portion of the Lease Area (Figure 3.1-4). Suction-bucket jackets would not be used for OSPs. See Table 3.1-7 and Table 3.1-8 for the maximum foundation parameters within the PDE.

Table 3.1-7. Maximum WTG foundation parameters

Foundation Type	Number of Foundations (Pile or Bucket)	Penetration Below Level Seabed	Foundation Diameter (Pile or Bucket)	Seabed Centerline Diameter	Footprint Diameter[1]
Monopiles	1	164.0 ft (50.0 m)	52.5 ft (16.0 m)	--	374.0 ft (114.0 m)
Piled Jacket	4	229.6 ft (70.0 m)	14.7 ft (4.5 m)	164.0 ft (50.0 m)	380.5 ft (116.0 m)
Suction-Bucket Jacket	4	65.6 ft (20.0 m)	65.6 ft (20.0 m)	180.4 ft (55.0 m)	521.6 ft (159.0 m)

Source: COP Volume 1, Table 3-2, Mayflower Wind 2022.
[1] Diameter measures across combined area from foundation, scour protection, and mud mats
ft = foot; m = meter.

Table 3.1-8. Maximum OSP foundation parameters

OSP Option	Foundation Type	Number of Foundations	Penetration Below Level Seabed	Piles or Bucket Diameter at Mudline	Seabed Centerline Diameter or Dimension	Permanent Footprint Area[1]
Option A – Modular	Monopile	1	164.0 ft (50.0 m)	52.5 ft (16.0 m)	52.5 ft (16.0 m)	2.52 ac (1.02 ha)
	Piled Jacket	3 to 4 foundations and 1 to 2 piles/ foundation = 3 to 8 piles	229.6 ft (70.0 m)	14.7 ft (4.5 m)	164.0 ft (50.0 m)	2.61 ac (1.05 ha)
Option B – Integrated	Piled Jacket	4 to 6 foundations and 1 to 3 pile/ foundation = 4 to 18 piles	277.2 ft (84.5 m)	11.7 ft (3.57 m)	213 x 105 ft (65 x 32 m)	7.54 ac (3.05 ha)
Option C – DC Converter	Piled Jacket	4 to 9 foundations and 1 to 3 piles/ foundations = 4 to 27 piles	295.3 ft (90.0 m)	12.8 ft (3.9 m)	279 x 197 ft (85 x 60 m)	9.79 ac (3.96 ha)

Source: COP Volume 1, Table 3-3, Mayflower Wind 2022.
[1] Includes combined area from foundation, scour protection, and mud mats.
ac = acre; ft = foot; ha = hectare; m = meter; N/A = not applicable.

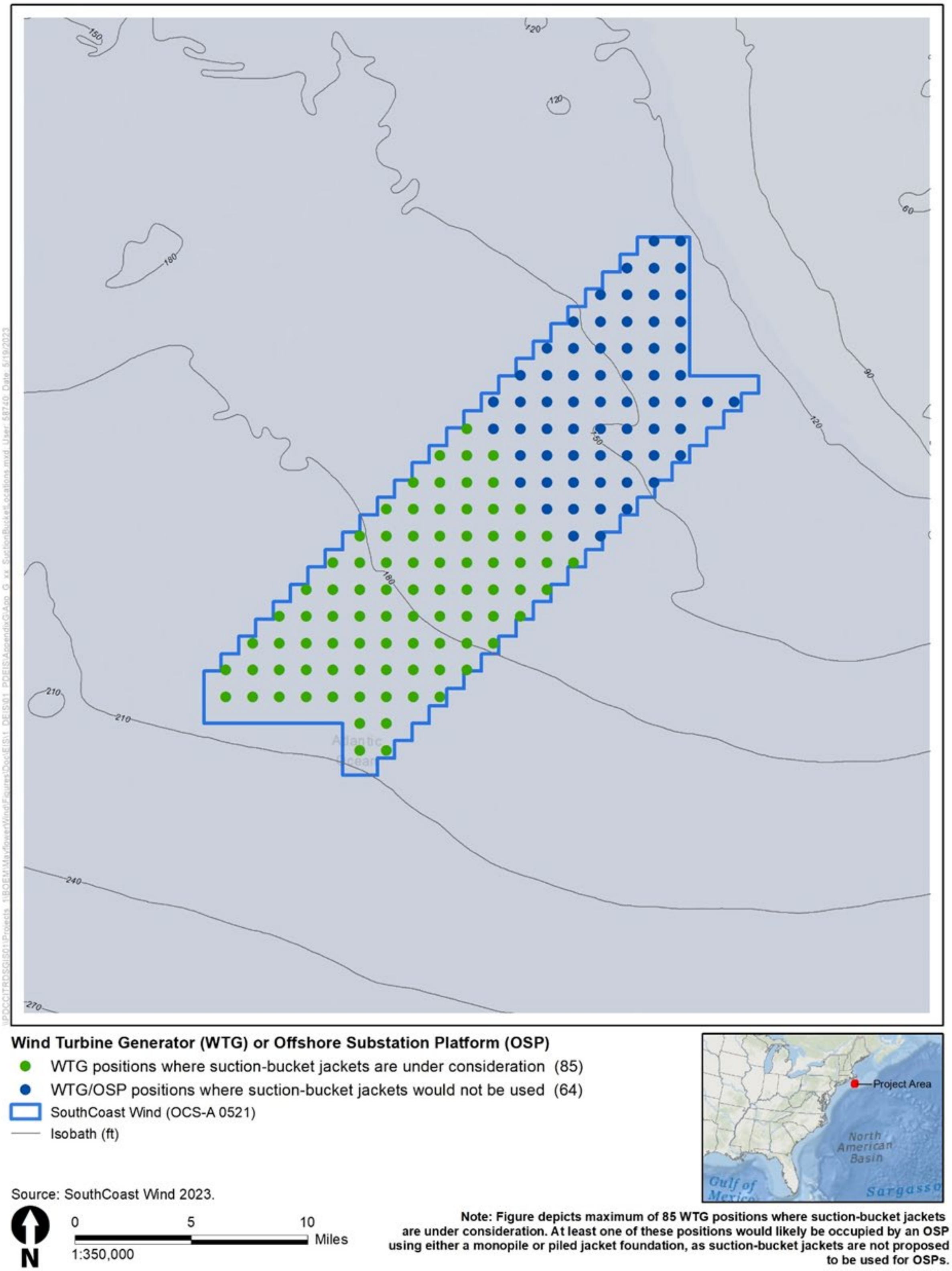


Figure 3.1-4. WTG positions where suction-bucket jacket foundations are under consideration

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 3.1-5.

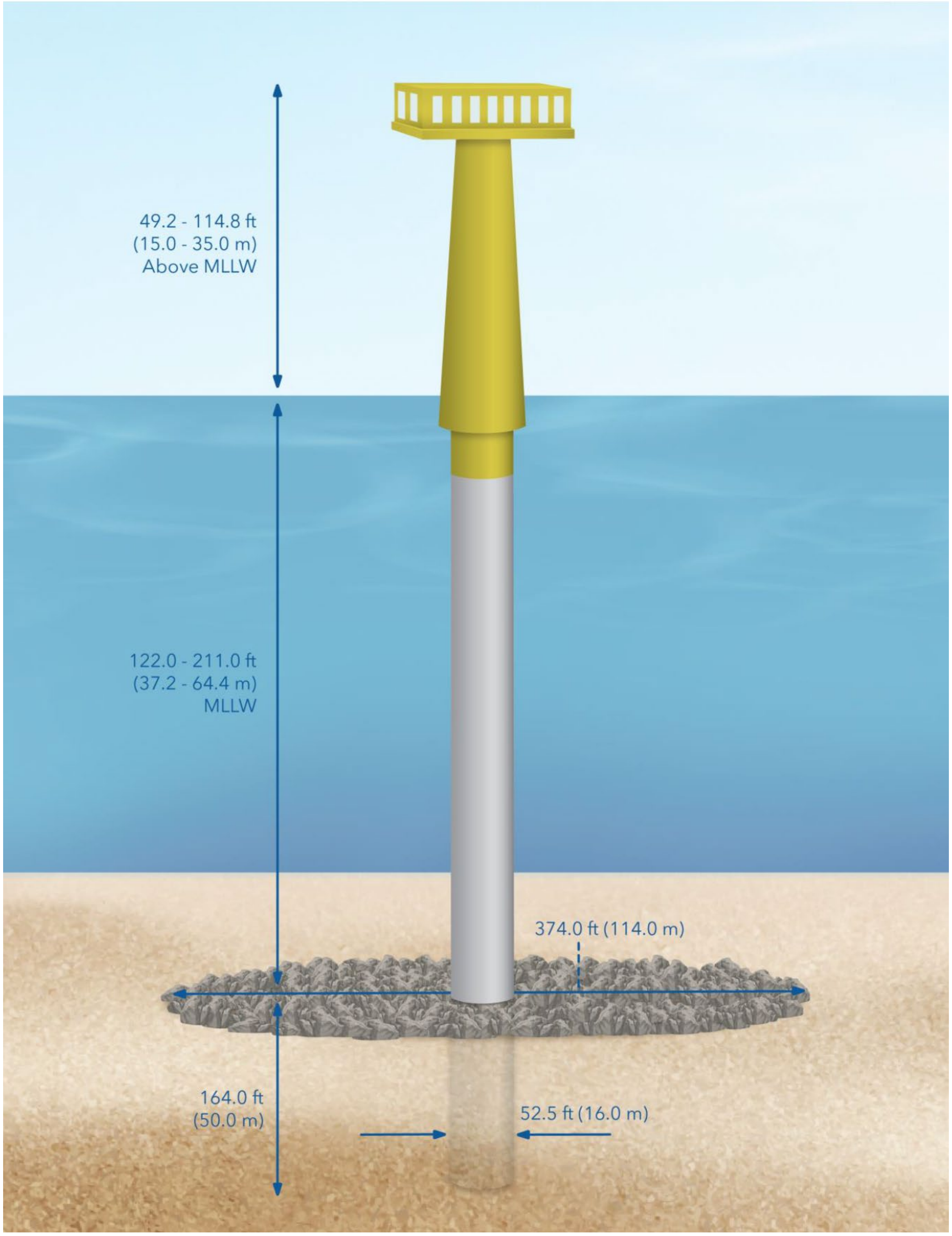


Figure 3.1-5. Indicative WTG monopile foundation diagram

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 3.1-6.

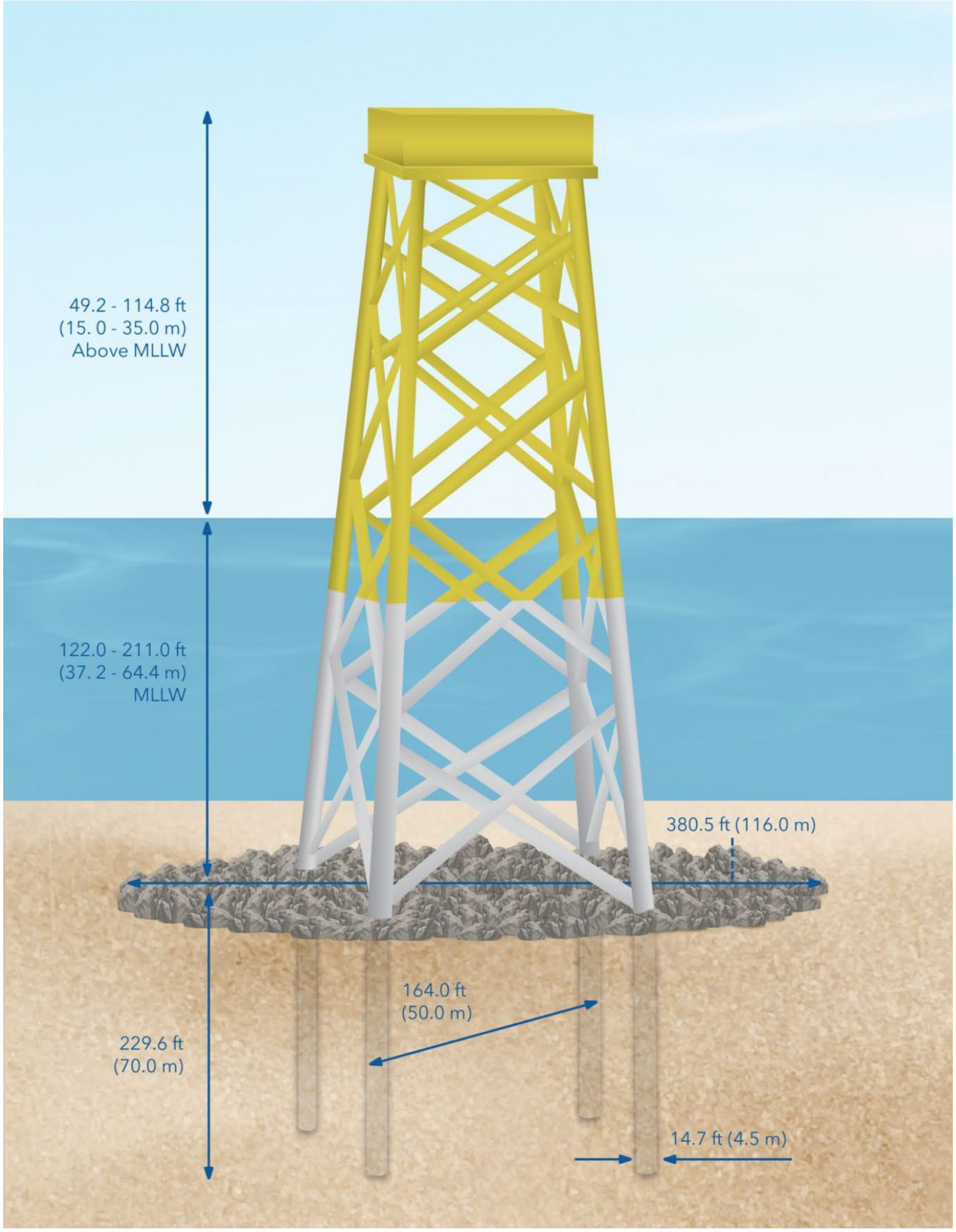


Figure 3.1-6. Indicative WTG piled jacket foundation diagram

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 3.1-7.

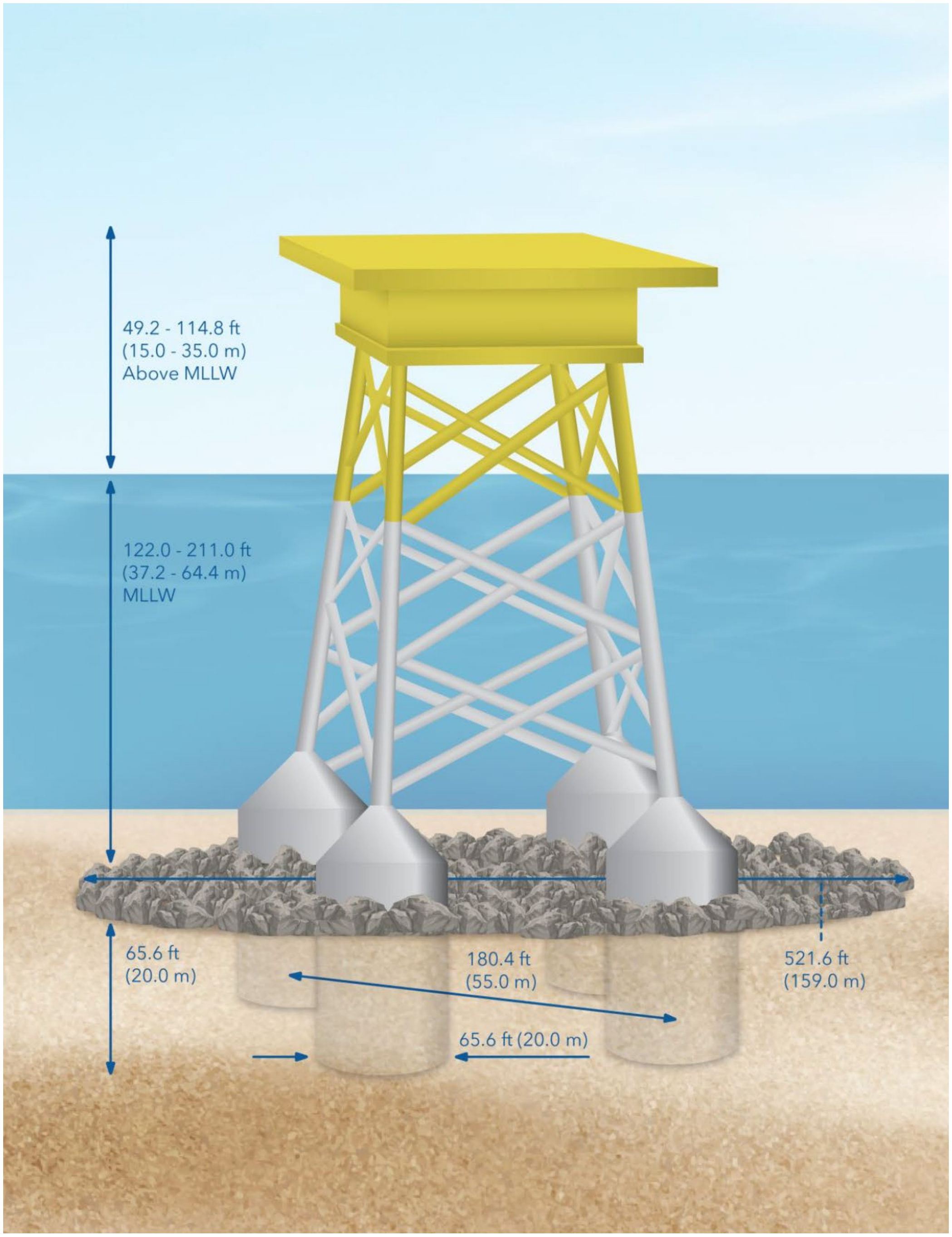


Figure 3.1-7. Indicative WTG suction-bucket foundation diagram

3.1.2.3.2 Foundation Installation

During construction, SouthCoast 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 (e.g., two monopile vessels, two piled jacket vessels, or one monopile vessel and one piled jacket vessel) to install foundations. Seabed preparation may be required prior to the installation of WTG and OSP foundations in certain areas depending on seabed condition and the foundation type. Seabed preparation activities may include removal of surface or subsurface debris and boulders and in-situ UXO/Munitions and Explosives of Concern disposal. There is an absence of boulder fields and individual boulders found in the 2020 and 2021 High-Resolution Geophysical (HRG) mapping of the Lease Area (Appendix E, Mayflower Wind 2022); however, a boulder relocation plan is currently in development for the ECCs and would apply to the interarray cables in the Lease Area should boulder removal and relocation become necessary. Seabed leveling and dredging would not be required for any foundation type. The estimated temporary and permanent disturbance areas associated with seabed preparation and foundation installation are provided in Table 3.1-9. Total seabed disturbance footprint from jack-up vessel use during WTG/OSP installation in the Lease Area would be 442 acres (179 hectares).

For monopiles and piled jacket foundations, pile-driving activity would be limited to between May 1 and December 31 based on time of year restrictions to reduce impacts on North Atlantic right whale (NARW) and other marine mammals, which are most present in the Project area from January to April. Pile driving may occur 24 hours per day to complete installation within as few years as possible during the multiple-year installation campaign expected for the entire Lease Area build-out. Installations of monopiles and piled jackets may occur on a schedule using both impact and vibratory hammering according to one of two scenarios, which are described in detail in Section 5.2.1. Prior to conducting nighttime pile driving, SouthCoast Wind would be required to submit a Nighttime Pile Driving Plan (NPDP) as part of the Alternative Monitoring Plan (AMP) to BOEM and NMFS for approval. The NPDP will describe the methods, technologies, monitoring zones, and mitigation requirements for any nighttime pile driving activities. Nighttime pile driving activities would be those occurring between 1.5 hours before civil sunset to one hour after civil sunrise. The full AMP would also describe details of the monitoring methods that will be used during low-visibility conditions and the efficacy of the alternative technologies that are demonstrated to allow monitoring of the entire pre-clearance and shutdown zones during daylight hours. BOEM does not anticipate an AMP would be required in lieu of any approved NPDP. In the absence of an approved NPDP, all pile driving would be initiated during daytime (i.e., between one hour after civil sunrise to 1.5 hours before civil sunset), and nighttime pile driving could only occur if unforeseen circumstances prevent the completion of pile driving during daylight hours and was deemed necessary to continue piling during the night to protect asset integrity or safety. Monitoring and mitigation measures for pile-driving activities, including nighttime pile driving, are 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 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. 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, 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 at an approximate rate of 300 to 500 cubic meters per hour creating a negative pressure within the bucket of approximately five bar, 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 of 65.6 feet (20 meters) (Figure 3.1-7). The connection of the required suction hoses is typically completed using a remotely operated vehicle (ROV).

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 3.1-9.

Table 3.1-9. Temporary disturbance, permanent disturbance, and scour parameters for WTG and OSP foundations

Parameter – WTGs	Monopile	Piled Jacket	Suction Bucket Jacket*
Permanent Footprint Area per WTG (including scour protection)	2.5 ac (1.0 ha)	2.6 ac (1.1 ha)	4.9 ac (2.0 ha)
Total Permanent Footprint Area (147 WTG foundations, including scour protection)	370.4 ac (149.9 ha)	383.7 ac (154.4 ha)	578.3 ac* (234.0 ha)
Scour Protection Volume per WTG	36,256 cy (27,720 m^3)	37,635 cy (28,774 m^3)	75,583 cy (57,787 m^3)
Total Scour Protection Volume (147 WTGs)	5,329,632 cy (4,074,840 m^3)	5,532,345 cy (4,229,778 m^3)	8,757,925 cy* (6,695,914 m^3)
Additional Temporary Disturbance from Seafloor Preparation During Construction per WTG	0.5 ac (0.2 ha)	0.5 ac (0.2 ha)	0.6 ac (0.3 ha)
Total Additional Temporary Disturbance from Seafloor Preparation During Construction (147 WTGs)	73.5 ac (29.4 ha)	73.5 ac (29.4 ha)	82.0 ac* (33.2 ha)
Parameter – OSPs (maximum disturbance)	**Piled Jacket**		
Permanent Footprint Area per OSP (including scour protection)	9.8 ac (3.96 ha)		
Total Permanent Footprint Area (2 OSPs, including scour protection)	19.6 ac (7.4 ha)		
Scour Protection Volume per OSP	157,193 cy (120,183 m^3)		
Total Scour Protection Volume (2 OSPs)	314,386 cy (240,366 m^3)		
Additional Temporary Disturbance from Seafloor Preparation During Construction per OSP	0.5 ac (0.2 ha)		
Total Additional Temporary Disturbance from Seafloor Preparation During Construction (2 OSPs)	1.0 ac (0.4 ha)		

* Total values in the suction-bucket jacket column are calculated using the assumed maximum 85 suction-bucket jacket foundations are installed along with 62 piled jacket foundations (for up to 147 WTGs).
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; m^3 = 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 kilometers) in length with a voltage between 60 and 72.5 kilovolts (kV) (Table 3.1-2). 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.

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. SouthCoast Wind will coordinate with relevant federal and state agencies in addition to SouthCoast 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 3.1-10 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. SouthCoast Wind estimates 10 percent of the interarray cable layout would require cable protection (approximately 49.7 miles [80 kilometers]). 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 3.1-10.

Table 3.1-10. Interarray cable—estimated seabed disturbance areas

Interarray Cable Activity	Area in Acres (Hectares)
Seabed Preparation	99 (40)
Cable Installation[1]	1,186 (480)
Cable Protection[2]	122 (50)
Total Area Disturbed	**1,408 (570)**

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

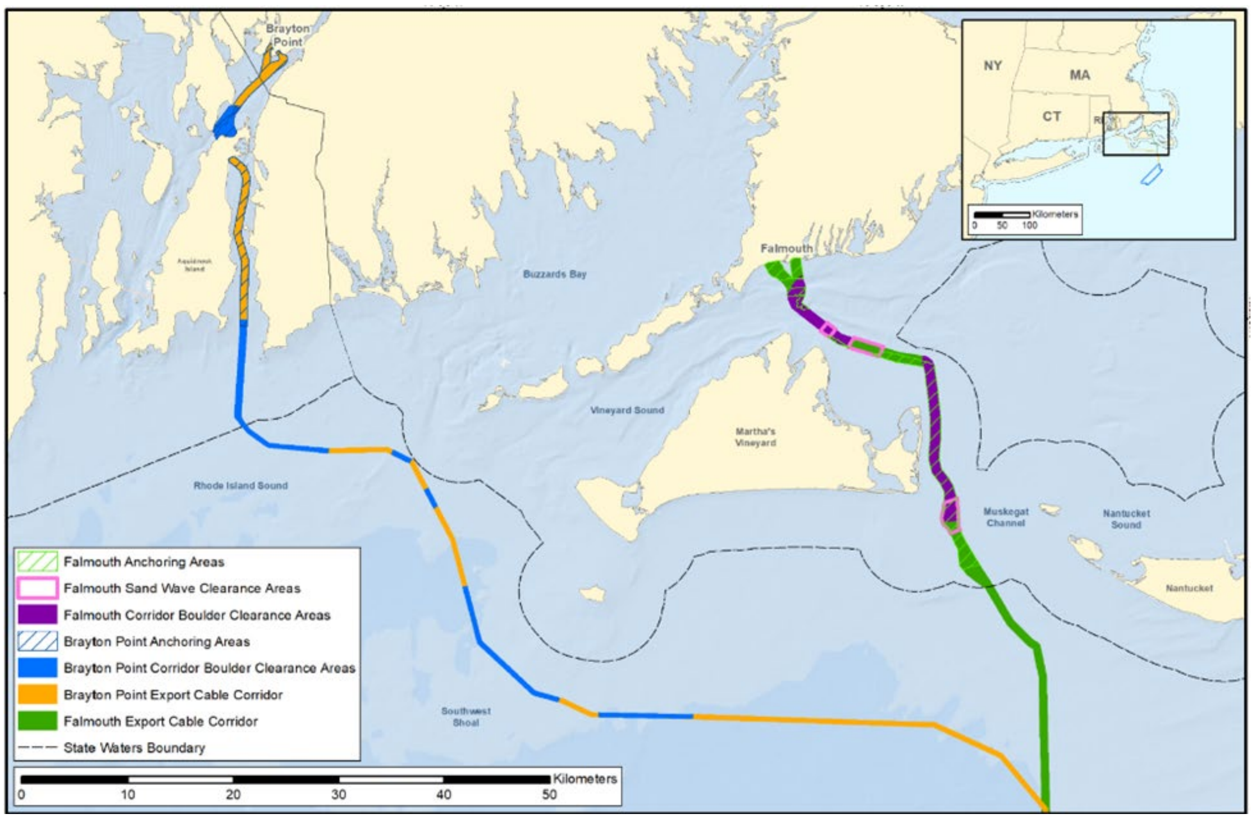
3.1.2.4.2.1 Description

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-kilometer) corridor would be a maximum of 435 miles (700 kilometers). Seabed preparation is expected within 5 percent of the Falmouth ECC for sand wave clearance via trailing suction hopper dredger or similar equipment. Suction hopper dredgers are typically self-propelled sea-going vessels equipped with propulsion machinery, sediment containers (i.e., hoppers), dredge pumps, and other specialized equipment required to excavate sediment 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). Dredging may also occur at offshore HDD exit pit locations (refer to Section 3.1.2.4.3). The total volume of dredged material, including sand wave clearance and dredging at HDD exit pits, is estimated to be 646,077 cubic yards (493,962 cubic meters) for the Falmouth ECC.

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-kilometer) corridor would be a maximum of 744 miles (1,200 kilometers). Within the Brayton Point ECC, no sand wave clearance is expected, so dredging will only occur at HDD exit pit locations (refer to Section 3.1.2.4.3). Potential dredge volumes could be up to 22,404 cubic yards (17,124 cubic meters). SouthCoast 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 (Figure 3.1-8). Boulders in the cable route that cannot be easily avoided by micro-routing could be removed with a grab lift or plow as necessary. Boulders will be relocated to areas of similar seabed conditions within the respective ECCs from which they were removed, and the coordinates and approximate sizes of the boulders will be recorded prior to and following relocation. 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 meters). Hopper dredges are discussed previously. Dredged material would be disposed of within the ECC on similar substrate (i.e., other existing 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 3.1-12 identifies the areal extent of seabed preparation disturbance, including dredging, for both ECCs.



Source: COP Appendix M.3, Figure 2-28; Mayflower Wind 2022

Figure 3.1-8. Anchoring areas, sand wave clearance areas, and boulder clearance areas

Once any necessary seabed preparations are completed, SouthCoast 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). SouthCoast 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 3.1-12.

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 (anchored) vessels and DP vessels would be used for the offshore export cable installation (refer to Section 3.1.2.6 for vessel use description). Moored vessels will typically be cable-lay barges, which employ a 6- or 8-point mooring pattern for station keeping, with temporary anchors deployed within the ECC and relocated along the relevant portion of the offshore export cable route. 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. The 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 kilometers]) of the Falmouth ECC and 15 percent (19 miles [30 kilometers]) of the Brayton Point ECC. SouthCoast Wind anticipates that the installation of fixed mooring(s) may be necessary in some locations in the Project area and will be determined at a later time. The location(s), mooring type, and number of moorings will be finalized and provided to BOEM pending final selection of suppliers. Anchoring disturbance is included in the cable installation disturbance acreage in Table 3.1-12.

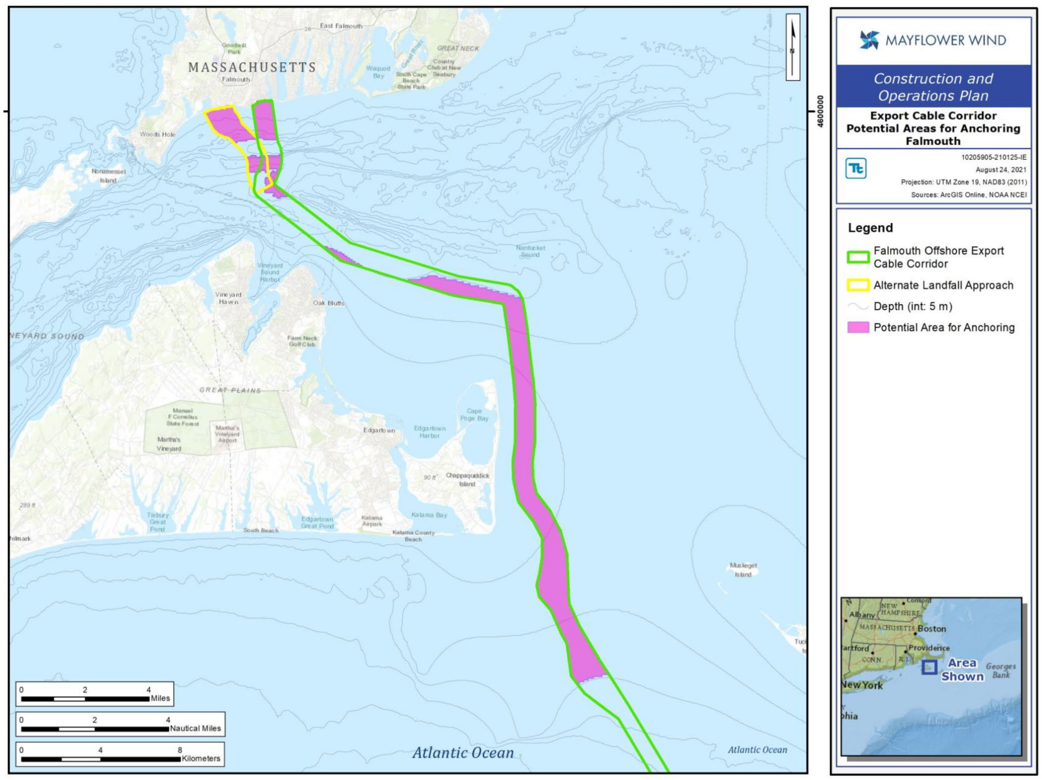


Figure 3.1-9. Potential areas for anchoring inside Falmouth export cable corridor

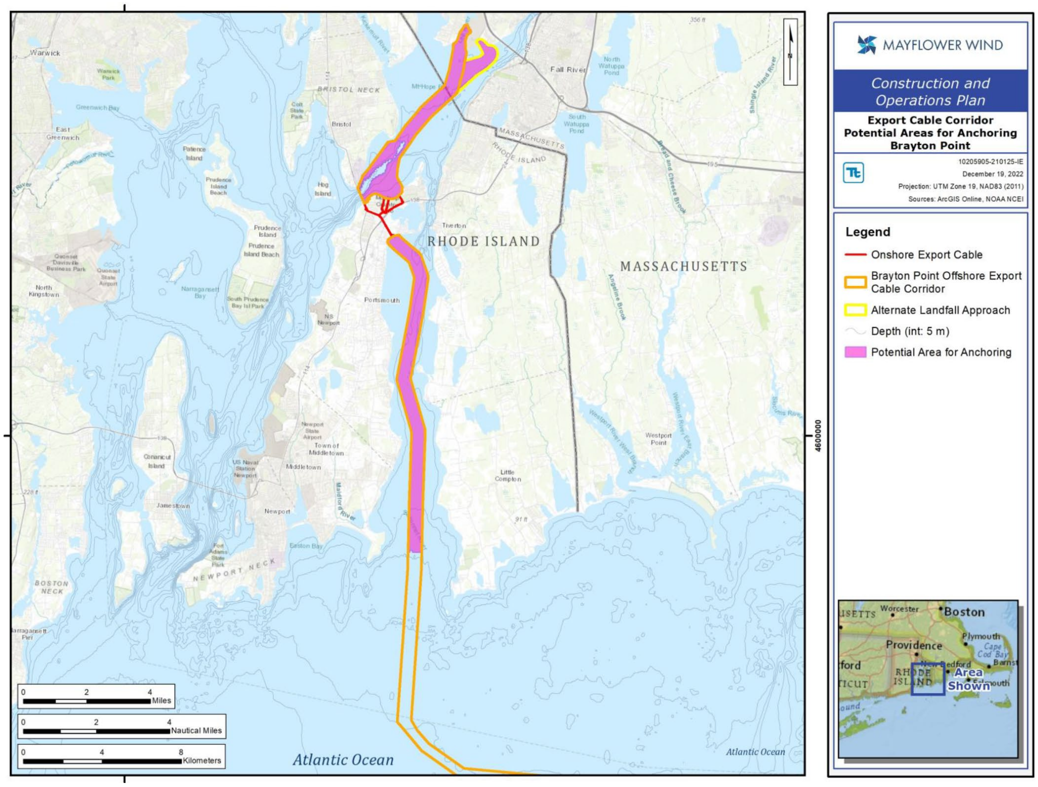


Figure 3.1-10. Potential areas for anchoring inside Brayton Point export cable corridor

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 meter]) and at existing cable crossings, cable protection would be used. A maximum of 10 percent of the Falmouth ECC (8.7 miles [14.0 kilometers]) and 15 percent of the Brayton Point ECC (18.6 miles [29.9 kilometers]) would require cable protection (refer to Table 3.1-12 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, SouthCoast 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 3.1-11. Cable crossing design will be determined by the cable crossing's proximity to shore and the third-party crossing agreement requirements.

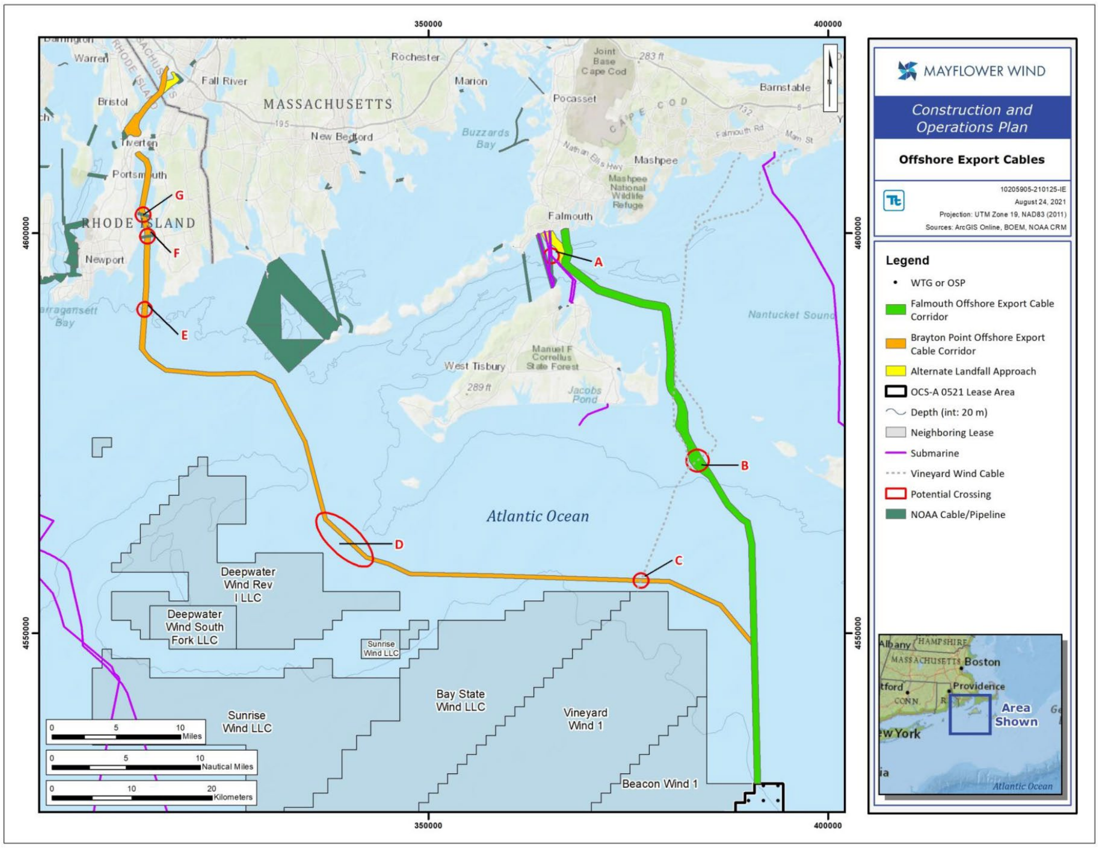


Figure 3.1-11. Potential cable and pipeline crossings

Table 3.1-11. Proposed cable/pipeline crossing

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

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

Table 3.1-12. Offshore export cables—estimated seabed disturbance areas

Offshore Export Cable Activity	Area in Acres (Hectares)
Falmouth Export Cable	
Seabed Preparation (per cable)[1]	138 (56)
Cable Installation (per cable)[2]	186 (75)
Cable Protection (per cable)[3]	27 (11)
Total Seabed Disturbance Area (per cable)	351 (142)
Total Seabed Disturbance Area (5 cables)	1,753 (709)
Potential volume of dredged material (m^3)	493,962
Brayton Point Export Cable	
Seabed Preparation (per cable bundle)	65 (26)
Cable Installation (per cable bundle)[1]	242 (98)
Cable Protection (per cable bundle)[2]	56 (23)
Total Seabed Disturbance Area (per cable bundle)	363 (147)
Total Seabed Disturbance Area (2 cable bundles)	727 (294)
Potential volume of dredged material (m^3)	17,124

Source: COP Volume 1, Table 3-29; Mayflower Wind 2022.
[1] Seabed preparation includes sand wave clearance and boulder field clearance
[2] Values also include anchor impacts. Width of surface impact estimated to be 19.7 feet (6 meters) around each cable.
[3] 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, SouthCoast Wind is considering three potential sea-to-shore transition locations in Falmouth, Massachusetts. For the Brayton Point ECC, SouthCoast 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 SouthCoast 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.

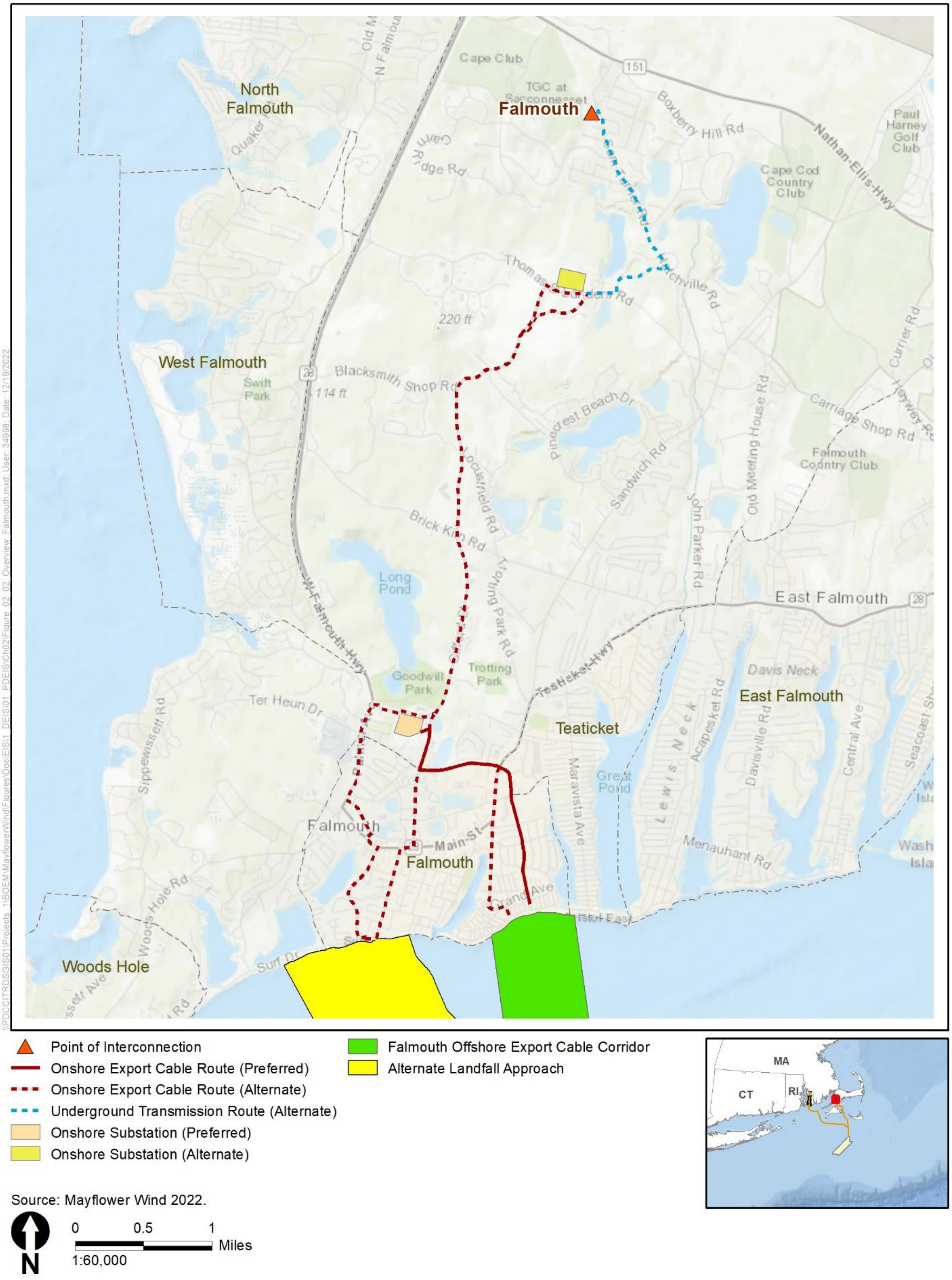


Figure 3.1-12. Falmouth ECC and landfall options

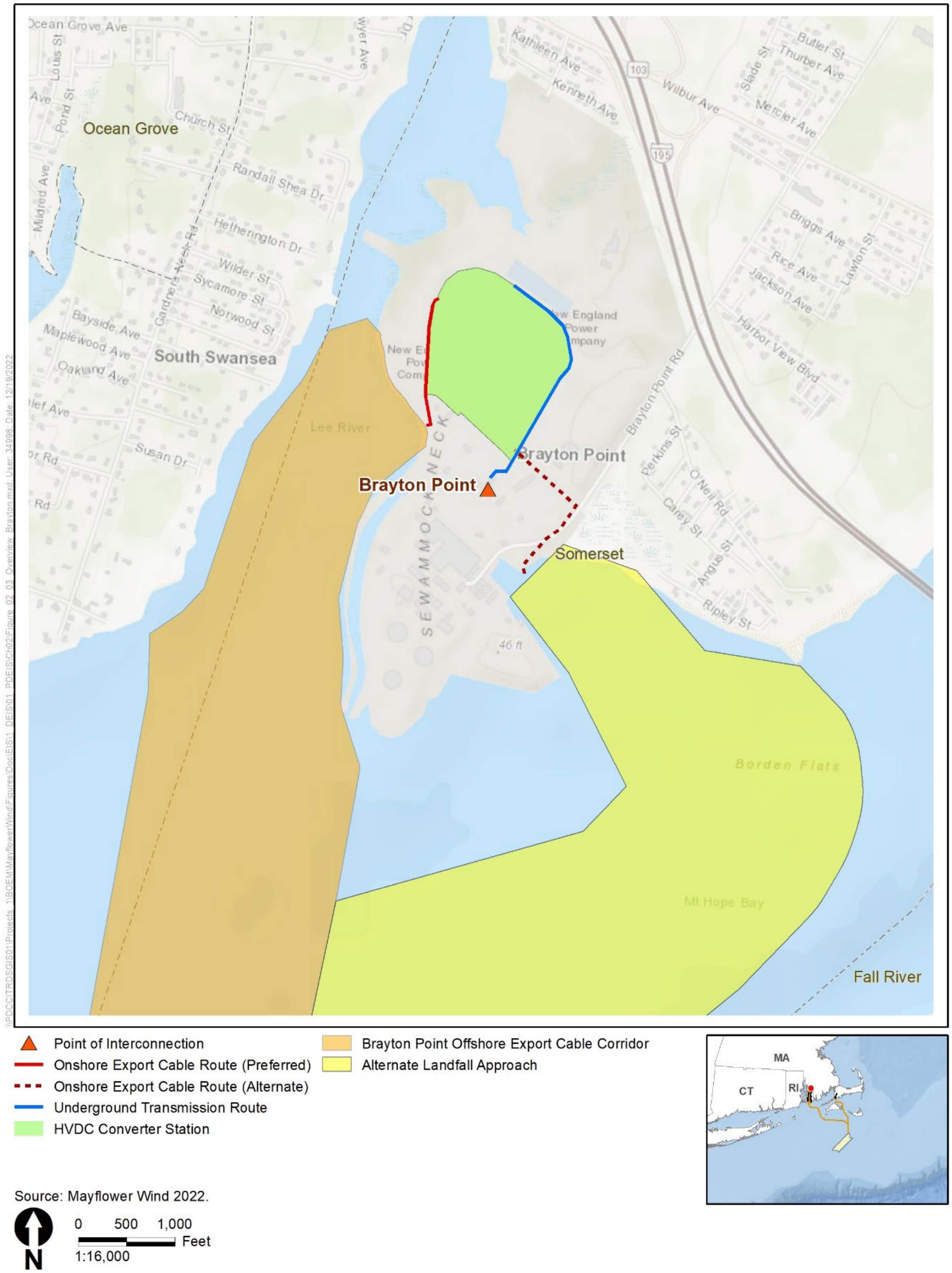


Figure 3.1-13. Brayton Point ECC and landfall options

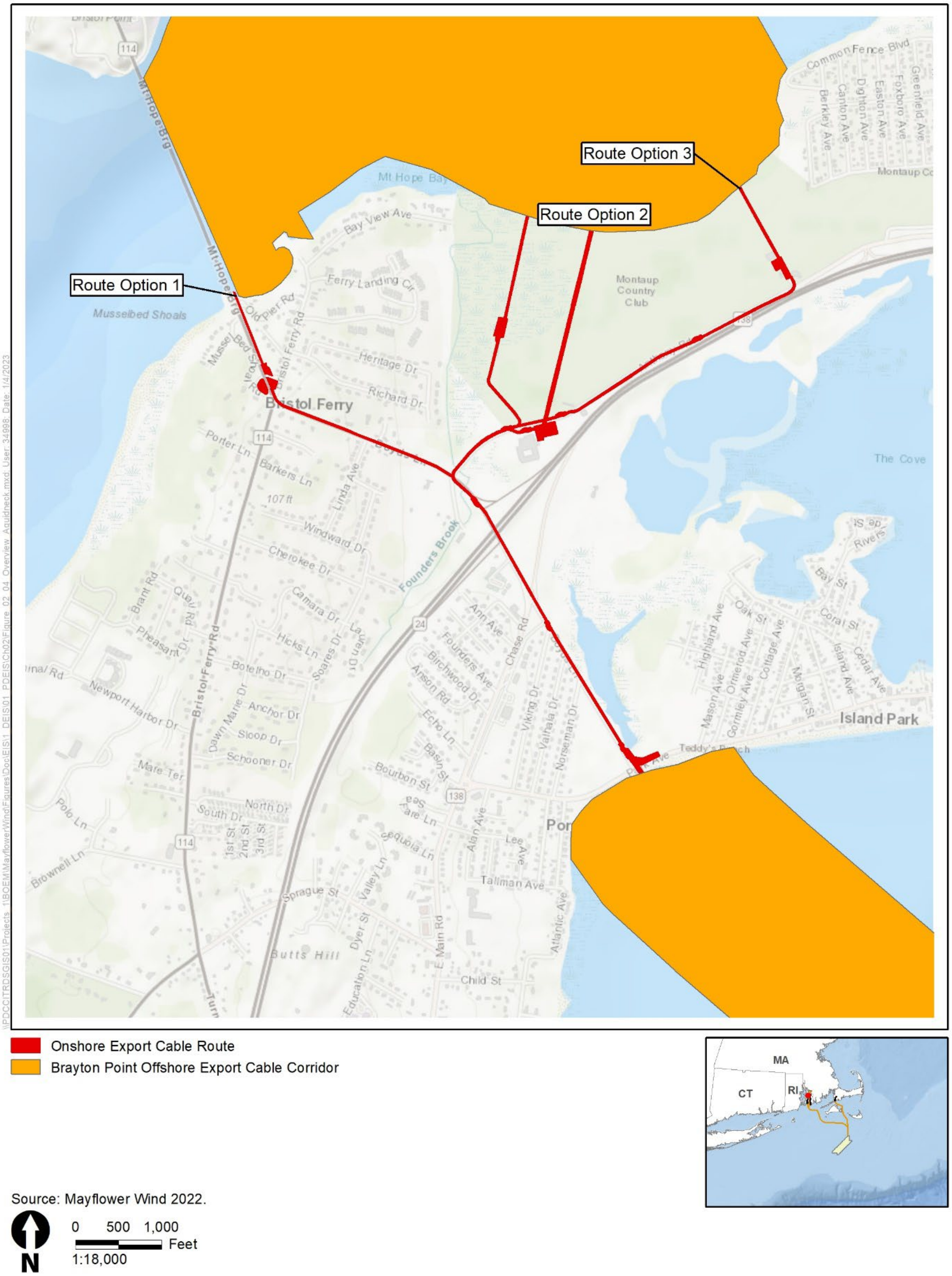


Figure 3.1-14. Brayton Point ECC and intermediate landfall options on Aquidneck Island

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. In addition to the previously discussed dredging methods (trailing suction hopper dredging and water injection dredging), mechanical dredging may also be considered for use in excavation activities nearshore, at HDD exit pits, which will be in shallower waters depths (< 10 meters). Mechanical dredging differs from the hydraulic dredging 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. Buckets on mechanical dredges typically range in size from 1 to 25 cubic yards (0.8 to 10 cubic meters) and include different designs such as a clamshell, environmental bucket, or excavator (NMFS and GARFO 2019).

Dredging will occur at up to twelve offshore HDD exit pits for the Brayton Point ECC, including four in the Sakonnet River and eight in Mount Hope Bay, directly offshore of the proposed landfall locations. The northern portions of the Brayton Point export cable corridor in the Sakonnet River and Mount Hope Bay are representative of river/estuary surficial conditions of Narraganset Bay, and primarily comprise muddy to sandy sediments in the lower portions of the Sakonnet River, and gravelly mud in the upper portions of Mount Hope Bay. For the Brayton Point and Aquidneck Island intermediate landfall locations, the HDD trajectory is anticipated to be 0.3 miles (0.5 kilometers) 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.

For the Falmouth ECC, dredging will occur at up to four HDD exit pits, directly offshore of the proposed landfall location. Seabed sediment within the Falmouth ECC consists of sand and muddy sand, coarse sediment, mixed sediment, and glacial till. For the Falmouth landfall locations, the HDD trajectory is anticipated to be 0.9 miles (1.5 kilometers) 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.

Refer to Section 3.1.2.4.2 regarding dredging volumes at HDD exit pits. Dredged material is planned to be sidecast and re-used for backfill of the offshore HDD work areas; however, if dredge material disposal is required, a plan will be prepared including identification of proposed disposal sites and material characterization. Seabed disturbances from HDD exit pits for landfall locations are shown in Table 3.1-13.

Table 3.1-13. Area of disturbance at HDD exit pits for landfall locations

Sea-to-Shore HDD	Area Disturbed, Acre (Hectare)
Falmouth	
Exit Pit /cofferdam (per HDD)	0.10 (0.04)
Total Area Disturbed (4 HDDs)	0.40 (0.16)
Brayton Point/Aquidneck Island	
Exit Pit /cofferdam (per HDD)	0.30 (0.12)
Total Area Disturbed (12 HDDs)	3.6 (1.45)

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 for the offshore export cables.

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

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 miles [1 kilometer]), Eastern (0.4 miles [0.6 kilometers])
- Aquidneck Island: All three route options are approximately 3 miles (4.8 kilometers)

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

SouthCoast 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 SouthCoast 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.

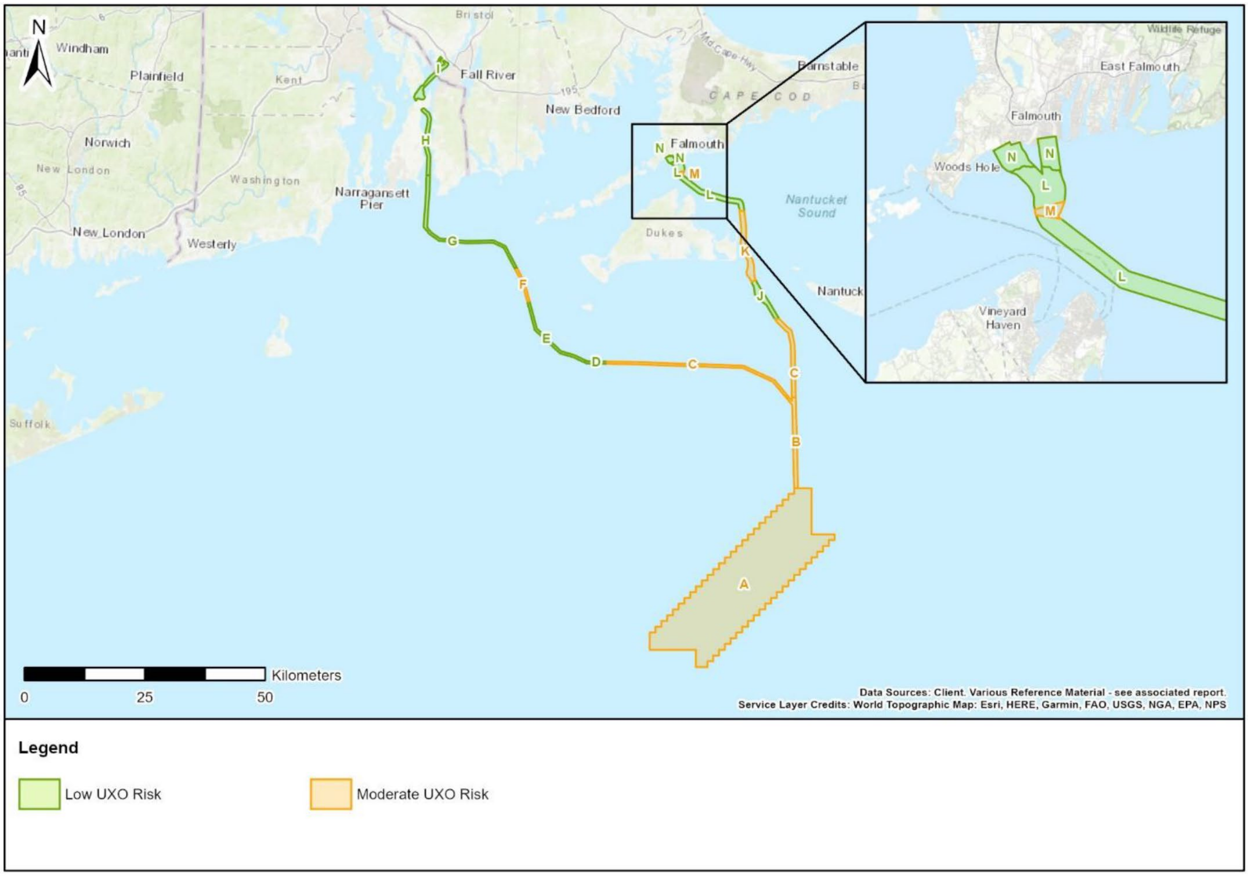


Figure 3.1-15. UXO risk in Lease Area and ECCs

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 3.1-14). 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 3.1-14).

During construction, continuous nighttime vessel lighting and construction area lighting would be required at the offshore location where the vessel and personnel are working. During transit and nighttime/low-visibility conditions, vessels would, at minimum, use navigation and deck lighting as required by the USCG and other applicable agencies and permit approval conditions, as necessary. During construction activities, the vessels will be illuminated to provide safe working conditions for personnel, as dictated by the operations ongoing at that time. These directed work lights are generally directed downwards onto the required work area, be it a vessel deck, monopile, WTG, OSP, or other, to provide required illumination for personnel or ongoing operations. The placements and intensity of lighting will be determined utilizing the API14F, EN 12464 or equivalent standard such that the lighting scheme provides safe illumination for personnel and minimizes direct and/or indirect lighting of the water surface and/or surrounding environment to the extent practicable.

During construction, SouthCoast 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 to support construction activities for the Project: Port of New London, Connecticut; Sparrows Point Port, Maryland; Ports of Fall River, New Bedford and Salem, Massachusetts; NJ Wind Port, New Jersey; Port of Coeyman, New York; Ports of Davisville and Providence, Rhode Island; Port of Charleston, South Carolina; Port of Virginia, Virginia; Ports of Argentia, Sheet Harbor, and Sydney in Canada; Port of Corpus Christi, Texas; and Port of Altamira in Mexico. While specific ports have not been identified where equipment and components may originate, SouthCoast Wind anticipates Project components (e.g., monopile foundations) could be fabricated in the U.S., Europe, Asia, and/or the Middle East. It is expected that components would typically first be shipped to ports in the U.S. or Canada for marshalling before transiting to the Project area. For example, all WTG components are to be marshalled/staged in New Bedford, Massachusetts before being installed offshore, so the point of origin for the WTG components would be the Port of New Bedford. Ports in the Gulf of Mexico, including Port of Corpus Christi, Texas and Port of Altamira in Mexico, may be used for transportation of components and equipment to the Project site. Vessels would be barge tug/tow with a max speed of 6 knots through the Gulf of Mexico and 6.5 knots north of Miami. Similarly, vessel traffic to Port of Coeymans on the Hudson River would be limited to barge tug/tow traffic with max speed between 5 to 6 knots.

It is estimated that the Project would require approximately 15–35 vessels per day on average during construction, with an expected maximum peak of 50 vessels in the Lease Area at one time, depending on activities. Vessel activity for decommissioning is anticipated to be similar to construction. 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. Anticipated ports to be used for decommissioning include Ports of Fall River, New Bedford and Salem, Massachusetts; Port of Providence, Rhode Island; and Port of New London, Connecticut. Anticipated vessel utilization parameters during construction and decommissioning, including estimated work duration and number of vessel trips, are provided in Table 3.1-14.

During O&M activities, service technicians would be delivered to the Lease Area by service operations vessels and CTVs. The ROVs, tugs, and other vessels would be used for repair and maintenance activities, as described in Table 3.1-15. The Ports of New Bedford and Fall River in Massachusetts and the Port of New London in Connecticut will be used for O&M activities. Current generalized vessel transit estimates are between 1–3 trips daily from O&M ports to support activities which include survey, cable repair, crew transfer, fuel, and service vessel movement, in addition to the SOV.

Although the exact number of trips to each port is undetermined, the vast majority of vessel trips are expected to be to Rhode Island and Massachusetts ports. For evaluating impacts in this BA, the maximum value of a given range was assumed.

This Page Intentionally Left Blank

Table 3.1-14. Estimated Proposed Action vessel and aircraft use parameters for SouthCoast Wind offshore wind farm and export cable construction and decommissioning

Vessel / Aircraft Type	Activity	No. of Each Type of Vessel / Aircraft	Vessel / Aircraft Length (meters)	Vessel Beam (meters)	Vessel Draft (meters)	Vessel Deadweight Tonnage (metric tons)	Operational Speed / Max Speed (knots)	Estimated Work Duration (days)			Supply Trips to Port (1–way)[1]	Estimated Number of Nautical Miles Traveled (for entire buildout)	Potential Ports to be Used During Construction (C) and Decommissioning (D)
								Federal Waters	Massachusetts Waters	Rhode Island Waters			
Airplane	Mammal watch, general support	1–2	10 –15	N/A	N/A	N/A	100–120	260	260	146	260	31,720	New Bedford Regional Airport (C,D)
Anchor Handling Tug	Anchor handling, general support	1–10	50–90	12–18	5–8	Up to ~2,500	10/15	240	30	28	16	4,288	Port of New Bedford (C,D) Port of Providence (C,D) Port of New London (C) Port of Fall River (C) Port of Salem (D)
Cable Lay Barge	Transportation and installation of cable and/or dredging (shallow water sections	1–3	40–130	15–35	2–6	Currently unknown	<5/15	0	120	120	2	240	Port of New Bedford (C,D) Port of New London (C,D) Port of Providence (C,D) Port of Fall River (C,D) Sparrows Point Port (C) Port of Charleston (C) Port of Salem (D)
Cable Transport and Lay Vessel	Transportation and installation of export cable and interarray and/or cable burial activities	1–5	118–165	28–35	5–9	Up to ~20,000	2/11.5	930	110	108	88	11,792	Port of New Bedford (C,D) Port of New London (C,D) Port of Providence (C,D) Port of Fall River (C,D) Sparrows Point Port (C) Port of Charleston (C) Port of Salem (D)
Crew Transfer Vessel	Commissioning, crew transport, general operations, environmental monitoring and marine mammal observers	2–5	25–40	8–12	1–2.5	50	10/35	1,960	1,608	1,608	1,608	294,532	Port of New Bedford (C,D) Port of New London (C,D) Port of Fall River (C,D) Port of Providence (D) Port of Salem (D)
Dredging Vessel	Seabed preparation, inspection, mattress installation, general support	1–5	90–230	20–45	5–18	5,500 – 80,000	2/15	400	40	40	100	20,000	Port of New London (C,D) Port of New Bedford (C) Port of Providence (C) Port of Salem (D)
Drones (Fixed wing, single and/or multi-rotor)	Onsite inspection, marine mammal monitoring and identification	1–5	1.25	1–3	N/A	N/A	0–100	800	84	84	12	1,608	N/A
Heavy Lift Crane Vessel	Transport, transfer and installation of Substructures, WTG, OSP(s) and related components	1–5	130–385	45–125	4–32	Up to ~22,000	0/15	828	90	90	18	2,412	Not anticipated in port; round trips are to safe waters during storm events

Vessel / Aircraft Type	Activity	No. of Each Type of Vessel / Aircraft	Vessel / Aircraft Length (meters)	Vessel Beam (meters)	Vessel Draft (meters)	Vessel Deadweight Tonnage (metric tons)	Operational Speed / Max Speed (knots)	Estimated Work Duration (days)			Supply Trips to Port (1–way)[1]	Estimated Number of Nautical Miles Traveled (for entire buildout)	Potential Ports to be Used During Construction (C) and Decommissioning (D)
								Federal Waters	Massachusetts Waters	Rhode Island Waters			
Heavy Transport Vessel	Transportation of substructures, WTG, OSP(s) and other project components	1–20	140–300	23–70	5.5–12	Up to ~60,000	12/15	28	6	6	6	1,608	Port of New Bedford (C,D) Port of New London (C,D) Port of Providence (C,D) Port of Davisville (C) Port of Altamira (C) Port of Salem (D)
Helicopter	Crew changes, part transport, general support	1–4	16	N/A	N/A	N/A	100–145	348	348	290	348	42,456	New Bedford Regional Airport (C,D)
Jack-up Accommodati on Vessel	Commissioning activities	1–2	50–151	42–72	4–10	Currently unknown	0/15	480	98	98	14	1,876	Not anticipated in port; round trips are to safe waters during storm events
DP Accommodati on Vessel	Commissioning activities	1–2	100–110	65–95	5.5–17	Currently unknown	0/15	720	16	16	16	2,144	Not anticipated in port; round trips are to safe waters during storm events
Multipurpose Support Vessel	Seabed preparation, inspection, mattress installation, diving, general support, environmental monitoring and marine mammal observers, noise mitigation, pre- and post- installation inspection surveys	1–8	12–100	5–25	1.5–10	Currently unknown	10/15	4,156	1,170	1,164	660	161,604	Port of New Bedford (C,D) Port of New London (C,D) Port of Providence (C,D) Port of Fall River (C,D) Port of Davisville (C) Port of Salem (D)
Scour Protection Installation Vessels	Scour protection installation	1–2	135–175	30–40	6–9.5	Up to ~20,000	2/15	400	40	40	100	20,000	US, European, or Canadian ports (C) - location unknown at this time Not applicable (D)
Service Operations Vessel	Commissioning using SOV, general operations	1–4	60–100	15–25	1.5–5	1,700 – 4,500	10/25	480	480	480	480	64,320	Port of New Bedford (C,D) Port of New London (C,D) Port of Providence (C,D) Port of Fall River (C,D) Port of Davisville (C) Port of Salem (D)
Survey Vessel	Specialized survey work, if required	1–5	28–75	6.5–12	4–7	Currently unknown	2/12	120	24	24	12	1,608	Port of New Bedford (C,D) Port of New London (C,D) Port of Providence (C,D) Port of Fall River (C,D) Port of Salem (C,D)

Vessel / Aircraft Type	Activity	No. of Each Type of Vessel / Aircraft	Vessel / Aircraft Length (meters)	Vessel Beam (meters)	Vessel Draft (meters)	Vessel Deadweight Tonnage (metric tons)	Operational Speed / Max Speed (knots)	Estimated Work Duration (days)			Supply Trips to Port (1–way)[1]	Estimated Number of Nautical Miles Traveled (for entire buildout)	Potential Ports to be Used During Construction (C) and Decommissioning (D)
								Federal Waters	Massachusetts Waters	Rhode Island Waters			
Tugboat	Transportation to site from staging port, port operations	1–12	30–90	10–13	3–7	Up to ~2,700	5/16	908	512	512	256	137,216	Port of New Bedford (C,D) Port of New London (C,D) Port of Providence (C,D) Port of Fall River (C,D) Port of Davisville (C) Port of Corpus Christi (C) Port of Altamira (C) Port of Salem (D)
Barge	Transportation of components to Site from staging port	1–6	76–146	15–33	3.65–9	Currently unknown	N/A	880	492	492	246	131,856	Port of New Bedford (C,D) Port of New London (C,D) Port of Providence (C,D) Port of Fall River (C,D) Port of Davisville (C) Port of Corpus Christi (C) Port of Altamira (C) Port of Salem (D)
							Total	**13,938**	**5,528**	**5,346**	**4,242**	**931,280**	

Source: modified from COP Volume 1, Table 3-21; Mayflower Wind 2022 with supplemental information provided by SouthCoast Wind in support of ESA consultation
N/A = not applicable
[1] Vessel trips are provided for construction. Estimated trips during decommissioning are anticipated to be approximately the same as during construction, where a decommissioning port is identified in the far right column.

Table 3.1-15. Estimated Proposed Action vessel and aircraft use parameters for SouthCoast Wind offshore wind farm and export cable operation and maintenance

Vessel / Aircraft Type	Activity	No. of Each Type of Vessel/Air craft	Vessel/ Aircraft Length (meters)	Vessel Beam (meters)	Vessel Draft (meters)	Vessel Deadweight Tonnage (metric tons)	Operational Speed/Max Speed (knots)	Estimated Work Duration (days)			Supply Trips to Port (1–way)	Estimated Number of Nautical Miles Traveled (for entire buildout)	Potential Ports to be Used During Operation and Maintenance
								Federal Waters	Massa-chusetts Waters	Rhode Island Waters			
Maintenance Crew/CTVs	Crew and technician transfer	1–4	25–40	8–12	1–2.5	50	10/35	15,015	15,015	15,015	15,015	2,614,260	Port of Fall River OR Port of New Bedford
Multipurpose Support Vessel/SOV	Supply and support	1	12–100	5–25	1.5–5	1,700 – 4,500	10/25	6,420 (MP support)/ 15,015 (SOV)	3,997.5 (MP support)/1,584 (SOV)	3,997.5 (MP support)/1584 (SOV)	1980 (MP support)/792 (SOV)	530,640 (MP support)/198,792 (SOV)	Port of Fall River OR Port of New Bedford Port of New London
Anchor Handling Tugs	Cable inspection and repairs	1–2	50–90	12–18	5–8	Up to ~2,500	10/15	2,970	792	792	396	106,128	Port of Fall River OR Port of New Bedford Port of New London
ROV	Foundation inspections	1–2	N/A	N/A	N/A	N/A	2/5	2,700	2,700	2,700	N/A	N/A	N/A
Heavy Lift/Jack Up Vessel with Crane	Large scale repairs	1–2	130–385	45–125	4–32	Up to ~22,000	0/12.5	2,970	231	231	33	4,422	Not anticipated in port; round trips are to safe waters during storm events
Scour Vessel or Barge	Scour top-up	1	135–175	30–40	6–9.5	Up to ~20,000	2/15	900	300	300	N/A	N/A	N/A
Inspection/Survey Vessel (Potentially ROV)	Inspection of cables or for surveys	1–2	28–75	6.5–12	4–7	Currently unknown	10/14	1,500	1,282.5	1,282.5	660	176,880	Port of Fall River OR Port of New Bedford Port of New London
Self-Propelled ROV/AUV	Inspections, repairs	1–2	N/A	N/A	N/A	N/A	6	8,100	900	900	N/A	N/A	N/A
Helicopter	Crew support or small supply delivery	1–2	16	N/A	N/A	N/A	100–145	1,980	1,980	1,980	1,980	241,560	New Bedford Regional Airport
Drone	Future potential for inspection or parts delivery	1–4	1.25	1–3	N/A	N/A	0–100	2,700	0	0	0	N/A	N/A
							Total	**60,270**	**28,782**	**28,782**	**20,856**	**3,872,682**	

Source: modified from COP Volume 1, Table 3-23; Mayflower Wind 2022 with supplemental information provided by SouthCoast Wind in support of ESA consultation
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 equipment 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 surveys will be conducted intermittently during construction (2 of the 5 years to be covered by SouthCoast Wind's requested incidental take regulations) to identify any seabed debris and provide general construction support. These surveys may use equipment such as multi-beam echosounders (MBES), sidescan sonars (SSS), shallow penetration sub-bottom profilers (SBPs) (e.g., "Chirp", parametric, and non-parametric SBPs), medium penetration sub-bottom profilers (e.g., sparkers), ultra-short baseline positioning equipment, and marine magnetometers. During the construction phase, an estimated 2,485 miles (4,000 kilometers) may be surveyed within the Lease Area and 3,106 miles (5,000 kilometers) 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, a 50-mile line (80 kilometers) will be surveyed per vessel each day at approximately 3.48 miles/hour (5.6 kilometers/hour and 3 knots). 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 SouthCoast Wind's requested incidental take regulations), an estimated 1,739.8 miles (2,800 kilometers) may be surveyed in the Lease Area and 1,988.4 miles (3,200 kilometers) along the ECCs each year. Using the same estimate of 50 miles (80 kilometers) of survey completed each day per dedicated survey vessel, approximately 75 days of survey activity would occur each year. Beyond the 5-year duration of the LOA, SouthCoast Wind will conduct any additional G&G surveys as required by BOEM or other relevant agencies. SouthCoast Wind plans to conduct periodic cable inspection surveys, as recommended by the cable manufacturer, which could use a combination of MBES, SSS, visual, and possibly other survey technologies (i.e., synthetic aperture sonar). The exact details, including frequency, of the cable inspection surveys will be determined once a cable manufacturer is selected.

SouthCoast Wind does not currently have any pre- or post-construction geotechnical surveys planned; however, if the specific location of certain Project components differs from the previously surveyed layout, SouthCoast Wind will perform additional geotechnical investigations at any new locations not already covered by previous investigations, as requested by BOEM.

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, SouthCoast 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. SouthCoast 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 studies 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. SouthCoast 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 2019b), 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 efforts, will 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.

Species to be targeted in surveys investigating impacts in the Lease Area are American lobster, Jonah crab, rock crab, larval fish and lobster, and over 50 demersal fish and invertebrate species found in the Lease Area (e.g., monkfish, windowpane flounder, summer flounder, black sea bass, winter flounder, yellowtail flounder, squid egg clusters, skates, sea scallops, and red hake). These species will be assessed using demersal otter trawl surveys, ventless trap surveys, and larval tow surveys. For trap surveys in the Lease Area, SouthCoast Wind and their research partners have had preliminary discussions with NOAA Fisheries regarding the use of trap gear without vertical lines. SMAST is in the process of obtaining an Incidental Take Permit (ITP) from NOAA Fisheries for their survey work for multiple offshore wind developers including SouthCoast Wind, and the fisheries monitoring plan for monitoring surveys to be conducted by SMAST in the SouthCoast Wind Lease Area is currently being finalized.

A fisheries monitoring plan (*Attachment K. Fisheries Monitoring Plan – Brayton Point ECC*, SouthCoast Wind 2022) has been developed for the portion of the Brayton Point ECC in Rhode Island state waters in accordance with the Rhode Island Ocean Special Area Management Plan (OSAMP), the Baseline Assessment Requirements in state waters, and other applicable sections of the Rhode Island Code of Regulations to characterize abundance and size structure, as well as presence, movement, and behavior of key fisheries species during the pre-construction, construction, and post-construction phases of the project. The species targeted by monitoring efforts will include the striped bass (*Morone saxatillis*), summer flounder (*Paralichthys dentatus*), tautog (*Tautoga onitis*), false albacore (*Euthynnus alletteratus*), channeled whelk (*Busycotypus canaliculatus*), and knobbed whelk (*Busycon carica*) using acoustic telemetry and trap surveys as the primary monitoring methodologies. Fisheries monitoring plans for other portions of the Project area are currently in development.

SouthCoast Wind will conduct acoustic telemetry monitoring along the Brayton Point ECC at the mouth of the Sakonnet River using a 12-receiver array of fixed station acoustic receivers to monitor the movements, presence, and persistence of several commercially and recreationally important species (e.g., striped bass, summer flounder, tautog, and false albacore). SouthCoast Wind will also conduct a trap survey to monitor whelk relative abundance and size structure along commercially fished sections of the Brayton Point ECC in the Sakonnet River. The survey will identify potential impacts from the short-term disturbance of submarine cable installation on the localized channeled and knobbed whelk resources. Sampling will occur from May to November to align with the commercial fishery for whelk within Narragansett Bay at four stations to be selected with input from the commercial fishing industry. All whelk and bycaught species caught will be separated by species, enumerated, and weighed to obtain catch per unit effort (CPUE) estimates on a per trap basis.

The other survey methods under consideration in Table 3.1-16 either directly or indirectly assess fish species and essential fish habitat (EFH) and could affect these resources.

Table 3.1-16. SouthCoast Wind fisheries surveys

Fish Surveys and Studies in the Planning Stage	Focus
Trawl Surveys	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.
Acoustic Surveys	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.
Underwater video/photography surveys (drop camera system, ROVs)	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.

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

Benthic habitat surveys using 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. Acoustic telemetry, trawl, trap, and underwater video/photography surveys will evaluate changes in the distribution and abundance of target finfish and invertebrate species in the Project area. Underwater video/photography surveys will utilize the SMAST drop camera technology and net camera survey system (i.e., open cod-end video trawl) while methods and equipment commonly employed in regional commercial fisheries will be used as part of trawl and trap surveys. If physical biological sampling is proposed, organisms captured during surveys would be removed from the environment for scientific sampling and commercial use while non-target organisms would be returned to the environment where practicable.

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 and cod 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, SouthCoast 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, SouthCoast Wind would be required to remove and/or decommission all Project infrastructure and clear the seabed of all obstructions when the Project reaches the end of its 35-year designed service life. Before ceasing operation of individual WTGs or the entire Project and prior to decommissioning and removing project components, SouthCoast 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, SouthCoast 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. SouthCoast 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 3.2-1. IPFs Associated with the Proposed Action mapped to species or critical habitat

	Marine Mammals						Sea Turtles					Elasmobranchs	Fish	
IPF	Blue Whale	Fin Whale	[1]NARW	Rice's Whale	Sei Whale	Sperm Whale	Green	Hawks-bill	Kemp's ridley	Leather-back	[1]Logger-head	Giant manta ray, Oceanic whitetip shark, Smalltooth sawfish	Atlantic salmon, Gulf sturgeon, Nassau grouper, Shortnose sturgeon	[1]Atlantic Sturgeon
Underwater & Other Noise														
Impact & Vibratory Pile-Driving	NLAA	**LAA**	**LAA**	--	**LAA**	**LAA**	NLAA	--	NLAA	**LAA**	**LAA**	--	--	NLAA
G&G Surveys	NLAA	NLAA	NLAA	--	NLAA	NLAA	NLAA	--	NLAA	NLAA	NLAA	--	--	NLAA
Cable Laying	NLAA	NLAA	NLAA	--	NLAA	NLAA	NLAA	--	NLAA	NLAA	NLAA	--	--	NLAA
Dredging	NLAA	NLAA	NLAA	--	NLAA	NLAA	NLAA	--	NLAA	NLAA	NLAA	--	--	NLAA
UXO Detonation	NLAA	NLAA	NLAA	--	NLAA	NLAA	NLAA	--	NLAA	NLAA	NLAA	--	--	NLAA
Vessels	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
Helicopter & Drones	NLAA	NLAA	NLAA	--	NLAA	NLAA	NLAA	--	NLAA	NLAA	NLAA	--	--	NLAA
WTGs	NLAA	NLAA	NLAA	--	NLAA	NLAA	NLAA	--	NLAA	NLAA	NLAA	--	--	NLAA
Vessel Traffic														
Risk of Vessel Strike	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
Vessel Discharges	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
Habitat Disturbance/Modifications														
G&G Surveys	--	--	--	--	--	--	NLAA	--	NLAA	NLAA	NLAA	--	--	NLAA
Fisheries Surveys – Risk of Capture and Entanglement	NLAA	NLAA	NLAA	--	NLAA	NLAA	NLAA	--	NLAA	NLAA	NLAA	--	--	**LAA**

	Marine Mammals						Sea Turtles					Elasmobranchs	Fish	
IPF	Blue Whale	Fin Whale	[1]NARW	Rice's Whale	Sei Whale	Sperm Whale	Green	Hawks-bill	Kemp's ridley	Leather-back	[1]Logger-head	Giant manta ray, Oceanic whitetip shark, Smalltooth sawfish	Atlantic salmon, Gulf sturgeon, Nassau grouper, Shortnose sturgeon	[1]Atlantic Sturgeon
Fisheries Surveys – Effects on Prey and/or Habitat	NLAA	NLAA	NLAA	--	NLAA	NLAA	NLAA	--	NLAA	NLAA	NLAA	--	--	NLAA
Habitat Conversion and Loss – Foundations and Scour Protection	NLAA	NLAA	NLAA	--	NLAA	NLAA	NLAA	--	NLAA	NLAA	NLAA	--	--	NLAA
Habitat Conversion and Loss – Cable Emplacement	NLAA	NLAA	NLAA	--	NLAA	NLAA	NLAA	--	NLAA	NLAA	NLAA	--	--	NLAA
Habitat Conversion and Loss – Spuds and Anchors	NLAA	NLAA	NLAA	--	NLAA	NLAA	NLAA	--	NLAA	NLAA	NLAA	--	--	NLAA
Turbidity	NLAA	NLAA	NLAA	--	NLAA	NLAA	NLAA	--	NLAA	NLAA	NLAA	--	--	NLAA
Dredging – Direct Effects	--	--	--	--	--	--	NLAA	--	NLAA	NLAA	NLAA	--	--	NLAA
Dredging – Impacts on Prey	--	--	--	--	--	--	--	--	NLAA	--	--	--	--	NLAA
Trenching	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Presence of WTGs on Atmospheric / Oceanographic Conditions	--	NLAA	NLAA	--	NLAA	--	NLAA	--	NLAA	NLAA	NLAA	--	--	NLAA
Physical Presence of WTGs on Listed Species	NLAA	NLAA	NLAA	--	NLAA	NLAA	NLAA	--	NLAA	NLAA	NLAA	--	--	NLAA
EMF and Heat from Cables	NLAA	NLAA	NLAA	--	NLAA	NLAA	NLAA	--	NLAA	NLAA	NLAA	--	--	NLAA

	Marine Mammals						Sea Turtles					Elasmobranchs	Fish	
IPF	Blue Whale	Fin Whale	[1]NARW	Rice's Whale	Sei Whale	Sperm Whale	Green	Hawks-bill	Kemp's ridley	Leather-back	[1]Logger-head	Giant manta ray, Oceanic whitetip shark, Smalltooth sawfish	Atlantic salmon, Gulf sturgeon, Nassau grouper, Shortnose sturgeon	[1]Atlantic Sturgeon
Lighting and Marking of Structures	NLAA	NLAA	NLAA	--	NLAA	NLAA	NLAA	--	NLAA	NLAA	NLAA	--	--	NLAA
Offshore Substations – Water Withdrawal and Discharge	NLAA	NLAA	NLAA	--	NLAA	NLAA	NLAA	--	NLAA	NLAA	NLAA	--	--	NLAA
Offshore Substations – Impacts on Prey	NLAA	NLAA	NLAA	--	NLAA	NLAA	NLAA	--	NLAA	NLAA	NLAA	--	--	NLAA
Other IPFs														
Air Emissions	NLAA	NLAA	NLAA	--	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	--	--	--
Port Modifications[2]	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Repair and Maintenance Activities	NLAA	NLAA	NLAA	--	NLAA	NLAA	NLAA	--	NLAA	NLAA	NLAA	--	--	NLAA
Potential Shifts of Ocean Users	NLAA	NLAA	NLAA	--	NLAA	NLAA	NLAA	--	NLAA	NLAA	NLAA	--	--	NLAA
Vessel Collision/Allision with Foundation	NLAA	NLAA	NLAA	--	NLAA	NLAA	NLAA	--	NLAA	NLAA	NLAA	--	--	NLAA
Failure due to Weather Events	NLAA	NLAA	NLAA	--	NLAA	NLAA	NLAA	--	NLAA	NLAA	NLAA	--	--	NLAA
Oil / Chemical Spill	NLAA	NLAA	NLAA	--	NLAA	NLAA	NLAA	--	NLAA	NLAA	NLAA	--	--	NLAA

[1] Critical habitats of these species that occurred within the Action Area (NARW, loggerhead sea turtle, Atlantic sturgeon) were removed from the table as there was determined to be **"no effect"** on any of the physical and biological features of these habitats. Other critical habitats did not occur within the Action Area.
[2]Port modifications are not part of the proposed Project.
"—" = no effect, DPS = distinct population segment; EMF = electromagnetic field; G&G = geotechnical and geophysical; IPF = impact-producing factor; LAA = likely to adversely affect; NARW = North Atlantic right whale; NLAA = not likely to adversely affect; OSP = offshore substation platform; UXO = unexploded ordnance; WTG = wind turbine generator

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 SouthCoast 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 SouthCoast 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 SouthCoast 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 ROD.

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, which are evaluated as part of the Proposed Action, 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 ROD. 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 has considered 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 (late fall through spring), zooplankton, and chlorophyll a (Curtice et al. 2019; 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 (Curtice et al. 2019; Northeast Ocean Data 2022). BOEM has included three measures to be evaluated as part of the Proposed Action, NS-1, NS-2, and NS-4, which are described in Table 3.3-2.

In addition, BOEM is in the process of evaluating the financial feasibility and practicability of two measures (NS-3 and NS-5), which are described below. These potential measures **are not part of the Proposed Action** (i.e., neither proposed by the applicant or any action agencies), but rather are requested to be discussed under further consultation for their effectiveness at reducing take as potential terms and conditions.

- **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 kilometers 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.** SouthCoast 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 impact or vibratory 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.

This Page Intentionally Left Blank

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 SouthCoast Wind Project submitted to NMFS (see 87 FR 62793; https://media.fisheries.noaa.gov/2022-10/MayflowerWindNewEng_2022ITA_App_OPR1.pdf) and the SouthCoast Wind COP

No	Measure	Description	Project Phase	Expected Effects
AMM-1	Observer Qualifications and Training	PSOs and Acoustic PSOs (APSO / 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

No	Measure	Description	Project Phase	Expected Effects
		At least one PSO on duty during all other daylight periods. PSOs will monitor for 30 minutes before and after each piling event. One PSO will monitor the shutdown zone with the naked eye, reticle binoculars and/or other electronic method(s) while one PSO periodically scans outside the shutdown zone using the mounted big eye binoculars and/or other electronic method(s). PSO will monitor the NMFS NARW reporting systems including WhaleAlert and SAS once every 4-hour shift during Project related activities. Follow PSO data recording requirements All data will be recorded based on standard (BOEM) PSO collection requirements using industry-standard software.		
AMM-8	Daytime Periods of Reduced Visibility	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	C	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
AMM-9	Nighttime Visual Monitoring	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 (Verfuss 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 daylight 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	C	Increase effectiveness of monitoring to avoid or minimize impacts on marine mammals from underwater noise-producing activities at night using enhanced detection equipment
AMM-10	Acoustic Monitoring	Since visual observations within the applicable shutdown zones can become impaired at night or during daylight hours due to fog, rain, or high sea states, visual monitoring with thermal and NVDs will be supplemented by PAM during these periods. 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 180 calendar days, but no later than 120 days, 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 requesting 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 vison 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.	C	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.

No	Measure	Description	Project Phase	Expected Effects
		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.		
AMM-11	Number of APSOs	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.	C	Increase detection of marine mammals and increase the area capable to be effectively monitored
AMM-12	Passive Acoustic Monitoring Methods	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.	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 may cause harassment or PTS.
AMM-13	Sound Source Verification – UXO Detonation	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	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.
AMM-14	Sound Source Verification – Pile Driving	Measurement of each pile type (monopiles and/or piled jackets) to be installed to determine the sound levels produced and effectiveness of the NAS(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 isopleths and/or other mitigation action distances align with the distances modelled. 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 modelled Level A and Level B isopleth	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.
AMM-15	Reporting Protocols	All vessels will utilize a standardized data entry format. A quality assurance/ quality control (QA/QC'd) database of all sightings and associated details (e.g., distance from vessel, behavior, species, group size/composition) within and outside of the designated shutdown 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.	C	Monitoring effectiveness of mitigation measures via reporting.
AMM-16	Underwater Noise (pile driving) – Pre-Start Clearance	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 NVD 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).	C	Minimize impacts on marine mammals and sea turtles from underwater noise-producing activities by ensuring the area is clear
AMM-17	Underwater Noise (pile driving) – Soft Start	Soft start procedures will be followed, to the extent practicable, at the beginning of each pile driving event or any 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.	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

No	Measure	Description	Project Phase	Expected Effects
		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).		vacate the area before pile driving begins
AMM-18	Underwater Noise (pile driving) – Shutdowns	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. If a marine mammal or sea turtle is sighted within the shutdown zone during a pause in piling, resumption of pile driving will be delayed until the animal(s) has 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 seals and 30 minutes for all other marine mammals). Following shutdown, pile driving will restart using the same procedure described above	C	Avoid or minimize impacts on marine mammals or sea turtles from underwater noise-producing activities by halting activities when animals enter an unsafe area
AMM-19	Underwater Noise (pile driving) – Shutdown Zones	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 • WTG Monopile during Impact driving − Low-Frequency Cetaceans: 2,600 m – 4,000 m − Mid-Frequency Cetaceans: NAS perimeter − High-Frequency Cetaceans: NAS Perimeter − Seals: NAS perimeter – 300 m • WTG Monopile during Vibratory driving − Low-Frequency Cetaceans: NAS perimeter – 200 m − Mid-Frequency Cetaceans: NAS perimeter − High-Frequency Cetaceans: NAS perimeter − Seals: NAS perimeter • WTG Jacket during Impact driving − Low-Frequency Cetaceans: 1,900 m – 2,300 m − Mid-Frequency Cetaceans: NAS perimeter − High-Frequency Cetaceans: NAS perimeter − Seals: NAS perimeter – 400m • WTG Jacket during Vibratory driving − Low-Frequency Cetaceans: NAS perimeter − Mid-Frequency Cetaceans: NAS perimeter − High-Frequency Cetaceans: NAS perimeter o Seals: NAS perimeter • OSP Jacket Impact Driving o Low-Frequency Cetaceans: 2,600 m – 2,800 m o Mid-Frequency Cetaceans: NAS perimeter o High-Frequency Cetaceans: NAS perimeter − Seals: 400 m – 500 m	C	Establish safety measures to avoid or minimize impacts on marine mammals from underwater noise-producing activities
AMM-20	Underwater Noise (pile driving) – Post Piling Monitoring	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.	C	Increase effectiveness of mitigations to avoid or minimize impacts on marine mammals from underwater noise-producing activities
AMM-21	Underwater Noise (pile driving) – Noise Attenuation	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, hydrosound 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	C	Increase effectiveness of mitigations to avoid or minimize impacts on marine mammals from underwater noise-producing activities by dampening sound

No	Measure	Description	Project Phase	Expected Effects
		determined. Based on prior measurements a combination of NAS is reasonably expected to achieve far greater than 10 dB broadband attenuation of impact pile driving sounds.		
AMM-22	Underwater Noise (pile driving) – Avoidance of NARW Activity	Potential Additional Measures to Protect North Atlantic Right Whales To complete installation within as few years as possible during the multiple year installation campaign expected for the entire Lease Area build-out, impact pile driving 24-hours per day is deemed necessary. The period from January through April is when the highest number of NARW are present in the region which means foundation installations during this period would likely result in greater potential impacts on this species. To reduce the need for foundation installations during this period and associated impacts on the NARW, SouthCoast Wind may conduct nighttime impact pile driving of monopile or piled jacket foundations during time periods when the fewest number of NARW are likely to be present in the region. Specific measures will include: Concentrating construction activities when NARW are less likely to be present within the region (May 1 through December 31), including in the Lease Area. Specific monitoring tools and plans will be developed as a part of the ongoing ITR Application process, but may include the use of advanced infrared systems, real-time PAM, autonomous underwater vehicles, autonomous aerial vehicles, or other advanced technologies that could improve the probability of detecting marine mammals at night.	C	Avoid or minimize impacts on NARWs from Project activities
AMM-23	Vessel Strike Avoidance – General Measures	All vessels, including those transiting to and from local ports and the Project area, will follow the vessel strike avoidance measures outlined below, except in cases where following these requirements would put the safety of the vessel or crew at risk. Captain, first mate, and/or designated vessel personnel working offshore will receive training on marine mammal awareness and vessel strike avoidance measures. A minimum of one PSO or trained vessel crew member will be present on all vessels when transiting. Observers will maintain a vigilant watch for all marine mammals and slow down, change course, slow down or stop vessels to avoid striking protected species. Observers will monitor the NMFS NARW reporting systems from November 1 through May 30 and whenever a dynamic management area (DMA) is established in the operational area.	C,O,D	Establish operational standards to minimize risk to marine mammals and sea turtles
AMM-24	Vessel Strike Avoidance – Separation Distances	Maintaining >500 m distance from any sighted NARW or an unidentified large marine mammal. Maintaining >100 m from all ESA-listed whales or humpback whales. Maintaining >50 m from all other marine mammals, with the exception of delphinids and pinnipeds that approach the vessel, in which case the vessel operator must avoid excessive speed or abrupt changes in direction.	C,O,D	Establish operational standards to minimize risk to marine mammals
AMM-25	Vessel Strike Avoidance – Actions Given Observed Marine Mammal	If underway, vessels will steer a course away from any NARW at 10 kts or less until the 500 m minimum separation distance has been established: If a NARW comes within 100 m, then the vessel will reduce speed and shift the engines into neutral, if safe to do so. The vessel will not engage engines until the NARW has moved beyond 100 m in which case any vessel will steer a course away from the animal at 10 kts or less until the 500 m minimum separation distance has been established. If the vessel is stationary, the vessel will not engage engines until the NARW has moved beyond 100 m in which case any vessel will steer a course away from the animal at 10 kts or less until the 500 m minimum separation distance has been established. If a vessel comes within 100 m of a non-NARW whale: If underway, the vessel must attempt to remain parallel to the animal's course, reduce speed and shift the engine to neutral, and must not engage the engines until the whale (e.g., large whale and/or ESA-listed whales besides NARW) has moved beyond 100 m. If stationary, the vessel must not engage engines until the whale has moved beyond 100 m. If underway, vessels must not divert to approach any small cetacean, seal, sea turtle, or giant manta ray. Report sightings of all dead or injured marine mammals or sea turtles within 24 hours	C,O,D	Establish operational standards to minimize risk to marine mammals
AMM-26	Vessel Strike Avoidance – Speed Reduction (marine mammals)	Vessels will comply with NMFS regulations and speed restrictions (≤10 kts) in NARW management areas including SMAs and active DMAs during migratory and calving periods from November 1 to April 30, except for CTVs. Operating vessels, except CTVs, will travel at speeds ≤10 kts in any DMA. All vessel speeds will be reduced to ≤10 kts when mother/calf pairs, pods, or large assemblages of marine mammals are observed. To facilitate the safe transit of CTVs at >10 kts in SMAs and DMAs SouthCoast Wind will implement (or participate in a joint program, if developed) a PAM system designed to detect NARW within the transit corridor and additional visual monitoring measures as described SouthCoast Wind Energy LLC Request for Incidental Take Regulations September 2022 LGL Ecological Research Associates, Inc. Page 125 below. A Vessel Strike Avoidance Plan that provides a more detailed description of the equipment and methods to conduct the monitoring summarized here will be provided to NMFS at least 90-days prior to commencement of vessel movements associated with the activities covered by the requested incidental take regulations. Acoustic Monitoring A PAM system consisting of near real-time bottom mounted and/or mobile acoustic monitoring systems will be installed such that NARW and other large whale calls made in or near the corridor can be detected and transmitted to the transiting vessel (either directly or through an operations base).	C,O,D	Establish operational standards to minimize risk to marine mammals

No	Measure	Description	Project Phase	Expected Effects
		The detections will be used to determine areas along the transit corridor where the CTV would be allowed to travel at >10 kts if no detections had occurred in the previous 12 hrs, or required to transit at <10 kts if detections had been made in the previous 12 hrs Visual Monitoring All CTVs operating at >10 kts will have a dedicated observer on watch (NMFS-approved PSO or trained crew member with no other duties) with standard equipment for daytime monitoring (handheld binoculars) and alternative equipment for low visibility conditions (night-vision devices and/or IR sensor). The dedicated observers will be trained in detection and identification of protected species, vessel strike minimization procedures and how and when to communicate with the vessel operator If the PAM system temporarily stops working the following procedures will be followed CTVs will transit at <10kts s in all SMAs (applicable November 1st to April 30th) and DMAs (at any time of year). Between May 1 and October 31, CTVs will transit at >10 kts and implement the visual monitoring measures with a dedicated observers as described above		
AMM-27	Vessel Encounters – Sea Turtles	SouthCoast Wind will ensure that all vessels underway do not intentionally approach any sighted sea turtle SouthCoast Wind will ensure that all vessels maintain a separation distance of 164 ft (50 m) or greater from any sighted sea turtles SouthCoast 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: Ensure that vessel operators and crews maintain a vigilant watch for sea turtles and slow down or stop their vessel to avoid striking these protected species Employ reporting system to NMFS in the event of a vessel strike	C,O,D	Avoid and minimize the risk of vessel encounters with sea turtles while watching for marine mammals and implementing avoidance measures
AMM-28	Marine Debris	SouthCoast Wind will adhere to all regulations under the USEPA Clean Water Act. SouthCoast 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 entrainment of sea turtles, while still ensuring the safety and integrity of the structure or device SouthCoast 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, SouthCoast Wind personnel must provide any assistance to authorized stranding response personnel as requested by BOEM or NMFS	C,O,D	Increase effectiveness of mitigations to avoid or minimize impacts on sea turtles from marine debris
AMM-29	Habitat Disturbance and Modification	SouthCoast 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) SouthCoast Wind will incorporate use of HDD at landing(s) and avoid disturbance to finfish and invertebrate EFH to the extent practicable SouthCoast Wind will incorporate use of HDD of subsea cables, as appropriate, to minimize spatial and temporal effects to Atlantic sturgeon	C	Increase effectiveness of mitigations to avoid or minimize impacts on sea turtles and ESA listed animals from habitat disturbance
AMM-30	Incident Reporting	The following situations would require reporting as defined below: 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. 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 (866-755-6622) or via the Whale Alert Application.	C,O,D	Increase operational awareness to minimize risk to marine mammals and sea turtles
AMM-31	Actions Given a Marine Mammal Is Taken in a Prohibited Manner by Construction Activities	Activity operations 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. SouthCoast 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	C,O,D	Increase effectiveness of mitigations to minimize impacts on marine mammals after a take occurs
AMM-32	Actions Given an Unknown and Recent Observed Dead or Injured Marine Mammal	SouthCoast 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 SouthCoast Wind to determine whether modifications to the activities are appropriate	C,O,D	Increase effectiveness of mitigations to minimize impacts on marine mammals after a take occurs
AMM-33	Actions Given Observation of a Dead or Injured Marine Mammal Not Associated with or	SouthCoast 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. SouthCoast Wind will include any documentation of the stranded animal sighting to NMFS and the Marine Mammal Stranding Network including photographs and video footage if available.	C,O,D	Increase effectiveness of mitigations to minimize impacts on marine mammals after injury occurs

No	Measure	Description	Project Phase	Expected Effects
	Related to Constriction Activities	Construction activity may continue.		
AMM-34	Seabed Preparation	SouthCoast Wind will use BMPs to minimize sediment mobilization during offshore component installation SouthCoast Wind, when feasible, will use technologies that minimize sediment mobilization and seabed sediment alteration for cable burial operations SouthCoast Wind, where practical and safe, will utilize DP vessels SouthCoast Wind will utilize HDD for sea-to-shore transition	C,O,D	Minimize impacts of turbidity on ESA listed animals
AMM-35	Avoiding Scour Development	SouthCoast Wind will utilize scour protection methods to avoid developing scour holes at the base of structures SouthCoast Wind will bury submarine cables at depths to guard against exposure from seabed mobility	C,O,D	Minimize impacts of habitat conversion and seabed disturbance for ESA listed animals
AMM-36	Prevention of Unplanned Releases	SouthCoast 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 SouthCoast 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 SouthCoast Wind will have an HDD Contingency Plan in place to mitigate, control, and avoid unplanned discharges related to HDD activities	C,O,D	Increase effectiveness of mitigations to minimize impacts of Accidental Events/ Hazards on ESA listed animals
AMM-37	Minimization of EMF	SouthCoast Wind will install offshore export cables and interarray cables to target burial depths and use cable shielding materials to minimize effects of EMFs	C	Increase effectiveness of mitigations to minimize impacts of EMF on ESA listed animals
AMM-38	Minimization of Entanglement Risk	SouthCoast 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 entrainment of marine mammals while still ensuring the safety and integrity of the structure or device SouthCoast 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 If an entangled live or dead marine protected species is reported, SouthCoast Wind personnel must provide any assistance to authorized stranding response personnel as requested by BOEM or NMFS	C,O,D	Minimize the risk of entanglement for marine mammals and sea turtles
AMM-39	Minimizing Risk from Planned Discharges	SouthCoast Wind will use approved OSRP mitigation measures to prevent animals from going to affected area including translocation to unaffected areas as necessary To minimize potential impacts on zooplankton from impingement and entrainment, the northernmost HVDC converter OSP will be located outside of a 10-km buffer of the 30-meter isobath from Nantucket Shoals.	C,O,D	Minimize impacts and exposure of ESA listed animals to planned discharges
AMM-40	HRG Surveys	HRG survey activities may be required during construction and the operations and maintenance (O&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 >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.	O	Increase effectiveness of mitigations to minimize impacts of HRG surveys
AMM-41	HRG Surveys – Monitoring Equipment	Two pairs of reticle binoculars Two hand-held or wearable night vision devices (NVDs) Two IR spotlights One data collection software system Two PSO-dedicated very high frequency (VHF) radios One digital single-lens reflex camera equipped with a 300-mm lens	O	Increase effectiveness of monitoring by using the best available equipment
AMM-42	HRG Surveys – Visual Monitoring	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 onboard The vessel captain (or crew member on watch) will conduct observations when the PSO is on required breaks; The PSO on duty will remain available to confirm sightings and any related mitigation measures while on break.	O	Increase effectiveness of monitoring to minimize impacts of HRG surveys

No	Measure	Description	Project Phase	Expected Effects
		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.		
AMM-43	HRG Surveys – Daytime Visual Monitoring	One PSO on watch during pre-start clearance periods and all source operations. PSOs will use reticle binoculars and the naked eye to scan the shutdown zone for marine mammals	O	Increase effectiveness of monitoring to minimize impacts of HRG surveys
AMM-44	HRG Surveys – Nighttime and Low Visibility Monitoring	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.	O	Increase effectiveness of monitoring to minimize impacts of HRG surveys by using enhanced detection equipment
AMM-45	HRG Surveys – Shutdown Zones	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	O	Establish safety measures to avoid or minimize impacts on marine mammals from underwater noise-producing activities
AMM-46	HRG Surveys – Pre-start Clearance	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 not 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).	O	Avoid impacts of underwater noise from HRG surveys to marine mammals and sea turtles by ensuring that the area is clear prior to the start of the HRG survey
AMM-47	HRG Surveys – Ramp-Up	The ramp-up procedure will not be initiated during periods of inclement conditions 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)	O	Avoid or minimize impacts of underwater noise from HRG surveys to marine mammals and sea turtles by using a ramp-up start to allow animals to vacate the area
AMM-48	HRG Surveys-Shutdowns	Immediate shutdown of impulsive, non-parametric HRG survey equipment other than CHRIP 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	O	Avoid or minimize impacts of underwater noise from HRG surveys to marine mammals and sea turtles by halting noise production once animals enter an unsafe area
AMM-49	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 consultation with a UXO specialist and in coordination with the agencies with regulatory oversite of UXO. For detonations that cannot be avoided due to	C	Increase effectiveness of mitigations to minimize impacts of underwater noise from UXO detonations on marine mammals and sea turtles

No	Measure	Description	Project Phase	Expected Effects
		safety considerations, a number of mitigation measures will be employed by SouthCoast Wind. No more than a single UXO will be detonated in a 24- hour period		
AMM-50	UXO Detonation – Pre-start Clearance	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 The detonation may commence when either the marine mammal(s) has voluntarily left the respective pre-start clearance zone and been visually confirmed beyond that pre-start clearance zone, or when 30 minutes have elapsed without redetection for whales, including the NARW, or 15 minutes have elapsed without redetection of dolphins, porpoises, and seals	C	Ensure the area is clear prior to the start of UXO detonation
AMM-51	UXO Detonation – Visual Monitoring	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 PSOs on duty on the primary vessel Visual PSOs 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	C	Increase effectiveness of monitoring to minimize impacts of UXO detonations
AMM-52	UXO Detonation – Acoustic Monitoring	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	C	Increase effectiveness of monitoring to minimize impacts of UXO detonations
AMM-53	UXO Detonation – Noise Attenuation	SouthCoast 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, SouthCoast Wind will implement mitigation measures for the larger unmitigated zone sizes with deployment of vessels adequate to cover the entire pre-start clearance zones	C	Increase effectiveness of mitigations to minimize impacts of underwater noise from UXO detonations on ESA listed animals by dampening noise
AMM-54	UXO Detonation – Seasonal Restriction	No UXO detonations are planned between January and April	C	Avoid detonations in the time of year where NARW activity is highest
AMM-55	UXO Detonation – Post Detonation Monitoring	Post-detonation monitoring will occur for 30 minutes	C	Ensure that UXO detonation was performed safely
AMM-56	UXO Detonation – Monitoring Equipment	Two pairs of reticle binoculars One pair of mounted “big-eye” binoculars One data collection software system	C	Increase effectiveness of monitoring by using the best available equipment

No	Measure	Description	Project Phase	Expected Effects
		Two PSO-dedicated VHF radios One digital single-lens reflex camera equipped with a 300-mm lens One monitoring station for real time PAM system *The selected PAM system will transmit real time data to PAM monitoring stations on the vessels and/or a shore side monitoring station.		
AMM-57	Air Emissions Reduction	SouthCoast Wind will ensure that vessels used for construction will use the jurisdictionally required compliant fuel, e.g., ultra-low sulfur diesel or a fuel with less emissions SouthCoast Wind will ensure fuels used for construction equipment comply with EPA or equivalent emissions standards SouthCoast Wind will use low-NOx engines when possible SouthCoast Wind will engage with EPA on how to satisfy Best Available Control Technology	C,O,D	Increase effectiveness of mitigations to minimize impacts of air emissions on ESA listed animals

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; CHRIP = compressed high intensity radar pulse; CTV = crew transfer vessel; ; D = Decommissioning; dB = decibel; DMA = dynamic management area; DP = dynamic positioning; EFH = essential fish habitat; EPA = Environmental Protection Agency; 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; mi = miles MMPA = Marine Mammal Protection Act; NARW = North Atlantic right whale; NAS = noise attenuation system; NMFS = National Marine Fisheries Service; NOx = nitrogen oxides; NVD = night vision device; O = operations; O&M = operations and maintenance; OPR = Office of Protected Resources; OSP = offshore substation platform; OSRP = oil spill response plan; PAM = Passive acoustic monitoring; PSO = protected species observer; QA/QC = quality assurance quality control; RWSAS = NMFS Right Whale Sighting Advisory System; SAS = sighting advisory system; SMA = seasonal management area; SPCC = spill prevention, control, and countermeasure; SWPP = stormwater pollution prevention plan; USCG = United States Coast Guard; USEPA = United States Environmental Protection Agency; UXO = unexploded ordinance; VHF = Very High Frequency

Table 3.3-2. Additional proposed mitigation monitoring, and reporting measures – BOEM proposed

No	Measure	Description	Project Phase	Expected Effects
Nantucket Shoals (NS)-1	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.	O&M	Nantucket Shoals supports dense aggregations of zooplankton such as gammarid shrimp and copepods, which in turn, support higher tropic levels of wildlife. While the SouthCoast 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 by excluding them from the enhanced mitigation area, which extends approximately 7 – 9 miles (11.2 – 14.5 kilometers) southwest of the 30-meter isobath. 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.
NS-2	Pile-Driven Foundations Only	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.	C, O&M	In May 2023, SouthCoast Wind removed GBS foundations entirely from its PDE and removed suction-bucket jackets as a foundation option for the northern portion of the Lease Area, which would include the enhanced mitigation area. As a result, SouthCoast Wind's Proposed Action only includes monopile and piled jacket foundations in the enhanced mitigation area. At this time, BOEM is retaining this mitigation measure given that an alternative BOEM is considering through the NEPA process evaluates GBS and suction-bucket jacket foundations throughout the entirety of the Lease Area. The foundation footprint, including scour protection, on the seabed would be reduced by a minimum of 8.94 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, smothering, by the larger foundation footprint of suction-bucket jacket and GBS foundations in this area.
NS-4	Pile-Driving Time of Year Restriction in Enhanced Mitigation Area	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.	C	The most recent modeled density of NARW indicate higher densities of NARW on Nantucket Shoals in the late fall through spring, 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.

No	Measure	Description	Project Phase	Expected Effects
MA-4	Sound Field Verification	BOEM will ensure that the distance to the PTS and behavioral thresholds for marine mammals, sea turtle injury and harassment thresholds, and Atlantic sturgeon injury and harassment thresholds are no larger than those modeled assuming 10 dB re 1 μPa noise attenuation are met by conducting field verification during pile driving. At least 180 calendar days before beginning the first pile driving activities for the Project, the Lessee must prepare, submit, and implement a Sound Field Verification Plan (SFVP) for each project phase for review and comment to USACE, BOEM (at renewable_reporting@boem.gov), and NMFS (at nmfs.gar.incidental-take@noaa.gov). DOI will review the SFVP and provide any comments on the plan within 45 calendar days of its submittal. SouthCoast Wind must resubmit a modified plan that addresses the identified issues at least 15 days before the start of the associated activity; at that time, BOEM, BSEE and NMFS will discuss a timeline for review of the modified plan to meet the Lessee's schedule to the maximum extent practicable. SouthCoast Wind must obtain BOEM's and BSEE's concurrence with this Plan prior to the start of pile driving activities. The plan(s) must describe how the first three piled installation sites and installation scenarios (i.e., hammer energy and number of strikes) are representative of the rest of the piled installations and, therefore, why these piled installations would be representative of the remaining piled installations. If the monitored pile locations are different from the ones used for exposure modeling, SouthCoast Wind will provide a justification for why these locations are representative of the modeling. In the case that these sites are not determined to be representative of all other pile installation sites, SouthCoast Wind must include information on how additional piles/sites will be selected for sound field verification (SFV). The plan must also include methodology for collecting, analyzing, and preparing SFV data for submission to NMFS GARFO. SouthCoast Wind's plan must describe how the effectiveness of the sound attenuation methodology will be evaluated based on the results. To validate the estimated sound field, SFV measurements will be conducted during pile driving on at least the first three piled foundations installed with noise attenuation activated. SouthCoast Wind must also provide, as soon as they are available, but no later than 48 hours after each installation, the initial results of each SFV measurement to BOEM, BSEE, and NMFS GARFO in an interim report after each piled foundation is installed. If any interim SFV report submitted for any of the first 3 piled foundations indicates the sound fields exceed the modeled distances to any protected species injury or behavioral harassment/disturbance thresholds (as modeled assuming 10 decibel attenuation), SouthCoast Wind must: a) identify additional noise attenuation measures that are expected to reduce sound levels to the modeled distances (e.g., add noise attenuation device, adjust hammer operations, adjust noise mitigation system [NMS]); and provide an explanation supporting how these measures will be effective; b) that determination; and, following NMFS GARFO's concurrence, deploy those additional measures on any subsequent piles that are installed (e.g., if threshold distances are exceeded on pile 1 then additional measures must be deployed before installing pile 2). Following BOEM approval, the approved adaptations must be deployed before installing the next pile; b) If any of the SFV measurements indicate that the distances to level A thresholds for ESA listed whales or PTS peak or cumulative thresholds for sea turtles are greater than the modeled distances (assuming 10 dB attenuation), the clearance and shutdown zones for subsequent piles must be increased so that they are at least the size of the distances to those thresholds as indicated by SFV. For every 1,500 meters that a marine mammal clearance or shutdown zone is expanded, additional PSOs must be deployed from additional platforms to ensure adequate and complete monitoring of the expanded shutdown and/or clearance zone; c) Following installation of the pile with additional noise attenuation measures required, if SFV results indicate that all isopleths of concern are within distances to isopleths of concern modeled assuming 10 dB attenuation, SFV must be conducted on two additional piles (for a total of at least three piles with consistent noise attenuation measures). If the SFV results from all three of those piles are within the distances to isopleths of concern modeled assuming 10 dB attenuation, then SouthCoast Wind must continue to implement the additional sound attenuation measures and may revert to the original clearance and shutdown zones or continue with the adaptive measures to expand clearance and shutdown zones. SouthCoast Wind must submit a Noise Attenuation System (NAS) inspection/performance report to BOEM and BSEE within 72 hours of the performance test, which must occur prior to the first pile installation as well as any additional piles for which SFV is conducted. This report must be submitted as soon as it is available, but no later than when the interim SFV report is submitted for the respective pile.	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.

No	Measure	Description	Project Phase	Expected Effects
BA-1	LOA Requirements	The measures required by the final MMPA LOA for Incidental Take Regulations would be incorporated into COP approval.	C	Incorporates all LOA requirements into COP approval.
BA-2	Geophysical Surveys and ESA Species	SouthCoast Wind must comply with all the Project Design Criteria and Best Management Practices for Protected Species from the documents "Project Design Criteria and Best Management Practices for Protected Species Associated with Offshore Wind Data Collection" and "Offshore Wind Site Assessment and Site Characterization Activities Programmatic Consultation" that implement the integrated requirements for threatened and endangered species in the June 29, 2021, programmatic consultation under the ESA (revised November 22, 2021), as well as the June 29, 2021, NMFS Letter of Concurrence (LoC).	C, O&M, D	Ensures consistency with design criteria and best management practices of programmatic ESA consultation
BA-3	Fisheries and Benthic Habitat Monitoring Surveys	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 (renewable_reporting@boem.gov) that includes results and analyses as described in the monitoring plans. The Lessee must share data in accordance with their data sharing plan.	Pre-C, C, O&M	Measure the impact of offshore wind development on marine resources
BA-4	Protected Species Detection and Vessel Strike Avoidance: Vessel Crew and Visual Observer Training Requirements	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 training course log sheet, and the Lessee must provide the log sheets to DOI upon request. The Lessee must communicate to all crew members its expectation for them to report sightings of sea turtles and marine mammals to the designated vessel contacts. The Lessee must communicate the process for reporting sea turtles and marine mammals (including live, entangled, and dead individuals) to the designated vessel contact and all crew members. The Lessee must post the reporting instructions including communication channels in highly visible locations aboard all Project vessels.	C, O&M, D	Increase effectiveness of mitigations to avoid or minimize impacts on marine mammals and sea turtles from vessel encounters
BA-5	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 SouthCoast 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 SouthCoast 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 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.	C, O&M, D	Increase effectiveness of mitigations to avoid or minimize impacts on marine mammals and sea turtles from vessel encounters

No	Measure	Description	Project Phase	Expected Effects
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 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 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.	C, O&M, D	Increase effectiveness of mitigations to avoid or minimize impacts on marine mammals and sea turtles from vessel encounters
BA-8	Vessel Strike Avoidance of Large Cetaceans	All vessel operators must check for information regarding mandatory or voluntary ship strike avoidance and daily information regarding NARW sighting locations. These media may include, but are not limited to: NOAA weather radio, U.S. Coast Guard NAVTEX and Channel 16 broadcasts, Notices to Mariners, the Whale Alert app, or WhaleMap website. Information about active SMAs and Slow Zones can be accessed at: https://www.fisheries.noaa.gov/national/endangered-species-conservation/reducing-vessel-strikes-north-atlantic-right-whales If an ESA-listed whale or large unidentified whale is identified within 1, 640 feet (500 meters) of the forward path of any vessel (90 degrees port to 90 degrees starboard), the vessel operator must immediately implement strike avoidance measures and steer a course away from the whale at 10 knots (18.5 kilometers per hour) or less until the vessel reaches a 1,640-feet (500 meter) separation distance from the whale. Trained lookouts, visual observers, vessel crew, or PSOs must notify the vessel captain of any whale observed or detected within 1,640 feet (500 meters) of the survey vessel. Upon notification, the vessel captain must immediately implement vessel strike avoidance procedures to maintain a separation distance of 1,640 feet (500 meters) or reduce vessel speed to allow the animal to travel away from the vessel. If a whale is observed but cannot be confirmed as a species other than a NARW, the vessel operator must assume that it is a NARW and execute the required vessel strike avoidance measures to avoid the animal. If an ESA-listed large whale is sighted within 656 feet (200 meters) of the forward path of a vessel, the vessel operator must initiate a full stop by reducing speed and shift the engine to neutral. Engines must not be engaged until the whale has moved outside of the vessel's path and beyond 1,640 feet (500 meters). If stationary, the vessel must not engage engines until the ESA-listed large whale has moved beyond 1,640 feet (500 meters).	C, O&M, D	Increase effectiveness of mitigations to avoid or minimize impacts on marine mammals and sea turtles from vessel encounters
BA-9	Vessel Strike Avoidance of	If pinnipeds or small delphinids of the genera Delphinus, Lagenorhynchus, Stenella, or Tursiops are visually detected approaching the vessel (i.e., to bow ride) or towed equipment, vessel speed reduction, course alteration, and shutdown are not required.	C, O&M, D	Increase effectiveness of mitigations to avoid or minimize impacts on marine mammals from vessel encounters

No	Measure	Description	Project Phase	Expected Effects
	Small Cetaceans and Seals	For small cetaceans and seals, all vessels must maintain a minimum separation distance of 164 feet (50 meters) to the maximum extent practicable, except when those animals voluntarily approach the vessel. When marine mammals are sighted while a vessel is underway, the vessel operator must endeavor to avoid violating the 164-foot (50-meter) separation distance by attempting to remain parallel to the animal's course and avoiding excessive speed or abrupt changes in vessel direction until the animal has left the area, except when taking such measures would threaten the safety of the vessel or crew. If marine mammals are sighted within the 164-foot separation distance, the vessel operator must reduce vessel speed and shift the engine to neutral, not engaging the engines until animals are beyond 164 feet (50 meters) from the vessel.		
BA-10	Vessel Strike Avoidance of Sea Turtles	The Lessee must slow down to 4 knots if a sea turtle is sighted within 328 feet (100 meters) of the operating vessel's forward path. The vessel operator must then proceed away from the turtle at a speed of 4 knots or less until there is a separation distance of at least 328 feet (100 meters) at which time the vessel may resume normal operations. If a sea turtle is sighted within 164 feet (50 meters) of the forward path of the operating vessel, the vessel operator must shift to neutral when safe to do so and then proceed away from the individual at a speed of 4 knots or less until there is a separation distance of at least 328 feet (100 meters), at which time normal vessel operations may be resumed. Between June 1 and November 30, all vessels must avoid transiting through areas of visible jellyfish aggregations or floating vegetation (e.g., *Sargassum* lines or mats). In the event that operational safety prevents avoidance of such areas, vessels must slow to 4 knots while transiting through such areas. All vessel crew members must be briefed on the identification of sea turtles and on regulations and best practices for avoiding vessel collisions. Reference materials must be available aboard all project vessels for identification of sea turtles. The expectation and process for reporting of sea turtles (including live, entangled, and dead individuals) must be clearly communicated and posted in highly visible locations aboard all project vessels, so that there is an expectation for reporting to the designated vessel contact (such as the lookout or the vessel captain), as well as a communication channel and process for crew members to so report.	C, O&M, D	Increase effectiveness of mitigations to avoid or minimize impacts on sea turtles from vessel encounters
BA-11	Reporting of All NARW Sightings	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 sent 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.	Pre-C, C, O&M, D	Enhanced measures to protect NARW
BA-12	Detected or Impacted Protected Species Reporting	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 any 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 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. At the end of each survey season, a report would be sent to NMFS that compiles all information on any observations and interactions with ESA-listed species. This report would also contain information on all survey activities that took place during the season including location of gear set, duration of soak/trawl, and total effort. The report on survey activities would be comprehensive of all activities, regardless of whether ESA-listed species were observed.	Pre-C, C, O&M, D	Reporting to inform on the condition of ESA-listed species to provide critical information for endangered species to regulators

No	Measure	Description	Project Phase	Expected Effects
BA-13	Detected or Impacted Dead Non-ESA-Listed Fish	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.	Pre-C, C, O&M, D	Reporting to inform on unusual mortality events for fish species to measure potentially unforeseen impacts
BA-14	Wind Turbine Foundations Pile Driving/Impact Hammer Activity: Pile-Driving Time-of-Year Restriction	The Lessee must not conduct any foundation pile-driving activities between December 1 and April 30. Pile driving must not occur in December unless unanticipated delays due to weather or technical problems arise that necessitate extending pile driving through December, and the pile driving is allowed by BOEM in accordance with the following procedures. 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 1 through December 31 to minimize the risk of exposure of NARWs to pile-driving noise, including noise from daily pre-construction geophysical surveys. BOEM will review the enhanced survey plan and provide comments, if any, on the plan within 30 calendar days of its submittal. 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.	C	Increase effectiveness of mitigations to avoid or minimize impacts on ESA-listed species from underwater noise
BA-15	Wind Turbine Foundations Pile Driving/Impact Hammer Activity: Pile-Driving Weather, Nighttime, and Visibility Restrictions	The Lessee must not conduct pile driving operations at any time when lighting or weather conditions (e.g., darkness, rain, fog, sea state) prevent visual monitoring of the full extent of the clearance and shutdown zones. In order to conduct nighttime pile driving, SouthCoast Wind would submit a Nighttime Pile Driving Plan (NPDP) as part of the Alternative Monitoring Plan (AMP) to BOEM and NMFS for approval. The NPDP will describe the methods, technologies, monitoring zones, and mitigation requirements for any nighttime pile driving activities. In the absence of an approved NPDP, all pile driving would be initiated during daytime and nighttime pile driving could only occur if unforeseen circumstances prevent the completion of pile driving during daylight hours and was deemed necessary to continue piling during the night to protect asset integrity or safety. The AMP, including the NPDP if nighttime pile driving is planned, must be submitted by the Lessee to BOEM and NMFS for review and approval 180 calendar days, but no later than 120 days, prior to the planned start of pile-driving. The full AMP may include deploying additional observers, alternative monitoring technologies such as night vision, thermal, and infrared technologies, and use of PAM and must demonstrate the ability and effectiveness to maintain clearance all pre-clearance and shutdown zones during daytime as outlined below in Part 1 and nighttime as outlined below in Part 2 to BOEM's and NMFS's satisfaction. The AMP must include two stand-alone components as described below: • Part 1 – Daytime when lighting or weather (e.g., fog, rain, sea state) conditions prevent visual monitoring of the full extent of the clearance and shutdown zones. Daytime being defined as one hour after civil sunrise to 1.5 hours before civil sunset. • Part 2 – Nighttime inclusive of weather conditions (e.g., fog, rain, sea state). Nighttime being defined as 1.5 hours before civil sunset to one hour after civil sunrise. The AMP should include, but is not limited to the following information: • Identification of night vision devices (e.g., mounted thermal/IR camera systems, hand-held or wearable NVDs, IR spotlights), if proposed for use to detect protected marine mammal and sea turtle species. • The AMP must demonstrate (through empirical evidence) the capability of the proposed monitoring methodology to detect marine mammals and sea turtles within the full extent of the established clearance and shutdown zones (i.e., species can be detected at the same distances and with similar confidence) with the same effectiveness as daytime visual monitoring (i.e., same detection probability). Only devices and methods demonstrated as being capable of detecting marine mammals and sea turtles to the maximum extent of the clearance and shutdown zones will be acceptable. • Evidence and discussion of the efficacy (range and accuracy) of each device proposed for low visibility monitoring must include an assessment of the results of field studies (e.g., Thayer Mahan demonstration), as well as supporting documentation regarding the efficacy of all proposed alternative monitoring methods (e.g., best scientific data available).	C	Increase effectiveness of mitigations to avoid or minimize impacts on ESA-listed species from underwater noise

No	Measure	Description	Project Phase	Expected Effects
		• Procedures and timeframes for notifying NMFS and BOEM of SouthCoast Wind's intent to pursue nighttime pile driving. • Reporting procedures, contacts and timeframes. BOEM may request additional information, when appropriate, to assess the efficacy of the AMP.		
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
BA-17	Wind Turbine Foundations Pile Driving/Impact Hammer Activity: Pile-Driving Monitoring Plan Requirements	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 180 calendar days, but no later than 120 days, before beginning the first pile-driving activities for the Project. 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;	C	Increase effectiveness of mitigations to avoid or minimize impacts on marine mammals and sea turtles from underwater noise

No	Measure	Description	Project Phase	Expected Effects
		• 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.		
BA-18	Wind Turbine Foundations Pile Driving/Impact Hammer Activity: Soft Start for Pile Driving	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 Pile Driving/Impact Hammer Activity: Pile-Driving Sound Field Verification Plan	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. The Lessee must submit a Sound Field Verification Plan (SFVP) for review and comment to the USACE, BOEM (at renewable_reporting@boem.gov), and NMFS (at nmfs.gar.incidental-take@noaa.gov) 180 calendar days, but no later than 120 days, before beginning the first pile-driving activities for the Project. 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 with NMFS, to consider reducing zone distances. The Lessee must ensure that locations identified in the SFVP for each pile type are representative of other piles of that type to be installed and that the results are representative for predicting actual installation noise propagation for subsequent piles. The SFVP must describe how the effectiveness of the sound attenuation methodology will be evaluated. The SFVP must be sufficient to document impacts in Level B harassment zones for marine mammals and injury and behavioral disturbance zones for sea turtles and Atlantic sturgeon.	C	Increase effectiveness of mitigations to avoid or minimize impacts on ESA-listed species from underwater noise
BA-20	Wind Turbine Foundations Pile Driving/Impact Hammer Activity: Adaptive Refinement of Clearance Zones, Shutdown Zones, and Monitoring Protocols	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 4,921 feet (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 sei, 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.	C	Increase effectiveness of mitigations to avoid or minimize impacts on marine mammals and sea turtles from underwater noise
BA-21	Wind Turbine Foundations Pile Driving/Impact Hammer Activity: Pile-Driving	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-	C	Increase effectiveness of mitigations to avoid or minimize impacts on sea turtles from underwater noise

No	Measure	Description	Project Phase	Expected Effects
	Clearance Zones (No-go Zones) for Sea Turtles	driving activity. Adherence to the 1,640-foot (500-meter) clearance and shutdown zones must be confirmed in the PSO reports.		
BA-22	Wind Turbine Foundations Pile Driving/Impact Hammer Activity: Impact Pile-Driving Clearance Zones (No-go Zones) for Marine Mammals	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: The Lessee must establish a clearance zone of 1.37 miles (2.2 kilometers) for large whales other than NARW using visual monitoring for impact pile driving. The Lessee must also establish a PAM clearance zone of 3.1 miles (5 kilometers) and a PAM shutdown zone of 1.23 miles (2 kilometers) for NARWs. 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 detection for mitigation purposes.	C	Increase effectiveness of mitigations to avoid or minimize impacts on marine mammals from underwater noise
BA-23	Wind Turbine Foundations Pile Driving/Impact Hammer Activity: Vibratory Pile-Driving Clearance Zones (No-go Zones) for ESA-listed Species and Marine Mammals	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. For all ESA-listed Mysticete whales and sperm whales, a clearance zone of 4,921 feet (1,500 meters) is to be established. For sea turtles, a clearance zone of 1,640 feet (500 meters) is to be established. 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. 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. Vibratory pile driving may begin only if all clearance zones are fully visible (e.g., not obscured by darkness, rain, fog, or snow) for at least 30 minutes as determined by the lead PSO. If conditions such as darkness, rain, fog, or snow prevent the visual detection of marine mammals in the clearance zones, construction activities must not begin until the full extent of all clearance zones are fully visible as determined by the lead PSO.	C	Increase effectiveness of mitigations to avoid or minimize impacts on ESA-listed species from underwater noise
BA-24	Wind Turbine Foundations Pile Driving/Impact Hammer Activity: Noise Mitigation for Impact Pile Driving	The Lessee must apply noise reduction technologies during all impact pile driving to minimize marine species noise exposure. The range measured to the Level B harassment threshold when noise mitigation devices are in use must be consistent with or less than the range modeled assuming 10 dB attenuation, determined via sound field verification of the modeled isopleth distances (e.g., Level B harassment distances). If a bubble curtain is used, the following requirements apply: • Bubble curtains must distribute air bubbles around 100 percent of the piling perimeter for the full depth of the water column. • The lowest bubble ring must be in contact with the seafloor for the full circumference of the ring, and the weights attached to the bottom ring must ensure 100 percent seafloor contact. • No parts of the ring or other objects may prevent full seafloor contact of the lowest bubble ring. The Lessee must train personnel in the proper balancing of air flow to the bubblers. The Lessee must submit an inspection and performance report to DOI within 72 hours following the performance test. Any modifications	C	Increase effectiveness of mitigations to avoid or minimize impacts on ESA-listed species from underwater noise

No	Measure	Description	Project Phase	Expected Effects
		to attenuation devices to meet the performance standards must occur before impact driving occurs and maintenance or modifications completed must be included in the report. The Lessee must ensure PSOs follow all pile driving reporting instructions and requirements.		
BA-25	Wind Turbine Foundations Pile Driving/Impact Hammer Activity: Pile-Driving Noise Reporting and Clearance or Shutdown Zone Adjustment	The Lessee must measure pile-driving noise in the field for at least three monopile foundations and submit initial results to NMFS, USACE, and BOEM (at renewable_reporting@boem.gov) as soon as they are available. BOEM will discuss the results as soon as feasible. The Lessee may request modification of the clearance and shutdown zones based on these results but must meet or exceed minimum distances for threatened and endangered species specified in the Biological Opinion (e.g., 3,280 feet [1,000 meters] for large whales and 1,640 feet [500 meters] for sea turtles). If the field measurements indicate that the isopleths for noise exposure are larger than those considered in the approved COP, the Lessee must coordinate with BOEM, BSEE, NMFS, and USACE to implement additional sound attenuation measures or larger clearance or shutdown zones before driving any additional piles. NMFS does not anticipate considering any reductions in the clearance or shutdown zones for NARWs.	C	Increase effectiveness of mitigations to avoid or minimize impacts on ESA-listed species from underwater noise
BA-26	Wind Turbine Foundations Pile Driving/Impact Hammer Activity: Pile-Driving Work Within a Slow Zone	If a visually triggered NARW Slow Zone overlaps with the NARW Shutdown Zone, the PAM system detection must extend to the largest practicable detection zone. PSOs must treat any PAM detection of NARWs in the clearance and shutdown zones the same as a visual detection and call for the required delays or shutdowns in pile installation.	C	Increase effectiveness of mitigations to avoid or minimize impacts on NARW from underwater noise
BA-27	Wind Turbine Foundations Pile Driving/Impact Hammer Activity: Submittal of Raw Field Data Collected for Marine Mammals and Sea Turtles in the Pile-Driving Shutdown Zone	Within 24 hours of detection, the Lessee must report to BOEM (at renewable_reporting@boem.gov) and BSEE (at protectedspecies@bsee.gov) the sighting of any marine mammal or sea turtle in the shutdown zone that results in a shutdown or a power-down. In addition, PSOs must submit the raw data collected in the field and daily report forms including the date, time, species, pile identification number, GPS coordinates, time and distance of the animal when sighted, time the shutdown or power-down occurred, behavior of the animal, direction of travel, time the animal left the shutdown zone, time the pile driver was restarted or powered back up, and any photographs.	C	Record the effectiveness of mitigations to avoid or minimize impacts on ESA-listed species from underwater noise
BA-28	Wind Turbine Foundations Pile Driving/Impact Hammer Activity: Weekly and Final Pile-Driving Reports	The Lessee must submit weekly PSO and PAM monitoring reports to DOI and NMFS during pile-driving. Weekly reports must document the daily start and stop times of all pile-driving, the daily start and stop times of associated observation periods by the PSOs, details on the deployment of PSOs, and all detections of marine mammals and sea turtles. The weekly reports must be submitted to BOEM (at renewable_reporting@boem.gov), BSEE (at OSWsubmittals@bsee.gov) and NMFS Greater Atlantic Regional Fisheries Office, Protected Resources Division (at nmfs.gar.incidental- take@noaa.gov) every Wednesday during construction for the previous week (Sunday through Saturday) of monitoring of pile-driving activity. Weekly monitoring reports must include: • Summaries of pile-driving activities and piles installed including, start and stop times, pile locations, and PSO coverage; • Vessel operations (including port departures, number of vessels, type of vessel(s), and route); • All protected species sightings; • Vessel strike-avoidance measures taken; and any equipment shutdowns or takes that may have occurred. Weekly reports can consist of raw data. Required data and reports provided to DOI may be archived, analyzed, published, and disseminated by BOEM. PSO data must be reported weekly (Sunday through Saturday) from the start of visual and/or PAM efforts during pile-driving activities, and every week thereafter until the final reporting period upon conclusion of pile-driving activity. Any editing, review, and quality assurance checks must be completed only by the PSO provider prior to submission to NMFS and DOI. The Lessee must submit to DOI at renewable_reporting@boem.gov and OSWsubmittals@bsee.gov a final summary report of PSO monitoring 90 days following the completion of pile driving.	C	Record the effectiveness of mitigations to avoid or minimize impacts on ESA-listed species from underwater noise
BA-29	Marine Debris Awareness and Elimination:	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	Pre-C, C, O&M, D	Increase the effectiveness of mitigations to avoid or minimize impacts on ESA-listed species from marine debris

No	Measure	Description	Project Phase	Expected Effects
	Marine Debris Awareness Training	(2) receiving an explanation from management personnel that emphasizes their commitment to the requirements. The marine trash and debris training videos, training slide packs, and other marine debris related educational material may be obtained at https://www.bsee.gov/debris or by contacting BSEE. The training videos, slides, and related material may be downloaded directly from the website. Operators engaged in marine survey activities must continue to develop and use a marine trash and debris awareness training and certification process that reasonably assures that their employees and contractors are in fact trained. The training process would include the following elements: • Viewing of either a video or slide show by the personnel specified above; • An explanation from management personnel that emphasizes their commitment to the requirements; • Attendance measures (initial and annual); and • Recordkeeping and the availability of records for inspection by DOI. By January 31 of each year, the Lessee would submit to DOI an annual report that describes its marine trash and debris awareness training process and certifies that the training process has been followed for the previous calendar year. The Lessee would send the reports via email to BOEM (at renewable_reporting@boem.gov) and to BSEE (at OSWsubmittals@bsee.gov).		
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 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 include and address information on unrecovered 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 marine debris
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 SouthCoast 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 renewable_reporting@boem.gov) and BSEE (at OSWsubmittals@bsee.gov) in an annual report, submitted by April 30 for the preceding calendar year. Reports must be submitted in Word format. Photographic and videographic materials will be provided on a drive in a lossless format such as TIFF or Motion JPEG 2000. Reports must include daily survey reports that include the survey date, contact information of the operator, location, and pile identification number, photographic and/or video documentation of the survey and debris encountered, any animals sighted, and the disposition of any located debris (i.e., removed or left in place). Required data and reports may be archived, analyzed, published, and disseminated by BOEM. BMPs will be coordinated with NOAA's marine debris program.	O&M, D	Record the effectiveness of mitigations to avoid or minimize impacts on ESA-listed species from marine debris, particularly ghost gear
BA-32	Establishment of Shutdown Zones for Vibratory Pile Driving	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, PSOs 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 the 500-meter shutdown zones must trigger the required shutdown in pile installation. Upon a visual detection of a sea turtles entering or within the shutdown zone during pile-driving, SouthCoast 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	C	Increase effectiveness of mitigations to avoid or minimize impacts on ESA-listed species from underwater noise

No	Measure	Description	Project Phase	Expected Effects
		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 SouthCoast 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.		
BA-33	Sea turtle Disentanglement	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 https://www.reginfo.gov/public/do/ DownloadDocument?objectID=102486501 and the procedures described in “Careful Release Protocols for Sea Turtle Release with Minimal Injury” (NOAA Technical Memorandum 580; https://repository.library.noaa.gov/view/noaa/3773).	C, O&M, D	Increase effectiveness of mitigations to avoid or minimize impacts on sea turtles from marine debris
BA-34	Sea Turtle/Atlantic Sturgeon Identification and Data Collection	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/2021-11/ 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. SouthCoast 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%20for%20S7_v1.1_Form%20to%20Use.xlsx?nullhttps://www.fisheries.noaa.gov/new-england-mid-atlantic/consultations/section-7-take-reporting-programmatics-greater-atlantic. D. All captured sea turtles and Atlantic sturgeon 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%2007162021.pdf?null) and submitted to NMFS as described in the take notification measure below.	C, O&M, D	Increase effectiveness of mitigations to avoid or minimize impacts on ESA-listed species by gathering biological data
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 begging any on-water activity (download at: https://media.fisheries.noaa.gov/dam-migration/sea_turtle_handling_and_resuscitation_measures.pdf).	C, O&M, D	Increase effectiveness of mitigations to avoid or minimize impacts on ESA listed species from unsafe handling

No	Measure	Description	Project Phase	Expected Effects
		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 handling the animal, 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.	C, O&M, D	Increase effectiveness of mitigations to avoid or minimize impacts on sea turtles from marine debris

AMP = alternative monitoring plan; BiOP = 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; GARFO = Greater Atlantic Regional Fisheries Office; 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; NAS = Noise Attenuation System; NAVTEX = NAVigational TeleX; NMFS = National Marine Fisheries Service; NMS = noise mitigation system; NOAA = National Oceanic and Atmospheric Administration; NPDP = Nighttime Pile Driving Plan; 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; PTS = permanent threshold shift; RWSAS = Right Whale Sighting Advisory System; SFV = sound field verification; 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

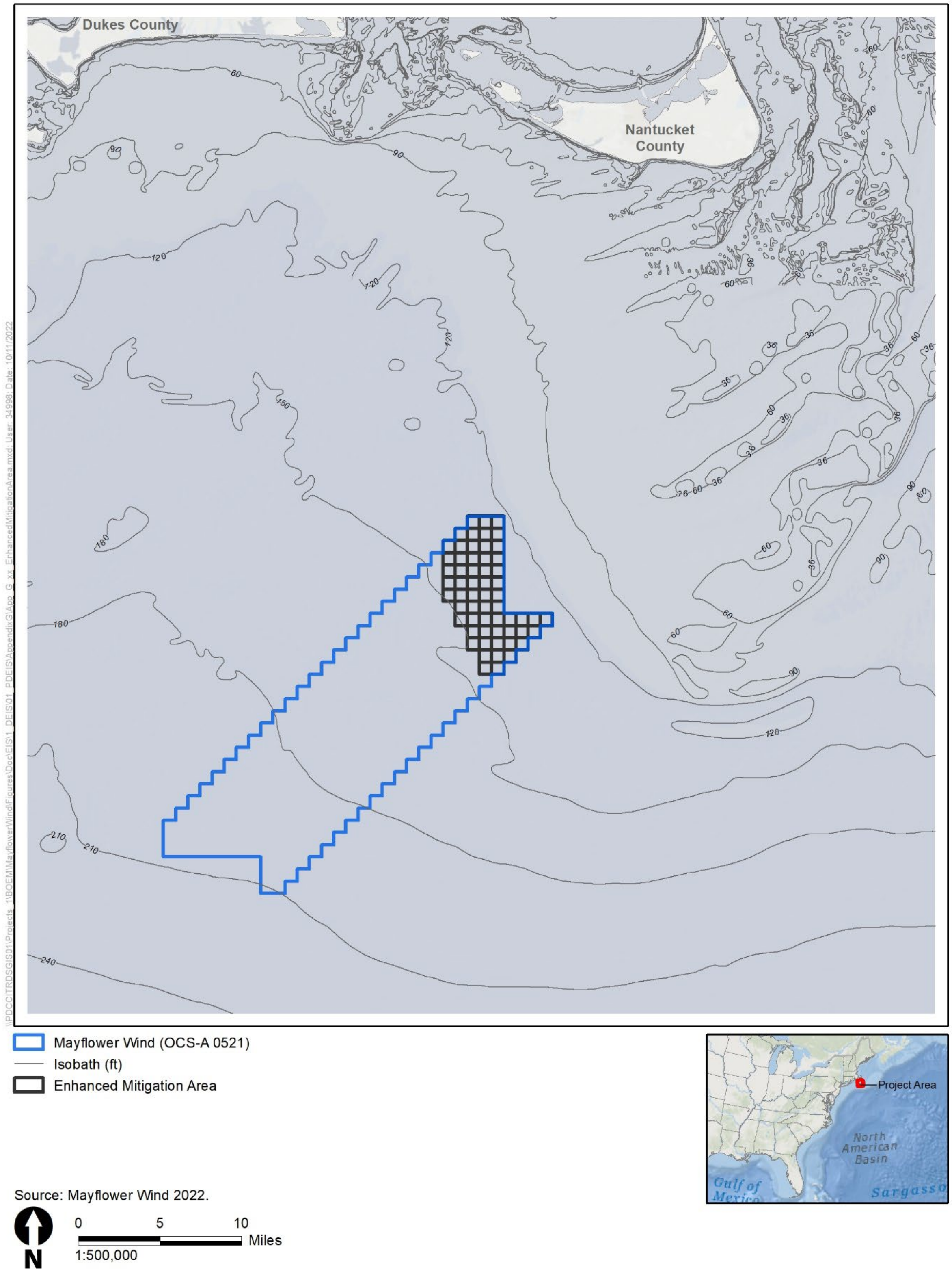


Figure 3.3-1. Enhanced mitigation area

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).

SouthCoast 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

SouthCoast 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 (COP Volume 2 and Appendix M, 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. Infaunal 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 (COP Volume 2 and Appendix K, 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 (COP Volume 2 and Appendix M, 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 (COP Volume 2 and Appendix M, 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 SouthCoast 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) (COP Volume 2 and Appendix E, 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 (COP Volume 2 and Appendix E3, Mayflower Wind 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 (COP Volume 2, Mayflower Wind 2022).

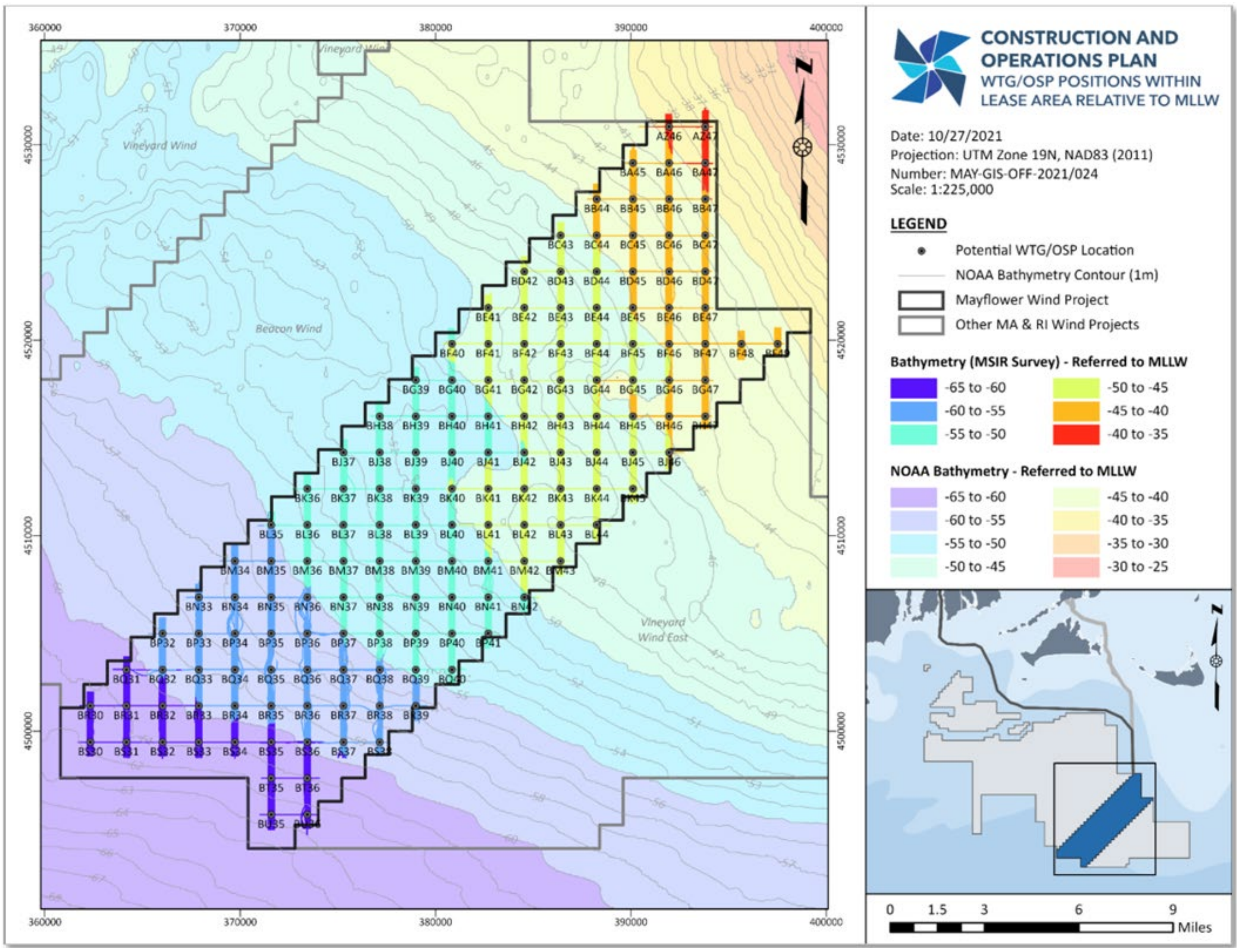


Figure 4.2-1. WTG/OSP positions in the Lease Area relative to MLLW

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 (CCS 2020).

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 (CCS 2020). 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 (Append H, 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 U.S. 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 shell fishing 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 (NBFSMN 2018). 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

The Lease Area is located in the continental shelf environment characterized by predominantly sandy seabed sediments. 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. Water depths in the Lease Area vary between 121 to 210 feet (37 to 64 meters). During the summer months (June-August), the average temperature of the upper 32.8 to 49.2 feet (10 to 15 meters) of the water column is higher, resulting in an increased surface layer sound speed. This creates a downward refracting environment in which propagating sound interacts with the seafloor more than in a well-mixed environment. Increased wind mixing combined with a decrease in solar energy in the fall and winter months (September-February) results in a sound speed profile that is more uniform with depth. The shoulder months between summer and winter vary between the two. The sound speed at the surface is, on average, 4,954 feet per second (1,510 meters per second). At a depth of 197 feet (60 meters), the average sound speed is 4,872 feet per second (1485 meters per second) (COP Appendix U2; Figure E-3).

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 SouthCoast Wind's COP (Mayflower Wind 2022). There are no permanent seabed installations, such as telecommunication 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 2021f; 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, SouthCoast Wind retained DNV Energy USA Inc. (DNV GL) to conduct an independent Navigation Safety Risk Assessment (NSRA) of the proposed SouthCoast 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 nautical miles (37 kilometers) 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.

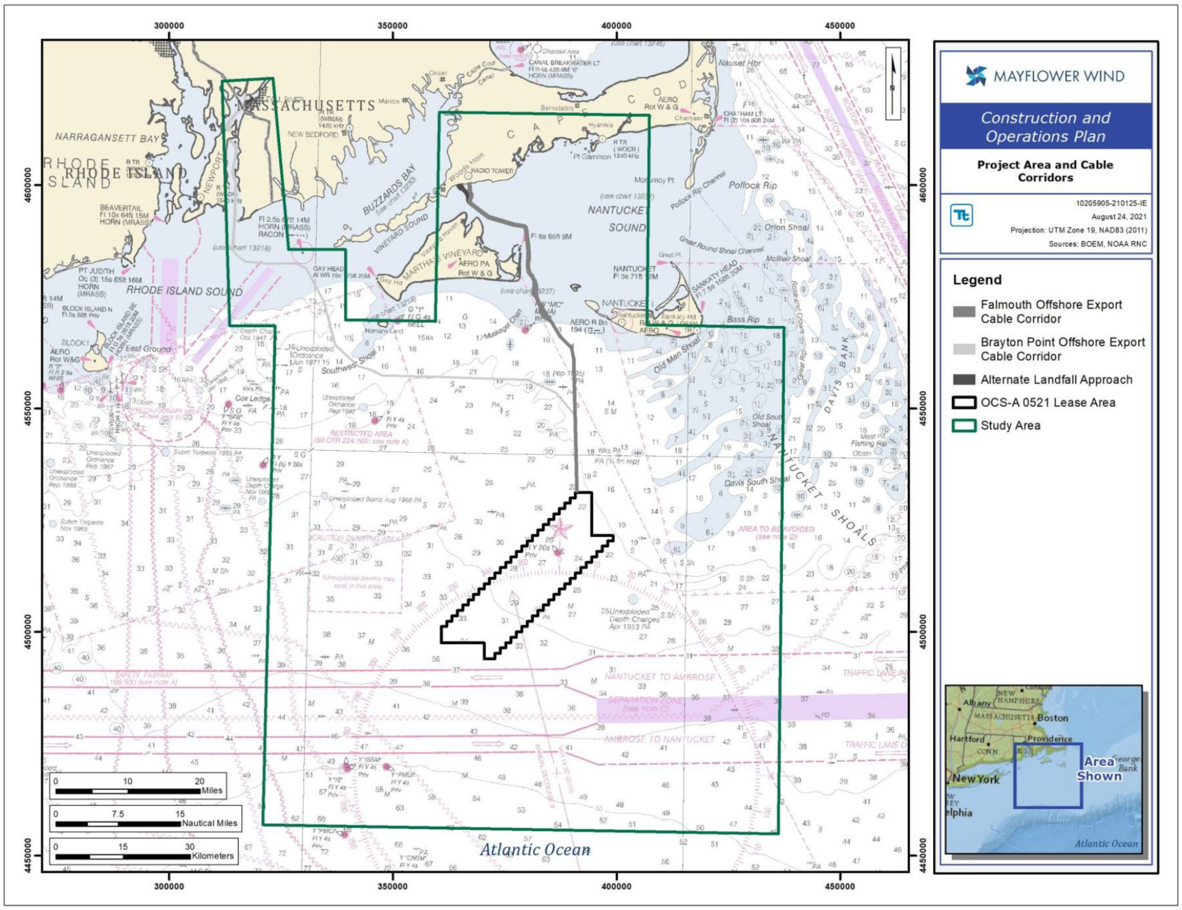


Figure 4.7-1. NSRA study area

Most cargo, carrier, and tanker vessel traffic near the study area use the Nantucket Ambrose Fairway and Narragansett Bay traffic separation schemes, 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 traffic separation scheme. 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.

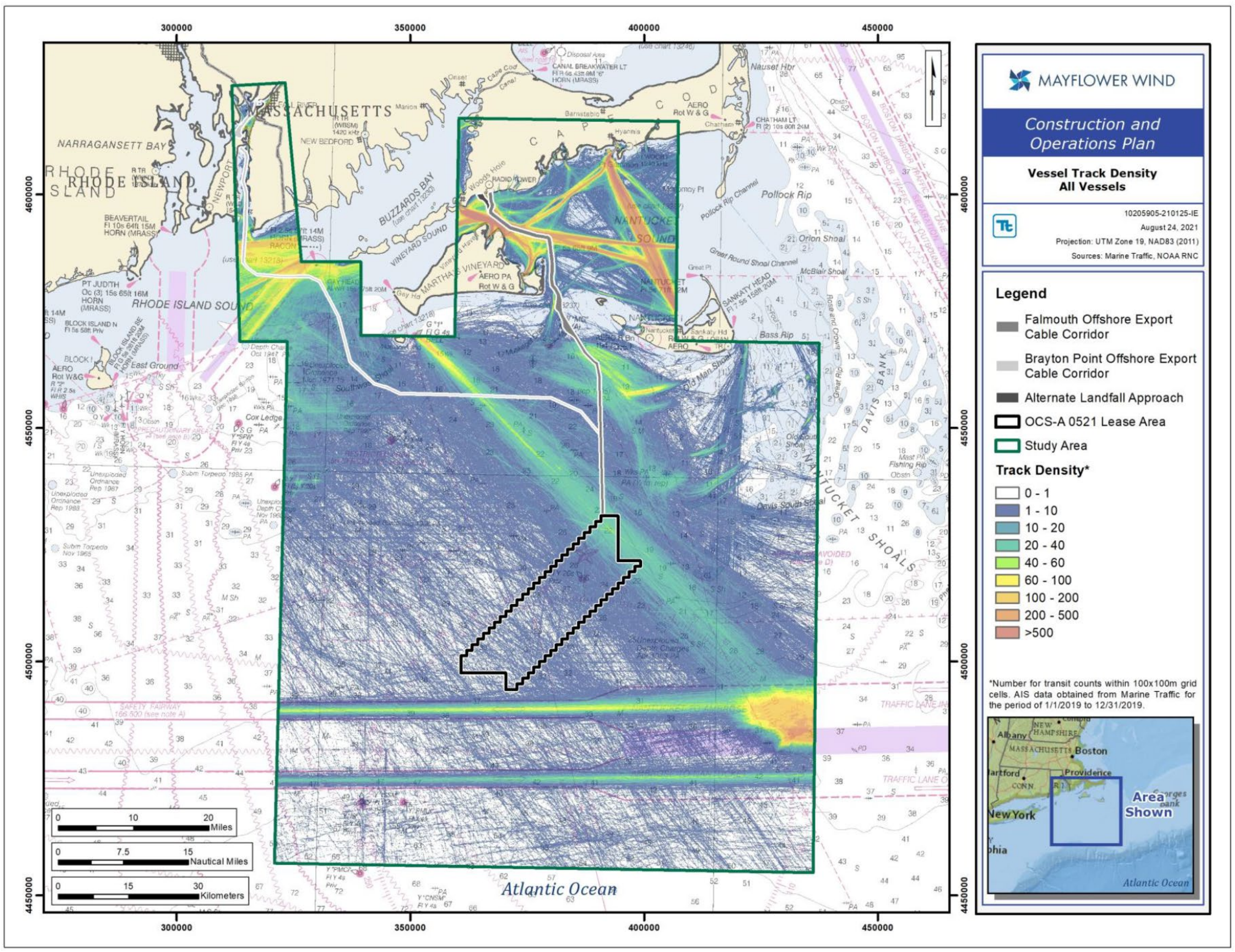


Figure 4.7-2. AIS traffic density in the NRSA study area (January to December 2019)

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)

Vessel Type	Draft	Average Speed	Average DWT	Average Beam (meters)	Average LOA (meters)	Vessel Tracks	Percent of Total
Cargo	Deep	13.7	59,862	35	251	163	1%
Fishing[1]	Shallow	4.7	N/A	7	25	11,303	38%
Passenger	Shallow	15.0	731	14	64	2,803	9%
Pleasure Craft/ Sailing[2]	Shallow	10.4	167	5	18	11,251	38%
Tanker	Shallow	11.8	36,919	28	172	180	1%
Tug/Tow	Shallow	4.9	522	6	19	1,708	6%
Other/Not Available[2]	Shallow	4.1	495	11	46	2,326	8%
Total						**29,734**	**100%**

Source: Office for Coastal Management 2022.
DWT = dead weight tonnage; LOA = length overall
[1] 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.
[2] 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. However, designated critical habitats are found within the larger Action Area that includes potential vessel routes to and from ports along the East Coast, in the Gulf of Mexico, and in Canada. Critical habitats for the Chesapeake Bay, Carolina, and New York Bight distinct population segments (DPSs) of Atlantic sturgeon, the North Atlantic right whale (NARW, *Eubalaena glacialis*), and the Northwest Atlantic Ocean DPS of loggerhead sea turtle (*Caretta caretta*) occur in the Action Area.

These critical habitats have the potential to be affected only by interactions with vessels outside of the offshore wind farm, offshore export cable system, and supporting ports for the proposed Project. Primarily, these interactions may be associated with transits of vessels and the transport of components during construction of the Project. As described in Sections 4.8.1 through 4.8.3, vessel traffic is not expected to affect any physical and biological features (PBFs) of critical habitat designated in the Action Area and is, therefore, **not likely to adversely affect** designated critical habitat for these species. Based on the rationale provided in the following sections, the critical habitats outlined below are discounted from further analysis in this BA.

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) and a calving area off the southeastern coast of the U.S. (Unit 2) (Figure 4.8-1). The Project area does not directly overlap designated NARW critical habitat, but both Unit 1 and Unit 2 regions fall within the larger Action Area. In addition, the Project is adjacent to and slightly overlaps the Nantucket Shoals. Nantucket Shoals is not designated as critical habitat for any ESA species but it is still 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). It is also important to note that climate change has affected the abundance and distribution of the NARW's primary prey species (Record et al. 2019). Recent analyses (O'Brien et al. 2022a) indicate that NARW habitat use has recently increased in Southern New England as a result of either changes in prey distribution within Southern New England, or a decline in prey in other areas abandoned by NARW. This climate-driven repatriation of feeding habitats could potentially extend the NARW's habitat-use patterns beyond Nantucket Shoals and into Southern New England WEAs.

The northeast NARW critical habitat area (Unit 1) is located to the north and west of the Project area and is included in the Action 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 PBFs of foraging habitat (Unit 1) that contribute to these high-density copepod areas, which 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 *C. finmarchicus* for right whale foraging, namely prevailing currents and circulation patterns, bathymetric features (basins, banks, and channels), oceanic fronts, density gradients, and temperature regimes;
- Low flow velocities in Jordan, Wilkinson, and Georges Basins that allow diapausing *C. finmarchicus* to aggregate passively below the convective layer so that the copepods are retained in the basins;
- Late stage *C. finmarchicus* in dense aggregations in the Gulf of Maine and Georges Bank region; and
- Diapausing *C. finmarchicus* in aggregations in the Gulf of Maine and Georges Bank region.

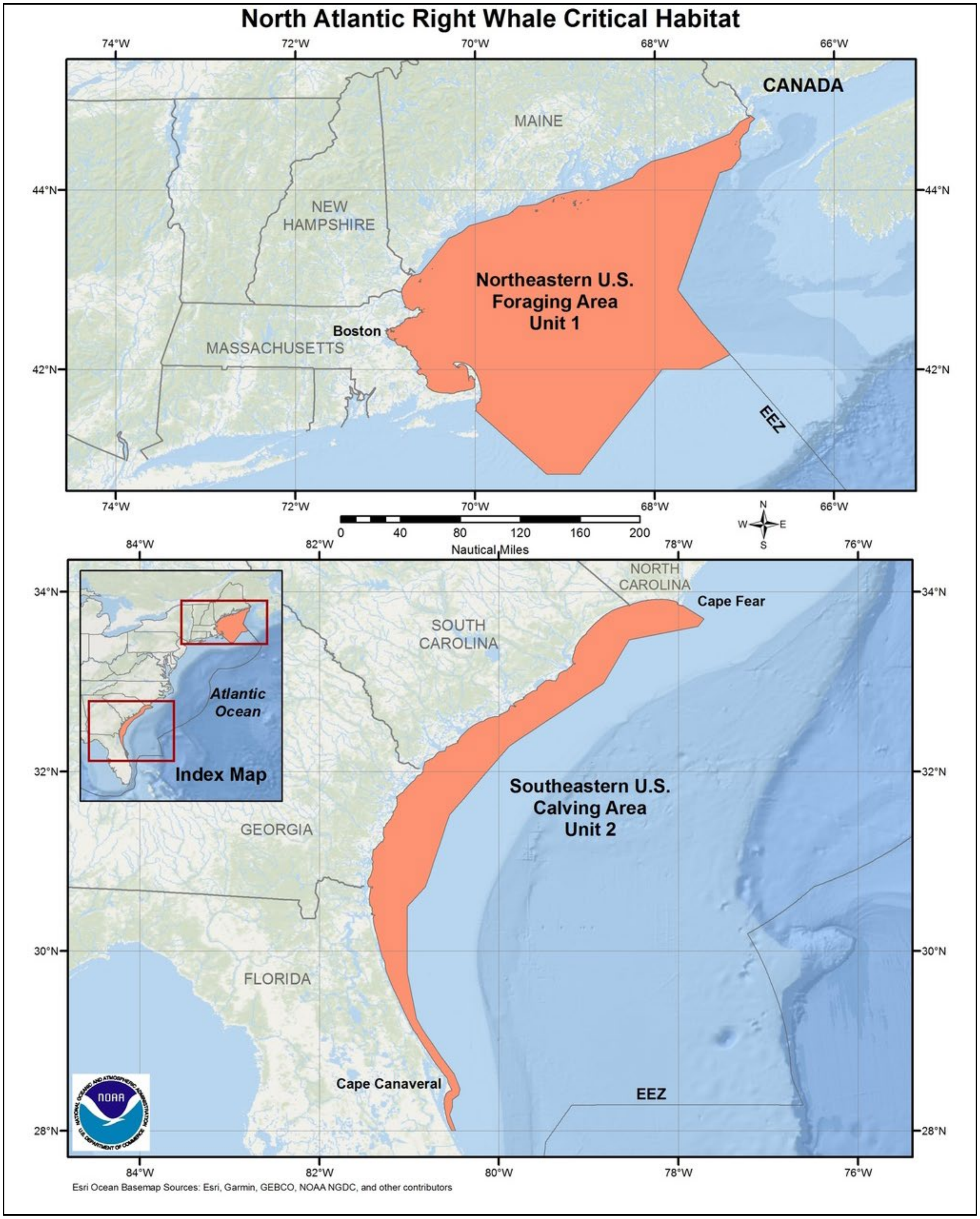
The physical oceanographic conditions, late stage *C. finmarchicus* aggregations, and aggregations of diapausing *C. finmarchicus* that have been identified as essential features are dynamically distributed throughout this specific area. The specific area includes the large embayments of Cape Cod Bay 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).

The southeast NARW critical habitat area (Unit 2) is located offshore of the southern U.S. The portion of the Action Area that includes potential vessel routes to and from South Carolina and ports in the Gulf of Mexico may overlap Unit 2, which includes waters off the coasts of North Carolina, South Carolina, Georgia, and the Atlantic coast of Florida.

The PBFs of calving habitat essential to conservation of the species include:

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

Vessel traffic through either the Unit 1 or Unit 2 portions of the Action Area would not affect any of their essential PBFs. Occasional vessel traffic will have no effect on the established oceanographic conditions in Unit 1 that concentrate copepod prey for foraging or on the sea state conditions in Unit 2 that provide appropriate calving habitat, nor on NARW selection of these areas for foraging or calving. As a precaution, and required by federal regulations, all vessels must maintain a distance of 1,640 feet (500 m) or greater from any sighted NARW. Compliance with this regulation aids in ensuring no adverse effects on the ability of whales to select an area with the co-occurrence of these features. In addition, Project vessels transiting along the Atlantic coast between North Carolina and Florida could use routes located offshore of the designated critical habitat and would not need to travel through that area. Therefore, the Proposed Action would not affect designated critical habitat (Unit 1 or Unit 2) for NARW and is discounted from further evaluation in this BA.



Source: NMFS 2023h

Figure 4.8-1. North Atlantic right whale critical habitat (Unit 1 and 2) in the Action Area

4.8.2 Critical Habitat for all Listed DPSs of Atlantic Sturgeon

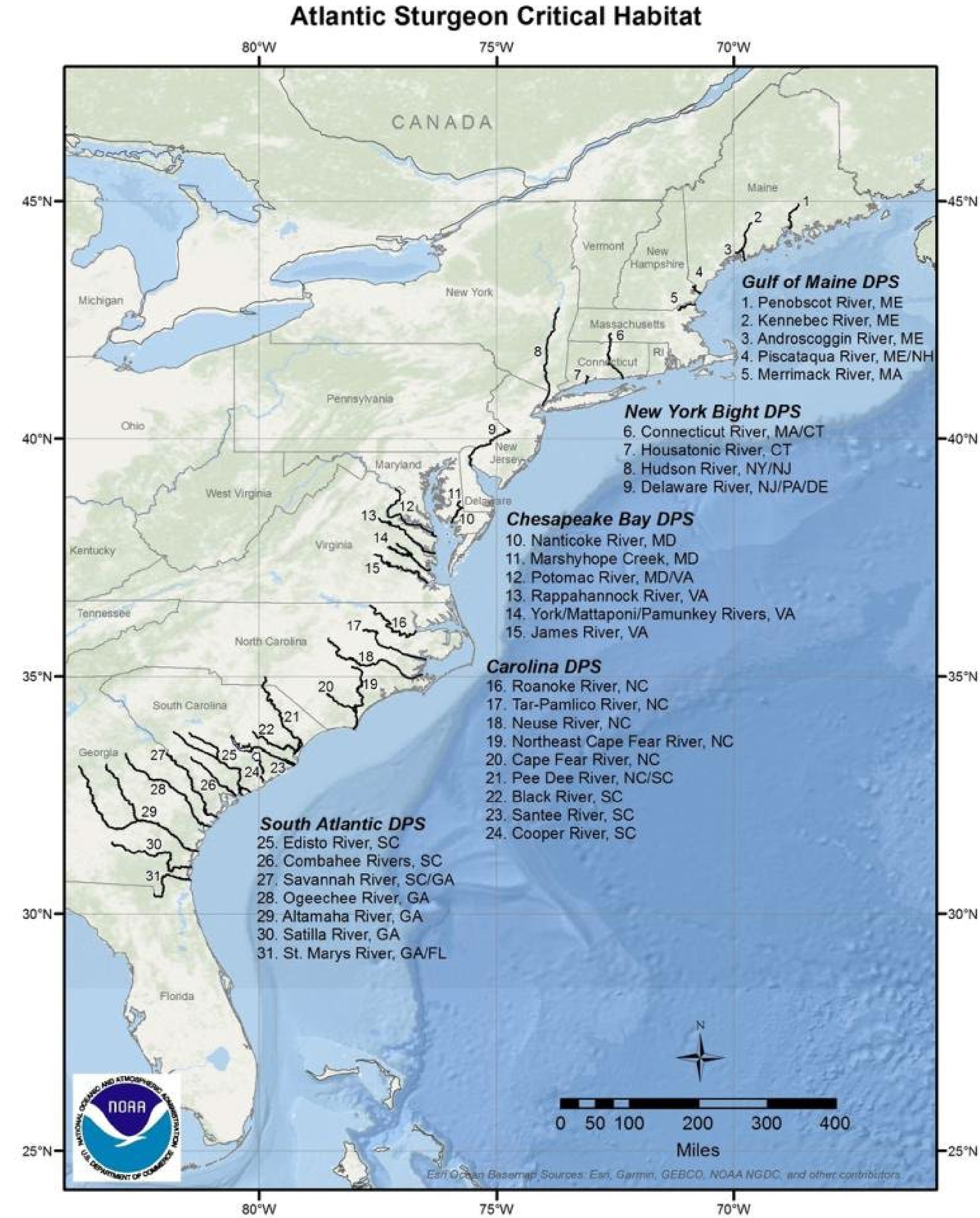
NMFS listed the New York Bight, Chesapeake Bay, and Carolina Distinct Population Segments (DPSs) of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus)* as endangered on February 6, 2012 (NMFS 2017a; NMFS 2017b). Subsequently, critical habitat was designated for each DPS (Figure 4.8-2). The following PBFs 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).

In addition to the first three PBFs given above, the critical habitat for the Atlantic Sturgeon Carolina DPS also includes:

- Water quality conditions, especially in the bottom meter of the water column, between the river mouths and spawning sites with temperature and oxygen values that support: (1) spawning; (2) annual and inter-annual adult, subadult, larval, and juvenile survival; and (3) larval, juvenile, and subadult growth, development, and recruitment. Appropriate temperature and oxygen values will vary interdependently and depending on salinity in a particular habitat. For example, 6.0 mg/L dissolved oxygen or greater likely supports juvenile rearing habitat, whereas dissolved oxygen less than 5.0 mg/L for longer than 30 days is less likely to support rearing when water temperature is greater than 25°C. In temperatures greater than 26°C, dissolved oxygen greater than 4.3 mg/L is needed to protect survival and growth. Temperatures 13°C to 26°C (55.4°F to 78.8°F) likely support spawning 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. Potential project ports that are located within or close to designated Atlantic sturgeon critical habitat include the Port of Coeymans (Hudson River), the New Jersey Wind Port (Delaware River), Port of Virginia (James River), and the Port of Charleston (Cooper River). The majority of the James River and Cooper River are upriver of the Ports of Virginia and Charleston, respectively, and would not be affected by vessel traffic impacts associated with the Project. While the Port of Coeymans and the New Jersey Wind Port are located well within their respective river systems, vessel traffic is not expected to affect the PBFs relating to bottom substrate, salinity, water depth, temperature, or dissolved oxygen and would not serve as a barrier to the passage of Atlantic sturgeon. Therefore, the Proposed Action would not have an impact on any relevant PBFs of the designated critical habitat of the New York Bight DPS, Chesapeake Bay DPS, and Carolina DPS of Atlantic sturgeon, and these critical habitats are discounted from further evaluation in this BA.



Source: NMFS 2023j

Figure 4.8-2. Critical Habitat for the New York Bight, Chesapeake Bay, and Carolina DPSs of Atlantic Sturgeon

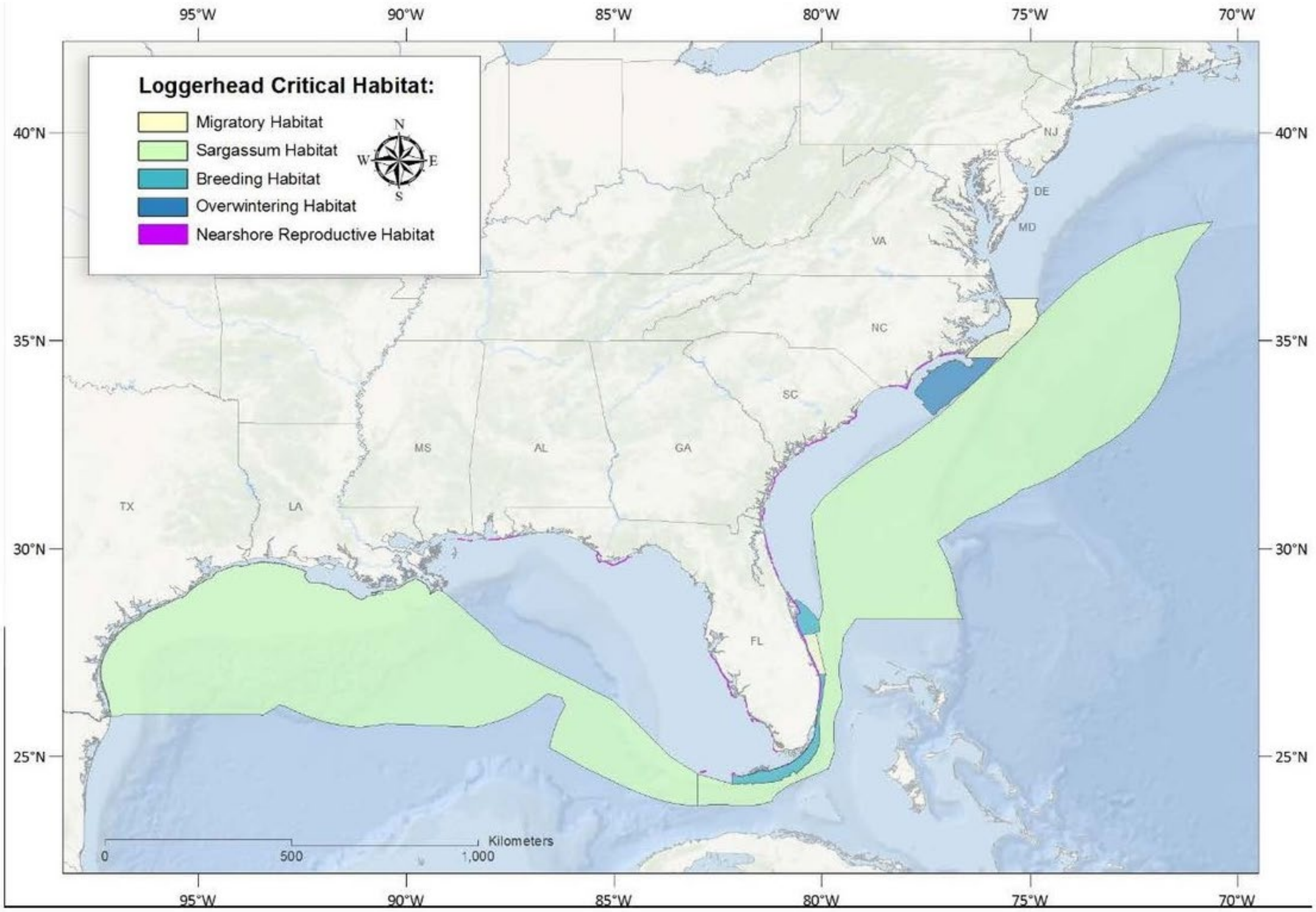
4.8.3 Critical Habitat for the Northwest Atlantic Ocean DPS of Loggerhead Sea Turtle

NMFS designated critical habitat for the Northwest Atlantic Ocean DPS of the loggerhead sea turtle on August 11, 2014 (NMFS 2014a). This designation included nearshore reproductive habitat, wintering habitat, breeding habitat, constricted migratory corridors, and/or *Sargassum* habitat in the Atlantic Ocean and Gulf of Mexico (Figure 4.8-3). Vessels transiting routes to and from the ports in South Carolina and the Gulf of Mexico may travel through wintering habitat, breeding habitat, migratory habitat, and/or *Sargassum* habitat.

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

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

All Northwest Atlantic loggerhead critical habitat areas are outside of the Project area, but vessel transits from non-local ports through designated areas may occur. However, vessel transits through loggerhead critical habitat due to the Proposed Action will not affect the physical oceanographic conditions or modify the oceanographic features associated with growth, migratory, and wintering area functions. No effects of the Proposed Action were identified to foraging habitat, the seafloor, or prey items. Further, no effects to sufficient prey availability or prey quality were identified because of the Proposed Action. Vessel transits due to the Proposed Action would not decrease water temperatures below 50°F (10°C) from November through April, alter habitat in continental shelf waters near the western boundary of the Gulf Stream, or change water depths between 65.5 and 328 feet (20 and 100 m). Though the vessel traffic component of the Action Area may overlap with the designated areas mentioned previously, the physical and oceanographic features of the habitat would not be affected in a manner that adversely impacts the critical habitat. Since Project activities would not affect any of these essential PBFs, the Proposed Action would not affect designated critical habitat for the Northwest Atlantic Ocean DPS of loggerhead sea turtle, and this critical habitat is discounted from further evaluation in this BA.



Source: NMFS 2023i

Figure 4.8-3. Critical Habitat for the Northwest Atlantic Distinct Population Segment of Loggerhead Sea Turtles

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 SouthCoast Wind (Mayflower Wind 2022).
- Protected Species Observer data collected in the Project area (Mayflower Wind 2022).
- Regional aerial survey data (New England Aquarium 2020a–2020m; O'Brien et al. 2021, 2022; Kraus et al. 2016).
- 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 (NEFSC and SEFSC, 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.
- Other regional data (Kenney and Vigness-Raposa 2010; LaBrecque et al. 2015; New England Aquarium 2020a–2020m; Palka et al. 2017; Stone et al. 2017).

Based on this information, 19 ESA-listed species may occur in the Action Area (Table 4.9-1): 6 marine mammal species, 5 sea turtle species, and 8 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

Species	District Population Segment	ESA Status		Critical Habitat Status	Critical Habitat Occurrence in Action Area
		Status	Listing Date		
Marine Mammals					
Blue whale	N/A	Endangered	1970	Not designated	N/A
Fin whale	N/A	Endangered	1970	Not designated	N/A
North Atlantic right whale	N/A	Endangered	1970	Designated	Yes
Rice's whale	N/A	Endangered	2019	Not designated	N/A
Sei whale	N/A	Endangered	1970	Not designated	N/A
Sperm whale	N/A	Endangered	1970	Not designated	N/A

Species	District Population Segment	ESA Status		Critical Habitat Status	Critical Habitat Occurrence in Action Area
		Status	Listing Date		
Sea Turtles					
Green sea turtle	North Atlantic	Threatened	2016	Designated	No
Hawksbill sea turtle	N/A	Endangered	1970	Designated	No
Kemp's ridley sea turtle	N/A	Endangered	1970	Not Designated	N/A
Leatherback sea turtle	N/A	Endangered	1970	Designated	No
Loggerhead sea turtle	Northwest Atlantic Ocean	Threatened	2011	Designated	Yes
Fish					
Atlantic Salmon	Gulf of Maine	Endangered	2009	Designated	No
Atlantic sturgeon	New York Bight, Chesapeake Bay, South Atlantic, Carolina, Gulf of Maine	Threatened, Endangered	2012	Designated	Yes
Giant manta ray	N/A	Threatened	2018	Not designated	N/A
Gulf sturgeon	N/A	Threatened	1991	Designated	No
Nassau grouper	N/A	Threatened	2016	Proposed	N/A
Oceanic whitetip shark	N/A	Threatened	2018	Not designated	N/A
Shortnose sturgeon	N/A	Endangered	1967	Not designated	N/A
Smalltooth sawfish	U.S.	Endangered	2003	Designated	No

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

Potential interactions with the Atlantic salmon (all DPSs), giant manta ray, gulf sturgeon, hawksbill sea turtle, Nassau grouper, oceanic whitetip shark, Rice's whale, and smalltooth sawfish are not expected in the Project area, but these species may be affected by transits from distant port locations during construction and installation of the proposed Project. In other cases, the occurrence of the species, such as shortnose sturgeon, is so unlikely or rare that the potential for adverse effects is discountable.

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). The Proposed Action vessel transit routes from Canada would not overlap the critical habitat of Atlantic salmon, which includes perennial rivers, streams, estuaries, and lakes connected to the marine environment in coastal Maine. 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 (NMFS and USFWS 2019). Therefore, effects to Atlantic salmon are not expected as a result of the Proposed Action.

4.9.1.2 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, although 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. The presence of giant manta rays may overlap in areas traversed by vessels from New Jersey and farther south, as well as in the portions of the Action Area where vessels would transit to and from the Gulf of Mexico. However, the encounter rate between this species and Project vessels is expected to be low. Additionally, the barge tug/tow vessels associated with the Project that would be transiting the Gulf of Mexico are expected to be moving at maximum speeds of 6 knots in the Gulf of Mexico and 6.5 knots north of Miami, which is slow enough to mitigate strike avoidance. The mitigation measures proposed for all Project vessels to steer course away from giant manta rays and follow vessel strike avoidance measures would further reduce the chance of any adverse effects to this species from the Proposed Action (AMM-25, Table 3.3-1).

Given the limited number of vessel transits through the portion of the Action Area where this species is most likely to occur (i.e., the portion associated with vessel transits to ports south of New Jersey including the Gulf of Mexico), the dispersed distribution of giant manta rays in the open ocean habitat where Project vessel transits would occur, the slow speeds of vessel transit in the southern portions of the Action Area, and the mitigation measures to avoid vessel strikes, effects to giant manta ray are not expected as a result of the Proposed Action.

4.9.1.3 Gulf Sturgeon

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

Gulf sturgeon have the potential to occur in the portion of the Action Area associated with vessel transits to and from the Gulf of Mexico. However, vessels transiting to and from Corpus Christi, Texas and the Port of Altamira, Mexico, are expected to follow general traffic patterns through the Straits of Florida and across the Gulf of Mexico, far offshore of the shallow nearshore waters occupied by Gulf sturgeon during its overwintering period. Additionally, the barge tug/tow vessels associated with the Project that would be transiting the Gulf of Mexico are expected to be moving at maximum speeds of 6 knots in the Gulf of Mexico. Given the habitat preference and seasonality of Gulf sturgeon in the marine environment, and the slow speeds at which vessels may be traveling through the Gulf of Mexico, Project vessels are not expected to encounter or injure Gulf sturgeon. Therefore, effects to Gulf sturgeon are not expected as a result of the Proposed Action.

4.9.1.4 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.

Hawksbill sea turtles occur regularly in the Gulf of Mexico and could therefore occur in the portion of the Action Area associated with vessel transits to and from this region. However, this species generally inhabits nearshore foraging grounds and is often associated with coral reefs (NMFS 2023l). Therefore, as the vessel will be transiting through the Straits of Florida and across the Gulf of Mexico in offshore waters, hawksbill sea turtle densities along vessel transit routes are expected to be low. If a Project vessel were to encounter a hawksbill sea turtle in the Action Area, any potential impacts would be minimized by the implementation of mitigation measures to avoid vessel strikes. At-sea vessels transiting from non-local ports traveling greater than 10 knots will utilize dedicated, trained lookouts or Protected Species Observers (PSO), or NMFS-approved visual detecting devices. Project vessels will maintain a separation distance of 164 feet (50 meters) or greater from any sighted sea turtles and adhere to vessel strike avoidance measures as outlined in Table 3.3-1. Additionally, the barge tug/tow vessels associated with the Project that would be transiting the Gulf of Mexico are expected to be moving at maximum speeds of 6 knots in the Gulf of Mexico.

Given the low density of hawksbill sea turtles, the low expected use of non-local ports, and the slow speeds at which vessels will be traveling across the Gulf of Mexico, the likelihood of an encounter resulting in a ship strike is very low. In addition, the mitigation measures to avoid vessel strikes would reduce the chance of any adverse effects to this species if an encounter did occur. Therefore, effects to hawksbill sea turtles are not expected as a result of the Proposed Action.

4.9.1.5 Nassau Grouper

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

Nassau grouper have the potential to occur in the portion of the Action Area associated with vessel transits to and from the Gulf of Mexico. However, given its rarity in the Gulf of Mexico, its preference for shallow reef habitats that would not co-occur with vessel transit routes, and the slow speeds at which vessels may be traveling through the southern portions of the Action Area, Project vessels are not expected to encounter or injure Nassau grouper. Therefore, effects to Nassau grouper are not expected as a result of the Proposed Action.

4.9.1.6 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 generally deeper than 604 feet (184 meters) (NMFS 2018b). The species has a clear preference for open ocean waters between latitudes of 10°N and 10°S but can be found in decreasing numbers out to 30°N and 35°S, with abundance decreasing with greater proximity to continental shelves

(Young et al. 2017). In the western Atlantic Ocean, oceanic whitetip sharks occur from Maine to Argentina, including the Caribbean and Gulf of Mexico. In the central and eastern Atlantic Ocean, the species occurs from Madeira, Portugal, south to the Gulf of Guinea, and possibly in the Mediterranean Sea (NMFS 2016b).

Given the species' preference for deep, offshore waters, it is possible but unlikely that they will transit through the Project area. There is a small chance that vessel transits and transport of Project components from the Gulf of Mexico or international ports would interact with oceanic whitetip sharks in the vessel traffic component of the Action Area. Vessels at sea would not be expected to travel at reduced speeds. However, given the low density of oceanic whitetip sharks and the low number of vessel transits from non-local ports, the likelihood of an encounter resulting in a ship strike is very low. Further, vessel strikes have not been identified as a threat to the species (NMFS 2018b), and there is no information to indicate that vessels would have adverse effects on this species (BOEM 2021). Given that project vessels are not expected to encounter oceanic whitetip shark, effects to this species are not expected as a result of the Proposed Action.

4.9.1.7 Rice's Whale

Rice's whale (*Balaenoptera ricei*) is listed as endangered throughout its range (NMFS 2019b). This species was originally classified as the Gulf of Mexico subspecies of Bryde's whale (*Balaenoptera edeni*) at the time of listing but was reclassified as a distinct species in 2021 (Rosel et al. 2021). This species is not found within the Project area or within the portion of the Action Area where vessels transit to and from local regional ports. Rice's whale only occurs in the Gulf of Mexico and has been consistently sighted in the northeastern Gulf of Mexico. They are generally distributed along the continental shelf break between 328 and 1,312 feet (100 and 400 meters) depth (NMFS 2023k). Therefore, the occurrence of this species would be limited to the portion of the Action Area where vessel transits to and from ports on the western coast of the Gulf of Mexico.

Given the rarity of this species (estimated abundance of 51 individuals; Hayes et al. 2021), the limited Project vessel traffic to ports in the Gulf of Mexico, the species preference for habitats in the northeastern Gulf of Mexico that would not be likely to overlap vessel transit routes to ports on the west coast of the Gulf of Mexico, and the slow speeds (6 knots or lower) at which Project vessels may be traveling through the Gulf of Mexico, it is extremely unlikely that a Project vessel would encounter or injure Rice's whales. If a Project vessel were to co-occur with a Rice's whale in the Action Area, any effects are extremely unlikely due to the implementation of vessel strike avoidance measures (Table 3.3-1). All Project vessels will utilize dedicated, trained lookouts to reduce the risk of vessel collision, will maintain 328-foot (100-meter) separation distances from large whales, and adhere to vessel strike avoidance measures as advised by NMFS. Based on the unexpected co-occurrence of Rice's whales and Project vessels in the Action Area and the mitigation measures already in place to avoid vessel strikes with whales, effects to Rice's whale are not expected as a result of the Proposed Action.

4.9.1.8 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) though movement of shortnose sturgeon between rivers is rare, and their presence in the marine environment is uncommon (BOEM 2018a). Shortnose sturgeon are grouped into three metapopulations (northern, mid-Atlantic, southern) and can be found in 41 rivers and bays along the East Coast of North America including the Delaware and Hudson Rivers in the Mid-Atlantic region (NOAA Fisheries 2023). Shortnose sturgeon exhibit variable site fidelity. For example, the Hudson River population is almost exclusively confined to the river (Kynard et al. 2016; Pendleton et al. 2019), differing from other populations that may use coastal waters to move into smaller coastal rivers nearby.

There is a dearth of recent shortnose sturgeon distribution and density data for areas where shortnose sturgeon could occur in the Project area. Little is known about shortnose sturgeon density in 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. Based on current known distributions, shortnose sturgeon is not expected to be found in the Project area.

However, vessels transiting to and from potential ports that may be used during the construction phase in the Delaware River (New Jersey Wind Port) and Hudson River (Port of Coeymans) may encounter shortnose sturgeon. Of the shortnose sturgeon carcasses salvaged between 2008 to 2016, 21 percent were found in the Delaware River and half of those showed evidence of interaction with vessels (NMFS 2021a). Given the amount of traffic in the Delaware River and the expected small increase in traffic due to the Project, the likelihood of a vessel strike on a shortnose sturgeon is extremely low. Similarly, Project vessel traffic in the Hudson River would likely represent only a small increase relative to existing boat traffic and the likelihood of a Project vessel strike on a shortnose sturgeon is also expected to be extremely low. Additionally, the slower speed of the Project's barge tug/tow traffic (5-6 knots) on the river would also reduce the potential for vessel strike. Therefore, the potential impacts of vessel traffic on shortnose sturgeon in the Action Area are expected to be discountable and effects to this species are not expected as a result of the Proposed Action.

4.9.1.9 Smalltooth Sawfish

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

Smalltooth sawfish have the potential to occur in the portion of the Action Area associated with vessel transits to and from ports in the Gulf of Mexico. However, vessels transiting to and from Corpus Christi, Texas or the Port of Altamira, Mexico are expected to follow general traffic patterns through the Straits of Florida and across the middle of the Gulf of Mexico, which is offshore of the shallow coastal waters occupied by smalltooth sawfish on the west coast of Florida. Given that its preferred habitat does not overlap with vessel transit routes, and the slow speeds at which vessels may be traveling through the Gulf of Mexico (6 knots or lower), Project vessels are not expected to encounter or injure smalltooth sawfish. Therefore, effects to this species are not expected as a result of the Proposed Action.

4.9.2 Marine Mammals

There are five marine mammal species under the ESA that are likely to occur in the Action Area and that have not been discounted from further analysis (refer to Section 4.9.1). The species carried forward in this BA are large whales: fin whale (*Balaenoptera physalus*), NARW (*Eubalaena glacialis*), sei whale (*Balaenoptera borealis*), sperm whale (*Physeter macrocephalus*), and blue whale (*Balaenoptera musculus*). Blue whales, while considered rare migrants in the U.S. Atlantic (Hayes et al. 2020), 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, although no other critical habitats have been designated for other ESA-listed marine mammals.

Mean monthly marine mammal density estimates (animals/100 square kilometers) for all species were obtained using the Duke University Marine Geospatial Ecology Laboratory model results and include recently updated model results for NARW. The updated model includes new estimates for NARW abundance in Cape Cod Bay in December. Additionally, model predictions are summarized over three eras, 2003–2018, 2003–2009, and 2010–2018, to reflect the apparent shift in NARW distribution around 2010. The modeling uses survey data from 2010-2018 for density predictions (Roberts et al. 2016, 2021a, 2021b). 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 SouthCoast Wind Lease Area

Month	Blue Whale Density (number / 100 km^2)	Fin Whale Density (number / 100 km^2)	NARW Density (number / 100 km^2)	Sei Whale Density (number / 100 km^2)	Sperm Whale Density (number / 100 km^2)
January	–	0.218	0.422	0.038	0.045
February	–	0.175	0.478	0.025	0.016
March	–	0.144	0.430	0.050	0.016
April	–	0.149	0.424	0.119	0.004
May	–	0.302	0.323	0.193	0.017
June	–	0.292	0.059	0.064	0.031
July	–	0.474	0.032	0.016	0.056
August	–	0.360	0.020	0.012	0.170
September	–	0.269	0.031	0.019	0.100
October	–	0.081	0.050	0.040	0.072
November	–	0.052	0.081	0.089	0.043
December	–	0.142	0.246	0.067	0.029
Annual Mean	0.001	0.222	0.216	0.061	0.050
May to December Mean	–	0.247	0.105	0.063	0.065

km = kilometer; km^2 = square kilometer; NARW = North Atlantic right whale
dash (—) indicates that (Blue Whale) density is predicted annually (Roberts et al. 2016)
Source: Density estimates are from habitat-based density modeling of the entire Atlantic Exclusive Economic Zone (EEZ) from Roberts et al. (2016, 2022a-e).

Species descriptions, status, likelihood, and timing of occurrence in the Action Area, information about feeding habits, and hearing ability of the five ESA-listed marine mammals are discussed in the sections that follow.

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 subtropics 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

1981; 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 U.S. 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 deep-water 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 hertz (Hz) to 35 kilohertz (kHz).

<u>4.9.2.1.2 Status and Population Trend</u>

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 U.S. is not known; however, a catalogue count of 402 individuals from the Gulf of St. Lawrence is the minimum population estimate (NOAA Fisheries 2020).

<u>4.9.2.1.3 Distribution and Habitat Use</u>

Blue whales were detected acoustically during the Northeast Large Pelagic Survey (NLPS) but were not 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 (AIS Inc. 2020; Mayflower-APEM 2020a–2020m). 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 square nautical miles [100 square kilometers]) (Roberts et al. 2022a).

4.9.2.2 Fin Whale

<u>4.9.2.2.1 Description and Life History</u>

The fin whale (*Balaenoptera physalus*) 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 2023). 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 2023).

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 2023). 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 hertz to 35 kilohertz.

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 (2019) determined that the species should be down listed 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. 2022a). 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 2023). 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 2023). 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 2023).

Fin whales may occur in the Action Area year-round. Recordings during the NLPS (i.e., detected visually or acoustically) in the Massachusetts and Rhode Island lease areas and the Project area reported peak occurrences during the late spring and summer (Kraus et al. 2016) and were observed during both the 2010–2013 AMAPPS I summer/fall shipboard and aerial surveys and the AMAPPS II 2015-2019 surveys (Palka et al. 2017, 2021). 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 square nautical miles (100 square kilometers) (Roberts et al. 2022b). 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 square nautical miles (100 square kilometers) (Roberts et al. 2022b).

4.9.2.3 North Atlantic Right Whale

4.9.2.3.1 Description and Life History

The NARW (*Eubalaena glacialis*) is a large mysticete that can reach lengths up to 52 feet (16 meters) and weighs up to 70 tons (64 metric tons) at maturity, with females being larger than males (NMFS 2023a). This species may live to 70 years of age or more. The NARW is recognized to be a separate species from the Southern right whale (*Eubalaena australis*), separated into distinct populations in the northern Atlantic and Pacific Oceans. The Western Atlantic population, what is known as the NARW, ranges from calving grounds in coastal waters of the southeastern U.S. to primary feeding grounds off New England, the Canadian Bay of Fundy, the Scotian Shelf, and the Gulf of St. Lawrence. During spring and summer months, NARW migrate north to the productive waters of the northeast region to feed and nurse their young. Female NARWs reach sexual maturity at approximately age 10 and have a calf every 3 to 4 years, although in recent years the time span between calvings has increased approximately to 6 to 10 years (NMFS 2023a). The gestation period is approximately 1 year, and calves are born primarily in the coastal waters of South Carolina, Georgia, and Florida.

The NARW is primarily planktivorous, preferentially targeting certain calanoid copepod species (*Pseudocalanus* and *Centropages* spp.), and primarily the late juvenile developmental stage of *Calanus finmarchicus* (McKinstry et al. 2013; Hudak et al. 2023). NARW feeding behavior varies by region in response to different seasonal and prey availability conditions. For example, NARWs may rely more frequently on skim-feeding when in transit between core habitats, or when dense concentrations of prey are less available (Whitt et al. 2013). Baumgartner et al. (2017) investigated NARW foraging ecology in the Gulf of Maine and southwestern Scotian Shelf using archival tags. The study reported that NARW diving behavior was variable but followed distinct patterns correlated with the vertical distribution of forage species in the water column, and notably 72 percent of their time were spent within 33 feet (10 meters) of the surface. Although NARWs are always at risk of ship strike when breathing, the risk increases substantially due to their black coloration, the absence of a dorsal fin, and the tendency to forage near but below the surface, making them hard to detect (Baumgartner et al. 2017).

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 hertz to 35 kilohertz. A study of the inner ear anatomy of NARWs estimated a hearing range of 10 hertz to 22 kilohertz (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 in 2022 as part of the species' 5-year status review, and its endangered status remains unchanged (NMFS 2022a). NARWs found in the Project area belong to the Western North Atlantic stock. Using data as of September 7, 2021, the latest Pace model (Pace et al. 2017) estimate for the size of the remaining NARW population in 2020 is 368 individuals (95% confidence range +/-14) (NMFS 2023a, Pettis et al. 2022). However, the most recent NMFS stock assessment (June draft) report gives a population estimate of 338 NARWs (Hayes et al. 2022b). In 2017, an Unusual Mortality Event (UME) began for NARW, totaling 34 dead stranded whales: 21 in Canada and 13 in the U.S. (NMFS 2023g). 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 from 2017 to 2021, bringing the preliminary cumulative total number of animals in the NARW UME up to 50 individuals. Given that there are 338 NARWs remaining, these 50 individuals in the UME represent a substantial loss of a critically endangered species (Pettis et al. 2022).

Threats to NARW include vessel strikes, entanglement, anthropogenic noise, and climate change. Vessel strike and entanglement are the leading causes of death in this species (Kite-Powell et al. 2007; Knowlton et al. 2012, Pettis et al. 2022). 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 (Jensen and Silber 2004). A total of 86 percent of NARWs show evidence of past entanglements, and entanglement may also be limiting population recovery (Pettis et al. 2022).

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 2023a). 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 the shallow, coastal waters off South Carolina, Georgia, and northern Florida.

NARWs are considered common visitors to the Project area with hotspots consistently observed along the northeastern boundary of the Lease Area, adjacent to the Nantucket Shoals, during surveys in spring 2011–2015, spring 2017–2019, and winter 2017–2019 (Quintana-Rizzo et al. 2021). From 2015 to 2019, Palka et al. (2021) reported acoustic detections of NARWs in all seasons in the northeastern portion of the Lease Area, with the highest number of days of acoustic detections in the winter and spring; with 22 to 67 days of acoustic detections from November to February and again from March to April. Generally, the highest densities of whales occur east of the Lease Area over Nantucket Shoals and may occur in any season in the Project area. There is also the potential for NARW year-round occurrence in the proposed ECCs, specifically near Brayton Point ECC, with a greater likelihood of occurrence during spring and winter months.

During 2018–2021 New England Aquarium (NEAq) aerial survey activities (Campaign 5 and Campaign 6b), NARWs were the third most observed whale species (O'Brien et al. 2022). In total, 175 sightings of 321 NARWs were recorded during Campaign 5. During Campaign 5, the majority of sightings occurred in the Nantucket Shoals, within 20 nautical miles (37 kilometers) of offshore wind lease areas, with one NARW sighted on the boundary of the SouthCoast Wind and Beacon Wind Lease Areas (O'Brien et al. 2021). During Campaign 6B, 90 sightings of 169 NARWs were recorded with all sightings outside of the Lease Area, but within 15 nautical miles (28 kilometers) of the Massachusetts lease areas (O'Brien et al. 2022). In 2021, two to five NARW were observed in the northeastern portion of the Lease Area during the Winter, while in the Spring, two to five NARW were observed in the southwest portion of the Lease Area (O'Brien et al. 2021, 2022). Modeled density of NARW from 2011 to 2020 peaked in the winter and spring months. During these months (November to May), abundance ranged from 0.16 to 1 NARW/29.15 square nautical miles (100 square kilometers) (Roberts et al. 2022e).

While the Project area does not occur in any designated critical habitat areas for NARWs, the Lease Area is adjacent to Nantucket Shoals, which is a recently identified foraging area for NARWs. The physical oceanographic and bathymetric features provide for year-round high phytoplankton biomass, likely contributing to increased availability of zooplankton prey for NARWs (Quintana-Rizzo et al. 2021). Waters from the Gulf of Maine, the Great South Channel, and Nantucket Sound mix in the shallow dune-like Nantucket Shoals. The convergence of these waters creates a well-mixed water column throughout the year (Limeburner and Beardsley 1982), making the Nantucket Shoals the only known winter foraging ground for NARWs (Quintana-Rizzo et al. 2021).

Observations of NARW in Nantucket Shoals have occurred year-round, primarily during winter and spring (Quintana-Rizzo et al. 2021, O'Brien et al. 2022). Similarly, modeled NARW abundance in the Nantucket Shoals from 2011 to 2020 also reports peak abundances in the winter and early spring months, with densities from January to May peaking at 4 to 6.3 NARW/29.15 square nautical miles (100 square kilometers) and again in November and December (Roberts et al. 2022e). 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) NARW were cited in all months except October (Quintana-Rizzo et al. 2021). As can be noted in the reports presented above, NARWs have become more common in southern New England waters and are staying in these waters for longer periods. This is likely due to prey items shifting northward and finding favorable conditions in Nantucket Shoals as NARW feeding has been observed in all seasons in the area. This increasing occurrence trend could mean an extension of critical habitat into southern New England waters (Quintana-Rizzo et al. 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 miles (0.8 kilometers) 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 kilometers) of the corner of the NARW Seasonal Management Area (SMA), off the west coast of Martha's Vineyard, and encompasses NARW migratory routes that may have elevated vessel traffic. To mitigate potential vessel strikes, all vessels 65 feet (19.8 meters) or longer in the NARW SMA are required to reduce speed to no more than 10 nautical miles per hour (9 knots, 16 kilometers 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 (*Balaenoptera borealis*) 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 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 Southern New England 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).

Sei whales usually travel alone or in small groups of two to five animals, occasionally in groups as large as ten (Hayes et al. 2020). In the North Atlantic, sei whales are known to use the waters of the Gulf of

Maine as a feeding ground between spring and early summer (Baumgartner et al. 2011). The prey preferences of sei whales closely resemble those of NARW (Hayes et al. 2020) and may co-occur with NARWs in the spring as both prey on calanoid copepods, particularly *Calanus finmarchicus*, thus, favoring similar feeding grounds with high concentrations of the copepod (NMFS 2011; Prieto et al. 2014).

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 hertz to 35 kilohertz.

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 (AIS Inc. 2020; Mayflower-APEM 2020a–2020m, TerraSond 2019). 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 square nautical miles (100 square kilometers) in the Project area. (Roberts et al. 2022c). Sei whale modeled density in the Nantucket Shoals was highest from April to May at 0.040 to 0.63 sei whales/29.15 square nautical miles (100 square kilometers), but also peaked, to a lesser degree, in November and December (Roberts et al. 2022c).

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 (NMFS 2023b). 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 hertz to 160 kilohertz.

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 00.04 animals per 29.15 square nautical miles (100 square kilometers) from December through April to 0.01 animals per 29.15 square nautical miles (100 square kilometers) in July (Table 4.9-2).

Modeled density of sperm whales in the Project area from 1998 to 2019 peaked in August and September at approximately 0.16 to 0.25 sperm whale/29.15 square nautical miles (100 square kilometers) and again in October at the same density (Roberts et al. 2022d). Modeled density of sperm whales peaked in June at 0.10 to 0.16 sperm whale/29.15 square nautical miles (100 square kilometers) in the nearby Nantucket Shoals (Roberts et al. 2022d).

4.9.3 Sea Turtles

There are four federally listed species of sea turtle likely to occur in the Action Area that have not been discounted from further analysis (refer to Section 4.9.1): green sea turtle (*Chelonia mydas*), Kemp's ridley sea turtle (*Lepidochelys kempii*), leatherback sea turtle (*Dermochelys coriacea*), and loggerhead sea turtle (*Caretta 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 no 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 5 km of the SouthCoast Lease Area

Species	Density (number/100 km^2)[1]			
	Spring	Summer	Fall	Winter
Kemp's ridley sea turtle	0.006	0.006	0.006	0.006
Leatherback sea turtle	0.027	0.630[3]	0.873[3]	0.027
Loggerhead sea turtle	0.076	0.206[4]	0.663[4]	0.076
Green sea turtle[2]	0.006	0.006	0.006	0.006

km = kilometer; km^2 = square kilometer
[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 5-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).

There are limited density estimates for sea turtles in the Lease Area. For this assessment, sea turtle densities were obtained from the U.S. Navy Operating Area Density Estimate (NODE) database on the Strategic Environmental Research and Development Program Spatial Decision Support System (SERDP-SDSS) portal (U.S. Navy 2012, 2017) and from the Northeast Large Pelagic Survey Collaborative Aerial and Acoustic Surveys for Large Whales and Sea Turtles (Kraus et al. 2016). These data are summarized seasonally (winter, spring, summer, and fall). Since the results from Kraus et al. (2016) use data that were collected more recently, those were used preferentially where possible.

Sea turtles were most commonly observed in summer and fall, absent in winter, and nearly absent in spring during the Kraus et al. (2016) surveys of the Massachusetts WEA and Rhode Island/Massachusetts WEAs. Because of this, the more conservative winter and spring densities from SERDP-SDSS are used for all species. It should be noted that SERDP-SDSS densities are provided as a range, where the maximum density will always exceed zero, even though turtles are unlikely to be present in winter. As a result, winter and spring sea turtle densities in the Lease Area, while low, are likely still overestimated.

For summer and fall, the more recent leatherback and loggerhead densities extracted from Kraus et al. (2016) were used. These species were the most commonly observed sea turtle species during aerial surveys by Kraus et al. (2016) in the Massachusetts WEA and Rhode Island/Massachusetts WEAs. However, Kraus et al. (2016) reported seasonal densities for leatherback sea turtles only, so the loggerhead densities were calculated for summer and fall by scaling the averaged leatherback densities from Kraus et al. (2016) by the ratio of the seasonal sighting rates of the two species during the surveys.

The Kraus et al. (2016) estimates of loggerhead sea turtle density for summer and fall are slightly higher than the SERDP-SDSS densities, and thus more conservative.

Kraus et al. (2016) reported only six total Kemp's ridley sea turtle sightings, so the estimates from SERDP-SDSS were used for all seasons. Green sea turtles are rare in this area and there are no density data available for this species, so the Kemp's ridley sea turtle density is used as a surrogate to provide a conservative estimate.

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 2023c). 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 2023c). In the U.S., breeding occurs in late spring and early summer, and nesting occurs in the Southeast between June and September, peaking in June and July (USNRC 2010 citing NOAA 2010; NMFS 2023c). During the nesting season, females come ashore to nest approximately every 2 weeks with clutch sizes of approximately 100 eggs (NMFS 2023c). 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 2023c).

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 2023c).

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 hertz. The hearing range for green sea turtles is from 50 to 1,600 hertz, with peak sensitivity between 200 and 400 hertz underwater and 300 and 400 hertz 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 Houtan et al. 2014). Green sea turtles are also subject to cold stunning, a hypothermic reaction due to exposure to prolonged cold water temperatures. This phenomenon occurs regularly at foraging locations throughout U.S. waters and leads to mortality in juveniles and adults (NMFS and USFWS 2015).

4.9.3.1.3 Distribution and Habitat Use

Green sea turtles inhabit tropical and subtropical waters around the globe. In the U.S., green sea turtles occur from Texas to Maine, as well as the Caribbean. 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 2019a).

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 2021). 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 2023d). 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 2023d). 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 2023d).

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 2023d). This species is also known to scavenge on dead fish and discarded bycatch (NMFS 2023d).

Though sea turtles possess auditory organs that are adapted for underwater hearing, their hearing range is limited to low frequencies, typically below 1,600 hertz. The Kemp's ridley hearing range extends from 100 to 500 hertz, with peak sensitivity between 100 and 200 hertz (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 2015,3 and its Endangered status remained unchanged (NMFS and USFWS 2015). In 2012, the population of individuals aged 2 years and up was estimated at 248,307 turtles (NMFS and USFWS 2015 citing Gallaway et al. 2013). Based on hatchling 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 (NMFS and USFWS 2015 citing Heppell. S., Oregon State University, unpublished data 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 2019a).

Kemp's ridley sea turtles could occur in the Action Area seasonally. They are mainly in the Project area during the summer and fall (Kraus et al. 2016). Kemp's ridley sea turtles were rarely observed in 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 2021). 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

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

July 2020. No Kemp's ridley sea turtles were observed during PSO surveys or aerial surveys conducted for the proposed Project (AIS Inc., 2020; Mayflower-APEM, 2020i).

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 and USFWS 2007b; NMFS 2023e). 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 U.S., 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 2020a; NMFS 2023e). Hatchlings emerge from the nest after approximately 2 months and disperse into offshore habitats (NMFS and USFWS 2020a). Unlike other sea turtle species, juvenile leatherback sea turtles do not undergo an ontogenetic shift in distribution to shallower habitats and continue to use mid-ocean and continental shelf habitats (NMFS and USFWS 2020a), though older life stages may occur in nearshore waters (NMFS and USFWS 1992).

Leatherback sea turtles often forage in upwelling areas (NMFS and USFWS 2020a citing Saba 2013), though they are known to utilize a variety of habitats for feeding (NMFS and USFWS 2020a citing Robinson and Paladino 2015). Unlike other sea turtle species, leatherbacks have tooth-like cups and sharp jaws, along with backward-pointing spines in their mouth and throat, all adaptations for their unique diet. This species consumes gelatinous prey almost exclusively from the post-hatchling to adult life stage (NMFS 2023e; NMFS and USFWS 2020a 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 hertz. The leatherback sea turtle's hearing range extends from approximately 50 to 1,200 hertz, with peak sensitivity between 100 and 400 hertz (Piniak et al. 2012a & Piniak et al. 2012b).

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 2020). Abundance of leatherback sea turtle was most recently evaluated in the 2020 review undertaken to determine whether to list separate DPSs of leatherbacks under the ESA. Among subpopulations of leatherback sea turtle, abundance estimates for nesting females range from less than 100 to nearly 10,000 (NMFS and USFWS 2020a). Recent data indicate that the abundance of nesting leatherback females has declined rapidly in several subpopulations. In the Northwest Atlantic, the abundance of nesting females is currently estimated at 20,569. This population is currently exhibiting an overall decreasing trend in annual nesting activity (NMFS and USFWS 2020a).

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

4.9.3.3.3 Distribution and Habitat Use

Leatherback sea turtles are found in the Atlantic, Pacific, and Indian Oceans (NMFS 2023e). This species can be found throughout the western North Atlantic Ocean as far north as Nova Scotia, Newfoundland, and Labrador (Ernst et al. 1994). While early life stages prefer oceanic waters, adult leatherback sea turtles are generally found in mid-ocean, continental shelf, and nearshore waters (NMFS and USFWS 1992). This species displays a marked migration pattern, entering the 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 (AIS Inc., 2020; Mayflower-APEM, 2020i).

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 2023f). 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 U.S. 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 hertz. The loggerhead sea turtle's hearing range extends from approximately 50 to 100 hertz up to 800 to 1,120 hertz (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. The 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 along with 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 2023f). U.S. continental shelf waters in southern New England have been identified as foraging habitat for juveniles (NMFS 2023f). 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 2019a).

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 and has not been discounted from further analysis (refer to Section 4.9.1). Critical habitat has been designated for this species but lies outside the Action Area.

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 in riverine systems (i.e., not offshore), 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 upstream 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 hertz (Lovell et al. 2005). Based on preliminary physiological analysis, Atlantic sturgeon may be able to detect sounds from below 100 hertz to perhaps 1,000 hertz 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 U.S. 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 DPSs considered in this BA are the New York Bight DPS, Chesapeake Bay DPS, and Carolina DPS.

New York Bight DPS

The New York Bight DPS is composed of all Atlantic sturgeon spawned in the watersheds that drain into coastal waters from Chatham, Massachusetts to the Delaware-Maryland border on Fenwick Island. In 2013, NMFS estimated the abundance of adult and subadult Atlantic sturgeon in the New York Bight DPS to be 34,566 based on available information on genetic composition and estimated Atlantic Sturgeon abundance in marine waters (NMFS 2022b). However, in a 2017 stock assessment, the ASMFC concluded that abundance of the New York Bight DPS was depleted relative to historical levels but that there was a relatively high probability that abundance may have increased since the implementation of the 1998 fishing moratorium (ASMFC 2017). In the most recent 5-year status review, NMFS determined that the number of spawning adults in the Hudson River spawning population is on the order of hundreds per year and the Delaware River spawning population is a fraction of the size of the Hudson River spawning population. Further, bycatch, vessel strikes, degraded water quality, dredging, and climate change effects continue to pose threats to the New York Bight DPS of Atlantic sturgeon (NMFS 2022b).

Chesapeake Bay 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 estimated the oceanic population abundance of the Chesapeake DPS at 8,811 fish (NMFS 2022c). 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 2022c).

Carolina DPS

Atlantic sturgeon spawning for the Carolina DPS has been verified to occur in the Roanoke River and is suspected to occur in the Tar-Pamlico, Neuse, and Cape Fear Rivers in North Carolina and the Pee Dee and Cooper Rivers in South Carolina (ASMFC 2017). While long term data on relative sturgeon abundance in the Carolina DPS is scarce, biomass and abundance status for the coastwide population of Atlantic sturgeon including the Carolina DPS are considered depleted relative to historical levels (ASMFC 2017). Poor habitat quality, specifically exceedances of temperature and dissolved oxygen tolerances of sturgeon, poses a major threat to the development and survival of all Atlantic sturgeon life stages in the Carolina DPS (NMFS 2017b). Habitat disturbance from dredging also adds to this threat when hard substrates that are considered part of the sturgeon critical habitat are altered or removed.

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 Wind Energy Area (Stein et al. 2004; Dunton et al. 2010).

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, nestling sex ratios, nesting habitat quality or availability, prey distribution or abundance, and availability of foraging habitat (Fuentes and Abbs 2010; Janzen 1994; Newson et al. 2009; Witt et al. 2010). Northward shifts in fish communities, including demersal finfish and shellfish, have been documented to occur concurrently with rises in sea surface temperature (Gaichas et al. 2015; Hare et al. 2016; Lucey and Nye 2010).

Ocean acidification is another major problem caused by the release of anthropogenic 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, along with applicant mitigation measures (AMM) (Table 3.3-1) and additional agency-proposed mitigation measures (Table 3.3-2) designed to minimize the impacts of the Proposed Action where applicable.

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*[4] effects are those that are extremely unlikely to occur. For an effect to be discountable, there must be a plausible adverse effect (i.e., a credible effect that could result from the action and that would be an adverse effect if it did 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

Exposure to high levels of underwater noise can affect ESA-listed species in the Action Area leading to the ESA-level takes of harm and/or harass. 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 include impact pile driving, vibratory pile driving, geotechnical and geophysical surveys, cable laying, dredging, UXO detonation, vessel activity, and WTG operations. These activities increase sound levels in the environment and may affect ESA-listed species in the Project area and Action Area. The sections that follow provide an overview of available information on ESA-listed species' hearing, the thresholds applied, and the results of the underwater noise modeling conducted. Discussions on the impact consequences for each potential underwater noise-generating activity for the Project are provided along with a summary of overall underwater noise effects to ESA-listed species in subsequent sections.

5.2.1 Underwater Noise Overview

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.

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

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).

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 2017a).

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

- Auditory thresholds for marine mammals (all activities): NMFS (2018b). Marine Mammal Acoustic Technical Guidance (2018) Revision to Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing, Office of Protected Resources, NOAA Technical Memorandum NMFS-OPR-59, April 2018.
- Non-auditory thresholds for marine mammals and sea turtles (UXO detonations): U.S. Department of the Navy (U.S. Navy) (2017a). Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III), June 2017. Thresholds for gastrointestinal and lung injury, and mortality for marine mammals and sea turtles due to explosive pressure based on impulse and peak pressure.
- Thresholds for fish (impact pile driving): Fisheries Hydroacoustic Working Group (FHWG) (2008). Agreement in Principle for Interim Criteria for Injury to Fish from Pile Driving Activities.
- Thresholds for fish (quantitative and qualitative; all activities): Popper et al. (2014). Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI Accredited Standards Committee S3/SC1 and registered with ANSI. ASA S3/SC1.4 TR-2014.
- Injury, impairment, and behavioral response thresholds for sea turtles developed for use by the U.S. Navy (Finneran et al. 2017) based on exposure studies (e.g., McCauley et al. 2000). Dual criteria (PK for peak sound pressure level and SEL for cumulative sound exposure level) 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 shock waves (from 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, SouthCoast 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:

- Denes, S.L., M.J. Weirathmueller, E.T. Küsel, K.E. Limpert, K.E. Zammit, and C.D. Pyć. 2021. Technical Report: Underwater Acoustic Modeling of Construction Sound and Animal Exposure Estimation for Mayflower Wind Energy LLC. Document 02185, Version 3.0 Revision 1. Technical report by JASCO Applied Sciences for AECOM.
- Limpert, K.E., S.C. Murphy, E.T. Küsel, H.P. Wecker, S.G. Dufault, K.E. Zammit, M.J. Weirathmueller, M.L. Reeve, and D.G. Zeddies. 2022. Mayflower Wind: Additional Underwater Acoustic Modeling Scenarios. Document 02772, Version 2.0. Technical report by JASCO Applied Sciences for LGL
- Li, Z. and S.L. Denes. 2020. Distances to Acoustic Thresholds for High Resolution Geophysical Sources: Mayflower Wind. Document 2239, Version 1.0. Technical memorandum by JASCO Applied Sciences for Mayflower Wind.
- Hannay, D.E. and M. Zykov. 2022. Underwater Acoustic Modeling of Detonations of Unexploded Ordnance (UXO removal) for Mayflower Wind Farm Construction. Document 02604, Version 4.2. Report by JASCO Applied Sciences for Mayflower Wind.

Definition of Take, Harm and Harass

Section 101(a) of the MMPA (16 USC 1361) prohibits persons or vessels subject to the jurisdiction of the U.S. from taking any marine mammal in waters or on lands under the jurisdiction of the U.S. or on the high seas (16 USC 1372(a) (l), (a)(2)). Sections 101(a)(5)(A) and (D) of the MMPA provide exceptions to the prohibition on take, which give NMFS (and USFWS) the authority to authorize the incidental but not intentional take of small numbers of marine mammals, provided certain findings are made and statutory and regulatory procedures are met. Under Section 3 of the MMPA, "take" of marine mammals is defined as "harass, capture, hunt, kill, or attempt to harass, capture, hunt, or kill any marine mammal." The incidental take of a marine mammal falls under three categories: mortality, serious injury, and harassment. Take authorizations divide underwater noise effects on marine mammals into Level A and Level B harassment categories. The MMPA requires that an incidental take authorization be obtained for the unintentional take of marine mammals incidental to specified activities other than commercial fishing. The MMPA defines Level A or Level B harassment as follows.

- Level A: Any act of pursuit, torment, or annoyance that has the potential to injure a marine mammal or marine mammal stock in the wild.
- Level B: Any act of pursuit, torment, or annoyance that has the potential to disturb a marine mammal or marine mammal stock in the wild by causing a disruption of behavioral patterns including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering but that does not have the potential to injure a marine mammal or marine mammal stock in the wild (16 USC 1362).

In this analysis, Level A harassment includes physiological impacts associated with PTS (auditory injury not leading to serious injury or mortality, and other non-auditory injury not leading to serious injury or mortality), whereas Level B harassment includes physiological impacts associated with TTS or behavioral effects.

5.2.2 Impact and Vibratory Pile Driving

Impact and vibratory pile driving would occur during construction to install WTG and OSP foundations (Section 3.1.2.3). Impact pile driving generates intense, impulsive underwater noise while vibratory pile driving generates non-impulsive, continuous 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.

To determine distances (exposure and acoustic ranges) to the established PTS and disturbance thresholds for marine mammals, sea turtles, and fish, acoustic source level, propagation, and animal movement modeling of the pile-driving activities for the Proposed Action was undertaken by JASCO Applied Sciences (Limpert et al. 2022). Sound generated during pile driving was modeled by characterizing the sound produced at the pile and then calculating how the sound propagates within the surrounding water column. Two types of piles representing the largest of potential foundation diameters in the PDE were modeled: 52-foot (16-meter) diameter monopiles and 15-foot (4.5-meter) diameter pin piles as part of the four-legged jacket foundations. Modeling was done for 146 WTGs and 3 OSPs. The acoustic modeling also included assumptions about the potential effectiveness of one or more NAS in reducing sounds propagated into the surrounding marine environment. Several recent studies summarizing the effectiveness of 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 (Buehler et al. 2015; Bellmann et al. 2020a). The use of one or more NAS is reasonably expected to achieve greater than 10 decibels broadband attenuation of impact pile driving sounds, therefore NAS performance of 10-decibel broadband attenuation was assumed when calculating ranges to threshold levels and potential exposures used in developing the total requested take. For comparison, exposure-based radial distance estimates assuming no attenuation, 6-decibel attenuation, and 15-decibel attenuation were also calculated with the full results available in the MMPA ITA application (LGL 2022).

Since sound transmission depends on many environmental parameters, such as the sound speeds in water and substrates, sound production parameters of the pile and how it is driven, including the pile material, size (length, diameter, and thickness), and the make and energy of the hammer, sound fields from the installation of piles were modeled using a theoretical 6,600- kilojoule impact hammer for monopiles and a Menck MHU 3500S impact hammer for pin piles. The sound fields were then modeled at two representative locations (L01 and L02) in the Project area (Figure 5.2-1). The locations were selected to represent the acoustic propagation environment with representative coverage of water depths within the Lease Area. At location L01, the water depth is approximately 174 feet (53 meters), while at location L02, the water depth is approximately 125 feet (38 meters).

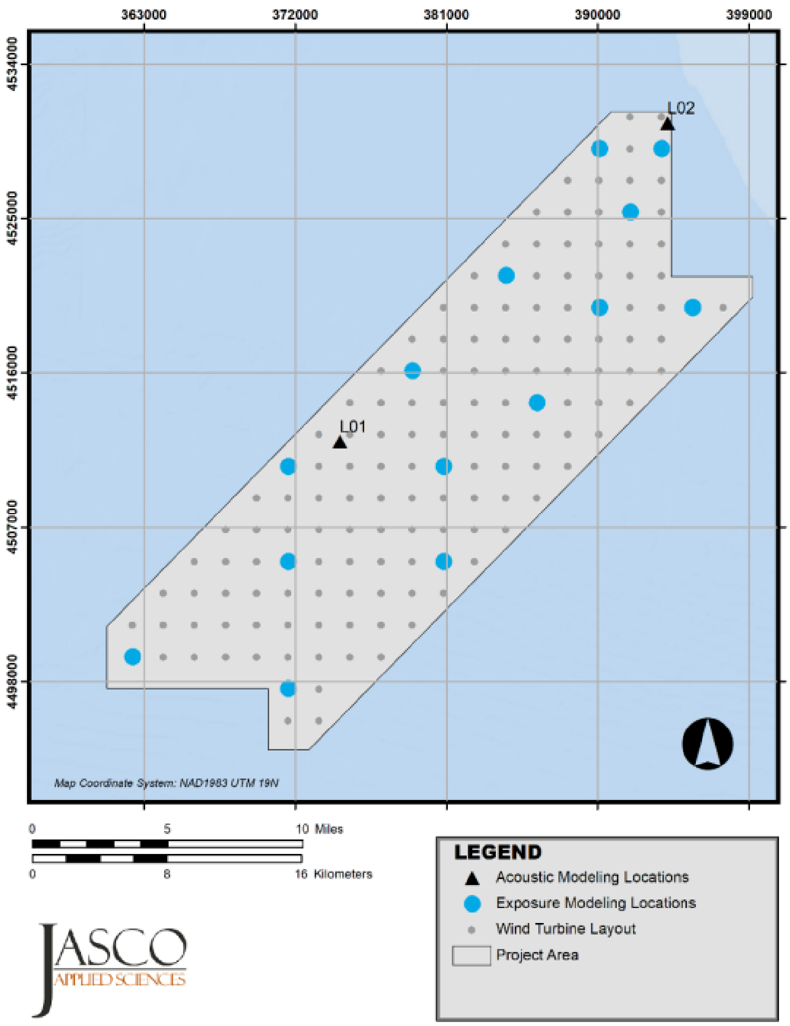


Figure 5.2-1. Locations of acoustic propagation and animal exposure modeling for WTG and OSP foundation installation

Acoustic and animal exposure modeling was also performed for 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 conducted for Scenarios 1 and 2 used separate sound speed profiles for "summer" months (April – November) and "winter" months (December – March). While modeling was conducted assuming installation from January through December, SouthCoast Wind does not intend to conduct pile driving activity from January 1 through April 30.

1. Scenario 1 – WTG monopiles, vibratory and impact piling with concurrent OSP installations

   - Consecutive installation of most WTG monopile foundations (9/16 meters) using vibratory and impact piling (108 monopiles); concurrent installation of OSP jacket foundations (32, 4.5 meter 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.

2. Scenario 2 – WTG piled jackets, vibratory and impact piling with concurrent OSP installations.
   - Consecutive installation of most (120) WTG jacket foundations (4, 4.5 meter pin piles per jacket) using vibratory and impact piling; concurrent installation of OSP jacket foundations (32, 4.5 meter 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 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 SouthCoast 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.

	Scenario 1		Scenario 2	
	WTG Monopiles	OSP Jackets	WTG Jackets	OSP Jackets
Foundations	146	3	147[1]	3
Piles per foundation	1	8-12	4	8-12
Pile Diameter (m)	9/16	4.5	4.5	4.5
Target Penetration Depth (m)	35	60	60	60
Maximum Hammer Energy (kJ)	6600	3500	3500	3500
Impact or Vibratory	Both	Impact	Both	Impact
Impact piling strikes per pile[2]	7000/5000	4000	4000/2667	4000
Impact piling duty cycle[2]	30	30	30	30
Piling duration (hours)	4	4	4	4
Piles Per Day	2	4	4	4
Total Pile Installation Days	146	8[4]	146	8[4]
Installation Years	2	2	2	2
Installation Months	May-Dec	Oct	May-Dec	Oct

m = meter; kJ = kilojoule
[1] The PDE covers a maximum of 149 positions for all foundations, but the modeling in Scenario 2 assumed one extra OSP to simulate noise from the largest possible number of jacket foundations (max of 147 WTGs allowed within the PDE, plus the 3 OSPs). This was not done for Scenario 1 as the original modeling assumed 2 monopiles per day, resulting in an even number of WTG foundations included in the scenario. Scenario 1 modeling may be updated in a future ITR application (SouthCoast Wind email communications, 8/9/2023).
[2] 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.
[3] Value shows the number of strikes per minute.
[4] The table in the ITR shows 7 for total pile installation days; this is an error and should be 8, which SouthCoast Wind will correct in a future ITR application (SouthCoast Wind email communications, 8/9/2023).

5.2.2.1 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 a 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.

To estimate radial distances to PTS thresholds (i.e., Level A harassment) for impact pile driving, NMFS (2018) hearing-group-specific, dual-metric thresholds for impulsive noise were used and marine mammal auditory weighting functions were applied. To estimate radial distances to behavioral thresholds, NMFS' impulsive noise threshold for Level B harassment under the MMPA was used (SPL_{RMS} of 160 dB re 1 μPa) (Table 5.2-2). 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 were 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[5] (e.g., bubble curtain system and an additional system). A 10 decibels 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).

Table 5.2-2. Marine mammal acoustic thresholds (dB) for impulsive and non-impulsive noise sources

	Injury - PTS			Impairment - TTS			Behavioral Disturbance	
Faunal Group	Impulsive L_{pk}	Impulsive L_E	Non-impulsive L_E	Impulsive L_{pk}	Impulsive L_E	Non-impulsive L_E	Impulsive L_p	Non-impulsive L_p
LFC	219	183	199	213	168	179	160	120
MFC	230	185	198	224	170	178	160	120

[5] The noise-abatement system implemented must be chosen, tailored, and optimized for site-specific conditions.

Faunal Group	Injury - PTS			Impairment - TTS			Behavioral Disturbance	
	Impulsive L_{pk}	Impulsive L_E	Non-impulsive L_E	Impulsive L_{pk}	Impulsive L_E	Non-impulsive L_E	Impulsive L_p	Non-impulsive L_p
HFC	202	155	173	196	140	153	160	120
PPW	218	185	201	212	170	181	160	120

dB = decibels; LFC = low-frequency cetaceans; MFC = mid-frequency cetaceans; HFC = high-frequency cetaceans; PPW = phocid pinnipeds (in-water); PTS = permanent threshold shift; TTS= temporary threshold shift
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}
Sources: GARFO 2020; NMFS 2018.

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" refers to acoustic modeling results that are based only on sound propagation modeling and not on animal movement modeling. Acoustic ranges assume receivers of the sound energy (i.e., 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 SPL_{pk} thresholds and the Level B SPL_{rms} threshold. For SEL_{cum} based thresholds, acoustic ranges represent the maximum distance at which a receiver would be exposed above the threshold level if it remained present within that range 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 was 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. This 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_{cum} threshold. Exposure ranges to injury (Level A SEL_{cum}) and behavioral (Level B SPL_{rms}) thresholds to noise from impact pile driving were calculated and are presented in Table 5.2-3 and Table 5.2-4, respectively. Sound exposure was modeled as described in Section 5.2.1 for Scenarios 1 and 2 assuming 10 decibels of attenuation in the summer and winter.

Effects of Noise Above the PTS Thresholds

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-decibel noise attenuation assumption included in the modeling (LGL 2022). For these results, all exposure ranges were larger in the winter than in the summer. For both fin whales and NARWs, the largest exposure ranges were 2.85 miles (4.60 kilometers) and 2.04 miles (3.28 kilometers), 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 2.21 miles (3.56 kilometers) under Scenario 1 (monopiles) with sequential impact-only installation methods. For all three LFCs (fin, NARW, and sei), 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 whales didn't accumulate enough exposure to reach the MFC threshold at any distance.

Table 5.2-3. Exposure ranges[1] (ER 95%) to injury (Level A [2]SEL_{cum}) thresholds for marine mammals during different scenarios of WTG and OSP impact pile driving under Scenarios 1 and 2, assuming 10 dB of noise attenuation

	Combined (impact + vibratory)		Concurrent (impact only)		Sequential (impact only)		
	Scenario 1	Scenario 2	Scenario 1	Scenario 2	Scenario 1	Scenario 2	Scenarios 1 & 2
	16 m WTG Monopile 2 piles/day	4.5 m WTG JPP 4 piles/day	16 m WTG Monopile and 4.5 m OSP JPP	4.5 m WTG JPP and 4.5 m OSP JPP	16 m WTG Monopile 2 piles/day	4.5 m WTG JPP 4 piles/day	4.5 m OSP JPP 4 piles/day
Exposure Ranges (km) during Winter							
Fin whale	4.60	2.56	—	—	4.55	2.55	3.5
NARW	3.28	1.78	—	—	3.27	1.85	2.13
Sei whale (migrating)	3.52	2.07	—	—	3.56	2.22	2.72
MFC (e.g., sperm whale)	0	0	—	—	0	0	0
Exposure Ranges (km) during Summer							
Fin whale	4.11	2.25	4.53	3.58	4.15	2.37	3.18
NARW	3.07	1.57	3.07	1.92	2.95	1.73	2.01
Sei whale (migrating)	3.13	1.84	3.44	2.41	3.19	1.96	2.59
MFC (e.g., sperm whale)	0	0	0	0	0	0	0

dB = decibel; km = kilometer; m = meter; NARW = North Atlantic right whale; MFC = mid-frequency cetacean
dash (—) = no results because potential concurrent installation would only occur in the summer months
[1] Exposure ranges are a result of animal movement modeling
[2] SEL_{cum} = weighted cumulative sound exposure level in dB referenced to 1 microPascal squared second; also written L_E
Source: Summarized from Tables 20 – 24 in MMPA Application (LGL 2022)

Acoustic Masking and Other Effects of Noise Above Behavioral Thresholds

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 1.86 miles (3 kilometers) 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 (i.e., animals moving rapidly away from the source) (Watkins et al. 1993), decreased vocal activity, and disruption in foraging patterns (Goldbogen et al. 2013).

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 kilohertz (LGL 2022). The short-term consequences of masking from Project activities range from temporary changes in vocalizations to avoidance. 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, then 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 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.

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_{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 hertz) forces to the pile. Based on empirical measurements of pile driving sounds, there appears to be little risk for hearing impairment to marine mammals from vibratory pile driving, given the sound levels from vibratory pile driving are not expected to exceed 165 dB re 1 µParms beyond 10 m (Illingworth and Rodkin 2007, 2017). Although the overall sound levels associated with vibratory hammering are typically lower than impact hammering, the lower behavioral disturbance threshold (120 dB re 1 µPa SPL_{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. Distances to injury thresholds for marine mammals, however, are shorter for non-impulsive sounds when compared to impulsive sounds (Matthews et al. 2018). Thus, it is unlikely that marine mammals would be exposed to vibratory pile driving at a sufficiently high level for a sufficiently long period to cause more than mild TTS.

For vibratory pile driving, the largest unweighted acoustic range was 52.59 miles (84.63 kilometers) under Scenario 1 (monopiles) in the winter, while the smallest unweighted acoustic range was 9.84 miles (15.83 kilometers) under Scenario 2 (jacket pin piles) in the summer. Distances to Level B harassment thresholds for each hearing group was also calculated for Scenarios 1 and 2. Individuals remaining within these distances from pile driving over 24 hours could experience behavioral effects without additional mitigation beyond the assumed 10-decibel noise attenuation included in the modeling (LGL 2022). For these results, acoustic ranges were larger in the winter than in the summer. Under Scenario 1 (monopiles), LFC within 5.31 miles (8.55 kilometers) of active impact pile driving could experience behavioral effects, while MFC could experience behavioral effects within 1.72 miles (2.77 kilometers). Under Scenario 2 (jacket pin pile), LFC within 2.72 miles (4.37 kilometers) of active impact pile driving could experience behavioral effects, while MFC could experience effects within 1.09 miles (1.75 kilometers).

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

Faunal Group	Vibratory (120 dB SPL_{rms})		Impact (160 dB SPL_{rms})		
	Scenario 1	Scenario 2	Scenario 1	Scenario 2	Scenarios 1&2
	16 m WTG Monopile 2 piles/day	4.5 m WTG JPP 4 piles/day	16 m WTG Monopile 2 piles/day	4.5 m WTG JPP 4 piles/day	4.5 m OSP JPP 4 piles/day
Acoustic Ranges (km) to Behavioral Thresholds during Winter					
Unweighted	84.63	21.92	8.63	4.41	5.24
LFC (e.g., fin, sei, NARW)	—	—	8.55	4.37	5.19
MFC (e.g., sperm whale)	—	—	2.77	1.75	2.17
Acoustic Ranges (km) to Behavioral Thresholds during Summer					
Unweighted	42.02	15.83	7.44	4.18	4.88
LFC (fin, sei, NARW)	—	—	7.36	4.14	4.84
MFC (sperm whale)	—	—	2.67	1.71	2.12

dB = decibel; km = kilometer; m = meter; LFC = low-frequency cetaceans; MFC = mid-frequency cetaceans; NARW = North Atlantic right whale;
dash (—) = frequency weighted results for vibratory pile driving are not available.
SPL_{RMS} = root mean squared sound pressure level in dB referenced to 1 microPascal squared; also written L_p or L_{rms}
Source: Summarized from Table 19 in MMPA Application (LGL 2022)

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 (monopiles) with 10 decibels of noise attenuation. Estimates for individuals exposed to Level A injury thresholds under Scenario 2 (jacket pin piles) were similar, with 20 fin whales, 8 NARW, and 5 sei whales exposed. For Level B exposures under Scenario 1, it was estimated that 1 blue whale, 614 fin whales, 179 NARWs, 85 sei whales, and 150 sperm whales could be exposed to an individual sound pressure level (SPL_{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, which suggests that WTGs with jacket pin piling may cause reduced behavioral impacts compared to those caused by monopile WTGs. It is important to note that the exposure estimates are calculated in the absence of the proposed monitoring and mitigation measures (Section 3.3) which are designed to prevent most Level A and B exposures.

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.

	Exposure Estimates (# individuals)			
	Scenario 1: 146 WTG Monopiles and 32 OSP Jacket pin piles		Scenario 2: 588 WTG Jacket pin piles and 32 OSP Jacket pin piles	
Species	Total Level A (SEL_{cum})	Total Level B (SPL_{rms})	Total Level A (SEL_{cum})	Total Level B (SPL_{rms})
Blue whale	0	1	0	1
Fin whale	25	614	20	282
NARW	8	179	8	124
Sei whale	5	85	5	55
Sperm whale	0	150	0	85

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

Considering the results of the underwater noise modeling and the large radial distances to PTS and behavioral thresholds, individual fitness-level impacts could occur due to pile driving activities. To help mitigate these impacts, SouthCoast Wind and BOEM have proposed several measures to avoid and/or minimize impacts of pile driving noise on marine mammals (Section 3.3, Table 3.3-1 and Table 3.3-2). These include the utilization of protected species observers and PAM system to monitor and enforce appropriate monitoring and exclusion zones (AMM-1 to AMM-16, AMM-20, BA-11, BA-15, BA-22, BA-25), soft-start procedures (AMM-17) to deter marine mammals from pile driving activities, shutdown zones (AMM-18 to AMM-20, BA-20), and noise-reduction technologies (AMM-21, BA-24).

Noise abatement systems (NAS), can be particularly effective in reducing the overall acoustic energy that is introduced in the environment and have shown that broadband sound levels can likely be reduced by 7 to 17 dB, depending on the environment, pile size, and configuration of the systems used (Buehler et al. 2015, Bellman et al. 2020). While the type and number of NAS to be used during construction have not yet been determined, it can be expected that a combination of systems (e.g., double big bubble curtain, hydrosound damper plus single bubble curtain) are reasonably expected to achieve more than a 10-decibel broadband attenuation from impact pile driving sounds, so exposures will likely be lower than the modeled results.

SouthCoast Wind has proposed nighttime pile driving (Section 3.1.2.3.2) to complete installation within as few years as possible during the multi-year installation campaign. As outlined in the MMPA ITA, piling during the night would reduce the total duration of construction activities, limit crew transfers and vessel trips, and concentrate construction during the time of the year when NARW are less likely to be present (May 1 through December 31), thereby, reducing the overall potential impact on this species. During these periods of low visibility, nighttime monitoring will employ the best currently available technology that can reliably monitor clearance and shutdown zones to mitigate potential impacts. Monitoring methods will include the use of night vision equipment (e.g., night vision goggles) and infrared/thermal imaging technology.

Recent studies have concluded that the use of infrared/thermal imaging technology allow for the detection of marine mammals at night (Verfuss et al. 2018). Guazzo et al. (2019) showed that the probability of detecting a large whale blow by a commercially available infrared camera was similar during night and day; camera monitoring distance was 1.3 miles (2.1 kilometers) from an elevated vantage point at night versus 1.9 miles (3 kilometers) for daylight visual monitoring from the same location. Advancements in nighttime detection such as the use of electro-optical and infrared (EO/IA) thermal imaging coupled with visual and passive acoustic monitoring have been demonstrated to reliably monitor regulated zones in different environmental conditions, which lends a viable option in monitoring protected species during nighttime operations (ThayerMahan, 2023). A NPDP will be submitted to BOEM and NMFS for review prior to any nighttime pile driving activity (BA-15, Table 3.3-2). The NPDP will describe the methods, technologies, and mitigation requirements for any nighttime pile driving activities. The NPDP should sufficiently demonstrate the efficacy of the alternative technologies and methods in monitoring the full extent of clearance and shutdown zones in order to obtain approval for nighttime pile driving activities. In the absence of an approved NPDP, nighttime pile driving would only occur if unforeseen circumstances prevented the completion of pile driving during daylight hours and it was deemed necessary to continue piling during the night to protect asset integrity or safety.

Since visual observations can become impaired at night or during daylight hours due to fog, rain, or high sea states, visual monitoring with thermal and night vision devices (NVDs) will be supplemented by a real-time PAM system during these periods. The use of PAM (or alternative) will supplement visual observations during pre-clearance and pile driving periods and allow initiation of pile driving when visual PSOs cannot observe the entire clearance zone due to poor visibility. 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 Pile-Driving Monitoring (PDM) Plan will be submitted to BOEM, BSEE, and NMFS for review, which will describe the visual and PAM components including all equipment, procedures, and protocols (BA-17). The PAM system will be designed to detect vocalizations from all marine mammals potentially present in the region, including low-frequency cetaceans such as NARW and fin whale, and should demonstrate detection capability in monitoring the full extent of the 160-decibel distance from the pile driving location.

Shutdown procedures will also be implemented should a marine mammal be detected entering within the respective shutdown zone. Shutdown zones, as presented in Table 3.3-1 and in the MMPA ITA, are based on the Level A exposure ranges with 10-decibel noise attenuation for Scenarios 1 and 2. The shutdown zones, ranging from 656 to 13,123 feet (200 to 4,000 meters), 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 a 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 and likely to result in smaller maximum distances to the Level A harassment isopleths. 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. An Acoustic Protected Species Observer (APSO) will be conducting acoustic monitoring in coordination with the visual PSOs, during all pre-start clearance, piling, and post-piling monitoring periods (daylight, reduced visibility, and nighttime monitoring).

Additional measures will be implemented to further reduce the potential effects of pile driving activities to NARWs. These include seasonal pile-driving restrictions that prohibits pile driving between January 1 and April 30 (AMM-22, BA-14). Agency-proposed time-of-year restrictions will also be implemented in the enhanced mitigation area near Nantucket Shoals (NS-4) wherein pile driving can only occur between June 1 to October 31 when NARW density is at its lowest, ensuring that no NARW are exposed to injurious levels of noise from pile driving activity (Section 3.3, Table 3.3-2). Implementing seasonal restrictions in the enhanced mitigation area is particularly crucial in minimizing the effects of Project activities that may occur near Nantucket Shoals, a known area of primary productivity and NARW winter foraging ground.

While 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, the implementation of a 30-minute pre-start clearance period where the shutdown zones are monitored will limit the potential for behavioral disturbance to all ESA-listed marine mammal species. SouthCoast Wind plans to implement a sound verification plan to allow for adaptive monitoring and the adjustment of these clearance zones, as needed, based on reported measurements (AMM-13 and MA-4). If a marine mammal were exposed to underwater noise above behavioral thresholds, it could result in displacement from a localized area around a pile. However, this displacement would be temporary for the duration of activity, which would be a maximum of four hours per pile, for two piles per day, with a four-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.

Overall, the potential for serious injury is minimized by the strict implementation of the mitigation measures as discussed above. Slight PTS (i.e., minor degradation of hearing capabilities at some hearing thresholds) may be expected but as the shutdown and clearance zones would cover the largest PTS zone of influence, the likelihood of exposure leading to PTS would be greatly reduced. Given a marine mammal's transient nature and ability to move away from noise disturbance, the potential for exposure to noise levels leading to behavioral disruption would also be reduced at the level of the individual animal and would not be expected to have population level effects.

As outlined in Table 5.2-5, no PTS (Level A) exposures are expected for blue whales and sperm whales, while exposures leading to PTS or auditory injury (Level A) are anticipated for fin whales, NARW, and sei whales in the absence of mitigation measures beyond the use of a10 dB NAS. However, with the implementation of the described mitigation and monitoring efforts, the likelihood of auditory injury would be reduced to the point of being **discountable.** Exposures leading to behavioral disturbance (Level B) are anticipated for blue whales, fin whales, NARWs, sei whales, and sperm whales. However, monthly average densities for blue whales within 10 kilometers of the Lease Area were zero year-round; since they are extremely unlikely to occur in the Project area, noise effects for blue whale are **discountable**. Given the anticipated Level B exposures for the remaining species in Table 5.2-5, behavioral impacts from pile driving cannot be discounted. Therefore, noise exposure from Project pile driving leading to behavioral disturbance **may affect, likely to adversely affect** fin whales, NARWs, sei whales, and sperm whale.

5.2.2.2 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 displacement are expected to be small. However, 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) based on the behavioral threshold recommended in the GARFO acoustic tool (GARFO 2020). As described in Section 5.2.2.1, modeling was performed under two scenarios: 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 injury or impairment when mitigated with 10-decibel broadband noise attenuation.

Table 5.2-6. Sea turtle acoustic thresholds (dB) for impulsive and non-impulsive noise sources

Faunal Group	Injury - PTS			Impairment - TTS			Behavioral Disturbance
	Impulsive L_{pk}	Impulsive L_E	Non-impulsive L_E	Impulsive L_{pk}	Impulsive L_E	Non-impulsive L_E	Impulsive L_p
Sea turtles	232	204	220	226	189	200	175

dB = decibels; PTS = permanent threshold shift; TTS= temporary threshold shift
L_{pk} = peak sound pressure level in decibels referenced to 1 microPascal squared; also written as SPL_{pk}
L_E = weighted cumulative sound exposure level in decibels referenced to 1 microPascal squared second; also written SEL_{cum}
L_p = root mean squared sound pressure level in decibels referenced to 1 microPascal squared; also written SPL_{rms} or L_{rms}
Sources: Table 15 MMPA ITA (Limpert et al. 2022 ; Finneran et al. 2017; McCauley et al. 2000)

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 0.62 miles (1 kilometers) (Table 5.2-7). 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) and the concurrent (impact only) installation during summer under Scenario 1 had the largest exposure ranges overall. The leatherback turtle had the largest exposure ranges compared to the other sea turtle species, from 0.23 – 0.62 miles (0.37 – 0.99 kilometers). The next largest exposure ranges were calculated for the green turtle, with exposure to injury ranges from < 0.006 – 0.37 miles (0.01 – 0.60 kilometers). The Kemp's ridley turtle had small exposure ranges, from 0 – 0.24 miles (0 – 0.39 kilometers), and the loggerhead turtle had the smallest exposure ranges from 0 – 0.14 miles (0 – 0.22 kilometers). Depending on species, sea turtles that remain within < 0.006 – 0.62 miles (0.01 – 0.99 kilometers) of pile driving over 24 hours could experience PTS, assuming 10 decibels of noise attenuation (Table 5.2-7).

Table 5.2-7. Exposure ranges to injury ([1]SEL_{cum}) thresholds for sea turtles during different scenarios of impact pile driving under Scenarios 1 and 2, assuming 10 dB of noise attenuation

Species	Combined (impact + vibratory)		Concurrent (impact only)		Sequential (impact only)		
	Scenario 1	Scenario 2	Scenario 1	Scenario 2	Scenario 1	Scenario 2	Scenarios 1&2
	16 m WTG Monopile 2 piles/day	4.5 m WTG JPP 4 piles/day	16 m WTG Monopile and 4.5 m OSP JPP	4.5 m WTG JPP and 4.5 m OSP JPP	16 m WTG Monopile 2 piles/day	4.5 m WTG JPP 4 piles/day	4.5 m OSP JPP 4 piles/day
Exposure Ranges (km) during Winter							
Kemp's ridley turtle	0.39	0	—	—	0.39	0	0.13
Leatherback turtle	0.96	0.39	—	—	0.96	0.37	0.57
Loggerhead turtle	0.14	0	—	—	0.14	0	0
Green turtle	0.60	< 0.01	—	—	0.55	0.15	0.15
Exposure Ranges (km) during Summer							
Kemp's ridley turtle	0.39	0	0.45	0.03	0.39	0	0.13
Leatherback turtle	0.89	0.39	0.99	0.45	0.89	0.37	0.57
Loggerhead turtle	0.02	0	0.22	0	0.13	0	0
Green turtle	0.55	< 0.01	0.57	0.20	0.55	0.15	0.15

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
[1] SEL_{cum} = weighted cumulative sound exposure level in decibels referenced to 1 microPascal squared second; also written L_E
Source: Summarized from Tables 32 – 38 and H-43 through H-56 in Appendix A of the MMPA Application (Limpert et al. 2022)
Density estimates are derived from the Strategic Environmental Research and Development Program – Spatial Decision Support System (Kot et al 2018).
Density estimates for leatherback sea turtles during the summer are averaged seasonal densities from 2011 to 2015 (Kraus et al. 2016).
Density estimates for loggerhead sea turtles during the summer were 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).
Densities of Kemp's ridley sea turtles are used for green sea turtles, as Kraus et al. 2016 did not observe any green sea turtles in the Lease Area.

In addition to exposure ranges calculated with animal movement, the potential effects of sound were also summarized as acoustic radial distances, which are the distances over which at least 95 % of the horizontal area that would be exposed to sound at or above the specified level occurred, assuming no animal movement (i.e., static receiver). Based on the modeled results at Location 1, pile driving sound levels could exceed cumulative injury thresholds for a "static receiver" sea turtle that remained within 1.37 – 1.43 miles (2.2 – 2.3 kilometers) of the sound over 24 hours with 10-decibel noise attenuation during monopile driving, and 0.81 miles (1.3 kilometers) during pin pile driving (Table 5.2-8). At Location 2, the radial distances to cumulative injury thresholds were about 1.12 miles (1.8 kilometers) for monopile driving and 0.75 miles (1.2 kilometers) for jacket pin-pile driving. Sound levels could exceed behavioral thresholds for a "static receiver" sea turtle during monopile driving with 10 dB of noise attenuation within 1.18 – 1.24 miles (1.9 – 2.0 kilometers) at Location 1 and 0.99 – 1.06 miles (1.6 – 1.7 kilometers) at Location 2. Sound levels could exceed behavioral thresholds within about 0.43 miles (0.7 kilometers) during jacket pin-piling with 10-decibel noise attenuation at both locations. Additionally, acoustic distances were slightly higher in the winter than in the summer at both locations.

Table 5.2-8. Summary of acoustic radial distances (R95% in kilometers) for sea turtles 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

Scenario	Location 1			Location 2		
	Injury [a] L_{pk}	Injury [a] L_E	Behavior [b] L_p	Injury [a] L_{pk}	Injury [a] L_E	Behavior [b] L_p
Range (km) during Winter						
16 m Monopile Scenario, NNN 6600 (b) hammer	–	2.27	2.00	–	1.82	1.68
4.5 m Post-pile Jacket Scenario, MHU 3500S (b) hammer	–	1.30	0.73	–	1.22	0.73
Range (km) during Summer						
16 m Monopile Scenario, NNN 6600 (b) hammer	–	2.19	1.92	–	1.75	1.61
4.5 m Post-pile Jacket Scenario, MHU 3500S (b) hammer	–	1.30	0.72	–	1.18	0.72

km = kilometer; m = meter; dB = decibel
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}
(–) dash indicates that distances could not be calculated because thresholds were not reached.
[a] Finneran et al. (2017)
[b] McCauley et al. (2000)
Source: Summarized from Tables 39 – 42 in Limpert et al. (2022)

The same exposure modeling was also used to estimate the number of individuals of each ESA-listed species that could be exposed to injury and behavioral effects from pile driving. The results show that 4 leatherback sea turtles and < 0.5 each of Kemp's ridley, loggerhead, and green sea turtles may be exposed to sound levels exceeding recommended injury thresholds (SEL_{cum} or L_E) under Scenario 1 (monopile WTGs) assuming 10 decibels of noise attenuation (Table 5.2-9). Estimated exposures were lower under Scenario 2 (jacket pin pile WTGs), with just 1 leatherback sea turtle, < 0.5 Kemp's ridley and green sea turtles, and 0 loggerhead sea turtles exposed to sound levels exceeding injury thresholds. For behavioral effects under Scenario 1 (monopiles), 7 leatherback turtles and 5 loggerhead turtles may be exposed to sound exceeding behavioral thresholds (SPL_{rms} or L_p), while both Kemp's ridley and green sea turtles may have fewer than 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 as Scenario 1 (< 0.5 individuals), while 3 leatherback and 6 loggerhead sea turtles may be exposed. Generally, exposures were much lower under Scenario 2 (jacket pin piles) than in Scenario 1 (monopile), suggesting that WTGs with jacket pin piling may cause lower behavioral and injurious levels of disturbance than monopile driving. Again, there were no sea turtles exposed to sound levels from a single pile driving event that exceeded injury thresholds (SPL_{pk} or L_{pk}). In addition, these exposure estimates do not consider potential behavioral avoidance or the use of PSOs, shutdown procedures, and other mitigation measures beyond the 10 dB noise attenuation applied during modeling, and are thus, considered conservative estimates of exposure.

Table 5.2-9. 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.

	Exposure Estimates (# individuals)					
	Scenario 1: 146 WTG Monopiles and 32 OSP Jacket pin piles			Scenario 2: 588 WTG Jacket pin piles and 32 OSP Jacket pin piles		
	Injury		Behavior	Injury		Behavior
Species	L_{pk}	L_E	L_p	L_{pk}	L_E	L_p
Kemp's ridley turtle	0	< 0.5	< 0.5	0	< 0.5	< 0.5
Leatherback turtle	0	4	7	0	1	3
Loggerhead turtle	0	< 0.5	5	0	0	6
Green turtle	0	< 0.5	< 0.5	0	< 0.5	< 0.5

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.
Density estimates are derived from the Strategic Environmental Research and Development Program – Spatial Decision Support System (Kot et al 2018).
Density estimates for leatherback sea turtles during the summer are averaged seasonal densities from 2011 to 2015 (Kraus et al. 2016).
Density estimates for loggerhead sea turtles during the summer were 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).
Densities of Kemp's ridley sea turtles are used for green sea turtles, as Kraus et al. 2016 did not observe any green sea turtles in the Lease Area.

potential for injury and behavioral disturbance is minimized by implementing a range of mitigation measures proposed by SouthCoast Wind and BOEM (Section 3.3, Table 3.3-1 and Table 3.3-2). These measures include the implementation of pre-clearance (AMM-16, BA-15), shutdown zones (AMM-18, BA-20, BA-32), and ramp-ups (AMM-17, BA-18) that would facilitate a delay of pile driving if turtles were observed approaching. Active visual monitoring (AMM-1 to AMM-5, AMM-7 to AMM-14, BA-15 to BA-17, BA-19 to BA-21) of the zone of influence (1,640 feet [500 meters]) is considered highly effective in mitigating cumulative PTS effects for sea turtles.

As stated in Section 3.1.2.3.2, pile driving may occur during nighttime hours. During these periods of low visibility, nighttime monitoring will use the best currently available technology that can reliably monitor clearance and shutdown zones to mitigate potential impacts (AMM-9, BA-15). Visual monitoring with thermal and NVDs will be supplemented by PAM during impaired visibility at night or during daylight hours due to fog, rain, or high sea states. An APSO will be conducting acoustic monitoring, in coordination with the visual PSOs, during all pre-start clearance, piling, and post-piling monitoring periods (daylight, reduced visibility, and nighttime monitoring). A Nighttime Pile Driving Plan (NPDP) will be submitted to BOEM and NMFS for review prior to any nighttime pile driving activity (BA-15, Table 3.3-2). The NPDP will describe the methods, technologies, and mitigation requirements for any nighttime pile driving activities. The NPDP should sufficiently demonstrate the efficacy of the alternative technologies and methods in monitoring the full extent of clearance and shutdown zones in order to obtain approval for nighttime pile driving activities. In the absence of an approved NPDP, nighttime pile driving would only occur if unforeseen circumstances prevented the completion of pile driving during daylight hours and it was deemed necessary to continue piling during the night to protect asset integrity or safety.

The implementation of noise-reduction technologies such as bubble curtains or a combination of systems (e.g., double big bubble curtain, hydrosound damper plus big bubble curtain) can also greatly reduce impact pile driving sounds (AMM-21, BA-24). 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 impact pile driving can only commence when the pre-clearance zones are fully visible to PSOs (AMM-16 to AMM-17) allows a high sea turtle detection capability and enables a high rate of success in implementation of these zones to avoid disturbance. These mitigation measures lower the likelihood for any ESA-listed turtle to be exposed to impact pile driving noise that would result in severe hearing impairment or serious injury.

Both injury and behavior exposures are expected to be negligible (< 0.5 individuals) for Kemp's ridley and green sea turtles due to their rarity in the area. The potential for PTS and behavioral disturbance for these two species is considered extremely unlikely to occur and is **discountable**. Impacts at the population level are not anticipated, given the low density of turtles in the Project area and the localized nature of noise impacts. Therefore, exposures leading to PTS or behavioral disturbance **may affect, not likely to adversely affect** Kemp's ridley and green sea turtles. Similarly for loggerheads, < 0.5 individuals will be exposed to cumulative exposures leading to PTS, which makes injury very unlikely and **discountable** for loggerhead sea turtles.

However, up to six individual loggerhead sea turtles could be exposed to noise above behavioral thresholds even with 10 decibels of noise attenuation, as reported in Table 5.2-9. A small number of individual leatherback sea turtles may be exposed to noise levels above PTS and behavioral thresholds if they remain near the sound source for 24 hours. Modeling indicates that up to four individual leatherback sea turtles may be exposed to cumulative pile driving noise above PTS thresholds and up to seven individuals may be exposed to pile driving noise above behavioral thresholds from the assumed combinations of impact and vibratory pile driving-generated sounds. It is likely that the pre-clearance zone (1,640 feet [500 meters]) would cover the behavioral disturbance zone; however, as the maximum acoustic radial distances leading to behavioral disturbance (e.g., ≥ 1.24 miles [2 kilometers]) exceeds the pre-clearance zone, increasing the clearance and shutdown zones and the adaptive refinement of pile-driving monitoring protocols through the Sound File Verification Plan (SFVP) will be necessary to sufficiently mitigate any potential Level A and Level B harassment (AMM-14, BA-19, BA-20, MA-4).

While the mitigation and monitoring measures and the animal's ability to avoid areas of loud construction noise are expected to decrease the potential impacts of these ESA-listed species to underwater noise, anticipated exposures above behavioral thresholds cannot be discounted loggerhead and leatherback sea turtles that are more common in the area. In addition, up to four leatherback sea turtles may be exposed to noise levels above PTS thresholds during monopile impact pile driving. Therefore, the effects of noise exposure from Project pile driving leading to PTS and behavioral disturbance **may affect, likely to adversely affect** leatherback and loggerhead sea turtles.

5.2.2.3 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 acoustic 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 5.2-10). 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). While ESA-listed fish evaluated in this BA (i.e., subadult and adult Atlantic sturgeon) is categorized as both “fish larger than 2 grams” and “fish having a swim bladder not involved in hearing”, as a conservative measure, acoustic thresholds for the Atlantic sturgeon in this BA were based on “fish larger than 2 grams”.

Table 5.2-10. Fish acoustic thresholds for impulsive noise sources

Fish Group	Physiological Effects		Behavioral Disturbance
	Impulsive L_{pk}	Impulsive L_E	Impulsive L_p
Fish ≥ 2 grams[a]	206	187	150
Fish < 2 grams[a,b]	206	183	150
Fish without swim bladder[c]	213	216	150
Fish with swim bladder not involved in hearing[c]	207	203	150
Fish with swim bladder involved in hearing[c]	207	203	150

Note: NMFS does not have physical injury thresholds for non-impulsive sources, except tactical sonar
dB = decibels; PTS = permanent threshold shift; TTS= temporary threshold shift
L_{pk} = peak sound pressure level in decibels referenced to 1 microPascal squared; also written as SPL_{pk}
L_E = weighted cumulative sound exposure level in decibels referenced to 1 microPascal squared second; also written SEL_{cum}
L_p = root mean squared sound pressure level in decibels referenced to 1 microPascal squared; also written SPL_{rms} or L_{rms}
Sources:
[a] NMFS recommended criteria adopted from the Fisheries Hydroacoustic Working Group 2008;
[b] Andersson et al. (2007), Mueller-Blenkle et al. (2010), Purser and Radford (2011), Wysocki et al. (2007)
[c] Popper et al. 2014

To estimate radial distances to behavioral thresholds for fish, thresholds developed by the NMFS Greater Atlantic Regional Fisheries Office (Table 5.2-10; Mueller-Blenkle et al. 2010; Purser and Radford 2011; Wysocki et al. 2007) were used in modeling that assumed no animal movement (Limpert et al. 2022). Although some fish may move away from sound during pile driving, for modeling purposes they were considered static receivers. Therefore, 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 5.2.2.1.

Based on model results, the distance to pile driving sound levels that could exceed recommended Atlantic sturgeon injury thresholds (fish ≥ 2 grams = 206 decibel SPL_{pk}) is 0.09 miles (0.15 kilometers) for single strikes and within up to 6.03 miles (9.7 kilometers) for cumulative exposure (187 decibels SEL_{cum}) during monopile driving, assuming 10 dB of noise attenuation (Table 5.2-11). During pin pile driving, the distance to pile driving sound levels that could exceed recommended Atlantic sturgeon injury thresholds (206 decibel SPL_{pk}) is 0.04 miles (0.06 kilometers) for single strikes and within up to 5.28 miles (8.5 kilometers) for cumulative exposure (187 decibels SEL_{cum}) with 10 dB of noise attenuation. Based on these results, to be exposed to potentially injurious levels of noise during pile driving, the Atlantic sturgeon would need to be within 5.28 to 6.03 miles (8.5 to 9.7 kilometers) of the pile being driven for a prolonged period. This is unlikely to occur as the Atlantic sturgeon would be expected to quickly move away from the ensonified area before injury levels are reached.

Table 5.2-11. Summary of acoustic radial distances (R95% 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

Fish ≥ 2 grams	Location 1			Location 2		
	Injury [a] L_{pk}	Injury [a] L_E	Behavior [b] L_p	Injury [a] L_{pk}	Injury [a] L_E	Behavior[b] L_p
Range (km) during Winter						
16 m Monopile Scenario, NNN 6600 (b) hammer	0.15	9.68	17.22	0.11	7.69	12.35
4.5 m Post-pile Jacket Scenario, MHU 3500S (b) hammer	0.06	8.21	13.02	0.06	6.30	11.07
Range (km) during Summer						
16 m Monopile Scenario, NNN 6600 (b) hammer	0.14	8.50	13.86	0.11	6.51	9.69
4.5 m Post-pile Jacket Scenario, MHU 3500S (b) hammer	0.06	7.34	10.99	0.06	5.48	8.34

km = kilometer; m = meter; dB = decibel
L_{pk} = peak sound pressure level in decibels referenced to 1 microPascal squared; also written as SPL_{pk}
L_E = weighted cumulative sound exposure level in decibels referenced to 1 microPascal squared second; also written SEL_{cum}
L_p = root mean squared sound pressure level in decibels referenced to 1 microPascal squared; also written SPL_{rms} or L_{rms}
Sources:
[a] NMFS recommended criteria adopted from the Fisheries Hydroacoustic Working Group (FHWG 2008).
[b] Andersson et al. (2007), Mueller-Blenkle et al. (2010), Purser and Radford (2011), Wysocki et al. (2007).
[c] Popper et al. (2014).
Source: Summarized from Tables 39 – 44 in Limpert et al. (2022)

Behavioral effects, such as avoidance or disruption of foraging activities, may occur in sturgeon exposed to noise above 150 decibels SPL_{rms}. Sound levels could exceed this behavioral threshold within 6.03 – 10.69 miles (9.7 – 17.2 kilometers) of monopile driving and within 5.16 – 8.08 miles (8.3 – 13.0 kilometers) of pin pile driving, assuming 10 dB of noise attenuation, and depending on season and location (lower exposure ranges at L02 and in summer, and higher at L01 and in winter). It is reasonable to assume that the Atlantic sturgeon, upon detecting underwater noise levels at or above these thresholds, would modify its behavior such that it redirects its course of movement away from the ensonified area surrounding the activity.

SouthCoast Wind and BOEM will implement measures to avoid, minimize, and mitigate impacts of pile-driving noise on fish (Section 3.3, Table 3.3-1 and Table 3.3-2). The implementation of soft-start procedures (AMM-17) would minimize the potential for exposure leading to injury or behavioral disturbance. Soft starts would facilitate a gradual increase of hammer blow energy and would be effective in deterring Atlantic sturgeon from impact pile driving activities prior to exposure that would result in serious injury. 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 (BA-18). Agency-proposed measures include a sound field verification plan to allow for adaptive monitoring and the adjustment of clearance zones, as needed, based on reported field measurements (MA-4). The potential for serious injury is also minimized by using a noise attenuation system (NAS) during all impact pile-driving operations. A combination of NAS (e.g., double big bubble curtain, hydrodsound damper plus single big bubble curtain) are reasonably expected to achieve far greater than 10 dB broadband attenuation of impact pile driving sounds. 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 will likely be present intermittently, moving through the Lease Area throughout their spring and fall migrations, and may forage opportunistically where benthic invertebrates are present. The Project area is not known to be a preferred foraging area and has not been identified as an aggregation area which reduces the potential for impact on this species from pile driving noise. Atlantic sturgeon could be exposed to noises above behavioral thresholds and may avoid the area; however, access to preferred foraging, spawning or overwintering areas would not be affected, 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. Any behavioral effects would be temporary and limited to the small area ensonified with sound levels above the behavioral threshold.

Given the dispersed distribution of Atlantic sturgeon in the Lease Area, the extremely unlikely potential for co-occurrence in time and space given the small area where exposure to peak noise could occur, and the anticipated avoidance of disturbing levels of sound, effects of exposure to sound levels above injury or behavioral thresholds is considered **discountable**. Therefore, the effects of noise exposure from Project impact pile driving leading to injury or behavioral disturbance **may affect**, **not likely to adversely affect** ESA-listed Atlantic sturgeon.

5.2.3 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.

During construction, it is estimated that 2,485.5 miles (4,000 kilometers) of HRG surveys will occur within the Lease Area and 3,106.8 miles (5,000 kilometers) will occur along the ECCs. Assuming 50 miles (80 kilometers) 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 702.1 square miles (1,130 square kilometers) in the Lease Area and 877.7 square miles (1,413 square kilometers) 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 1,739.8 miles (2,800 kilometers) of HRG surveys will occur within the Lease Area and 1,988.4 miles (3,200 kilometers) will occur within the ECCs. Assuming 50 miles (80 kilometers) is surveyed per day, this 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 491.5 square miles (791 square kilometers) in the Lease Area and 561.7 square miles (904 square kilometers) 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 1,474.5 square miles (2,373 square kilometers) and within the ECCs would be 1,685.2 square miles (2,712 square kilometers).

5.2.3.1 Marine Mammals

Geotechnical and geophysical survey noise may affect marine mammals through auditory injuries, stress, disturbance, and behavioral responses. HRG survey equipment have the potential to be audible to marine mammals (MacGillivray et al. 2014) including equipment with operating frequencies below 180 kilohertz.

To estimate distances to threshold levels, acoustic propagation modeling was undertaken by JASCO Applied Sciences (Li and Denes, 2020) based on manufacturer-provided source levels and operational parameters for HRG equipment that are currently being considered under the Proposed Action. A summary of the specification for representative equipment that was used in the modeling is presented in Table 5.2-12. Equipment with operating frequencies above 180 kilohertz were not considered in the modeling as they are above the hearing ranges of all listed species and are therefore not anticipated to cause injury or disturbance.

Table 5.2-12. Representative HRG survey equipment and operating frequencies

Equipment Type	System	Operating Frequency (kHz)	Source Level (dB)	
			L_{pk}	L_E
Sparker	SIG ELC 820 @ 750 J	0.01 – 1.9	213	203
Sub-bottom profiler	Teledyne Benthos Chirp III	2 – 7	204	199
Boomer	Applied Acoustics S-boom @ 700 J	0.01 – 5	211	205

dB = decibel; kHz = kilohertz
L_{pk} = peak sound pressure level in decibels referenced to 1 microPascal squared; also written as SPL_{pk}
L_E = weighted cumulative sound exposure level in decibels referenced to 1 microPascal squared second; also written SEL_{cum}
Source: Summarized from Table 31 (Li and Denes 2020)

The largest horizontal impact distances for marine mammals based on the representative geophysical survey equipment were calculated and shown in Table 5.2-13. Based on the modeling output, the largest distance to a PTS (Level A) threshold from a sparker, sub-bottom profiler, or boomer source for low frequency cetaceans is less than 33 feet (10 meters). The largest modeled distance to the behavioral harassment threshold (Level B) was 463 feet (141 meters) 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_{rms} for all HRG survey activity to provide a conservative estimate of sound exposure. This was done by assuming an average of 50 miles (80 kilometers) of survey activity would be completed daily by each survey vessel when active. A 463-feet (141 meters) perimeter around 50 miles (80 kilometers) of survey line was calculated to estimate a daily ensonified area of 8.7 square miles (22.6 square kilometers).

Table 5.2-13. Summary of Level A (SEL_{cum}) and Level B (SLP_{rms}) horizontal impact distances (meters)

Equipment	System	Level A horizontal impact distance (m) for LFC		Level A horizontal impact distance (m) for MFC		Level B horizontal impact distance (m)
		L_{pk}	L_E	L_{pk}	L_E	
Sparker	SIG ELC 820 @ 750 J	-	1	-	< 1	141
Sub-bottom profiler	Teledyne Benthos Chirp III	-	2	-	< 1	66
Boomer	Applied Acoustics S-boom @ 700 J	-	< 1	-	< 1	90

dash (—) indicates the HRG equipment source level is below the relevant threshold level
LFC = low frequency cetacean group; MFC = mid-frequency cetacean group; m = meters
L_{pk} = peak sound pressure level in decibels referenced to 1 microPascal squared; also written as SPL_{pk}
L_E = weighted cumulative sound exposure level in decibels referenced to 1 microPascal squared second; also written SEL_{cum}
Source: Summarized from Table 31 (Li and Denes. 2020)

Based on the model results, PTS from Level A exposures could only occur if marine mammals are close to survey activities and remain within 3.3 – 6.6 feet (1 – 2 meters) of the equipment while it's in use for 24 hours. Therefore, HRG survey equipment is unlikely to result in injury given that sound levels diminish rapidly with distance from the survey equipment (BOEM 2018c).

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 restricted beam shape and 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.

To calculate potential Level B exposures from HRG surveys within the Lease Area and the ECC, the annual average marine mammal densities in Table 5.2-14 were multiplied by the total expected ensonified area. The estimated exposure for ESA-listed whales is shown in Table 5.2-15. The greatest annual Level B exposure during early construction is 1.9 for NARW in the ECC and 2.1 NARWs during the operations phase of construction (3 of the 5 years to be covered by the requested incidental take regulations). During the initial construction period, the highest total Level B exposure is for 7 NARWs. Over the 3-year construction operations phase, up to 15 NARWs may be exposed to levels of sound inducing behavioral effects. Thus, a conservative estimate of up to 22 NARW individuals might experience behavioral effects from HRG survey activities, but no Level A exposures leading to injury.

Table 5.2-14. Annual average marine mammal densities within 10 km (6.2 mi) of the Lease Area and within 5 km (3 mi) of the ECCs.

Species	Annual Average Density (individuals/km^2)	
	Lease Area	ECC
Blue whale	0.0000	0.0000

Species	Annual Average Density (individuals/km^2)	
	Lease Area	ECC
Fin whale	0.0022	0.0008
NARW	0.0027	0.0023
Sei whale	0.0006	0.0003
Sperm whale	0.0005	0.0001

ECC = export cable corridor; km = kilometer; km^2 = square kilometer; mi = miles
Source: Table 28 and Table 30 MMPA ITA (LGL, 2022)

Table 5.2-15. Estimated Level B exposures for ESA-listed marine mammals during the 5-year period in mean number of individuals

Species	Construction Phase Take by Survey Area Year 1		Construction Phase Take by Survey Area Year 2		Total Density-based Exposure Estimates	PSO Data Exposure Estimate	Mean Group Size	Total Level B Exposure
	Lease Area	ECC	Lease Area	ECC				
Blue whale	0.0	0.0	0.0	0.0	0.0	-	1.0	1
Fin whale	1.5	0.7	1.0	0.5	3.6	5.3	1.8	6
Sei whale	0.4	0.2	0.3	0.2	1.1	1.4	1.6	2
NARW	1.8	1.9	1.2	1.3	6.3	-	2.4	7
Sperm whale	0.3	0.1	0.2	0.1	0.7	0.4	1.5	2

Species	Annual Operations Phase Exposure by Survey Area (Years 3 – 5)		Annual Total Density-based Exposure Estimates	Annual PSO Data Exposure Estimate	Highest Annual Level B Exposure	3-Year Level B Exposure
	Lease Area	ECC				
Blue whale	0.0	0.0	0.0	-	1	3
Fin whale	1.8	0.7	2.5	3.6	4	12
Sei whale	0.5	0.3	0.7	0.9	2	6
NARW	2.1	2.1	4.2	-	5	15
Sperm whale	0.4	0.1	0.5	0.3	2	6

ECC = export cable corridor; PSO = protected species observer
Source: Summarized from Table 33 and 34 (Li and Denes 2020)

SouthCoast Wind and BOEM will implement several mitigation measures for HRG survey activities (AMM-40 to AMM-48) when operating equipment that produces sound within marine mammals' hearing range (i.e., less than 180 kilohertz) (Section 3.3, Table 3.3-1). Additional agency-proposed measures (BA-2) require compliance with all PDC and BMPs for site assessment and characterization activities. 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&G surveys for the Proposed Action would be temporary and are not expected to result in stock or population-level effects.

Based on modeling, Level A thresholds in the areas ensonified by all anticipated HRG survey equipment would not be reached during early or late construction periods. Therefore, PTS exposures leading to serious injury or mortality are not expected for any ESA-listed species during HRG surveys, thus there is **no effect**.

During early and late construction periods, behavioral disturbance through Level B exposures to noise are possible. However, due to the small ensonified area from HRG survey equipment (463 feet [141 meters] or less, depending on equipment) wherein sound exposure would be brief and temporary, along with the implementation of monitoring and shutdown zones (328– 1,640 feet [100 – 500 meters]) that would more than cover the behavioral disturbance area, 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. Individual effects would be so small that they could not be measured, detected, or evaluated and are therefore **insignificant**. Given the low number of potential exposures during all phases of the Project, 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.

5.2.3.2 Sea Turtles

Noise from G&G surveys has the potential to affect sea turtles through auditory injuries, stress, disturbance, and behavioral responses. However, sea turtles would have to be very near G&G survey activity to experience injury-level exposures (PTS/TTS). Due to the short duration and mobile nature of survey activity, it is unlikely G&G surveys would result in injury as sea turtles would likely avoid these temporarily disturbed areas. Low level behavioral exposures could occur; however, these disruptions would be limited in extent and duration and would have short-term effects on both the individual and population.

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 295 feet (90 meters) of a sparker or the loudest G&G sound source. In fact, NMFS (2021c) 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) within 105 – 118 feet (32 – 36 meters) from the source, based on the boomer and sparker systems proposed for the Project (NMFS 2021c).

Given the limited spatial 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 of this brief exposure would be so small that they could not be measured, detected, or evaluated and are therefore **insignificant**.

SouthCoast Wind will implement several mitigation measures for HRG surveys (AMM-40 to AMM-48), which include pre-clearance zones, shutdown zones, and ramp-up procedures (Section 3.3, Table 3.3-1). Pre-clearance and shutdown zones for sea turtles are set at 328 feet (100 meters) which is more than three times larger than the distance identified as exceeding the sea turtle behavioral threshold for the proposed boomer and sparker equipment. Monitoring this zone for sea turtles is considered highly effective in mitigating effects due to noise from HRG surveys. Additionally, agency-proposed mitigation measures (BA-2) include compliance with all PDC and BMPs for site assessment and characterization activities. With the application of these mitigation measures, the potential for ESA-listed sea turtles to be exposed to noise above behavioral thresholds is plausible but considered extremely unlikely to occur and is **discountable**. Sea turtle peak pressure distances for all HRG sources are below the threshold level of 232 dB, so HRG survey sound will not cause PTS or injury to sea turtles, either. Therefore, the effects of noise exposure from Project HRG surveys leading to injury or behavioral effects **may affect, not likely to adversely affect** ESA-listed sea turtles.

5.2.3.3 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). Behavioral impacts on Atlantic sturgeon from Project-related G&G surveys would also be localized and temporary. Mobile, intermittent, non-impulsive HRG survey sound sources, such as multi-beam echosounders and side-scan sonar, are not likely detectable by Atlantic sturgeon as they operate above the hearing sensitivity of this species (above 1 kilohertz; Table 5.2-12) making the potential for auditory injury and behavioral disturbance unlikely.

For the HRG systems proposed for the Project, the distance to PTS for fish was 13 feet (4 meters) for the sparker and 8.2 feet (2.5 meters) for the boomer (Table 5.2-16). During HRG surveys using impulsive equipment, finfish and invertebrates close to sparkers and boomers may experience temporary displacement (BOEM 2021e). This type of behavioral impact would be localized to within 1,847 – 2,070 feet (563 – 631 meters) of 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.

Table 5.2-16. Summary of impulsive HRG equipment source levels and associated PTS and behavioral disturbance distances for fish.

Equipment	System	Highest Source Level (dB re 1 μPa)		PTS Distance (m) for Fish		Behavioral Disturbance Distance (m) for Fish
		L_{pk}	L_E	L_{pk}	L_E	
Sparker	SIG ELC 820 @ 750 J	214	182	4.0	0	631
Sub-bottom profiler	Teledyne Benthos Chirp III[a]	214	193	NA	NA	32
Boomer	Applied Acoustics S-boom @ 700 J	211	172	2.5	0	563

[a]Measured highest source levels were not provided for this exact system, so used generalized values for chirp sub-bottom profilers from Table 1 in NMFS 2021c.
dB = decibel; HRG = high resolution geophysical; m = meters; PTS = permanent threshold shift

L_{pk} = peak sound pressure level in decibels referenced to 1 microPascal squared; also written as SPL_{pk}
L_E = weighted cumulative sound exposure level in decibels referenced to 1 microPascal squared second; also written SEL_{cum}
NA = not applicable due to the sound source being out of the hearing range for the group
Source: Summarized from Table 1 and Tables A.2 – A.5 (NMFS 2021c)

With the implementation of measures (AMM-40 to AMM-48) that would help mitigate the effects of HRG survey activities, the potential for serious injury is minimized. For example, ramp-up procedures (AMM-47) would facilitate a gradual increase of equipment energy that would allow the Atlantic sturgeon to avoid the area prior to the start of operations. In addition, as the survey equipment is secured to the survey vessel or towed behind a survey vessel and is only turned on when the vessel is traveling along a survey transect, the potential effects are transient and intermittent.

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

5.2.4 Cable Laying

Noise-producing activities associated with cable laying during construction include route identification surveys, trenching, jet plowing, backfilling, and installation of cable protection. 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 4,921 feet (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 3.3 feet (1 meter) from the source (Nedwell et al. 2003).

Modeling based on noise data collected during a 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.

5.2.4.1 Marine Mammals

Noise from cable laying activities is not expected to reach levels that would cause PTS, TTS, or injury to any ESA-listed whales; it might, however, reach levels that exceed thresholds for behavioral effects (120 dB re 1 uPa2 s). 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 hertz, 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 kilohertz 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 NFMS behavioral response thresholds (120 decibels for continuous sound sources) relatively quickly and is unlikely to cause harassment to marine mammals (Reiser et al. 2010, 2011; Tetra Tech 2014).

SouthCoast Wind will implement mitigation measures that would minimize the effects of cable-laying noise that includes the application of noise attenuation technologies, visual and acoustic monitoring, and vessel separation distances as outlined in Section 3.3 (Table 3.3-1). With the application of these measures, 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, sei whales, and sperm 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, 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 MMPA and is, therefore, considered **insignificant**. Thus, 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.

5.2.4.2 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 disturbance is 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 Project are expected to be below the established PTS injury thresholds for all marine mammal hearing groups as outlined in Section 5.2.3.1 above. As turtles are less sensitive to underwater noise than marine mammals, it can be inferred cable-laying noise sources will also have **no effect** on PTS for ESA-listed sea turtles.

Cable-laying operations could exceed the disturbance threshold for sea turtles (175 dB re 1 µPa L_{rms}). 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 are 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 cable-laying operations leading to behavioral disturbance **may affect, not likely to adversely affect** ESA-listed sea turtles.

5.2.4.3 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.

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 **discountable**. 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 the animal has left the area. SouthCoast Wind will implement mitigation measures that could minimize the effects of cable-laying noise that includes the application of noise attenuation technologies and vessel separation distances as outlined in (Section 3.3, Table 3.3-1). 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**. Along with the proposed mitigation measures, the effects of noise exposure from Project cable-laying operations leading to behavioral disturbance **may affect, not likely to adversely affect** ESA-listed Atlantic sturgeon.

5.2.5 Dredging

Dredging would not be required for any foundation type in the Lease Area and 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.

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. Noise produced by mechanical dredging 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).

5.2.5.1 Marine Mammals

Based on the available source level information presented above, hydraulic and mechanical dredging are 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). 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 would likely not extend into Nantucket Shoals, the area where the greatest densities of ESA-listed marine mammals are found. Timing of NARW migrations includes a northward migration during March – April and a southward migration during November – 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.

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.

SouthCoast Wind will implement mitigation measures that include the implementation of pre-clearance and shutdown zones, the application of noise reduction technologies, and active visual and acoustic monitoring (Table 3.3-1). Based on these measures, 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, the established mitigation and monitoring measures proposed, and the limited extent of dredging expected for the Project, 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 injury or behavioral disturbance **may affect, not likely to adversely affect** ESA-listed marine mammals.

5.2.5.2 Sea Turtles

Based on the available source level information presented above, hydraulic and mechanical dredging are unlikely to exceed turtle PTS thresholds and therefore there is **no effect** for all sea turtles.

If dredging occurs in one area for relatively long periods, noise exposure exceeding behavioral thresholds could be possible. As discussed 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 / non-impulsive noise (Popper et al. 2014), like dredging.

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

5.2.5.3 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**.

If dredging occurs in one area for relatively long periods, noise exposure exceeding behavioral thresholds could be possible. Behavioral responses of fish to dredging noise are expected to be similar to responses to vessel noise, which include changes in swimming speed, direction, or depth, avoidance, and changes in schooling behaviors as described in Section 5.3.1.3. Behavioral effects associated with dredging noise are considered possible but would be temporary with effects dissipating once the activity has ceased or an 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 injury or behavioral disturbance **may affect, not likely to adversely** affect ESA-listed Atlantic sturgeon.

5.2.6 UXO Detonation

SouthCoast Wind may encounter UXO on the seabed in the Project area. The Falmouth ECC does not overlap any UXO areas or former defense sites; however, Brayton Point ECC intersects one formerly used defense site. The Lease Area does not coincide with any UXO site and the nearest site is 10 miles (16 kilometers) west of the Massachusetts and Rhode Island WEA (COP Volume 2, Section 14.1.1; Mayflower Wind 2022). The exact number and type of UXOs in the Project area are not yet known. As a conservative approach, it is currently assumed that up to five UXOs in the Lease Area and up to five along the ECCs may have to be detonated in place. Several alternative strategies will first be considered prior to detonating a UXO in place. These strategies 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). If such alternatives are not possible, UXOs may need to be removed by controlled explosive detonation.

Modeling the acoustic fields generated by UXO detonations was undertaken by JASCO Applied Sciences (Hannay and Zykov 2022) using a combination of semi-empirical and physics-based computational models. To capture a range of potential UXOs, five categories or “bins” of net explosive weight established by the U.S. Navy (U.S. Navy 2017a) were selected for acoustic modeling (Table 5.2-17).

Table 5.2-17. Navy “bins” and corresponding maximum charge weights (equivalent TNT) modeled

Navy Bin Designation	Maximum Equivalent Weight (TNT) in Kilograms	Maximum Equivalent Weight (TNT) in Pounds
E4	2.3	5
E6	9.1	20
E8	45.5	100
E10	227.0	500
E12	454.0	1000

TNT = trinitrotoluene
Source: Table 37 MMPA ITA (LGL, 2022)

Sound propagation away from detonation sources 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 representative sites (S1 to S5) within the SouthCoast Wind Project area (two along the eastern ECC, one on the western ECC, and two in the Lease Area) (Figure 5.2-2). The modelled water depths at each site ranged from 148-197 feet (45-60 meters) in the Lease Area and 33-98 feet (10-30 meters) in the two ECCs.

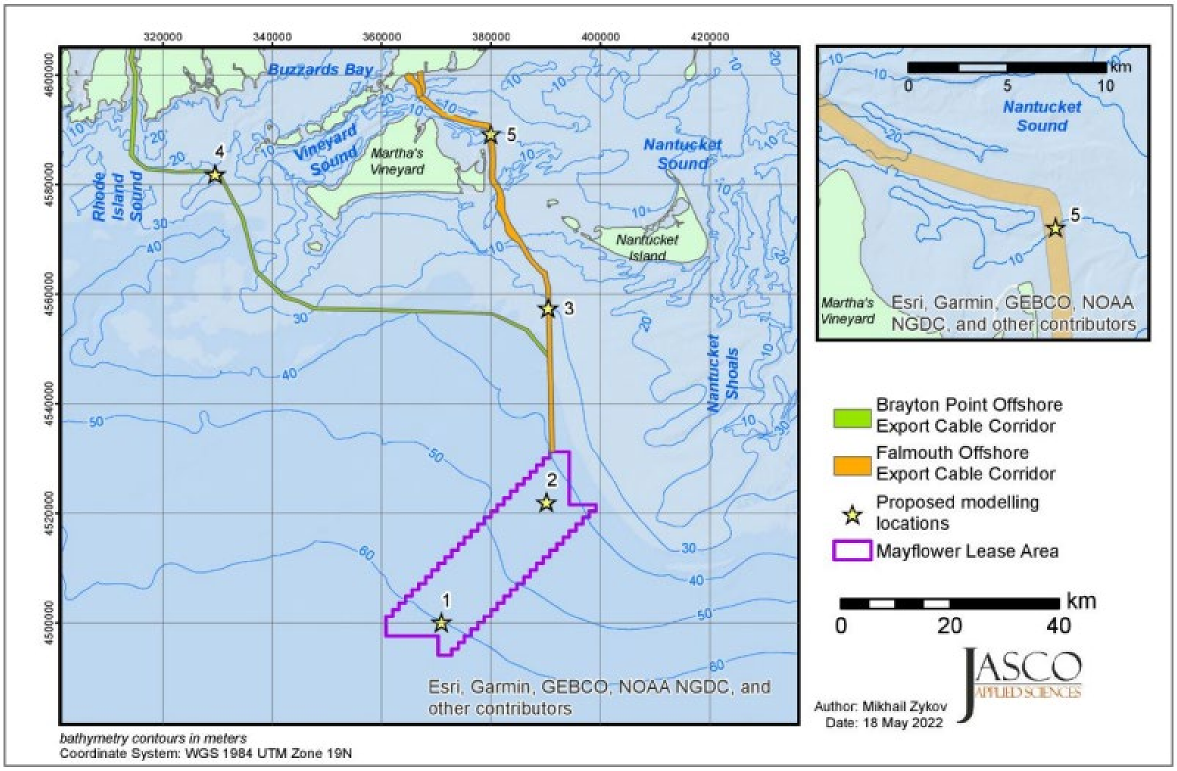


Figure 5.2-2. Locations of UXO acoustic modeling sites in the Lease Area and ECC

For UXO detonations, 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 Project area. 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 decidecade frequency bands using JASCO Applied Sciences' Marine Operations Noise Model (MONM). This model applied a parabolic equation approach for frequencies below 4 kilohertz and a Gaussian beam ray trace model at higher frequencies. In this location, sound speed profiles changed little with depth, so these environments do not have strong seasonal influence on sound propagation. The propagation modeling was performed using a sound speed profile representative of September, which is slightly downward refracting and therefore conservative, and represents the most likely time of year for UXO removal activities.

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 (U.S. Navy 2017a) 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 5.2-18). The results from these equations were used in the subsequent analyses.

Table 5.2-18. U.S. Navy impulse and peak pressure threshold equations for estimating at what levels marine mammals and sea turtles have a 1% probability of experiencing mortality or non-auditory injury due to underwater explosions (U.S. Navy 2017a).

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

dB = decibel ; M = animal mass in kilograms (kg) ; D = animal depth in meters (m)
Source: Table 7 MMPA ITA (LGL 2022)

5.2.6.1 Marine Mammals

Underwater explosions from UXO detonations generate high pressure levels that could cause disturbance and injury to marine mammals. The physical range at which injury or mortality could occur will vary based on the amount of explosive material in the UXO, size of the animal, and the location of the animal relative to the explosive. Injuries may include physical (non-auditory) injury such as hemorrhages or damage to the lungs, liver, brain, or ears, as well as auditory impairment such as PTS and TTS (Ketten 2004). Smaller animals are generally at a higher risk of blast injuries. The behavioral response of marine mammals to UXO detonations is relatively unknown. For marine mammals that are at a distance but within hearing range of the blast, behaviors could include a short startle response, temporarily displacing LFCs that are migrating or foraging. The response would likely be brief, and the animal would be expected to resume pre-detonation activities.

Potential impacts to marine mammals from underwater explosions are assessed using separate criteria for mortality, non-auditory injury, gastrointestinal injury, auditory injury, and behavioral responses. The largest ranges to the thresholds for the ECC and Lease Area sites were selected for each UXO size class and marine mammal size class or hearing group. In all cases, distance to mortality, non-auditory lung injury, and gastrointestinal injury thresholds (Table 5.2-19) were shorter than to auditory injury thresholds (Table 5.2-20).

Table 5.2-19. Ranges (meters) 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.

Range per UXO Charge Size	Mortality				Non-Auditory Lung Injury				GI Injury
	ECC		Lease Area		ECC		Lease Area		L_{pk} threshold 237 dB re 1 μPA
	Calf/ Pup	Adult	Calf/ Pup	Adult	Calf/ Pup	Adult	Calf/ Pup	Adult	
E4 R95% Distance (m)	5	5	5	5	6	5	5	5	21
E6 R95% Distance (m)	6	5	5	5	17	5	14	5	34
E8 R95% Distance (m)	23	6	18	5	54	16	45	13	58
E10 R95% Distance (m)	69	22	63	18	153	51	156	44	99
E12 R95% Distance (m)	108	34	108	29	132	81	242	78	125

dB = decibel; ECC = export cable corridor; GI = gastrointestinal; m = meter; UXO = unexploded ordnance

L_{pk} = peak sound pressure level in decibels referenced to 1 microPascal squared; also written as SPL_{pk}
GI injury combines ECC and Lease Area, Calf/Pup and Adult. Thresholds are based on animal mass and submersion depth.
Source: Summarized from Tables 38 – 42 MMPA ITA (LGL, 2022)

Since the size and type of UXOs that may be detonated are currently unknown, all area of impact calculations were made using the largest UXO size class (E12). The E12 ranges to Level A and Level B exposure thresholds within the ECC were used as radii to calculate the area of a circle (pi × r^2 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 Lease Area and the ECC and are shown in Table 5.2-19. The same method was used to calculate the maximum area potentially ensonified above threshold levels from a single detonation as shown in the last row of Table 5.2-20.

Table 5.2-20. Range (km) 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 5 UXO charge sizes assuming 10 dB of noise attenuation, and the maximum area exposed above this threshold

Range per UXO Charge Size	ECC (LFC)		Lease Area (LFC)		ECC (MFC)		Lease Area (MFC)	
	Level A	Level B	Level A	Level B	Level A	Level B	Level A	Level B
E4 R95% Distance (km)	0.72	2.74	0.34	2.82	0.06	0.41	<0.05	0.45
E6 R95% Distance (km)	1.46	4.45	0.78	4.68	0.11	0.71	<0.05	0.77
E8 R95% Distance (km)	2.86	7.21	1.75	7.49	0.24	1.23	0.09	1.24
E10 R95% Distance (km)	4.16	10.3	3.33	10.5	0.47	2.03	0.28	2.12
E12 R95% Distance (km)	4.84	11.8	4.30	11.9	0.60	2.48	0.32	2.55
Single Detonation Maximum Area (km^2)	73.6	437	58.1	445	1.10	19.3	0.30	20.4

dB = decibels; ECC = export cable corridor; km = kilometer; km^2 = square kilometer; LFC = low frequency cetaceans; MFC = mid frequency cetaceans; PTS = permanent threshold shift; TTS = temporary threshold shift
Source: Summarized from Tables 43 - 45 MMPA ITA (LGL, 2022)

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 take place. Instead, for the UXO acoustic propagation models, the highest average monthly density for each species from May through November from within 9.3 miles (15 kilometers) of the ECCs and Lease Area was used in the estimates of potential exposures (Table 5.2-21).

Table 5.2-21. Maximum average monthly marine mammal densities within the Lease Area and ECC from May through November and the month in which the maximum density occurs for each marine mammal species.

Species	Lease Area		ECC	
	Maximum Monthly Density (individuals/km^2)	Maximum Density Month	Maximum Monthly Density (individuals/km^2)	Maximum Density Month
Blue whale	0.0000	Annual	0.0000	Annual
Fin whale	0.0047	July	0.0013	May
NARW	0.0037	May	0.0022	May

Species	Lease Area		ECC	
	Maximum Monthly Density (individuals/km²)	Maximum Density Month	Maximum Monthly Density (individuals/km²)	Maximum Density Month
Sei whale	0.0019	May	0.0007	May
Sperm whale	0.0017	August	0.0003	August

ECC = export cable corridor; km² = square kilometer
Source: Summarized from Tables 35 - 36 MMPA ITA (LGL 2022)

To calculate the potential exposure from UXO detonations in the Lease Area and ECC, the maximum areas to Level A and Level B thresholds from a single detonation in the Lease Area and the ECC summarized in Table 5.2-20 were then multiplied by 3 (for Year 1) and 2 (for Year 2) and then multiplied by the estimated marine mammal densities (Table 5.2-22). The division of 5 total detonations across the two years was based on the relative number of foundations to be installed in each year. Based on the calculations, the largest potential Level A exposure from UXO detonations with 10-decibel attenuation is 3 NARW individuals and the largest potential Level B exposure is 21 fin whales (Table 5.2-22).

Table 5.2-22. Estimated Level A and Level B exposures (# of individuals) from potential UXO detonations for construction years 1 and 2 assuming 10 dB of attenuation.

Species	Estimated Level A and Level B exposures (# of individuals) from UXO detonations											
	Year 1				Year 2				PSO Data Exposure Estimate	Mean Group Size	Total Level A Take	Total Level B Take
	Level A		Level B		Level A		Level B					
	ECC	LA	ECC	LA	ECC	LA	ECC	LA				
Blue whale	-	-	-	-	-	-	-	-	-	1.0	1.0	1.0
Fin whale	0.3	0.8	6.2	6.3	0.2	0.5	4.1	4.2	0.5	1.8	2.0	21
NARW	0.5	0.6	4.9	5.0	0.3	0.4	3.3	3.3	-	2.4	3.0	17
Sei whale	0.2	0.3	2.5	2.6	0.1	0.2	1.7	1.7	-	1.6	2.0	9.0
Sperm whale	-	-	0.1	0.1	-	-	0.1	0.1	1.5	1.5	2.0	2.0

dB = decibel ; ECC = export cable corridor ; LA = Lease Area ; PSO = protected species observer ; UXO = unexploded ordnance
Source: Table 47 MMPA ITA (LGL 2022)

Should UXOs be encountered in the Project area, non-explosive methods will first be employed to lift and move these UXOs. Only after these alternatives are considered would a decision to detonate the UXO in place be made and no more than a single UXO will be detonated in a 24-hour period. Decisions on removal methods will be made in consultation with a UXO specialist and in coordination with the agencies with regulatory oversite of UXO. For detonations that cannot be avoided due to safety considerations, a number of mitigation measures will be employed by SouthCoast Wind (Section 3.3, Table 3.3-1, AMM-49 to AMM-56). These measures include active visual and acoustic monitoring by PSOs to establish clearance zones shown in Table 5.2-23.

Table 5.2-23. Mitigation and Monitoring Zones (meters) Associated with In-Situ UXO Detonation of Binned Charge Weights, with a 10 dB Noise Attenuation System.

Hearing Group	UXO Charge Weight[1]				
	E4 (2.3 kg)	E6 (9.1 kg)	E8 (45.4 kg)	E10 (227 kg)	E12 (454 kg)
Lease Area Pre-start Clearance Zone[2] (m)					
LFC	400	800	1,600	3,000	3,700
MFC	50	50	100	400	500
ECC Pre-start Clearance Zone[2] (m)					
LFC	600	1,000	1,800	3,000	3,800
MFC	50	80	200	400	500

dB = decibel; ECC = export cable corridor; kg = kilogram; m = meters; LFC = low frequency cetaceans; MFC = mid frequency cetaceans; UXO = unexploded ordnance

[1] UXO charge weights are groups of similar munitions defined by the U.S. Navy and binned into five categories (E4-E12) by weight (equivalent weight in TNT). For this assessment, four project sites (S1-S4) were chosen and modeled (see Hannay and Zykov 2022) for the detonation of each charge weight bin.

[2] Pre-start clearance zones were calculated by selecting the largest Level A threshold (the larger of either the PK or SEL noise metric). The chosen values were the most conservative per charge weight bin across each of the four modeled sites.

Source: Table 51 MMPA ITA (LGL, 2022)

A 30-minute pre-start clearance zone will be established prior to detonation. A PAM operator will begin acoustic monitoring 30 minutes prior to detonation. All marine mammals must be confirmed to be out of the pre-start clearance zone before detonation may commence. Sound source verification will allow for adaptive monitoring and the adjustment of clearance zones as needed based on reported measurements (AMM-13 and MA-4). Post detonation monitoring will occur for 30 minutes. Only one detonation would occur in a 24-hour period and planned UXO detonations will not be conducted during nighttime hours. Further, as an additional measure to minimize impacts to NARWs, planned detonations are prohibited between January and April where NARW density is at its highest.

A noise attenuation system (NAS) similar to those described for monopile foundation installations is planned to be used during any UXO detonations (AMM-53). The use of a NAS is expected to achieve at least the same 10 decibels 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 as summarized in Table 5.2-19.

The injury zones surrounding explosives detonations are of key importance for developing mitigation designed to minimize takes. As reported in Table 5.2-19, the ranges for mortality, lung, and gastrointestinal injury are short distances; the greatest distance is 794 feet (242 meters). As the pre-clearance zones are considerably larger than this distance and were calculated by selecting the largest Level A threshold (the larger of either the PK or SEL noise metric), the potential for these injuries would be greatly reduced. Along with the low number of potential UXOs (conservatively up to five in the Lease Area and five in the ECCs) identified in the Project area and SouthCoast Wind's commitment to implement extensive mitigation and monitoring measures, potential Level A harassment associated with UXO detonations would be considered extremely unlikely to occur and thus **discountable**. As the behavioral zones are larger than the PTS zones, behavioral disturbance (Level B) could potentially occur. However, Level B harassment would also be greatly reduced by the mitigation measures outlined above and would only occur at the level of the individual animal and are not expected to have population-level effects. Individual effects would be so small that they could not be measured, detected, or evaluated and are therefore **insignificant**. Therefore, adverse effects of UXO detonation leading to Level A and Level B harassment **may affect, not likely to adversely affect** ESA-listed marine mammals.

5.2.6.2 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 SouthCoast 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 (Appendix E7, 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; OSG, 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 kilograms) 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 kilograms) underwater charge off Panama City, FL in 1981. The charge was detonated at mid-depth in water 120 feet (37 meters) deep. Although details are limited, the following were recorded: at a distance of 500-700 feet (150-200 meters), a 400 pounds (180 kilograms) sea turtle was killed; at 1,200 feet (370 meters), a 200-300 pounds (90-140 kilograms) sea turtle experienced "minor" injury; and at 2,000 feet (600 meters) a 200-300 pounds (90-140 kilograms) sea turtle was not injured (O'Keeffe & Young, 1984).

Acoustic modeling has been conducted for SouthCoast Wind Project scenarios (Hannay and Zykov 2022). Maximum exceedance distance to TTS and PTS for the largest class of UXO with no mitigation in place were modeled to be 3,839 feet (1,170 meters) and 2,011 feet (613 meters) respectively (Table 5.2-24). Accounting for 10-decibel mitigation, maximum exceedance distances for TTS and PTS for the largest class of UXO were modeled to be 1,309 feet (399 meters) and 692 feet (211 meters) respectively. The range to exceedance of Level-A and Level-B exposures were modeled at depths of 33-98 feet (10-30 meters) to approximate the ECC and 148-197 feet (45-60 meters) to approximate the Lease Area (Table 5.2-25). Range to Level A threshold exceedance was found to be 0.4 miles (0.6 kilometers) in the ECC and 0.2 miles (0.3 kilometers) in the Lease Area for the largest UXO charge size. Range to Level B threshold exceedance was found to be 6,988 feet (2,130 meters) in the ECC and 7,382 feet (2,250 meters) in the Lease Area under the largest UXO charge size. These model results assume 10 decibels of noise attenuation. Ranges for the onset of mortality, non-auditory lung injury, and gastrointestinal injury in adult sea turtles were also modeled (Table 5.2-26). Under the largest UXO classification, mortality was found to occur at a range of 689 feet (210 meters) in the ECC and 735 feet (224 meters) in the Lease Area. Onset of non-auditory lung injury was found to occur at a range of 1,309 feet (399 meters) in the ECC and 1,483 feet (452 meters) in the Lease Area. The onset of gastrointestinal injury was found to occur at a range of 410 feet (125 meters).

Table 5.2-24. Sea turtles PTS and TTS maximum exceedance distances (meters) to TTS and PTS thresholds for peak pressure (L_{pk}) for various UXO charge sizes

Mitigation	TTS / PTS L_{pk} threshold (dB re 1 μPa)	E4 (2.3 kg)		E6 (9.1 kg)		E8 (45.5 kg)		E10 (227 kg)		E12 (454 kg)	
		TTS	PTS	TTS	PTS	TTS	PTS	TTS	PTS	TTS	PTS
Unmitigated	226 / 232	201	105	318	166	543	285	929	487	1170	613
10 dB Mitigation	226 / 232	69	36	108	57	185	98	317	168	399	211

dB = decibel; kg = kilogram; PTS = permanent threshold shift; TTS = temporary threshold shift; UXO = unexploded ordnance
L_{pk} = peak sound pressure level in decibels referenced to 1 microPascal squared; also written as SPL_{pk}
Source: Table 10 and Table 33 (Hannay and Zykov 2022).

Table 5.2-25. Range (meters) to SEL PTS-onset and SEL TTS-onset exposure thresholds in the ECC and Lease Area for sea turtles for 5 UXO charge sizes assuming 10 dB of noise attenuation, and the maximum area exposed above this threshold.

Range per UXO Charge Size	ECC		Lease Area	
	PTS	TTS	PTS	TTS
E4 R95% Distance (m)	<50	134	<50	203
E6 R95% Distance (m)	72	358	<50	448
E8 R95% Distance (m)	190	796	63	870
E10 R95% Distance (m)	424	1610	201	1780
E12 R95% Distance (m)	555	2130	300	2250

dB = decibel; ECC = export cable corridor; m = meter; PTS = permanent threshold shift; TTS = temporary threshold shift; UXO = unexploded ordnance
SEL = frequency weight sound exposure level in decibels referenced to 1 microPascal squared second; also written L_E
Source: Summarized from Tables 46 – 55 (Hannay and Zykov 2022).

Table 5.2-26. Ranges (meters) 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 adult sea turtles. GI injury combines ECC and Lease Area. Thresholds are based on animal mass and submersion depth.

Range per UXO Charge Size	Mortality		Non-Auditory Lung Injury		GI Injury
	ECC	Lease Area	ECC	Lease Area	L_{pk} threshold 237 dB re 1 uPA
E4 R95% Distance (m)	6	5	15	13	21
E6 R95% Distance (m)	18	14	43	34	34
E8 R95% Distance (m)	56	44	126	126	58
E10 R95% Distance (m)	151	155	298	326	99
E12 R95% Distance (m)	210	224	399	452	125

dB= decibel; ECC = export cable corridor; GI = gastrointestinal; m = meters; UXO = unexploded ordnance
L_{pk} = peak sound pressure level in decibels referenced to 1 microPascal squared; also written as SPL_{pk}
Source: Summarized from Tables 34 – 44 (Hannay and Zykov 2022).

UXO detonations would only occur from May through November. While this coincides with the highest densities of leatherback and loggerhead sea turtles, the potential for serious injury is minimized by the implementation of a range of mitigation measures (AMM-49 to AMM-56) that include establishing 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 (Section 3.3, Table 3.3-1). Pre-start clearance zones, commensurate with marine mammal hearing group and UXO charge weight, range from 164 to 20,341 feet (50 to 6,200 meters). Thirty minutes prior to detonation, this zone will be monitored visually with multiple vessels and acoustically with the use of a PAM system. These ranges cover observed PTS/TTS ranges for sea turtles: <656 feet (<200 meters) lethal, 1,214 feet (370 meters) minor injury, and 1,969 feet (600 meters) no injury (U.S. Navy 2017a citing O'Keeffe and Young 1984). Any sightings of a sea turtle would cause the clock to restart, after the animal has moved out of the monitoring zone. Only one detonation would occur in a 24-hour period and no planned detonation will occur during nighttime hours. These measures 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 exposed—would more likely have the potential to result in slight PTS (i.e., minor degradation of hearing capabilities at some hearing thresholds). The potential for PTS/non-auditory injury is further minimized by the use of a NAS during all UXO detonations (AMM-53). The proposed requirement that UXO detonations can only commence when the pre-clearance zones are fully visible to PSOs (AMM-51 and 56) allows the potential for high turtle detection capability and enables a high rate of success in implementation of these zones to avoid serious injury. With the strict implementation of these mitigation measures, the potential for PTS or TTS exposure to these sea turtle species is considered extremely unlikely to occur and is **discountable**.

Studies of the reactions of sea turtles to explosives are limited in 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). Klima et al. (1988) studied sea turtle reactions to the removal of oil platforms in the Gulf of Mexico using explosives and to the use of explosives in the area by the U.S. Navy. Results indicated a possible positive correlation with explosive use and sea turtle stranding on nearby beaches.

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 PTS/mortality/slight lung injury/gastrointestinal injury **may affect, not likely to adversely affect** ESA-listed sea turtles.

5.2.6.3 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 SPL 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 5.2-27. The injurious effects thresholds for all fish species groups are the same: SPL = 229–234 dB re 1 µPa. The present assessment has applied the lower range value of SPL = 229 dB re 1 µPa for potential mortal injury and mortality. Acoustic modeling of UXO detonations by SouthCoast Wind estimated the exceedance distances for the onset of injury within fish (Table 5.2-28). Under the largest UXO category, injury was modeled to occur at a range of 2,779 feet (847 meters) with no mitigation in place, however, with 10 dB noise attenuation, exceedance distance was reduced to 951 feet (290 meters).

Table 5.2-27. Effects of detonation pressure exposures

Type of Animal	Mortality and potential mortal injury	Recoverable injury	TTS	Masking	Behavior
Fish: where swim bladder is not involved in hearing (particle motion detection	229-234 dB	Near field: High	Near field: High	N/A	Near field: High
		Intermediate field: High	Intermediate field: Moderate		Intermediate field: High
		Far field: Low	Far field: Low		Far field: Low

dB = decibel; TTS = temporary threshold shift, N/A = not applicable
Source: Table 9 (Hannay and Zykov, 2022)

Table 5.2-28. Exceedance distances (m) for Onset of Injury for fish with and without a swim bladder due to peak pressure exposures, for various UXO charge sizes

Mitigation	Onset Injury L_{pk} (dB re 1 µPa)	E4 (2.3 kg)	E6 (9.1 kg)	E8 (45.5 kg)	E10 (227 kg)	E12 (454 kg)
Unmitigated	229	145	230	393	671	847
10 dB Mitigation	229	49	80	135	230	290

dB = decibel; kg = kilogram; m = meter; UXO = unexploded ordnance
L_{pk} = peak sound pressure level in decibels referenced to 1 microPascal squared; also written as SPL_{pk}
Source: Summarized from Table 22 and Table 45 (Hannay and Zykov, 2022).

Reaction of fish to explosives is largely absent from 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 5.2-27).

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. 2004). 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 2023g) 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. 2004). This 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 (AMM-53). The use of NAS is expected to provide 10 decibels of noise mitigation and would reduce the exceedance distance for the onset of injury to 751 feet (229 meters) for the largest UXO detonations. This, coupled with the unlikely detonation of UXO, the low number of potential detonations required for the Proposed Action (modeled for no more than 10), further reduces the potential for exposure to Atlantic sturgeon. Thus, the risk of injury or behavioral disturbance from UXO detonation is **discountable,** and UXO noise **may affect, not likely to adversely affect** Atlantic sturgeon.

5.2.7 Summary of Underwater Noise Effects

5.2.7.1 Marine Mammals

Noise associated with 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. Vibratory pile driving is also not typically associated with physical injury or mortality, but for this Project, the effects of vibratory pile driving were modeled concurrently with impact pile driving and could not be evaluated separately. 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, 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.

5.2.7.2 Sea Turtles

Noise associated with 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 and concurrent vibratory 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.

5.2.7.3 Fish

Noise associated with 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 associated with impact and concurrent vibratory pile driving 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 hertz) (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 3.1-14 and Table 3.1-15 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 ranges 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 SPL_{rms} with frequencies between less than 40 hertz and 100 hertz (McKenna et al. 2012). Smaller support vessels typically produce higher-frequency sound concentrated in the 1,000 hertz to 5,000 hertz range, with source levels ranging from 150 to 180 dB re 1 µPa SPL_{rms} (Kipple 2002; Kipple and Gabriele 2003).

5.3.1.1 Marine Mammals

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. Since PTS exposures are not expected for any of the ESA-listed marine mammal species during Project vessel activities, injury or mortality from vessel noise is unlikely and noise exceeding PTS thresholds will have **no effect**.

Vessel noise overlaps with the hearing range of marine mammals and may cause behavioral responses, stress responses, and masking of their communication space (Erbe et al. 2018, 2019; Nowacek et al. 2007; Southall et al. 2007; Richardson et al. 1995). Observed behavioral responses include startle responses, changes in dive patterns or swim velocities, and avoidance. These responses have been shown to vary by gender and by individual, and in certain cases, have been correlated with numbers of vessels and their proximity, speed, and directional changes. In additional to behavioral responses, physiological or stress responses like changes in respiration rates can occur. 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).

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. 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.

Masking may interfere with detection of prey and predators and reduce communication distances. Modeling results indicate that vessel noise has the potential to substantially reduce communication distances for NARWs (Hatch et al. 2012).

Vessel activity associated with the Proposed Action is expected to cause repeated, intermittent impacts on ESA-listed marine mammals resulting from short-term, localized behavioral responses to vessel noise. 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 (U.S. Navy 2018). In addition, SouthCoast Wind and BOEM will implement several mitigation measures (Section 3.3, Table 3.3-1, Table 3.3-2) to reduce the possibility of exposure of ESA-listed marine mammals to vessel noise. These measures include active visual and acoustic monitoring (AMM 1 to 4, AMM-6 to 12, BA-4 to 5), vessel separation distances (AMM-24-25, BA-7 to 8), and vessel speed reduction (AMM-26).

Based on these mitigation measures, and the fact that behavioral effects would not be biologically significant for individual marine mammals, exposure to vessel noise 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 animal's ability to avoid harmful noises, and the established mitigation and monitoring measures being proposed, 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 and is, therefore, **insignificant**. Noise exposure from Project vessel operations leading to injury or behavioral disturbance **may affect, not likely to adversely affect** ESA-listed marine mammals.

5.3.1.2 Sea Turtles

It is unlikely that received levels of underwater noise from vessel activities would exceed PTS thresholds for sea turtles; therefore, injury or mortality from vessel noise is unlikely and noise exceeding PTS thresholds will have **no effect**.

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). 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 to vessels with 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 vessel noise. 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).

Vessel noise associated with the Proposed Action could cause repeated, intermittent impacts on sea turtles resulting from short-term, localized behavioral responses. 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 mitigation measures outlined in Section 3.3 (Table 3.3-1 and Table 3.3-2), potential behavioral effects are further reduced. Such measures (BA-2) include vessel speed reductions to 4 knots when a sea turtle is sighted within 328 feet (100 meters) of the forward path and avoiding transiting through areas of visible jellyfish aggregations or floating *Sargassum*, which 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 of 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 injury or behavioral disturbance **may affect, not likely to adversely affect** ESA-listed sea turtles.

5.3.1.3 Fish

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**.

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 hertz) 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.

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 injury or behavioral disturbance **may affect, not likely to adversely affect** ESA-listed Atlantic sturgeon.

5.3.2 Helicopters and Drones

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 3.1-14. 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 hertz) and continuous with sound levels at or below 160 decibels referenced to 1 micropascal (Richardson et al. 1995). Kuehne et al. (2020) demonstrated that large Boeing EA-18G Growler aircrafts produced underwater noise levels of 134 (± 3) dB re 1 μPa SPL_{rms} measured at a depth of 30 m. Noise levels from helicopters required for the Project are expected to be lower than those generated by much larger aircrafts, but could still 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 (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 to aircraft noise above PTS, TTS, and behavioral thresholds for all ESA-listed marine mammal species is considered extremely unlikely to occur and **discountable**. 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

Patenaude et al. (2002) showed that aircraft operations could result in temporary behavioral responses to marine mammals, however, similar studies on sea turtles are not available in the literature. When traveling at relatively low altitude, helicopter noise could 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). 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 is 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); thus, aircraft noise represents an intermediate risk for behavioral disturbance. However, 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.

Exposure to Project aircraft noise above PTS, TTS, and behavioral thresholds for all ESA-listed sea turtles is extremely unlikely to occur and is **discountable**. 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 **discountable**. 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-hertz to 8- kilohertz frequency range (Tougaard et al. 2020). Noise levels produced by WTGs are only expected to exceed ambient underwater noise levels at frequencies below 500 hertz (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 enters the water through the air-water interface. Mechanical noise associated with the operating WTG is transmitted into the water as vibration through the foundation and subsea cable. Both airfoil sound and mechanical vibration may result in long-term, continuous noise in the offshore environment; however, operational noise from WTGs has been measured at source levels that are at least 10–20 dB lower than received levels of ship noise in the same frequency range. Measured underwater sound levels in the literature are limited to smaller geared wind turbines (less than 6.15 MW), as summarized by Tougaard et al. (2020). Underwater noise generated by these smaller geared turbines is measured at a low frequency and relatively low strength near the foundation, dissipating to ambient background levels within 0.6 miles (1 kilometers) in low ambient noise areas (Dow Piniak et al. 2012; Elliott et al. 2019; summarized in Tougaard et al. 2020).

Tougaard et al. 2009 measured SPLs ranging between 109 and 127 dB re 1 µPa underwater at 46 and 66 feet (14 and 20 meters) from the foundations at frequencies below 315 hertz up to 500 hertz. Wind turbine acoustic signals above ambient background noise were detected up to 2,066.9 feet (630 meters) from the source (Tougaard et al. 2009). Noise levels were shown to increase with higher wind speeds (Tougaard et al. 2009). Another study detected SPLs of 125 to 130 dB re 1 µPa up to 984 feet (300 meters) from operating turbines in frequencies between 875 and 1,500 hertz (Lindeboom et al. 2011). At 164 feet (50 meters) from a 3.6 megawatt (MW) monopile wind turbine, Pangerc et al. (2016) recorded maximum SPLs of 126 dB re 1 µPa with frequencies of 20 to 330 hertz, which also varied with wind speed. Kraus et al. (2016) measured ambient noise conditions at 3 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. They also found that maximum operational noise levels typically occurred at higher wind speeds when baseline noise levels are also higher due to wave action.

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 was available in the literature; Elliott et al. (2009) measured SPLs of 114 to 121 dB re 1 μPa at 164 feet (50 meters) from the source for a 6 MW direct-drive turbine.

Based on measurements from WTGs 6 MW and smaller, Stöber and Thomsen (2021) estimated that operational noise from larger (10 MW WTG) current-generation WTGs would generate higher source levels (177 dB re 1 μPa-m) than measured from smaller turbines in earlier research. Additionally, Stöber and Thomsen (2021) estimated that a shift from gear-driven wind turbines to direct drive turbines would decrease sound levels by 10 decibels resulting in an acoustic range to the 120 dB re 1 μPa behavioral threshold of 0.9 miles (1.4 kilometers). Using the least-squares fits from Tougaard et al. (2020), SPLs from 11.5 MW turbines (in 38-knot [20 meters per second], gale-force wind) would be expected to fall below the same behavioral threshold within 804 feet (245 meters). In lighter 19-knot winds (10 meters per second), the predicted acoustic range to behavioral thresholds would be only 460 feet (140 meters). Both models were based on small turbines and a small sample size, adding uncertainty to the modeling results.

Stöber and Thomsen (2021) used only the loudest measurements from each study cited. While this is reasonable practice for most sound source studies, sound from an operating WTG can be expected to correlate with wind speed and therefore with higher environmental noise. However, scaling the loudest sound measurements linearly with turbine power will scale environmental noise up along with it and can be expected to overestimate sound levels from larger turbines. Tougaard et al. (2020) took wind speed into account for each of the measurements in their least-squares model fit and scaled the sound level with WTG power using a logarithmic measurement. Because of these factors, range estimates based on Tougaard et al. (2020) are considered more relevant to this assessment.

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 proposed 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 19-knot (10 meters per second) 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.[6] 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 19-knot (10 meters per second) 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 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 kilohertz (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.

As the Project area is near Nantucket Shoals, noise exposure from WTG operations may affect migratory and foraging behavior in ESA-listed mammals in this area. Timing of migrations includes a northward migration during March and 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-

[6] These are 50th and 90th percentile levels in the 20–447 hertz frequency band for monitoring locations RI-1, RI-2, and RI-3, as reported by Kraus et al. (2016).

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). Underwater noise emitted by WTGs are generally in the lower frequency spectrum below 2,000 hertz (Hz) and overlap with the hearing sensitivity and communications used by LFCs. The full extent of how WTG operations may affect LFC behavior is unknown. NARWs do not appear particularly sensitive to other low frequency sounds emitted by vessels (Nowacek et al. 2004); however, the animals may still be adversely affected by noise stimuli even in the absence of overt behavioral reactions (Rolland et al. 2012). Cetaceans are not expected to be significantly disrupted from 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.

Behavioral disturbance from WTG operations is not expected to impede the migration of NARWs to critical habitats located to the north and south of the Lease Area as animals would be able to travel beyond the disturbance area around the Lease Area (should they avoid it). 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.

Masking of LFC communications is considered likely but as with behavioral disturbance, the extent of these effects is unknown. NARWs appear to be particularly sensitive to the effects of masking by underwater anthropogenic noise and have faced significant reductions in their communication space. Calling right whales in the Stellwagen Bank National Marine Sanctuary were exposed to noise levels greater than 120 dB re 1 µPa for 20% of the time during peak feeding months (Hatch et al. 2012). Communication disruptions caused by anthropogenic noise have implications on the physiological health of NARWs with potential population-level consequences. Over the last 50 years NARWs have been reported to shift their "upcalls" (communication used between mother and calf during separation events) to a higher-frequency band (Tennessen and Parks 2016). Rolland et al. (2012) identified an association between exposure to low frequency ship noise and an increase in stress-related metabolites in NARWs, which can potentially contribute to poorer reproductive success and immune suppression. Anthropogenic noise has also been highlighted as a probable cause for shifts in NARW distribution between 2004 and 2014, with decreased relative detections in the Gulf of Maine and increases in the Mid-Atlantic region after 2010 (Davis et al. 2017). Reduced communication space caused by anthropogenic noise could potentially contribute to the population fragmentation and dispersal of the NARW (Hatch et al. 2012; Brakes and Dall 2016).

The Lease Area does not extend beyond the continental slope where sperm whales are more commonly observed. If sperm whales are exposed to underwater noise above behavioral thresholds, effects would be confined to the Project area. Sperm whales would be expected to resume pre-exposure activities once the animal moves out of the disturbance zone. Masking of high-frequency echolocation clicks used by sperm whales is not anticipated; however, some masking of other communications used by this species is possible. These effects are not expected to overlap with areas frequently used by this species or in areas where they hunt for preferred prey (i.e., squid in deep waters).

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 hertz. 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 hertz.

While ESA-listed marine mammals may still be exposed to noise levels above the behavioral threshold, such exposure would be brief while they transit through the wind farm. Any effects associated with behavioral responses to these brief exposures are expected to be too small to be meaningfully measured or detected and are thus **insignificant**. Given the small scale of anticipated effects, the effects of noise exposure generated by WTG operations from the Project leading to behavioral disturbance **may affect, not likely to adversely affect** any ESA-listed marine mammals.

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; U.S. 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 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 hertz and 8 kilohertz, 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 328 feet (100 meters) from the turbine during 22 miles per hour (10 meters per second) 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 164 feet (50 meters) of the foundations (Miller and Potty 2017; Tougaard et al. 2009b). 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 164 feet (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 **discountable**. 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 wherein behavioral reactions may include avoidance of the area. As described above, it is expected that Atlantic sturgeon would occur intermittently in the Lease Area throughout their spring and fall migrations and may forage opportunistically in areas where benthic invertebrates are present. The area is not known to be a preferred foraging area and has not been identified as an aggregation area which reduces the potential for impact on this species from long-term operation noise. Given the interim definition for ESA harassment, the animals ability to avoid harmful noises, the intermittence of foraging and aggregation 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. SouthCoast 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 due to increased 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, a daily average of 15-35 vessels depending on construction activities with a maximum peak of 50 vessels could be present in the Lease Area at one time 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 (UMEs) 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, and 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 swimming 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). The 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 individual 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 important factors for determining the probability and severity of vessel strikes. The size and bulk of large vessels inhibit the ability of 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 262 feet (80 meters) or longer travelling at speeds greater than 13 knots (6.69 meters per second). 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 slower 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; Jensen and Silber 2004).

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 grapnel run vessels, construction support vessels, and tugs and barges (Table 3.1-14). The remaining 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 reduce reaction time for both the marine mammal and for the vessel operator conducting a maneuver to avoid the marine mammal.

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

SouthCoast Wind has committed to a range of mitigation measures to avoid, minimize, and mitigate impacts on marine mammals associated with vessel traffic (Section 3.3, Table 3.3-1). This includes strict adherence to NMFS Regional Viewing Guidelines (NMFS 2023p) for vessel strike avoidance. Mitigation measure AMM-23 sets the general measure for all vessels to follow during all phases of the Project. This requires all underway vessels, including those transiting to and from local ports, to follow all vessel strike avoidance measures and have a dedicated trained visual observer or NMFS-approved PSO on duty at all times to monitor for marine mammals. Visual observers must be equipped with alternative monitoring technology during periods of low visibility (e.g., darkness, rain, and fog). Observers will monitor the NMFS NARW reporting system from November 1 through May 30 and whenever a dynamic management area (DMA) is established in the operational area. AMM-26 requires all vessels, except for CTVs, to comply with NMFS regulations and speed restrictions (≤10 knots) in NARW management areas including seasonal management areas (SMA) and active DMAs during migratory and calving periods from November 1 to April 30. All vessels, however, will reduce speed to ≤10 knots when mother/calf pairs, pods, or large assemblages of marine mammals are observed. A PAM system will be developed consisting of near real-time monitoring such that NARW or other large whale calls made in or near the transit corridor can be detected and transmitted to the transiting vessel and will also be used to facilitate the safe transit of CTVs in SMAs and DMAs (AMM-26). In the event the system temporarily stops working, CTVs would then be required to reduce speed to < 10 knots. AMM-24 and AMM-25 require separation distances between the vessel and sighted NARWs or unidentified large marine mammals, including the actions taken by the vessel when a marine mammal is in the vicinity. These actions include active avoidance of spotted NARWs at 10 knots or less, shifting engines to neutral in the event a NARW approaches the vessel, and reporting protocols for dead and/or injured marine mammals.

To further minimize impacts on marine mammals from vessel encounters, agency-proposed measures (BA-4 through BA-8) will be implemented along with those proposed by the developer. BOEM proposed measures BA-4 and BA-5 require the Lessee provide the required training to keep watch for and report on marine mammals and requires the vessel to follow speed restrictions and course corrections when marine mammals are present. BA-6 requires near real-time communication among Project vessels working in the same area when ESA-listed species are sighted (marine mammals and sea turtles). BA-7 ensures that vessels of all sizes operating port to port will reduce speeds to 10 knots or less between November 1 and April 30 and that vessel speed reductions in SMAs, DMAs, slow zones, and when marine mammals are sighted are followed. BA-8 requires that vessel operators check daily for NARW sightings and adhere to separation distances and full-stop procedures when ESA-listed marine mammals are encountered.

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 risk of vessel strikes is **discountable.** Project vessel activities **may affect, not likely to adversely affect** 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 one third of loggerhead and leatherback sea turtles and 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).

From 50 – 500 loggerhead sea turtles and 5 – 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, 15 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. 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 vessel propellers. With the exception of leatherbacks, sea turtles prefer to stay within the first few meters of the water's surface. Information on swim depth is 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 – 75 percent of their time within 33 feet (10 meters) of the surface; leatherback sea turtles spend about 20 percent of their time within 33 feet (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 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.

Sea turtle density estimates 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/kilometer) than in the summer (0.19 turtles/kilometer). 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, 18 sightings of 19 leatherback turtles were observed during general surveys. Sea turtles were sighted in 5 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/kilometers (fall 2020), 5.3 turtles/kilometers (summer), and 2.9 turtles/kilometers (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). Vessels transiting from Port of Salem, Massachusetts and Canadian ports could potentially transit across Nantucket Shoals, where the greatest numbers of turtles were observed. However, these vessels would be able to avoid Nantucket Shoals via the Cape Cod Canal or by transiting through the Vineyard Sound.

To reduce the probability of a vessel strike resulting from the Proposed Action, especially during peak vessel activity, several mitigation measures will be implemented by SouthCoast Wind (Table 3.3-1). These measures (AMM-27 and AMM-2) include 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. 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. Visual observers must be equipped with alternative monitoring technology for periods of low visibility (e.g., darkness, rain, and fog). Sea turtle exposure to vessel strike risk would be expected to be minor and localized to surface habitats in the transit path between ports and the Lease Area.

Additionally, BOEM-proposed measure BA-10 requires vessels to slow down to 4 knots if a turtle is sighted within 33 feet (100 meters) of the operating vessel's forward path. The vessel must then move away from the sea turtle until a 33-foot (100 meter) separation distance is achieved. Additionally, from June 1 through November 30, all vessels must avoid transiting through areas of visible jellyfish aggregations or floating vegetation, or slow down to 4 knots while transiting such areas. Further, crew members will be briefed on the identification of sea turtles, and the process for reporting sea turtles must be clearly communicated and posted in highly visible areas aboard all Project vessels.

Based on this analysis of seasonal presence and the proposed mitigation measures, the risk of vessel strike due to the Proposed Action is unlikely given that sea turtles only seasonally occur in small numbers with dispersed regional 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. In the event that ESA-listed sea turtles occur in the Action Area, the implementation of mitigation measures mentioned above will greatly reduce impacts from vessel encounters. Vessel strikes are not anticipated when mitigation measures are implemented; thus the potential for vessel strikes to ESA-listed sea turtle species is extremely unlikely and considered **discountable**. Therefore, the potential for vessel strikes due to Project vessel traffic **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 from 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 (≤ 24 feet [7.3 meters]) ocean cargo vessels traveling to the Port of Richmond. The greatest number of vessel strike mortality carcasses recovered from 2007 to 2010 occurred 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 depth of ocean cargo vessels overlaps 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, demersal Atlantic sturgeon would have greater spatial separation from vessel hulls due to deeper water and increased ability to avoid vessels (i.e., as opposed to within the confines of a shallower river), so the risk of vessel strike would be significantly lower. There is the potential for Project vessels to encounter Atlantic sturgeon in the Hudson River during trips to the Port of Coeymans during the construction phase of the Project; however, Project vessel trips in the Hudson River are expected to represent a very small portion of the existing traffic on the Hudson River.

SouthCoast Wind has proposed measures to avoid or reduce vessel strike risk for marine mammals and sea turtles (AMM-23 to AMM-27), some of which may also benefit ESA-listed fish species (Table 3.3-1). Given the small incremental increase in vessel traffic due to Project vessels compared to existing traffic and the limited time when Project vessels would travel in the Hudson River during the construction phase, the increased collision risk for Atlantic sturgeon is expected to be very small, and thus, **insignificant**. Given the very small increase in collision risk, the effects of vessel strikes from Project activities leading to injury or mortality **may affect, not likely to adversely affect** 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. In addition, SouthCoast Wind has developed an OSRP (COP Appendix AA, Mayflower Wind 2022) with measures to avoid accidental releases and a protocol to respond to such a release if one occurs. Under AMM-28 and AMM-36 (Table 3.3-1), SouthCoast Wind will adhere to all regulations under the USEPA Clean Water Act. In addition, to reduce the accumulation of marine debris from lost gear, BOEM-proposed measures BA-29 through BA-31 (Table 3.3-2) require the Lessee to provide Marine Debris Awareness Training to all individuals onboard vessels for Project-related activities, prohibits the disposal of trash overboard, and in the event of an accidental release of trash, efforts must be made to retrieve the debris and report the debris to BSEE. Therefore, effects due to 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 mitigation measures in place to prevent accidental releases, the 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 2010) or sublethal effects, including but not limited to adrenal effects, dehydration, hematological effects, increased disease incidence, hepatological effects, poor body condition, and dermal and musculoskeletal effects (Bembenek-Bailey et al. 2019; Camacho et al. 2013; Mitchelmore et al. 2017; NOAA 2010; 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 SouthCoast Wind has developed an OSRP with measures to avoid accidental releases and a protocol to respond to such a release if one occurs. Under AMM-28 and AMM-38, SouthCoast Wind will adhere to all regulations under the USEPA Clean Water Act. To reduce the accumulation of marine debris from lost gear, BOEM-proposed measures BA-29 through BA-31 (Table 3.3-2) require the Lessee to provide marine debris awareness training to all individuals onboard vessels for Project-related activities, prohibits the disposal of trash overboard, and in the event of an accidental release of trash, efforts must be made to retrieve the debris and report the debris to BSEE. Therefore, effects due to accidental releases are considered unlikely.

Given the proposed mitigation measures designed to minimize the event and effects of accidental releases, the low likelihood of a discharge, and given that the Proposed Action would not result in a measurable increase in accidental releases in the Action Area, the 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).

The Proposed Action would comply with all laws regulating at-sea discharges of vessel-generated waste and SouthCoast Wind has developed an OSRP with measures to avoid accidental releases and a protocol to respond to such a release if one occurs. Under AMM-28 and AMM-38, SouthCoast Wind will adhere to all regulations under the USEPA Clean Water Act. SouthCoast Wind will ensure the use of appropriate mooring gear that minimizes the risk of entanglement or entrainment of sea turtles that would just as likely benefit the Atlantic sturgeon. Further, to reduce the accumulation of marine debris from lost gear BOEM proposed measures BA-29 through BA-31 require the Lessee to provide marine debris awareness training to all individuals onboard vessels for Project-related activities, prohibits the disposal of trash overboard, and in the event of an accidental release of trash, efforts must be made to retrieve the debris and report the debris to BSEE.

Therefore, effect due to 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**. Therefore, the effects of vessel discharges from the Project **may affect, not likely to adversely affect** 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, effects from vessel discharges associated with the Proposed Action would be **insignificant** for all 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, effects from vessel discharges associated with the Proposed Action would be **insignificant** for all 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, effects from vessel discharges associated with the Proposed Action would be **insignificant** for 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, submarine cables, 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, and
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 1,640-foot (500 meter) monitoring zones in all directions; 1,640-foot (500 meter) shutdown zones (NARWs); 328-foot (100 meter) 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 in the Southern U.S. and Gulf of Mexico 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). SouthCoast 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 have **no effect** on 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. These effects would be localized and short-term. Recolonization and recovery of prey species in disturbed sediment 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 sea 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 in disturbed sediment 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 **insignifican**t, and **not likely to adversely affect** Atlantic sturgeon.

5.5.2 Fisheries and Habitat Surveys and Monitoring

As described in Section 3.1.2.7, SouthCoast Wind will be working with the 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. Fisheries monitoring plans are still under development, but 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. SouthCoast Wind has proposed a variety of survey methods they may choose to evaluate the effects of construction and operations on benthic habitat structure and composition and economically valuable fish and invertebrate species. These survey methods could include acoustic, trawl, trap and pot, and video/photography surveys, as well as other methods of sampling the biota in the area. In addition to specific requirements for monitoring during the construction and operations period, periodic PAM deployments may occur over the life of the Project for other scientific monitoring needs.

Video trawl surveys would be used to collect baseline data to evaluate changes in mesoscale abundance and distribution of finfish (demersal and benthic species) and squid resources within the Project area while acoustic surveys would be used to collect data and evaluate changes to the abundance and distribution of pelagic and highly migratory fish species around offshore structures. Video trawl surveys will utilize the SMAST net camera technology which is typically deployed on open cod-end video trawls. Habitat surveys using video and photographic imaging would be used to evaluate changes in benthic habitat structure and invertebrate community composition while also monitoring reef effects of offshore structures and foundations. 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 2021d) to limit interactions with protected species.

Additionally, SouthCoast 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, SouthCoast 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 SouthCoast Wind, will likely follow similar surveys for other wind farms. These tows are typically shorter in duration than conventional commercial trawl tows, and less frequent for research fishing vs. commercial fishing, often spread out over a much larger area. Additionally, SouthCoast Wind is proposing video trawls of finfish and squid resources. These video surveys will typically 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 surveys would be conducted to collect baseline data and evaluate changes to abundance and distribution of pelagic and highly migratory fish species throughout the duration of the Project. These surveys typically employ a combination of fixed (e.g., attached to piers or buoys) or mobile (e.g., attached to vessels or unmanned underwater vehicles) hydrophone receivers to monitor fish presence and movement. Continuous marine mammal observational periods (AMM-1 to AMM-6, AMM-23, BA-4 to BA-6, BA-11, BA-31 in Table 3.3-1, Table 3.3-2) will be implemented, and therefore, reduce the risk of entanglement and interactions to marine mammals. 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 180 days but no less than 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 (AMM-10 to AMM-12 in Table 3.3-1). To further minimize the risk of entanglement, mooring 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 (AMM-28 and AMM-38 in Table 3.3-1).

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. Further, to reduce the risk of entanglement from marine debris, BOEM-proposed measure BA-36 (Table 3.3-2) would require lost survey gear to be recovered when possible, and for all lost gear to be reported to BSEE. With the mitigation measures discussed above, the potential for entanglement of ESA-listed marine mammals in PAM survey equipment is considered extremely unlikely to occur and is discountable.

Given that survey activities anticipated are unlikely to pose an entanglement risk to ESA-listed marine mammals and the mitigation measures required for the survey activities, entanglement of ESA-listed marine mammals during fisheries surveys would be extremely unlikely to occur and are thus **discountable**. 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** 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, USFWS and SEMARNAT 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, much of the 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 (BA-33, Table 3.3-2). 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 SouthCoast 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 (Lutcavage and Lutz 1997).

As discussed in Section 5.5.2.1.1, acoustic telemetry to monitor for pelagic and highly migratory fish 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 (AMM-28 and AMM-38, Table 3.3-1). Therefore, passive acoustic equipment is not expected to pose a meaningful risk of entanglement to sea turtles. 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 ESA-listed sea turtles are expected to be negligible. Additionally, BOEM-proposed measures BA-33 through BA-35 (Table 3.3-2) require sea turtle disentanglement protocols and equipment, sea turtle identification and data collection of incidentally caught sea turtles during fishery surveys, and for vessel crews to be well-versed in sea turtle handling and resuscitation guidelines. Further, to reduce the risk of entanglement from marine debris, BOEM-proposed measure BA-36 would require lost survey gear to be recovered when possible, and for all lost gear to be reported to BSEE.

Based on the potential survey methods identified, and with effective implementation of mitigation measures to minimize impacts from fisheries and habitat surveys, mortality of sea turtles is not anticipated. There could still be a chance for sea turtles to be captured or entangled during the anticipated surveys; however, due to the patchy distribution and low densities of sea turtles within 3 miles (5 kilometers) of the SouthCoast Lease Area (< 1 turtle per 100 square kilometers in and near the Lease Area for all species in any season) and the implementation of safe handling procedures, the effect of habitat and monitoring surveys on sea turtle populations is expected to be **insignificant**. 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** ESA-listed 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 8 long term trawl surveys recorded no injuries or mortalities among nearly 900 caught Atlantic and shortnose sturgeon 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 would typically 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 2016b). Northeast Fisheries Observer Program (NEFOP) data calculates mortality rates of Atlantic sturgeon caught in otter trawl gear are approximately 5 percent (Stein et al. 2004; 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 2016b). To date, no serious injuries or mortalities of any sturgeon have been recorded in those surveys. In contrast, individual Atlantic sturgeon have been incidentally captured and released with minor injuries during trawl-based monitoring surveys conducted for the South Fork Wind project (BOEM 2023). While the dispersed nature of Atlantic sturgeon, the likely limited number of open cod-end tows, and expected short tow duration of fisheries and habitat surveys are not expected to result in Atlantic sturgeon mortality, 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 and highly migratory fish 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 studies utilizing moored systems would be required to use the best available technology to reduce any potential risks of entanglement (AMM-38, Table 3.3-1). 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 sturgeon are expected to be negligible. Additionally, BOEM-proposed measures BA-34 through BA-35 (Table 3.3-2) require Atlantic sturgeon identification and data collection of incidentally caught sturgeon during fishery surveys and for vessel crews to be well-versed in sturgeon handling and resuscitation guidelines. Further, BOEM proposed measure BA-36 would require lost survey gear to be recovered if possible, and all lost gear will be reported to BSEE.

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 measures to reduce the risk of entanglement, 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 (e.g., demersal otter trawl; open cod-end video trawl) 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, and are thus **insignificant**. Additionally, ESA-listed marine mammal species do not utilize benthic habitats, where disturbance from monitoring surveys is likely to occur. Therefore, effects of fisheries and habitat surveys associated with the Proposed Action leading to impacts on prey or habitat **may affect**, **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 SouthCoast 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 from the video trawl surveys that 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 and are thus **insignificant**. 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, not likely to adversely affect** ESA-listed sea turtles.

5.5.2.2.3 Fish

SouthCoast Wind proposed video trawl surveys which are not expected to retain bycatch (i.e., open cod-end video trawl). Atlantic sturgeon 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 sturgeon from collection of potential Atlantic sturgeon 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 and would be **insignificant**. Therefore, effects of fisheries and habitat surveys associated with the Proposed Action leading to impacts on prey or habitat **may affect, not likely to adversely affect** the ESA-listed Atlantic sturgeon.

5.5.3 Habitat Conversion and Loss

Installation of WTGs, OSPs, 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 open water pelagic habitat would be converted to hard-bottom and vertical structured habitat, respectively. This habitat loss and conversion would last through the O&M phase and into decommissioning.

Seafloor habitats within the Lease Area and southern portions of the Falmouth and Brayton Point ECCs are homogenous sand plains, which are prevalent feature on the OCS. Greater habitat complexity, including hard bottom habitats, are found in the northern portions of both ECCs as they enter state waters (Table 5.5-1). Communities well adapted to disturbance within their habitats (e.g., soft-sediment fauna dominant in sand habitats in the Lease Area and southern portions of the ECCs) are expected to quickly recolonize a disturbed area, while communities less 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 portions of the ECCs) 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 portions of the Falmouth and Brayton Point ECCs. In areas with complex habitat (i.e., northern portions of the ECCs), 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, 2020). 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 (HDR 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 (HDR 2020). The epifaunal and sediment characteristics varied between WTGs and between survey years. Similar results may be expected during the operations phase of the proposed Project due to the close proximity of the Lease Area to the Block Island Wind Farm (located approximately 56.3 miles [90.6 kilometers] southeast of the Block Island Wind Farm).

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

Habitat Types	Lease Area	Falmouth ECC Route - Federal	Falmouth ECC Route – MA State Waters	Brayton Point ECC Route - Federal	Brayton Point ECC Route – RI State Waters
Glacial Moraine A	-	-	1,691	411	185
Bedrock	-	-	-	-	3
Gravel Pavement	-	-	1,818	-	-
Mixed-Size Gravel	-	-	-	18	510
Boulder Fields Present	-	2.6	544	945	184
Coarse Sediment	-	-	2,325	1,026	0.1
Mud to Muddy Sand	49,731	15	444	4,015	3,851
Soft bottom sand	777	4,406	4,174	9,596	1,478
SAV	-	-	295	-	-
Shell accumulations	-	-	1,531	-	1,342
Anthropogenic	-	-	-	-	7
HAPC	-	151	10,895	0	6,210

ECC = export cable corridor; HAPC = habitat area of particular concern; MA = Massachusetts; RI = Rhode Island; SAV = submerged aquatic vegetation;

According to geophysical surveys along the Brayton Point ECC, sediment mobility along the corridor and risk to the cable is 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 benthic area of impact from seafloor preparation activities and installation of WTG and OSP foundations are presented in Table 3.1-9. The area of impact from seafloor preparation activities and export cable installation is presented in Table 3.1-12., and include activities carried out by dredging. The anticipated volume of dredged material within the Falmouth ECC is approximately 646,077 cubic yards (493,962 cubic meters) while the anticipated volume of dredged material within the Brayton Point ECC is approximately 22,404 cubic yards (17,124 cubic meters). The area of disturbance from HDD activities are shown in Table 3.1-13.

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. SouthCoast Wind will coordinate with relevant federal and state agencies in addition to SouthCoast 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 3.1-9.

The installation of 147 52.5-foot- (16-meter) diameter monopile foundations for the WTGs and 2 OSPs with piled jacket foundation types would render approximately 390 acres (158 hectares) of soft-bottom (fine sand and silt/mud) into hard bottom habitat for the 30-year life of the Project through decommissioning when the foundation and scour protection are to be removed (Table 3.1-9). For piled-jacket foundation WTGs, the equivalent estimated benthic habitat disturbance area is 403 acres (163 hectares). SouthCoast Wind is considering suction-bucket jackets for up to 85 WTG positions in the southern portion of the Lease Area. If suction-bucket jackets are used, maximum benthic habitat disturbance would be 598 acres (242 hectares) associated with 85 suction-bucket jackets WTGs, 62 piled jacket foundation WTGs, and 2 OSPs with piled jacket foundation types piled-jacket foundations. During decommissioning, foundations that required pile driving for installation (i.e., monopiles and piled jacket WTGs), will be cut at an approved depth within the subsurface and subsequently pulled out of the seabed. Suction-bucket foundations may require pumps to allow them to be more easily removed from their position suctioned to the seabed.

The average water depth in the Lease Area is approximately 164 feet (50 meters) (COP Volume 2, Mayflower Wind 2022) and the installation of vertical structures in the water column would introduce new hard surfaces extending from the seabed to the water surface. The resulting underwater vertical structure from any foundation type installed would alter the characteristics of pelagic habitats used by many EFH species and their prey and foraging resources. 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). Over time, these new hard surfaces will become colonized by sessile organisms, creating complex habitats that effectively serve as artificial reef. In addition to reef effects, the WTGs may create localized hydrodynamic effects that could have localized effects on food web productivity and pelagic eggs and larvae. Hydrodynamic effects are described in Section 5.5.7.

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). 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 complex benthic habitats. Sperm whales, on the other hand, 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. 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 2022) 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. To further reduce sediment disturbance, SouthCoast Wind will use HDD for sea-to-shore transitions and use BMPs to minimize sediment mobilization during offshore component installation (AMM-34, Table 3.3-1).

While seafloor 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 (i.e., will be **insignificant)** on the ability of marine mammals to find suitable prey elsewhere within their seasonal range. Therefore, benthic habitat alteration due to the presence of foundations and scour protection **may affect, not likely to adversely affect** ESA-listed marine mammals.

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. In the nearshore Falmouth area, sea-to-shore transition of cables at landfall will be made via HDD in order to avoid direct impacts to documented SAV beds dominated by eelgrass in the nearshore Falmouth area, as well as BMPs to minimize sediment disturbance during offshore component installation (AMM-34, Table 3.3-1). This method would effectively reduce any adverse effects to 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 that forage on crabs, mollusks, and other invertebrates associated with benthic habitats (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.

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 through increased foraging opportunities. In the Gulf of Mexico, green, Kemp's ridley, leatherback, and loggerhead sea turtles have been documented in the presence of offshore oil and gas platforms (Gitschlag and Herczeg 1994; Gitschlag and Renauld 1989; Hastings et al. 1976; Rosman et al. 1987), indicating that sea turtles are likely to use habitat created by in-water structures to forage. 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 presumably 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, the ability of these species to adjust their diet in response to resource availability, and the implementation of mitigation measures to reduce such impacts, any effects from habitat conversion due to WTGs/OSPs or scour protection are expected to be so small that they cannot be meaningfully measured, evaluated or detected, so are **insignificant**, and benthic habitat alteration due to the presence of foundations and scour protection **may affect, not likely to adversely affect** ESA-listed sea turtles.

5.5.3.1.3 Fish

Installation of WTGs, OSPs, and scour protection would transform potential soft bottom foraging habitat for Atlantic sturgeon into coarse, hard-bottom habitat through placement of monopiles and jacketed piles, scour protection, and cable protection (see Table 3.1-9 for seabed disturbance and scour protection amount by foundation type); such changes will persist through the O&M phase. The addition of the WTGs and OSPs is expected to result in long-term habitat alteration in the area immediately surrounding each foundation from a 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 Atlantic 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).

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. 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 available habitat area. is expected that due to the highly mobile behavior of the Atlantic sturgeon, the large foraging areas over which Atlantic 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, the effects of long-term habitat conversion from soft to hard bottom habitat is expected to be so small that it cannot be meaningfully measured, evaluated or detected , and is thus **insignificant**. Any impacts due to sediment disturbance or alteration would be further minimized as SouthCoast Wind intends to use HDD for sea-to-shore transitions and use BMPs to minimize sediment mobilization during offshore component installation (AMM-34, Table 3.3-1). Therefore, benthic habitat alteration due to the presence of foundations and scour protection **may affect, not likely to adversely affect** ESA-listed Atlantic sturgeon.

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 ECC where sea-to-shore transition activities (HDD) would occur, the two cable bundles will split into up to four HDD exit pits at each of three landfall locations: south of Aquidneck Island, north of Aquidneck Island, at Brayton Point. The Falmouth landfall location would also 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 on areas of impact to benthic habitats is based on information from COP Appendix M.3 (Mayflower Wind 2022), which was compiled to assess impacts to EFH based on 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 3.1-8.

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 429 acres (174 hectares) may be temporarily impacted by sand wave removal. The potential impacted habitat includes 52 acres (21 hectares) of large grained complex habitat, 140 acres (57 hectares) of complex habitat, and 237 acres (96 hectares) of soft bottom habitat.

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 both the Brayton Point ECC and 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-foot-wide (15 meters) boulder plow will be minimized.

In the Brayton Point ECC, up to 1,135 acres (459 hectares) may be temporarily impacted by boulder removal. Habitat types potentially impacted include 4 acres (1.4 hectares) of anthropogenic habitat, 31 acres (13 hectares) of large grained complex habitat, 150 acres (61 hectares) of complex habitat, 56 acres (23 hectares) of heterogeneous complex habitat, and 894 acres (362 hectares) of soft bottom habitat.

In the Falmouth ECC, up to 498 acres (202 hectares) may be temporarily impacted by boulder removal. Potential habitats impacted include 144 acres (58 hectares) of large-grained complex habitat, 220 acres (89 hectares) of complex habitat, 17 acres (7 hectares) of heterogenous habitat, and 117 acres (47 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 both ECCs and the interarray cable locations 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 to 438 hectares), which does not include the ~71 acres (29 hectares) of temporary seafloor disturbance surrounding each of the 149 foundation locations. 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 estimated area of 453.8 acres (183.6 hectares) that could potentially reach a maximum range of ~463 to 593 acres (187.4 to 240 hectares). Habitat types potentially impacted include 1.5 acres (0.6 hectares) of anthropogenic habitat, 13 acres (5 hectares) of large-grained habitat, 60 acres (24 hectares) of complex habitat, 22 acres (9 hectares) of heterogeneous complex habitat, and 358 acres (145 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 58 acres (23 hectares) of large grained complex habitat, 163 acres (66 hectares) of complex habitat, 7 acres (3 hectares) of heterogeneous complex, and 405 acres (164 hectares) of soft bottom habitat.

Cable installation tools for all cables would measure up to ~20 feet (6 meters) wide for all cable installation. To minimize the impacts of habitat conversion and seabed disturbance to ESA-listed species, SouthCoast Wind intends to bury submarine cables at depths between 3 to 8 feet (1 to 2.5 meters) for inter-array cables and between 3 to 13 feet (1 to 4 meters) for export cables (AMM-35, Table 3.3-1).

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 62 to 104 acres (24 to 42 hectares) for up to 5 export cables. Potential habitat types impacted would be 58 acres (23 hectares) of large grained complex habitat, 163 acres (66 hectares) of complex habitat, 7 acres (3 hectares) of heterogeneous complex habitat, and 405 acres (164 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 acres (28 hectares) to 89 acres (28 to 36 hectares) for up to 2 cable bundles for Brayton Point. Habitat types potentially impacted include 1.5 acres (0.6 hectares) of anthropogenic habitat, 13 acres (5 hectares) of large grained complex habitat, 60 acres (24 hectares) of complex habitat, 22 acres (9 hectares) of heterogeneous complex habitat, and 358 acres (145 hectares) of soft bottom habitat. For the interarray cables, 26 to 115 acres (11 to 47 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 artificial reef effect (Causon and Gill 2018; Taormina et al. 2018).

HDD Exit Pits

Disturbance impacts from HDD exit pits are identified in Table 3.1-13. For Aquidneck Island intermediate landfalls, all potential impacts at these landfall options are located entirely in habitats cross-walked to the NOAA Complexity Category of complex due to the presence of *Crepidula* Substrate, with the exception of the Roger Williams University landfall which was classified as 70 percent complex and 30 percent soft bottom. At the Brayton Point landfalls, the total area of disturbance 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 plan 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 where cable protection is present and wherever boulders are relocated. Some areas where cables cannot be buried would be hard bottom habitat already, thus the addition of cable protection would not remarkably change the sediment type. Sand wave clearance is only expected for five 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 relative to the area available for forage for prey species and marine mammals.

The only permanent effects of cable emplacement expected are from cable protection and sand wave clearance, all other impacts due to habitat conversion and loss are expected to be temporary. Further, under AMM-34 (Table 3.3-1), SouthCoast Wind will use technologies that will minimize sediment mobilization and seabed sediment alteration for cable burial operations. To effectively assess the impacts to benthic habitats, BOEM will require the Lessee to conduct Benthic Habitat Surveys of at a minimum, one year during pre-construction, one year during construction, and two years post-construction (BA-3, Table 3.3-2).

Given the small scale of anticipated effects and the application of mitigation and monitoring measures to minimize such effects, any effects on habitat conversion and loss due to cable emplacement or maintenance are expected to be so small that they cannot be meaningfully measured, evaluated or detected and are therefore **insignificant.** Cable emplacement and maintenance **may affect, not likely to adversely affect** ESA-listed marine mammals.

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 where cable protection is present and wherever boulders are relocated. Some areas where cables cannot be buried would be hard bottom habitats thus the addition of cable protection would not remarkably change the sediment type. 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 only permanent effects of cable emplacement expected are from cable protection and sand wave clearance, all other impacts due to habitat conversion and loss are expected to be temporary. Further, under AMM-34 (Table 3.3-1), SouthCoast Wind will use technologies that will minimize sediment mobilization and seabed sediment alteration for cable burial operations. To effectively assess the impacts to benthic habitats, BOEM will require the Lessee to conduct Benthic Habitat Surveys of at a minimum, 1 year during pre-construction, 1 year during construction, and 2 years post-construction (BA-3, Table 3.3-2).

Given the small scale of anticipated effects and the application of mitigation and monitoring measures to minimize such effects, any effects from habitat conversion due to cable emplacement or maintenance are expected to be so small that they cannot be meaningfully measured, evaluated or detected, so are **insignificant**, and thus **may affect, not likely to adversely affect** ESA-listed sea turtles.

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 where cable protection is present and wherever 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 only permanent effects of cable emplacement expected are from cable protection and sand wave clearance, all other impacts due to habitat conversion and loss are expected to be temporary. To minimize the effects of habitat conversion due to cable emplacement and maintenance, SouthCoast Wind will design sea-to-shore transitions to reduce the dredging footprint and effects to Atlantic sturgeon from cofferdam installation (AMM-29, Table 3.3-1). SouthCoast Wind also intends to use technologies that will minimize sediment mobilization and seabed sediment alteration for cable burial operations (AMM-34, Table 3.3-1). To effectively assess the impacts to benthic habitats, BOEM will require the Lessee to conduct Benthic Habitat Surveys of at a minimum, 1 year during pre-construction, 1 year during construction, and 2 years post-construction (BA-3, Table 3.3-2).

Given the small scale of anticipated effects and the application of mitigation and monitoring measures to minimize such effects, the effects of habitat conversion due to cable emplacement or maintenance are expected to be so small that they cannot be meaningfully measured, evaluated or detected, so are **insignificant**, and thus **may affect, not likely to adversely affect** ESA-listed Atlantic sturgeon.

5.5.3.3 Spuds/Anchors

Dynamic positioning (DP) 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 3.1-9 and Figure 3.1-10). 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 442 acres (179 hectares) 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 only ~16 feet (5 meters) in diameter. Although up to 203 anchor points could be used in the Brayton Point corridor, anchors will be spaced every 886 feet (270 meters) totaling < 1 acre (0.4 hectares) 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 spaced every 886 feet (270 meters) for a total of 1 acre (0.4 hectares) of impact; however, similar to the Brayton Point ECC, a conservative estimate of 1 to 5 acres of impact is anticipated. 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 from 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 six to eight 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 are 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/OSPs foundation and scour protection and cable presence/protection. The 442 acres (179 hectares) impacted by spuds/anchoring is spread over 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; thus, it is not expected that benthic habitats temporarily impacted by anchoring would result in long-term habitat conversion or loss. In addition, SouthCoast Wind has committed to using DP vessels when practical and safe in order to reduce the total area impacted by anchoring (AMM-34, Table 3.3-1).

Given this small, localized, and temporary reduction in benthic habitat due to vessel anchoring and with the implementation of mitigation measures to reduce such impacts, any effects are expected to be so small that they cannot be meaningfully measured, evaluated, or detected and is therefore **insignificant**. Habitat conversion and loss due to spuds/anchors **may affect, not likely to adversely affect** ESA-listed marine mammals.

5.5.3.3.2 Sea Turtles

The effect of habitat conversion and loss associated with anchoring/spuds for the Proposed Action on ESA-listed sea turtles is relatively small compared to WTGs/OSPs foundation and scour protection and cable presence/protection. The 442 acres (179 hectares) impacted by spuds/anchoring is spread over the entire Project area. Benthic habitats are expected to recover from more invasive installation activities than anchoring; thus, it is not expected that benthic habitats temporarily impacted by anchoring would result in long-term habitat conversion or loss. In addition, SouthCoast Wind has committed to using DP vessels when practical and safe in order to reduce the total area impacted by anchoring (AMM-34, Table 3.3-1).

Given this small, localized, and temporary reduction in benthic habitat due to vessel anchoring and with the implementation of mitigation measures to reduce such impacts, any effects are expected to be so small that they cannot be meaningfully measured, evaluated, or detected and is therefore **insignificant**. Habitat conversion and loss due to spuds/anchors **may affect, not likely to adversely affect** ESA-listed sea turtles.

5.5.3.3.3 Fish

The effect of habitat conversion associated with mats/anchoring for the Proposed Action on ESA-listed fish species is relatively small compared to WTGs/OSPs foundation and scour protection and cable presence/protection. The 442 acres (179 hectares) impacted by spuds/anchoring is spread over 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; thus, it is not expected that benthic habitats temporarily impacted by anchoring would result in long-term habitat conversion or loss. In addition, SouthCoast Wind has committed to using DP vessels when practical and safe in order to reduce the total area impacted by anchoring (AMM-34, Table 3.3-1).

Given this small, localized, and temporary reduction in benthic habitat due to vessel anchoring and with the implementation of mitigation measures to reduce such impacts, any effects are expected to be so small that they cannot be meaningfully measured, evaluated, or detected and is therefore **insignificant**. Habitat conversion and loss due to spuds/anchors **may affect, not likely to adversely affect** ESA-listed Atlantic sturgeon.

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 2020a 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 mg/L at 65 feet (20 meters) from the jet plow, with concentrations decreasing to 43 mg/L within 656 feet (200 meters) (NMFS 2020a 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 0.6 mile (1 kilometer). 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 200 mg/L and 10 mg/L concentrations lasted for longer than about 2 hours and a several hours after re-suspension, respectively. Deposition thicknesses exceeding 0.2 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 pounds per gallon) are found at a maximum distance of 755 feet (230 meter) and 492 feet (150 meters), the impacted areas are respectively 4.2 acres (1.7 hectares) and 3.7 acres (1.5 hectares). Similarly, deposited sediments exceeding 5 mm thickness for the neap and spring tides are expected to occur 85 feet (26 meters) and 105 feet (32 meters) 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.

Routine maintenance activities during Project operation, 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 (Appendix F1, Mayflower Wind 2022). To further minimize any impacts of turbidity to ESA-listed species, SouthCoast Wind will implement mitigation measures that would reduce sediment disturbance (AMM-29 and AMM-34, Table 3.3-1) such as the application of BMPs to minimize sediment mobilization during offshore component installation, the use of technologies that minimize sediment mobilization and seabed sediment alteration for cable burial operations, the use of DP vessels, and the use of HDD for sea-to-shore transition.

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 (Appendix F1, Mayflower Wind 2022).

5.5.4.1 Marine Mammals

As marine mammals may occur within the 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. Elevated suspended sediment may cause these species to alter their normal movements but 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 responses would be temporary and **insignificant** (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), based on modeling done in the Hudson River. Sediment dispersion modeling done for the SouthCoast Wind ECC and inter-array cable routes indicated that plumes generated from the cable installation activities with concentrations exceeding 50 mg/L would be limited to the first 16 feet (5 meters) above the seabed. Sediment plumes with concentrations above 100 mg/L (0.0008 lb/gal) would be expected to extend to a maximum of 1,214 feet (370 meters) horizontally from the corridor centerline and affect a cumulative area of 4,569 acres (1,849 hectares) for the entirety of the offshore export cable corridors and inter-array cable routes. Turbidity levels associated with the HDD exit pit dredging are significantly smaller compared with the impact resulting from the cable trenching/dredging, with concentrations exceeding 100 mg/L (0.0008 lb/gal) found at a maximum distance of 118 feet (36 meters). Potential plumes would generally remain suspended for two hours before the maximum TSS levels drop to 10 mg/L (0.00008 lb/gal) and below 1 mg/L (0.000008 lb/gal) after less than four hours. Given the short duration and 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. 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. 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). Given that presence of ESA-listed marine mammals is greatest in offshore areas that may experience up to 100 mg/L TSS concentrations in areas near the cable centerline for a maximum of 2 hours, the relatively 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**.

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 on *Pseudocalanus* spp. and *Centropages* spp. copepods (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). Sei whales also feed on copepods; 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.

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 16 feet (5 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.

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. Sperm whales hunt for food during deep dives, with feeding occurring at depths of 1,640 to 3281 feet (500 to 1,000 meters) (NMFS 2010). Deepwater squid make up the majority of their diet (NMFS 2010). 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.

As discussed above, 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. 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 and the proposed mitigation measures designed to minimize sediment mobilization and alteration (AMM-34), the effects of elevated turbidity or deposition of suspended sediments associated with the Proposed Action would be too small to be meaningfully measured, detected, or evaluated. Therefore, the effects of increased turbidity and deposition on marine mammals or their prey is **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 total suspended sediment on juvenile and adult sea turtles. While the increase in suspended sediments may cause sea turtles to alter their normal movements, these minor alterations in movements and behaviors would be too small to be meaningfully measured or detected (NMFS 2020a). Sea turtles breathe air and would be able to swim through the turbidity plume without adverse effects from passing through the area. 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 2020a). 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 2020a citing USEPA 1986). The maximum suspended sediment concentrations associated with pile driving (5 – 10 mg/L) and jet plowing (235 mg/L) are below the threshold that could have negative impacts on benthic communities (390 mg/L). Thus, water column turbidity should have no effect on benthic communities.

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 nearshore 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.

Increased deposition of suspended sediments during construction and decommissioning could impact the benthic prey/forage species of sea turtles, including SAV. The maximum deposition thickness (0.4 inch [1 millimeter]) would mostly be limited to an area 100 – 115 feet (30 – 35 meters) from the cable centerline; in areas where there are finer grain sediments, the maximum deposition thickness could increase locally up to 540 feet (165 meters) from the ECC cable centerline. 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 of cable installation activities. 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 2020a), including sea turtles.

Based on the anticipated non-detectable changes in sea turtle movements, the negligible reductions in prey species, and the proposed mitigation measures (AMM-34) designed to minimize sediment mobilization and alteration, the effects of elevated turbidity and sediment deposition associated with the Proposed Action would be too small to be meaningfully measured, detected, or evaluated and is **insignificant** Therefore, the effects of increased turbidity and deposition levels from Project construction activities **may affect, not likely to adversely affect** ESA-listed sea turtles.

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 2020a 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 fish species such as the ESA-listed Atlantic sturgeon may become stressed when DO falls below certain levels (NMFS 2020a).

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. Instead, Atlantic sturgeon rely on their barbels to detect prey and are known to forage during nighttime hours (NMFS 2017). Suspended sediment concentrations below thresholds for physiological impacts are not expected to inhibit 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 alterations would be too small to be meaningfully measured or detected and are thus **insignificant**. 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 2020a). 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 2020a 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.

Increased deposition of suspended sediments during construction and decommissioning could impact the benthic prey/forage species of sea turtles, including SAV. The maximum deposition thickness (0.4 inch [1 millimeter]) would mostly be limited to an area 100 – 115 feet (30 – 35 meters) from the cable centerline; in areas where there are finer grain sediments, the maximum deposition thickness could increase locally up to 540 feet (165 meters) from the ECC cable centerline. 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 the Proposed Action is completed. 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 2020a), including Atlantic sturgeon.

Overall, suspended sediment concentrations associated with the Proposed Action is considered to be below physiological thresholds for sturgeon and reductions in foraging opportunities for Atlantic sturgeon is found to be **insignificant**. Furthermore, such effects would be further reduced with the implementation of mitigation measures (AMM-34) designed to minimize sediment mobilization and seabed sediment alteration. Therefore, the effects of increased turbidity levels and sediment deposition from Project construction activities **may affect, not likely to adversely affect** ESA-listed Atlantic sturgeon**.**

5.5.5 Dredging

The short-term and long-term impacts of dredging to the benthic environment that have the potential to affect ESA-listed species are discussed in 5.5.3.1 and 5.5.3.2 and 5.5.4. During seabed preparation of the ECCs and HDD exit pit dredging, trailing suction hopper dredges and water injection dredges are expected to move at speeds between 1 to 3 knots while dredging while mechanical dredges would be stationary during dredging activities (Reilly 1950). The physical presence of dredging during the construction phase of the Proposed Action in the ECCs on ESA-listed species is discussed below. No dredging is anticipated in the Lease Area.

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 do not consume benthic prey species that may be captured in dredge equipment where dredging is to occur. 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

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). Mechanical dredging, including the use of a clamshell dredge, is not expected to capture, injure, or kill sea turtles (USACE 2020). The sea turtle species most often affected by dredge interactions are 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 enough to be **discountable** in the offshore environment where dredging for seabed preparation in approximately five percent of the Falmouth ECC would be expected to occur (Michel et al. 2013; USACE 2020). Given the low likelihood of effects, physical interactions associated with dredging for the Proposed Action leading to injury or mortality **may affect, not likely to adversely affect** 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 and is thus **insignificant**. Dredging in the Project area is only anticipated to occur in five percent of the Falmouth ECC and at HDD exit pit locations. 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, prey entrainment and benthic disturbance associated with dredging for the Proposed Action leading to reduced prey availability **may affect, not likely to adversely affect** 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. However, there are no known areas of sturgeon aggregations within the Project area. As sturgeon are known to forage over soft-bottom sediments (Dadswell 2006), this behavior may increase the risk of interaction between sturgeon and dredges. 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 of hydraulic dredges 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 2023g). 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 entrainment 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 2023g).

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 Project 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 very unlikely and thus, **discountable**. Given the low likelihood of effects, the effects of physical interactions associated with dredging for the Proposed Action leading to injury or mortality **may affect, not likely to adversely affect** 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 13 to 282 feet (4 to 86 meters) 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 sand lance, mollusks, polychaete worms, amphipods, isopods, and shrimp, with polychaetes and isopods being the primary 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. Studies summarized in Reine and Clarke (1998) indicate a mortality rate of 38 percent for fish entrained by hydraulic dredging. It is expected that dredging in sand waves to allow for cable installation will result in the entrainment and mortality of some sand lance. Benthic infauna and epifauna will likely experience 100 percent mortality during dredging activities. However, given the size of the area where dredging will occur and the short duration of dredging, the loss of benthic invertebrates and sand lance will be small, temporary, and localized. With the opportunistic feeding nature of Atlantic sturgeon, it is expected that any impact from the loss of Atlantic sturgeon prey items would be small and cannot be meaningfully measured, evaluated, or detected, so it is **insignificant**. Therefore, the effects of entrainment from Project dredging leading reduced prey availability **may affect, not likely to adversely affect** ESA-listed Atlantic sturgeon.

5.5.6 Trenching

The noise, benthic habitat, and water quality 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. 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. Sand wave clearance dredging, described in Section 5.5.3.2 and Section 5.5.5, will occur over 5 percent of the Falmouth ECC while the main seafloor preparation activity prior to cable installation would be boulder removal.

While there are six types of equipment potentially used for trenching in the ECCs and four types 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 days; approximately 14 days would occur at distances 12 to 55 miles (20 to 88 kilometers) offshore in depths ranging from 69 to 131 feet (21 to 40 meters). The advance rate (movement of the equipment forward) is 0.1 miles/hour (200 meters/hour). Nearshore trenching activities from the landfall location to 12 miles (20 kilometers) offshore in depths ranging from 14 to 66 feet (4 to 20 meters) are expected to last 4 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 days. Trenching activity in Mount Hope Bay is expected over 6 miles (10 kilometers) for a duration of 48 hours at depths ranging from 3 to 32 feet (1 to 10 meters). Trenching activity in the Sakonnet River is expected over 11 miles (18 kilometers) for a duration of 90 hours at depths ranging from 26 to 66 feet (8 to 20 meters). Trenching activity offshore is expected over 73 miles (118 kilometers) for a duration of 590 hours at depths ranging from 26 to 66 feet (20 meters to 40 meters).

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 miles (800 kilometers) in depths ranging from 125 to 207 feet (38 to 63 meters).

The direct physical effects of trenching equipment during the construction phase of the Proposed Action 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 do not consume benthic prey species that may be killed by trenching equipment where trenching would occur. Therefore, the effects 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 for a physical interaction to occur. As discussed, impacts on prey from turbidity due to cable laying are likely insignificant. Further, the width of direct impacts from trenching (i.e., the area directly impacted by jetting/cutting), is expected to be 3.3 feet (1 meter), which is a very small area of potential prey mortality relative to the foraging area for sea turtles. 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 for a physical interaction to occur. As discussed, impacts on prey from turbidity due to cable laying are likely insignificant. Further, the width of direct impacts from trenching (i.e., the area directly impacted by jetting/cutting), is expected to be 3.3 feet (1 meter), which is a very small area of potential prey mortality relative to the foraging area for sea turtles. 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 in the water 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 ecosystem dynamics.

Oceanographic Effects due to Changes in Atmospheric Conditions

The extraction of wind energy by wind turbine blades can potentially alter atmospheric forcings that could affect surface mixing and lead to changes in local water flow at a fine scale near the WTGs. This atmospheric wake phenomenon can affect oceanographic processes as follows:

- Energy extraction can affect advection and Ekman transport. 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 in mixing rates occur near the pycnocline depth.
- 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 energy extraction from offshore wind farms (Brostörm 2008; Paskyabi and Fer 2012; Ludewig 2015, Floeter et al. 2022). 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 from energy extraction of turbine blades 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 (Christiansen et al. 2022).

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 295 feet (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. These model results reflect a buildout of turbines that is almost 8 times the approximately 3,100 WTGs currently expected to be installed for all wind farms on the East Coast from Massachusetts to North Carolina. 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. 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 modeling efforts using 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 492 and 328 feet [150 and 100 meters], respectively) offshore wind turbines will be nearly imperceptible.”

Hydrodynamic Effects of In-Water Structures

The presence of WTG vertical structures such as towers and foundations in the pelagic environment may affect the flow of water within and near the Lease Area. 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 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, which may increase vertical mixing (Carpenter et al. 2016; Cazenave et al. 2016; Segtnan and Christakos 2015). Additional mixing downstream of the pile structures of wind turbines has been documented in the form of narrow turbulent wakes up to 984 feet (300 meters) past the structure (Carpenter et al. 2016; Grashorn and Stanev 2016; Schultze et al. 2020); however, changes were indistinguishable from natural variability in a subsequent year (Schultze et al. 2020). The range of observed changes in current speed and direction beyond 984 feet (300 meters) past a monopile is likely related to local conditions, wind farm scale, and sensitivity of the analysis.

Results from a recent hydrodynamic model (Johnson et al. 2021) 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. 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 energy from the wind. 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 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. However, biological changes in the demersal community due to increased local fecal pellet excretions from mussels on and around the structures have been observed over relatively small distances of (<164 feet [50 meters]) (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, in-water 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 3 to 7 feet (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. 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 oceanographic and hydrodynamic conditions caused by the presence of offshore structures are not fully understood at this time but may conservatively range from 100 meters to tens of kilometers (Dorrell et al. 2022, Christiansen 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 disperse 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 (Christiansen et al 2022).

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*, *Pseudocalanus*, and *Centropages* 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. 2020; 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) and, more recently, showing increased species diversity of zooplankton with increased krill and gelatinous zooplankton, and periodic shifts between larger copepods such as *Calanus finmarchicus* and smaller copepods (NEFSC 2022). Aggregations of plankton, which provide a dense food source for NARWs to efficiently feed upon, are concentrated by physical and oceanographic features. Increased mixing could disperse these aggregations, thereby decreasing 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 sperm whales, which may be in the area but do not rely on oceanographic features for foraging, and blue whales which are very unlikely to occur near enough Project activities to experience any changes driven by 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 whose distributions are not dependent on frontal features or hydrodynamics. Sei whales are more euryphagous than fin whales or NARWs and will feed on copepods, krill, and small fish such as anchovies (Mizorch et al. 1984). While fin and sei whales inhabit similar ranges in higher latitudes, sei whales can be found farther offshore than fin whales. For NARW, adverse effects may be greater because their population size is so small that the loss of an individual could have a population-level effect. However, there is no empirical evidence to suggest that hydrodynamic changes would alter the aggregation of lipid-rich prey so much that NARWs could not adapt or relocate to an area with more concentrated prey if needed; this feeding flexibility has been observed in the repatriation of NARWs back into New England waters from the previously used foraging grounds in the Gulf of Maine (O'Brien et al. 2022). Ultimately, the Lease Area and Nantucket Shoals are not the only areas available for foraging for the whale species considered. While effects on the environment and prey of ESA-listed whale species may occur, the overall impact is likely to be so small that it could not be measured, detected, or evaluated, and will be **insignificant.** Therefore, changes in oceanographic conditions and hydrodynamics due to the presence of structures in the water **may affect, not likely to adversely affect** fin whales, sei whales, and NARWs**.**

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).

The presence of in-water structures could reduce water flow immediately downstream of foundations but return close to background levels within approximately eight pile diameters downstream of the pile center (Miles et al. 2017). 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.

Green sea turtles, loggerhead sea turtles, and Kemp's ridley sea turtles consume prey that are not strongly tied to physical oceanographic features such as currents and upwelling. However, leatherback sea turtles consume planktonic prey that are not able to move independently of normal ocean currents. Leatherback sea turtles are known to follow jellyfish aggregations, and thus forage around areas of upwelling (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 prey for leatherback sea turtle 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 and near the Lease Area (< 1 turtle per 100 square kilometers near the Lease Area for all species in any season), the overall impact would be so small that it cannot be meaningfully measured, evaluated, or detected and will be **insignificant**. Therefore, changes in oceanographic conditions and hydrodynamics due to the presence of structures **may affect, not likely to adversely affect** ESA-listed sea turtles.

5.5.7.3 Fish

As described for sea turtles in Section 5.5.7.2, 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).

The presence of WTGs is likely to create localized hydrodynamic effects that could have small-scale impacts on food web productivity and the dispersal of pelagic eggs and larvae. The 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; 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).

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 monopile (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 (Schultze 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 feet (200 to 400 meters) downstream of each monopile. Because the WTGs in the Proposed Action would be spaced by 1 nautical mile (1.9 kilometers), 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 changes could have localized effects on food web productivity and the transport of 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, adult and juvenile fish are expected to elicit an avoidance behavioral response away from potential unsuitable habitat due to hydrodynamic effects from monopiles.

Changes in hydrodynamics resulting from the presence of structures offshore, 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. 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). Any impacts on primary productivity associated with Project structures are expected to have little effect on ESA-listed fish species. Johnson et al. (2021) determined that the presence of structures in the offshore environment could affect planktonic 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 population effects as their eggs and larvae are confined to riverine systems and juveniles do not enter the marine environment before they are two years old. Potential impacts on larval dispersion and survival of Atlantic sturgeon prey species may occur, but due to ample foraging availability in the region, effects of hydrodynamics on prey availability would be so small that they cannot be meaningfully measured, evaluated, or detected and will be **insignificant**. Therefore, changes in oceanographic conditions and hydrodynamics due to the presence of structures **may affect, not likely to adversely affect** ESA-listed Atlantic sturgeon.

5.5.8 Physical Presence of WTGs on Listed Species

In addition to effects on hydrodynamics and oceanographic conditions (Section 5.5.7), the physical presence of WTGs in the water during operation may have direct effects on ESA-listed species in the Action Area through behavioral disruptions like avoidance, displacement, or attraction. 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.

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 prey, and their presence could affect marine mammal behavior. However, the likelihood and significance of these effects are uncertain.

The 149 foundations would be placed in a grid-like pattern with approximate spacing of 1 nautical mile (2 kilometers) between WTG and OSP locations. Based on documented body 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 nautical mile (2 kilometers) 80 to 100+ times over. Although spacing between the structures would be sufficient to allow marine mammals to use 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 presence of WTG structures could displace marine mammals from preferred habitats or alter movement patterns. 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. In contrast, 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. The study of long-term exclusion or attraction effects was identified as a priority research topic by Kraus et al. (2019) as little is currently known about the behavioral changes of large whales due to the presence of WTGs.

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, which might result in additional 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 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). In 2021, there were five active entanglements/entrapment cases, three of which were new. Of the three newly entangled whales (with attached gear), two were in U.S. waters and one in Canadian waters. When factoring in entanglement scars, a further seven additional entanglement events occurred in Canadian waters and four in U.S. waters in 2021 (Pettis et al. 2022). 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, which could reduce the chance of marine mammals encountering free-floating abandoned gear in the area, but debris tangled with WTG foundations could still pose a hazard to marine mammals, particularly if they prove to be attracted to the structures. 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 the presence of 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), which would be expected to generally prevent the formation of thin, vertically compressed layers of copepods that allow for efficient NARW feeding (Baumgartner and Mate 2003; Baumgartner et al. 2017). In other regions, NARWs feed on copepods in well-mixed waters during winter, but during other times of the year, they preferentially feed on the larger and more nutritious life stages of *Calanus finmarchicus*. 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). While Nantucket Shoals is well mixed, it is possible the strong currents could serve to aggregate prey patches along ephemeral frontal boundaries or along the edges of the tidal jet running along the western side of the Shoals (comment from NMFS).

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 Lease Area, 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 appreciable increase in the primary prey species of NARWs, fin whales, or sei whales (NMFS 2021a).

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 increased risk of entanglement in fishing gear associated with the foundations. In light of this risk, BOEM proposes a monitoring condition that would alleviate potential entanglement impacts on marine mammals from gear lost from expected increases in fishing around WTG foundations. The BOEM proposed measure BA-31 (Table 3.3-2) would require the Lessee to survey ten different WTGs annually via underwater imagery or divers to determine the frequency and locations of marine debris. Surveys will collect associated data on location, pile identification number, images, videos, disposition of located debris (removed or left in place), and any animals sighted and submit to BOEM in an annual report. In addition, best management practices will be coordinated with NOAA's marine debris program. With these monitoring measures in place, the likelihood of injury and mortality leading to population level effects due to the presence of WTGs is reduced to the point of being **discountable.** Thus, the any effects due to the presence of WTGs during operations **may affect, not likely to adversely affect** ESA-listed marine mammal populations.

5.5.8.2 Sea Turtles

In the Gulf of Mexico, loggerhead, leatherback, green, and Kemp's ridley sea turtles 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, and residency times around structures may increase with the age of structures if communities develop on and around foundations. 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. 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.

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 reef effect due to 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. However, BOEM proposes a monitoring condition that would alleviate potential entanglement impacts on marine mammals from gear lost from expected increases in fishing around WTG foundations. The BOEM proposed measure BA-31 (Table 3.3-2) would require the Lessee to survey ten different WTGs annually via underwater imagery or divers to determine the frequency and locations of marine debris. Surveys will collect associated data on location, pile identification number, images, videos, disposition of located debris (removed or left in place), and any animals sighted and submit to BOEM in an annual report. In addition, best management practices will be coordinated with NOAA's marine debris program.

Contrasting the potential attraction due to the reef effect, 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 and insignificant.

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 oceanographic 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 that might alter the distribution of the leatherback's planktonic jellyfish prey, but there is uncertainty around these potential effects. Changes in ocean mixing and thermal stratification, while small compared to other naturally occurring mixing mechanisms (Schultze et al. 2020), could also influence sea turtle dive behavior and thermoregulation. Any potential long-term, intermittent impacts could persist until decommissioning is complete and structures are removed.

Due to the patchy distribution and low densities of sea turtles within 3 miles (5 kilometers) of the SouthCoast Lease Area (< 1 turtle per 100 square kilometers in and near the Lease Area for all species in any season), the overall impact of displacement, the reef effect, or increased entanglement risk on sea turtles is expected to be so small that it cannot be meaningfully measured, evaluated, or detected and will be **insignificant**. Therefore, the physical presence of structures in the Project area during operations **may affect**, **not likely to adversely affect** ESA-listed sea turtles.

5.5.8.3 Fish

The addition of new hard surfaces and structures, including WTG and OSP foundations, scour protection, and hard protection on top of cables, to a mostly sandy seafloor would create a more complex habitat in the Project area. 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) and increases in primary productivity could occur. 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), increasing the biomass and modifying food web dynamics near these structures. These impacts would likely be permanent or remain as long as the structure remains. However, Atlantic sturgeon generally prefer to forage on the polychaete worms and isopods associated with soft bottom habitat, which is abundantly available in the region. The effects of habitat conversion and loss are discussed in Section 5.5.3.

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[7] 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. BOEM proposes a monitoring condition that would alleviate potential entanglement impacts on marine mammals from gear lost from expected increases in fishing around WTG foundations. The BOEM proposed measure BA-31 (Table 3.3-2) would require the Lessee to survey ten different WTGs annually via underwater imagery or divers to determine the frequency and locations of marine debris. Surveys will collect associated data on location, pile identification number, images, videos, disposition of located debris (removed or left in place), and any animals sighted and submit to BOEM in an annual report. In addition, best management practices will be coordinated with NOAA's marine debris program.

The effects of the presence of 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 alter the movements of individual fish, but they are not expected to have broad impacts on Atlantic sturgeon migration as 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 as needed.

Given that any effects on migratory deviations would be too small to be meaningfully measured or detected, the small scale of changes in the context of available habitat in the region, and the monitoring efforts proposed to alleviate entanglement risk, the effects of the presence of structures are not expected to result in measurable changes in entanglement, foraging opportunities, or migratory patterns for Atlantic sturgeon, and will be **insignificant**. Therefore, the physical presence of structures in the Project area during operations **may affect**, **not likely to adversely affect** ESA-listed Atlantic sturgeon.

[7] *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.

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. To reduce any potential effects from EMF and heat from underwater cables, SouthCoast Wind would bury cables to a target burial depth of 6 feet (~2 meters) wherever possible (AMM-37, Table 3.3-1). Possible burial depth ranges below level seabed are 3–13 feet (1–4 meters) along the ECCs and 3–8 feet (1–2.5 meters) for the interarray cables (Table 3.1-2). In areas where sufficient cable burial is not feasible, surface cable protection would be utilized.

5.5.9.1 Marine Mammals

Marine mammals can detect magnetic field gradients of 0.1 percent of the Earth's magnetic field (i.e., approximately 0.05 microtesla) (Kirschvink 1990). Based on this sensitivity, marine mammals are likely very sensitive to minor changes in magnetic fields (Walker et al. 2003) and may react to local variation in geomagnetic fields associated with cable EMFs. These variations could result in short-term effects on swimming direction or migration detours (Gill et al. 2005). However, no EMF impacts on marine mammals associated with underwater cables have been documented.

SouthCoast Wind modeled EMF levels from 60-Hz AC cables that could be generated by submarine and onshore export cables in the Project area (Appendix P1, Mayflower Wind 2022). The model estimated induced magnetic field levels from Project cables ranging from 85 milligauss for buried cables (6.6-foot [2-meter] burial depth) to 1,859 milligauss for unburied cables with cable protection (1-foot-thick [0.3-meter-thick] concrete mattress) (COP Volume 1 and Appendix P1, Table 3.3; Mayflower Wind 2022). At a distance of 10 feet from the cable center line, modeled EMF levels rapidly decline to 28.8 milligauss and 41.9 milligauss for buried and unburied cables, respectively. Reviews and analyses on potential EMF effects from offshore renewable energy projects (CSA Ocean Sciences Inc. 2021; Normandeau et al. 2011) and studies on the effects of EMF on marine organisms (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. The 50-milligauss detection threshold is theoretical, conservative, and an order of magnitude lower than magnetic field strengths that have been found to induce behavioral responses in marine mammals (Normandeau et al. 2011). Based on EMF modeling results (COP Volume 1 and Appendix P1, Table 3.3; Mayflower Wind 2022), marine mammals would only encounter detectable EMF (>50 milligauss) within 10 feet of either buried or unburied AC cables, and effects of any detection are unlikely. Further, marine mammals in the Project area would likely be transiting or foraging and are not expected to spend significant time on the seafloor in proximity to the interarray and export cables, reducing potential EMF exposure.

Buried submarine cables can warm the surrounding sediment in contact with the cables up to tens of centimeters away (Taormina et al. 2018). No data is available 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 narrow width of the cable corridors and estimated area of thermal radiation, impacts on benthic organisms are not expected to be regionally significant (Taormina et al. 2018) and would be limited to a small area around the cables. Considering the anticipated cable burial depths, thermal effects are not expected to 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, the probable lack of interaction between ESA-listed marine mammals and the benthos in the Project area, and measures to bury cables and/or install cable surface protection, any EMF effects on marine mammals and their prey 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 can detect magnetic fields though the threshold for inducing behavioral responses varies among species. Normandeau et al. (2011) reported that loggerhead sea turtles exhibited responses to field intensities ranging from 0.0047 to 4,000 microtesla (0.047 milligauss to 40,000 milligauss) while green sea turtles have responded to field intensities ranging from 29.3 to 200 microtesla (293 to 2000 milligauss). 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 for benthic prey or resting on the bottom near export and interarray cables. No data is currently available on the effects of EMF associated with underwater cables on sea turtles. Migratory disruptions have been documented in sea turtles with magnets attached to their heads (Luschi et al. 2007), but there is no evidence that EMF associated with offshore wind activities would result in deviations from direct migration routes (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. To reduce any potential effects from EMF and heat from underwater cables, SouthCoast Wind would bury cables to a target burial depth of 6 feet (1.8 meters) wherever possible (AMM-37, Table 3.3-1). 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 detected or meaningfully measured.

The available evidence indicates that sea turtles are magnetosensitive and orient to the Earth's magnetic field for navigation but are unlikely to detect magnetic fields below 50 milligauss (5 microtesla) (Normandeau et al. 2011). Normandeau et al. (2011) further summarized theoretical concerns in the literature that anthropogenic EMF could disrupt adult sea turtle migration to and juvenile migration from nesting beaches; however, nesting beaches are not present near the parts of the Action Area where cables will be installed. Although the Proposed Action would produce magnetic field effects above the 50 milligauss detection threshold, a sea turtle would have to be within 10 feet of either a buried or unburied AC cable with cable protection to detect any EMF above 50 milligauss. Given the low densities of sea turtles in the Project area, 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 very unlikely to occur and are, therefore, **discountable**.

Magnetic fields associated with the operation of energy transmission lines could also impact benthic organisms that serve as sea turtle prey. Opportunities to effectively forage for fish, jellyfish, copepods, and krill are extremely unlikely to be affected 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.

Buried submarine cables can warm the surrounding sediment in contact with the cables up to tens of centimeters away (Taormina et al. 2018). No data is available 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 estimated 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 cables. Considering the anticipated cable burial depths, thermal effects are not expected to occur at the surface of the seabed where benthic-feeding sea turtles would forage.

Based on the analysis above and measures to bury cables and/or install cable surface protection, any potential impacts from EMF associated with the Proposed Action on sea turtles and their prey are expected to be so small that they cannot be meaningfully measured, evaluated, or detected and are, therefore, **insignificant**. Thus, the effects of EMF from the Project **may affect, not likely to adversely affect** ESA-listed sea turtles**.**

5.5.9.3 Fish

During operation, powered transmission cables would produce EMFs though 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 EMF may include interference with navigation, predator/prey interactions, avoidance or attraction behaviors, and physiological and developmental effects (Taormina et al. 2018). Electromagnetic-sensitive species (e.g., sharks, rays) have been shown to respond to HVAC cables, but adverse consequences have not been established (Gill et al. 2012). EMF from AC 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).

A review of responses to DC cable EMF found inconsistent evidence of behavioral effects in some marine species and an absence of conclusive evidence supporting whether observed behavioral responses are indicative of potential population-level detrimental impacts (COP Appendix P2; Mayflower Wind 2022). While the amplitude of EMF generated by DC cables can be up to three times greater than that of AC cables (Hutchison et al. 2020), AC and DC EMFs differ in the way they interact with organisms and direct comparisons cannot be made (CSA Ocean Sciences, Inc. and Exponent 2019). However, previous studies on DC undersea cables showed only temporary alterations in mobility and behavior of some fish species with no appreciable effects on overall movement or population health (Klimley et al. 2017; Wyman et al. 2018). Research conducted by Klimley et al. (2017) at the Trans Bay DC undersea cable near San Francisco, California, found that migration success and survival of chinook salmon and green sturgeon was not impacted by the cable EMF although temporary alterations in behavior were observed. Salmon appeared to linger at the activated cable, while migration time for sturgeon increased or decreased depending on the direction of migration. While DC undersea power cables resulted in altered patterns of fish mobility, these changes were temporary and did not interfere with migration success.

Love et al. (2016) conducted a series of surveys between 2012 and 2014 to track fish populations at both energized and unenergized submarine cables off the California coast. These studies were designed to assess whether EMF produced by the energized cable had any *in situ* effects on the distribution of marine species. Over three years of observations, no differences in fish communities at energized and unenergized cable sites were noted, indicating that EMF had no effect on fish distributions. 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 at a lateral distance of 10 to 25 feet (3 to 7.6 meters) from the center of the cable. (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. To reduce any potential effects from EMF and heat from underwater cables, SouthCoast Wind would bury cables to a target burial depth of 6 feet (1.8 meters) wherever possible (AMM-37, Table 3.3-1), 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.

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. Consequently, and along with measures to bury cables and/or install cable surface protection, any effects on sturgeon prey availability would be too small to be detected or meaningfully measured and are thus **insignificant**. 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 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. As discussed in Section 3.1.2, during transit and nighttime/low-visibility conditions, vessels would, at minimum, use navigation and deck lighting as required by the USCG and other applicable agencies and permit approval conditions, as necessary. SouthCoast Wind does not anticipate utilizing continuous lighting on the WTGs at the water's surface; however, SouthCoast Wind does plan to illuminate, at a minimum, the landing during crew transfers (specifically, the Walk to Work gate). The gangway from operations vessels will be fitted with necessary lighting that meets minimum requirements to assure safe transfers of technicians. The placements and intensity of lighting will be determined utilizing the API14F, EN 12464 or equivalent standard (FAA, IALA, USCG, and BOEM) such that the lighting scheme provides safe illumination for personnel and minimizes direct and/or indirect lighting of the water surface and/or surrounding environment to the extent practicable. Vessels will be illuminated to provide safe, working conditions for personnel, as dictated by the operations ongoing at that time. These operations include installation and removal of WTGs, OSPs, interarray cables, and export cables. During construction, continuous nighttime vessel lighting and construction area lighting would be required at the offshore location where the vessel and personnel are working. Work lights are generally directed downwards onto the required work area, be it a vessel deck, cranes, monopile, WTG, OSP, or other facility, to provide required illumination for personnel or ongoing operations. During O&M, SouthCoast Wind will utilize lighting during operations as required by the USCG, FAA, and/or relevant regulatory body and abide by all applicable standards. This includes lighting to be placed on all offshore structures that will be visible throughout a 360-degree arc to aid in mariner navigation. SouthCoast Wind will implement an ADLS, which will activate the lighting system on WTGs based on approaching air traffic. 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 (Víkingsson 1997; Baumgartner et al. 2003; Baumgartner and Fratantoni 2008; Guilpin et al. 2019). Sperm whales also forage at night but are expected to feed in deeper waters outside the Project area. While the effects of artificial lighting on marine mammals themselves are largely unknown, impacts are anticipated to be negligible if appropriate design techniques and uses are employed (Orr et al. 2013). SouthCoast Wind would light WTGs and OSPs in compliance with FAA and USCG standards and BOEM guidelines and would avoid intentionally illuminating the water surface. SouthCoast 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. The effects of Project-associated lighting on marine mammals and their prey are expected to be so small that they cannot be meaningfully measured, evaluated, or detected and are, therefore, **insignificant**. The effects of lighting of vessels and offshore structures associated with the Proposed Action **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), suggesting that other hard-shelled sea turtle species expected to occur in the vicinity of the Projects (i.e., green or Kemp's ridley) 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. SouthCoast 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. SouthCoast 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. The effects of Project-associated lighting on sea turtles are expected to be so small that they cannot be meaningfully measured, evaluated, or detected and are, therefore, **insignificant**. Therefore, effects of lighting of vessels and offshore structures associated with the Proposed Action **may affect, not likely to adversely affect** ESA-listed sea 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 are likely to be exposed to artificial light associated with the Proposed Action. 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 and are thus **discountable**. 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 habitat effects due to the presence of the structures are discussed in previous sections. The potential effects of offshore stations related to cooling water withdrawals, thermal discharge, and impacts on prey species are discussed in this section.

SouthCoast Wind has proposed the use of one or more HVDC converter OSPs, which would require seawater to be pumped into a cooling water intake system (CWIS) to cool the electrical equipment and then discharge back into the ocean. As described in Section 3.1.2.2, SouthCoast Wind has selected and filed a NPDES permit application (Tetra Tech and Normandeau Associates, Inc. 2023; Appendix A) for one HVDC converter OSP for the Brayton Point interconnection. The analysis presented in the following sections is largely based on the information contained in the NPDES permit application for a single HVDC converter OSP. If SouthCoast Wind chooses to develop an additional HVDC converter OSP, the parameters and modeling results from the NPDES permit application for the Brayton Point interconnection would be representative of the additional HVDC converter OSP, which would be located in the southern portion of the Lease Area.

Potential impacts associated with HVDC converter OSPs include impingement of fish, entrainment of planktonic life stages of fish and invertebrate species, temperature changes at the heated effluent discharge site, and the use of anti-biofouling treatments on the system.

5.5.11.1 Water Withdrawal and Discharge

As reported in the SouthCoast Wind Offshore Converter Station NPDES Permit Application (Tetra Tech and Normandeau Associates, Inc. 2023; Appendix A) and outlined in Table 3.1-5, the HVDC converter OSP for Brayton Point would include up to three approximately 3-foot (1-meter)-diameter vertical-shaft intake pipes, with flared ends to accommodate intake velocity requirements. The CWIS is designed to withdraw water at a depth of approximately 25 to 115 feet (8 to 35 meters) below the surface and 33 feet (10 meters) above and perpendicular to the seafloor. This mid-water column intake depth minimizes biofouling and entrainment impacts as it avoids the higher concentrations of buoyant ichthyoplankton that inhabit surface waters and those planktonic taxa associated with benthic habitats (Kendall and Naplin 1981). The intake pipes are fitted with an inline seawater filter (mesh size ranging from 250 micrometers to 25 millimeters) and may be equipped with a bar rack with bars spaced 6 to 10 inches (15 to 25 centimeters) apart to minimize entrapment of debris or marine organisms.

The CWIS is expected to withdraw cooling water from the ocean in the immediate vicinity of the HVDC converter OSP at rate of up to10.2 million gallons per day (MGD) and maintain an intake velocity of less than 0.5 feet per second (0.15 meters per second). The USEPA considers intake velocities less than 0.5 feet per second (0.15 meters 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 (0.15 meters per second) velocity requirement, and there are no traveling screens on which a fish could become impinged, potential impingement impacts due to HVDC converter intake is discountable and will no longer be discussed in the subsequent sections.

SouthCoast Wind modeled thermal plumes from HVDC cooling water discharge to predict water temperature changes around the discharge location during critical tidal conditions in fall, winter, spring, and summer months using a thermal mixing zone analysis in CORMIX v12.0GTD Advanced Tools (Tetra Tech and Normandeau Associates, Inc. 2023; 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). The CORMIX 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. The plume dynamics were evaluated during minimum and maximum tidal conditions during four separate seasons to determine potential zones of initial dilution during those periods.

From four modeled maximum temperature delta scenarios (Table 5.5-2), the temperature change at the edge of the NFR ranged from 0.7°F (0.4 °C) in the winter to 1.4°F (0.8°C) in the fall. The NFR distances from the outfall were 56 feet (17 meters) in the fall, 155 feet (47 meters) in the winter, 93 feet (28 meters) in the spring, and 65 feet (20 meters) in the summer. The effluent plume area where a temperature change of 1.8°F (1°C) was observed was highest in the winter at 898 square feet (83 square meters) and lowest in the fall at 455 square feet (42 square meters). These CORMIX results indicate that impacts to the ocean temperature are localized and minimal when the maximum temperature deltas occur.

Table 5.5-2. CORMIX results for maximum temperature delta scenarios for a SouthCoast Wind HVDC OSP modeled in the Atlantic Ocean

Parameter	Fall Max. Temp. Delta	Winter Max. Temp. Delta	Spring Max. Temp. Delta	Summer Max. Temp. Delta
Ambient ocean temperature at the edge of NFR, °F (°C)	55.4 (13.0)	40.2 (4.6)	39.6 (4.2)	52.4 (11.3)
Temperature delta at the edge of NFR, °F (°C)	1.4 (0.8)	0.7 (0.4)	1.0 (0.6)	1.2 (0.7)
Dilution ratio at the edge of NFR	26.0	77.4	52.6	33.6
NFR distance (distance from the outfall), feet (meters)	56 (17)	155 (47)	93 (28)	65 (20)
Ambient ocean temperature at the edge of the plume, °F (°C)	55.9 (13.3)	41.4 (5.2)	40.4 (40.7)	53.1 (11.7)
Dilution ratio at the edge of the plume	20.0	28.0	28.6	22.0
Plume Length where temperature delta is 1.8°F (1°C), feet (meters)	44 (13)	102 (31)	75 (23)	51 (16)
Plume Width (maximum) where temperature delta is 1.8°F (1°C), feet (meters)	30 (9)	9 (3)	11 (3)	21 (6)
Plume area where temperature delta is 1.8°F (1°C), feet^2 (meter^2)	455 (42)	898 (83)	816 (76)	537 (50)

Source: Modified from Tetra Tech and Normandeau Associates, Inc. 2023; Appendix A
NFR = near-field region; °F = degrees Fahrenheit; °C = degrees Celsius

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 (Tetra Tech and Normandeau Associates, Inc. 2023; Appendix A). This concentration is small and is equivalent to 0.0002 percent per unit volume. Residual free chlorine within discharged effluent would be negligible and oxidized in the water with no negative impact on any marine species.

Entrainment mitigation measures that may be used at the converter station facility include single pump operation, the use of variable frequency drives, and a fixed depth of water withdrawal (Tetra Tech and Normandeau Associates, Inc. 2023). With the extent of entrainment being directly proportional to the intake flow volume, utilizing a single pump instead of two pumps at full capacity or running two pumps at 50 percent capacity reduces the cooling intake flow volume by 50 percent leading to a proportional reduction in entrainment levels. However, single pump operation may also result in an increase in the temperature of discharge water and the heated effluent impact. Variable frequency drives may be used in the CWIS to control flow and minimize the total flow volume required. This allows for the maintenance of safe operational parameters in the HVDC converter while reducing the water intake volume and entrainment impact.

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 would not be at risk for entrapment or impingement but could experience indirect effects during water withdrawals if their prey species become entrained in very large numbers (as discussed further in Section 5.5.11.2).

In addition to secondary impacts, the HVDC converter OSP would discharge warmer water into the surrounding ocean, which could potentially have localized impacts on marine mammals. As shown in Table 5.5-2, the CORMIX modeling results indicate the greatest distance to the edge of the NFR (i.e., the portion of the water primarily influenced by the heated discharge) occurred during winter with a NFR of 155 feet (47 meters). The effluent plume area was also largest in winter, reaching a maximum of 898 square feet (83 square meters). Potential thermal effects from cooling water discharge at the HVDC converter OSP would not be expected to affect ESA-listed marine mammals due to the small discharge plume and localized temperature increase within the mixing zone in comparison to larger CWIS at other coastal facilities. Similar results would be anticipated if SouthCoast Wind selects an additional HVDC converter OSP for the southern portion of the Lease Area.

Based on the analysis above, the ecological effects from thermal discharge and discharged effluent from HVDC converter OSP(s) are expected to be minimal and extremely localized. Further, marine mammals are not at risk for entrainment, nor do they have juvenile life stages that are susceptible to entrainment. Therefore, the potential effects from the operation of HVDC converter OSP(s) and associated CWIS intake and discharge are expected to be so small that they cannot be meaningfully measured, evaluated, or detected and are, therefore, **insignificant.** Thus, water withdrawals and discharges from offshore substations **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 one or more HDVC converter OSPs, 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 could be entrapped 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 (e.g., those of nuclear power plants) (Florida Power and Light, 1995; Florida Power Corporation, 1998). 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 feet per second [0.15 meters per second] and appropriately sized bar racks) are expected to minimize these risks further. Bar racks with spacings 6 to 10 inches (15 –

25 centimeters apart) are under consideration; however, SouthCoast Wind is currently in the preliminary design stage and will consult with USEPA and NMFS to ensure that the final engineering design and spacing of the bar racks are appropriate and protective to marine organisms to minimize the overall 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 but 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 SouthCoast Wind cooling operations due to the small size of the discharge plume and extremely localized temperature increase within the mixing zone in comparison to other larger CWISs at coastal facilities.

Given the very low abundance of sea turtles in the Project area, the likelihood of entrapment in the HVDC converter OSPs and intake pipes is small and would be further minimized with the implementation of mitigation measures to reduce overall entrapment. The associated thermal discharge is also expected to be extremely localized and the overall effects are so small that they cannot be meaningfully measured, evaluated, or detected and are, therefore, **insignificant**. Therefore, the installation and operation of HVDC converter OSP(s) and associated CWIS intake pipes **may affect, not likely to adversely affect** ESA-listed sea turtles.

5.5.11.1.3 Fish

Impacts of entrainment on finfish and planktonic larvae at HVDC converter intake locations are expected to be limited to the immediate area around an OSP. The ESA-listed Atlantic sturgeon spawn in freshwater rivers where larvae remain for at least two years until they reach the subadult life stage (Bain 1997), and therefore are not susceptible to entrainment at a CWIS located offshore. Impingement of adult Atlantic sturgeon is considered improbable given the expected CWIS intake configuration (e.g., intake velocity not exceeding 0.5 feet per second (0.15 meters per second); equipped with appropriately sized bar rack; no traveling screens; Table 3.1-5) and planned entrainment mitigation measures (e.g., single pump operation, use of variable frequency drives) during operation of SouthCoast Wind's offshore HVDC converter OSP(s).

As the HVDC converter OSP would discharge warmer water into the surrounding ocean, thermal discharge 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). SouthCoast Wind modeled thermal plumes of the discharged cooling seawater from the HVDC converter OSP for Brayton Point, as described above in Section 5.5.11.1. Based on modeling results, impacts on water temperature from heated effluent discharge are expected to be minimal (Tetra Tech and Normandeau Associates, Inc. 2023; Appendix A). Similar results would be anticipated if SouthCoast Wind selects an additional HVDC converter OSP for the southern portion of the Lease Area.

Adult Atlantic sturgeon are thought to have low abundance in the Project area (Dunton et al. 2010). As the occurrence of Atlantic sturgeon in the Lease Area would be rare, Atlantic sturgeon are not expected to be susceptible to impingement and entrainment at the HVDC converter OSP(s).

Due to the limited range of warmed water, the ability of fish to move out of the affected area, and the mitigation measures in place, the overall effects of water withdrawals and discharges at HVDC converter

OSPs are expected to be so small that they cannot be meaningfully measured, evaluated, or detected and are, therefore, **insignificant**. Therefore, the operation of HVDC converter OSP(s) and associated CWIS intake pipes **may affect, not likely to adversely affect** ESA-listed Atlantic sturgeon.

5.5.11.2 Impacts on Prey

To provide estimates of the entrainment impact from the HVDC converter OSP for Brayton Point, data from the EFH mapper, MarMap/EcoMon ichthyoplankton surveys (1977–2019), and MA DMF trawl surveys were used as a proxy to determine the species and life stages most susceptible to entrainment (Tetra Tech and Normandeau Associates, Inc. 2023). Based on monthly mean larval densities of species observed within 10 miles (16 kilometers) of the CWIS location and assuming a water withdrawal rate of 10 million gallons per day (MGD), the taxa with the highest estimated annual larval entrainment were unspecified hake (3.94 million), Atlantic herring (3.92 million), sand lance (3.3 million), summer flounder (1.4 million), and silver hake (0.50 million). Atlantic cod were estimated to have relatively low annual larval entrainment of 86,173 individuals between January and April, with a peak of 41,137 individuals in March. While entrainment estimates were generated from the best available data, these estimates do not reflect the current species composition in the study area, seasonality, population dynamics, and natural variability. Furthermore, ichthyoplankton data used in this analysis were from various water column depths as opposed to the fixed depth of the CWIS intake at 33 feet (10 meters) above the seafloor; thus, this analysis may overestimate larval entrainment as individuals settling in demersal habitats or floating on the surface will likely not be susceptible to the CWIS intake flow. Similar results would be anticipated if SouthCoast Wind selects an additional HVDC converter OSP for the southern portion of the Lease Area.

In addition to mitigation measures that include siting the northernmost HVDC converter OSP outside of a 6-mile (10-kilometer) buffer of the 30-meter isobath from Nantucket Shoals (AMM-39, Table 3.3-1), an agency-proposed measure (NS-1, Table 3.3-2) will be implemented in the enhanced mitigation area to minimize the potential impacts to prey items especially in areas with high densities of zooplankton. This measure prohibits open-loop cooling systems in the enhanced mitigation area, increasing the size of this enhanced mitigation area to extend approximately 7 – 9 miles (11 – 14.5 kilometers) southwest of the 30-meter isobath, thereby reducing the entrainment of zooplankton in the HVDC cooling system. While Project activities would not overlap with the highest modeled densities of zooplankton in the Nantucket Shoals region, this precautionary measure is expected to minimize mortality to prey species of higher trophic level animals compared to the PDE.

In the context of regional abundances and species life histories, estimated losses of ichthyoplankton from entrainment by OSP HVDC converter platforms are small. At a water withdrawal rate of 10.2 MGD, the CWIS influences only 0.00015 percent of the total water volume in the Lease Area given an average water depth of 164 feet (50 meters) and the estimated annual entrainment losses of ichthyoplankton would represent a small proportion of regional populations. When considering the high mortality rates in early life stages of fishes, fish eggs and larvae lost to entrainment are expected to be inappreciable when compared to natural mortality rates. At this scale, and with the implementation of mitigation measures designed to reduce the impacts to prey species, 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

The HVDC converter OSP(s) may result in entrainment of certain prey species (e.g., copepods [*Calanus* spp., *Pseudocalanus* spp., *Centropages* 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 as 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 on marine mammals (Northeast Gateway 2012). The model was used to address concerns around whether or not the Northeast Gateway Project 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 SouthCoast OSP(s), 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 while present off the coast of Massachusetts on a seasonal basis were estimated at 1,415 pounds/day (642 kilograms/day) and 103,707 pounds/year (46,587 kilograms/year), (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 was considered negligible in the prior assessment. The Northeast Gateway operation intake was estimated as 56 million gallons of seawater per day; the SouthCoast OSP operations would intake considerably less cooling water, up to 10 million gallons per day, so would be expected to entrain proportionally much lower numbers of copepods and zooplankton.

Marine mammal prey may also be susceptible to thermal impacts from subsequent heated discharge effluent released back into receiving waters. However, the thermal mixing zone analysis (Tetra Tech and Normandeau Associates, Inc. 2023; Appendix A) indicated that impacts of heated effluent to the ocean temperature would be minimal due to the small discharge plume and localized minimal temperature increase. To further reduce potential impacts on zooplankton, SouthCoast Wind has committed to siting the northernmost HVDC converter OSP outside of a 6-mile (10-kilometer) buffer of the 30-meter isobath from Nantucket Shoals, an area of high productivity and foraging value for several marine species (AMM-39 in Table 3.3-1). Further, a BOEM proposed measure would increase the size of this enhanced mitigation area to extend approximately 7 – 9 miles (11 – 14.5 kilometers) southwest of the 30-meter isobath (NS-1 in Table 3.3-2).

Given the low proportion of potentially entrained prey items, the small and localized effects from thermal discharge, and the applicant- and agency-proposed mitigation measures in place, OSP operations are not expected to make any measurable impacts to prey availability and are considered **insignificant**. Therefore, the installation and operation of HVDC converter OSP(s) and associated CWIS intake pipes **may affect, not likely adversely affect** marine mammal prey.

5.5.11.2.2 Sea Turtles

Sea turtle prey may be susceptible to entrainment. The CWIS is designed to withdraw water at a depth of approximately 25 to 115 feet (8 to 35 meters) below the surface and 33 feet (10 meters) above the seafloor. This mid-water column intake depth would minimize potential entrainment impacts as it avoids prey items that inhabit surface waters and those associated with benthic habitats. However, pelagic prey that are found throughout the water column, such as salps and jellyfish, may still be susceptible to entrainment. To reduce potential impacts on these prey items, SouthCoast Wind has committed to siting the northernmost HVDC converter OSP outside of a 6-mile (10-kilometer) buffer of the 98-foot (30-meter) isobath from Nantucket Shoals, an area of high foraging value for several marine species (AMM-39 in Table 3.3-1). Further, a BOEM proposed measure would increase the size of this enhanced mitigation area to extend approximately 7 – 9 miles (11 – 14.5 kilometers) southwest of the 30-meter isobath (NS-1 in Table 3.3-2). Sea turtle prey may also be susceptible to thermal impacts from subsequent heated discharge effluent released back into receiving waters. However, the thermal mixing zone analysis (Tetra Tech and Normandeau Associates, Inc. 2023; Appendix A) indicated that impacts of heated effluent to the ocean temperature would be minimal due to the small discharge plume and localized minimal temperature increase.

Given the CWIS depth of withdrawal, the small and localized effects from thermal discharge, and 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; thus, effects will be **insignificant**. Therefore, the installation and operation of HVDC converter OSP(s) and associated CWIS intake pipes **may affect, not likely adversely affect** sea turtle prey.

5.5.11.2.3 Fish

The Atlantic sturgeon is a bottom feeder and typically feeds on crustaceans, worms, and mollusks. As the CWIS is designed to withdraw water from the middle of the water column at a depth of approximately 25 to 115 feet (8 to 35 meters) below the surface and approximately 33feet (10 meters) above the seafloor, prey items associated with benthic habitats would not be at risk to entrainment.

Atlantic sturgeon prey may also be susceptible to thermal impacts from subsequent heated discharge effluent released back into receiving waters. However, the thermal mixing zone analysis (Tetra Tech and Normandeau Associates, Inc. 2023; Appendix A) indicate that impacts of heated effluent to the ocean temperature would be minimal due to the small discharge plume and localized temperature increase.

Due to the depth of water withdrawal and the small and localized effects from thermal discharge, OSP operations are not expected to make any measurable difference in foraging and prey availability and thus effects are expected to be **insignificant**. Therefore, the installation and operation of HVDC converter OSP(s) and associated CWIS intake pipes **may affect, not likely adversely affect** prey availability of ESA-listed Atlantic sturgeon.

5.5.12 Summary of Habitat Disturbance Effects

5.5.12.1 Marine Mammals

Habitat disturbance or modifications associated with G&G surveys, dredging, and trenching would have no effect on ESA-listed marine mammals. Habitat conversion and loss associated with WTGs, OSPs, scour protection, cable emplacement, and vessel anchoring is expected to have an insignificant effect on foraging opportunities for ESA-listed marine mammals. Reef effects could increase recreational fishing activity around offshore structures which would consequently increase the risk of entanglement. Similarly, fisheries and habitat surveys may pose an entanglement risk to ESA-listed marine mammals; however, required mitigation measures would minimize such incidences to the point that effects could not be detected, measured, or meaningfully evaluated, and discountable. Potential long-term, intermittent impacts would be low in intensity from habitat surveys and increased presence of recreational fishing would be unlikely, and therefore discountable. 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 on prey distribution. However, there is uncertainty around the potential effects and with the wider available habitat and implementation of monitoring measures for entanglement risks, the likelihood of population level effects due to the presence of WTGs is reduced to the point of being discountable. Effects on ESA-listed marine mammals from EMF associated with submarine cables, lighting of structures, and offshore substation water withdrawal and discharge are also expected to be insignificant. Therefore, the effects of habitat disturbance or modification from related Project activities **may affect, not likely to adversely affect** ESA-listed mammals.

5.5.12.2 Sea Turtles

Habitat disturbance associated with G&G surveys, dredging, and trenching would be short-term and localized to a small area. Therefore, associated impacts on benthic-feeding Kemp's ridley sea turtle would be insignificant. Other ESA-listed sea turtles do not forage in soft bottom habitats and would therefore have no effect from habitat disturbances due to G&G surveys, dredging, and trenching. Habitat conversion and loss associated with WTGs, OSPs, scour protection, cable emplacement, and vessel anchoring are expected to have insignificant effects on foraging opportunities for ESA-listed sea turtles. Reef effects would increase recreational fishing activity around offshore structures and may consequently increase entanglement risk. Similarly, fisheries and habitat surveys could pose an entanglement risk for ESA-listed sea turtles, with a higher likelihood for leatherback and loggerhead sea turtles that are more present in the Project area. However, the short duration of surveys, the type of survey methods, the overall low densities and patchy distribution of all ESA-listed sea turtles, and the required mitigation measures during surveys would minimize such incidences. 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 on prey distribution. Any direct or indirect effects associated with the presence of WTGs are expected to be insignificant for ESA-listed sea turtles. Effects on ESA-listed sea turtles and their prey from EMF and heat associated with submarine cables, lighting of structures, and offshore substation withdrawal and discharge are expected to be so unlikely as to be discountable. Therefore, the effects of habitat disturbance from related Project activities **may affect, not likely to adversely affect** ESA-listed sea turtles.

5.5.12.3 Fish

Habitat disturbance associated dredging, trenching and G&G surveys would be short-term and localized to a small area. Therefore, associated impacts from these activities on Atlantic sturgeon would be insignificant. Habitat conversion and loss associated with WTGs, OSPs, scour protection, cable emplacement, and vessel anchoring are also expected to have insignificant effects on foraging opportunities for Atlantic sturgeon. Reef effects could increase recreational fishing activity around offshore structures and may consequently increase entanglement risk. Similarly, fisheries and habitat surveys would pose as an entanglement risk and a source of minor injuries and/ incidental capture due to trawl surveys and are therefore **likely to adversely affect** Atlantic sturgeon. However, the short survey times, the likely use of open-cod end survey equipment, and the required mitigation measures during surveys would minimize the risk of capture and entanglement. Potential long-term, intermittent impacts would be low in intensity and any effects would have no population-level effects for this species. Increased turbidity associated with the Proposed Action may result in short-term localized effects on Atlantic sturgeon, but these effects would be insignificant. The physical presence of WTGs in the Lease Area could directly affect Atlantic sturgeon through avoidance, displacement, or behavioral disruption. Any effects associated with the presence of WTGs are expected to be insignificant for Atlantic sturgeon. Effects on Atlantic sturgeon from EMF and heat associated with submarine cables, lighting of structures, and offshore substation withdrawal and discharge are also expected to be insignificant. Therefore, the effects of habitat disturbance from related Project activities **may affect, not likely to adversely affect** ESA-listed Atlantic sturgeon, except for the increased risk of entanglement during fisheries and habitat surveys, which cannot be discounted.

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 and 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 affect 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. However, the rates of prey removal due to OSP operations are expected to be too small to make any measurable difference in prey availability. Therefore, the effects of habitat disturbance from related Project activities leading to the reduction of prey **may affect, not likely to adversely affect** ESA-listed species.

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 and the installation equipment on board Proposed Action vessels. The total construction phase air emissions and the total O&M phase air emissions for the Proposed Action are shown in Table 5.6-1, which is derived from SouthCoast Wind's air emissions inventory provided in Appendix G, *Air Emissions Report*, of the COP (Mayflower Wind 2022).

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. Emissions from Project activities offshore would be permitted as part of an OCS air permit issued by the USEPA and must demonstrate compliance with National Ambient Air Quality Standards (NAAQS). SouthCoast Wind submitted an OCS Air Permit application to USEPA in November 2022.

The installation of the SouthCoast Wind Project provides a clean energy alternative for the state(s) that will get power supplied from the Project. Emissions of CO_2, NO_x, and SO_2 associated with a similarly sized fossil-fuel fired generator in the Project area were estimated using emission factors from EPA's Avoided Emissions and Generation Tool (AVERT) version 3.0. These emissions would act as a hypothetical baseline to then subtract emissions associated with the SouthCoast Wind OCS Project construction and operations. In essence, the Commonwealth of Massachusetts avoids 692 tons of NO_x emissions per year or 22,825 tons over the Project lifespan, 4,038,482 tons of CO^2 emissions per year or 133,269,904 tons over the Project lifespan, and 313 tons of SO_2 emissions per year or 10,324 tons over the life of the Project by choosing an offshore wind project over a fossil-fueled fired project of equal power output.

Table 5.6-1. SouthCoast Wind Total Air Emissions (U.S. tons)

	Total Emissions (tons)												
	Total Fuel Use (gal)	NO_x	VOC	CO	PM_{10}	$PM_{2.5}$	SO_2	CO_2	CH_4	N_2O	Pb	HAPs	CO_2e
Construction Phase Air Emissions[1]													
Year 1	11,037,093	2,352	104	497	469	244	91	159,360	0.73	5.5	$8.2e^{-3}$	5	160,834
Year 2	60,374,086	12,819	545	2,542	818	446	498	834,012	4.1	30	$4.7e^{-2}$	28	842,139
Year 3	84,982,427	18,728	733	3,872	1,016	560	730	1,214,881	6.2	46	0.07	40	1,227,336
Year 4	25,842,115	6,066	208	1,373	594	316	237	398,774	2.2	16	$2.6e^{-2}$	12	403,096
Total	182,235,721	39,965	1,590	8,284	2,897	1,566	1,556	2,607,027	13.2	98	0.15	85	2,633,405
Total O&M Phase Air Emissions													
Project Lifespan	110,110,702	24,061	441	5,922	787	614	933	1,548,541	10	71	0.11	51	1,613,637
Annual (tons per year)	3,336,688	729	13	180	24	19	28	46,925	0.3	2.2	$3.5e^{-3}$	1.6	48,898

CH_4 = methane; CO = carbon monoxide; CO_2 = carbon dioxide; CO_2e = carbon dioxide; HAPs = hazardous air pollutants; N_2O = nitrous oxide; NO_X = nitrogen oxides; Pb = lead; PM10 = particulate matter with an aerodynamic diameter less than or equal to 10 microns; $PM_{2.5}$ particulate matter with an aerodynamic diameter less than or equal to 2.5 microns; SO_2 = sulfur dioxide; VOC = volatile organic compounds

[1]SouthCoast Wind has revised its construction schedule to 7 years from 4 years; however, SouthCoast Wind COP Appendix G (the source for the emissions data in this table) reflects 4 years of construction emissions. BOEM expects that total construction emissions over a 7-year period would be similar to the totals shown in the table, but that maximum annual emissions would be less than in the table because construction would be spread out over 7 years instead of 4.

Source: SouthCoast Wind Air Emissions Report (Appendix G, Mayflower Wind 2022)

Construction and installation and O&M vessels are the primary source of Project-related emissions that could potentially affect ESA-listed marine mammals and sea turtles. ESA-listed fish species would not be exposed to airborne emissions and would therefore not be affected by this stressor. Most Project vessels are ocean-going ships and tugs powered by diesel engines with exhaust stacks that discharge emissions above the vessel. Summaries of estimated annual and total pollutant emissions during Project construction and installation and O&M are provided in Table 5.6-1. Project vessel activities during construction would result in short-term increases in Project-related air emissions. During O&M, Project vessels would result in long-term increases in emissions; however, estimated air emissions from O&M vessel activities would be lower than emissions generated during construction activities due to fewer vessels operating daily and are not expected to have a significant effect on regional air quality. Air emissions during decommissioning are expected to be similar to or lower than emissions estimated for construction activities.

The Proposed Action includes the following mitigation measures to minimize pollutant emissions associated with each Project phase: ensuring fuels used are compliant with EPA emissions standards, use of low sulfur fuels to the extent practicable; use of low NO_x engines when possible; and full compliance with international standards regarding air emissions from marine vessels (AMM-57 in Table 3.3-1).

5.6.1 Marine Mammals

Whales could be particularly vulnerable to concentrated pollutant emissions, as they do not have sinuses to filter air and lack olfactory receptors that would allow them to sense and perhaps avoid vessel emissions. Additionally, whales spend much of their time diving, which increases air pressure in their lungs allowing for pollutants to enter their blood more rapidly than for non-diving animals at normal atmospheric pressure (B.C. Cetacean Sightings Network 2022). While individual animals may periodically approach mobile Project vessels, it is unlikely that whales would remain close enough to those vessels for long enough periods of time to experience an adverse level of exposure to vessel emissions. 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 2019a). Given that long-term effects of Project vessel activities 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 be so small that they cannot be meaningfully measured, detected, or evaluated and, therefore, are **insignificant**. The effects of air emissions from Project vessels **may affect, not likely to adversely affect** ESA-listed marine mammals**.**

5.6.2 Sea Turtles

Sea turtle exposures to air pollutant emissions during Project construction and installation and O&M are anticipated to be temporary and short-term in duration. Given the fact that vessel exhausts are located high above the water surface, and most vessel activity will occur in the open ocean where exhaust will be readily dispersed by steady winds, the likelihood of individual animals being repeatedly exposed to high concentrations of airborne pollutants from Project vessels and equipment is low. 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 NAAQS are designed to ensure that air quality does not significantly deteriorate from baseline levels. Additionally, the Project's use of 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 ESA-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.

5.6.3 Fish

As stated previously, fish do not breathe air, thus air emissions from the Project will 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**. Therefore, the effects of repair and maintenance activities from the Project **may affect, not likely to adversely affect** any of the ESA-listed species**.**

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 fishing gear, which is described in Section 5.5.8.

Additional vessel traffic during construction may cause difficulties with navigation and increased risk of collision, therefore causing some fishing or other vessels to change normal routes. Once construction is completed, some commercial fisherman may avoid the Lease Area if large numbers of recreational fisherman cause vessel congestion. See Section 5.4.1 for further discussion of the risk of vessel strikes on marine mammals, sea turtles, and marine fish.

Due to the large distance of SouthCoast Wind's Lease Area from shore, the likelihood of a significant increase in recreational fishing vessel traffic in the Lease Area is low. This is particularly true when compared to the Block Island Wind Farm. Outreach by SouthCoast Wind to the local recreational fishing community has shown that the distance of 23 miles (37 kilometers) from the closest turbine to shore will preclude large increases in recreational fishing vessel traffic owing to the time/fuel considerations and the composition of the recreational fishing fleet. Outreach to the recreational fishing community as well as anecdotal observations by SouthCoast Wind G&G survey vessels indicate that a small number of larger recreational fishing vessels utilize the Lease Area during the summer months to target high profile gamefish, while a larger number of more diverse recreational fishing vessels utilize the export cable corridors and surrounding area to target a wider array of species.

5.9.1.1 Marine Mammals

Structures in the water could result in fishing vessel displacement or gear type 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, or due to increased vessel congestion from recreational fishing, there would be a potential increase in the number of vertical lines, resulting in an increased risk of marine mammal interactions with fishing gear (as described in Section 5.5.8). These potential long-term, intermittent impacts would be low in intensity and persist until decommissioning is complete and structures are removed.

The long-term presence of WTG structures could displace marine mammals from preferred habitats or alter movement patterns, potentially changing exposure to commercial and recreational fishing activity. The evidence for long-term displacement is unclear and varies by species and location. With only short-term displacement of harbor porpoises (1-2 days) during construction of a North Sea wind farm, it was shown that there were no population level impacts (Kraus et al. 2019; Brandt et al. 2016). Tielmann and Carstensen (2012) observed long-term (greater than 10 years) displacement of harbor porpoises from commercial wind farm areas in Denmark, while other marine mammals may be attracted to wind farm areas by increases in prey. If commercial fishing is displaced from the Lease Area and into adjacent areas, there is potential for reduction in prey in those areas removed by fishing pressure. Displacement effects remain a focus of ongoing study.

While the potential for displacement effects (i.e., gear shift, recreational fishing congestion, and changes in interactions with fishing lines) are acknowledged, the likelihood and significance of adverse effects on ESA-listed marine mammals is at present unknown but expected to be **insignificant**. Therefore, the potential displacement of ocean users during operations **may affect, not likely adversely affect** ESA-listed marine mammals.

5.9.1.2 Sea Turtles

One possible long-term impact of the presence of structures during O&M is the concentration of 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 (as described in Section 5.5.8). A majority of the recreational and commercial prime fishing areas and fishing activity occurs outside of the Project area (COP Appendix X; Mayflower Wind 2022). 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. 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, while Kemp’s ridley and green sea turtles are less likely to be exposed.

Project construction activities could result in some level of displacement of sea turtles out of the Lease Area and into areas with higher levels of vessel traffic and/or recreational or commercial fishing activity. If structures result in vessel displacement or shifts in gear types, the potential effects on sea turtle populations are uncertain, but due to the patchy distribution and low densities of sea turtles in the Project area, is likely to be **discountable**. Therefore, the potential displacement of ocean users during operations **may affect, not likely to adversely affect** ESA-listed sea turtles.

5.9.1.3 Fish

One possible long-term impact of the presence of structures during O&M is the concentration of recreational fishing around foundations, potentially increasing the risk of Atlantic sturgeon entanglement in both vertical and horizontal fishing lines (as described in Section 5.5.8). A majority of the recreational and commercial prime fishing areas and fishing activity occurs outside of the Project area with medium to low levels of fishing in the northern portion of the Project area and sparse, low levels of fishing in the southern portion of the Project area (DNV-GL 2021). If there is an increase in recreational fishing within 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. The presence of structures could also result in fishing vessel displacement or gear type shift. The potential impact on Atlantic sturgeon from these changes is uncertain. 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. Further, due to the large distance of SouthCoast Wind's Lease Area from shore, the likelihood of a significant increase in recreational fishing vessel traffic in the Lease Area is low. While the potential for displacement effects is acknowledged, the likelihood and significance of adverse effects on Atlantic sturgeon is at present unknown but expected to be **insignificant**. Therefore, the potential displacement of ocean users during operations **may affect, not likely to adversely affect** ESA-listed 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), or oil spills (Section 5.9.2.3).

5.9.2.1 Vessel Collision/Allision with Foundation

Vessel collisions or allisions may result in accidental discharges of fuel, fluid, or hazardous materials, which are addressed in Section 5.4.2. These events are considered unlikely given the lighting requirements for Project vessels and offshore structures, vessel speed restrictions, proposed spacing of Project structures, inclusion of Project structures on navigational charts, and Notices to Mariners issued by the U.S. Coast Guard. Therefore, effects on ESA-listed species due to vessel collisions or allisions are extremely unlikely to occur and are **discountable**. Given the low likelihood of effects, the effects of vessel discharges associated with collisions or allisions **may affect, not likely adversely affect** 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 hurricanes or extratropical storms, which are common in the area between October and April. 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 and are **discountable**. Given the low likelihood of occurrence, the effects of catastrophic WTG failure leading to injury or mortality **may affect, not likely to adversely affect** 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 3.1-2 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).

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, SouthCoast Wind has developed an OSRP (Appendix AA, Mayflower Wind 2022) with measures to avoid accidental releases and a protocol to respond to such a release if one occurs. AMM-36 will require SouthCoast Wind to comply with regulations related to the prevention and control of unplanned release. Therefore, effects on ESA-listed species due to oil spill/chemical release are extremely unlikely to occur and are **discountable**. Given the low likelihood of occurrence and low relatively low volumes involved, effects of oil spills or chemical releases from vessels or Project structures **may affect, not likely to adversely affect** any of the ESA-listed species considered.

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 SouthCoast Wind COP, subject to applicable mitigation measures. BOEM worked with SouthCoast 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 positions that would not be developed are located on the northeastern edge of the Lease Area, which is near Nantucket Shoals (Figure 6-1). 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, 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 SouthCoast Wind COP, subject to applicable mitigation measures. However, to minimize seabed disturbance in the Muskeget Channel, the Falmouth offshore export cable route would use ±525 kilovolts 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.

Though fewer DC cables would be installed under Alternative F within the Falmouth ECC (three DC cables under Alternative F compared to five AC cables under the Proposed Action), the amplitude of

EMF generated by DC cables can be up to three times greater than that of AC cables (Hutchison et al. 2020). However, AC and DC EMFs differ in the way they interact with organisms and direct comparisons cannot be made (CSA Ocean Sciences, Inc. and Exponent 2019). Measures to reduce EMF into the surrounding area, including cable burial and shielding where sufficient burial is not possible, are expected to reduce the EMF of DC cables to levels where impacts from EMF are localized to the immediate area of the cable (CSA Ocean Sciences, Inc. and Exponent 2019). Previous studies on DC undersea cables have shown only temporary alterations in mobility and behavior of some fish species with no appreciable effects on overall movement or population health (Klimley et al. 2017; Wyman et al. 2018). Because impacts associated with cable installation and maintenance would still occur in the same corridor, the impacts on EMF-sensitive species 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 6-1), and a reduction in offshore wind development in this area may lessen the impacts on these species.

Nantucket Shoals is relatively shallow (< 164 feet [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 SouthCoast 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 Habitat Area of Particular Concern (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, SouthCoast 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, the Falmouth offshore export cable route would use ±525 kilovolts HVDC cables connected to one HVDC converter OSP, instead of HVAC cables connected to one or more HVAC OSPs. During operation, there would be increased intake and discharge from the additional HVDC converter OSP, which could result in increased entrainment of prey of ESA-listed species compared to if only one HVDC converter OSP is used. The additional HVDC converter OSP associated with Falmouth would be located in deeper waters in the southern portion of the Lease Area at a further distance from Nantucket Shoals and potential impacts would remain localized in the immediate vicinity of the OSPs. Because SouthCoast Wind's preference under the Proposed Action is to use two HVDC converter OSPs in the Lease Area, as described in Section 3.1.2.2, which is also proposed under Alternative F, there would be no difference in impacts between the two alternatives. The Falmouth offshore export cable would include only three cables under Alternative F compared to five cables under the Proposed Action, which would reduce the total seafloor disturbance by approximately 700 acres. 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, to minimize seabed disturbance in the Muskeget Channel, the Falmouth offshore export cable route would use up to three ±525 kilovolts HVDC cables instead of up to five HVAC cables as proposed under the Proposed Action. Approximately 2,140 acres of complex habitat (coarse sediment, glacial moraine A, and boulder fields) can be found within an 8.2-mile (13.2-kilometer) segment of the Falmouth ECC as it crosses the Muskeget Channel (INSPIRE 2022). The total width of disturbance of the cables would be reduced from 98.5 feet (30 meter) (assuming a 19.7-foot-wide [6 meter] disturbance per cable; COP Volume 1, Table 3-29; Mayflower Wind 2022) under the Proposed Action to 59.1 feet (18 meters) under Alternative F, reducing the extent of impacts on habitats along this segment of the Falmouth cable corridor from 98 acres to 59 acres. Depending on the final cable placement within the ECC, up to a 40-percent reduction in seabed disturbance from installation of the Falmouth offshore export cables can be anticipated which would reduce impacts on benthic habitats, in particular complex habitats found in the Muskeget Channel that may be important EFH. Additionally, lesser installation activity from fewer cable emplacements along the cable corridor may reduce the temporary construction impacts on ESA-listed species. Offshore impacts on marine mammal prey from cable emplacement and anchoring may also be reduced due to the lesser number of cables installed. Because impacts associated with cable installation and maintenance would still occur in the same corridor and there would be no change in impacts from other offshore components (e.g., WTGs), BOEM does not anticipate that impacts to ESA-listed species under Alternative F would be materially different than those described under the Proposed Action.

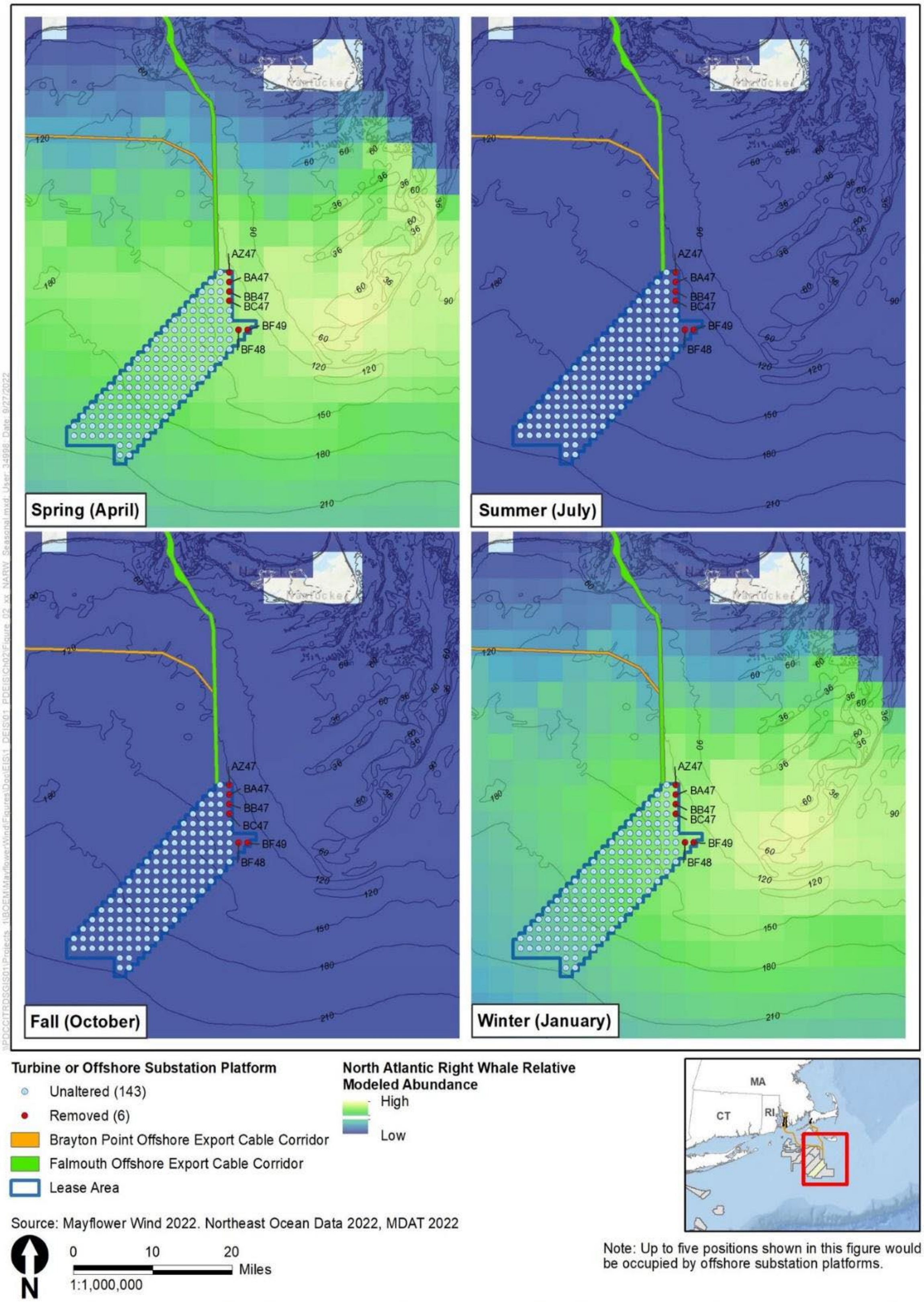


Figure 6-1. Alternative D WTG Removal and NARW seasonal density

7. Cumulative Effects[8]

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).

[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

Six ESA-listed marine mammal species under NMFS jurisdiction may occur in the Action Area for the Proposed Action. However, one of these species, Rice's whale, is limited to a portion of the Action Area along vessel routes to ports in the Gulf of Mexico and was discounted from further analysis. Potential effects on this species would be limited to vessel traffic effects (e.g., vessel strike, vessel noise, and vessel discharges) and were considered extremely unlikely to occur given the low population size, the low expected volume of vessel traffic traveling at slow speeds, and the mitigation measures in places to avoid vessel interactions. Blue whales are very rare migrants to the northeast but have a higher potential of occurring near the Project area, so the species was not discounted from further analysis. However, each IPF and stressor analyzed was found to be discountable, insignificant, or have no effect on blue whales (Table 8.4-1). Thus, the Proposed Action **may affect, not likely to adversely affect** both blue whales and Rice's whale.

Fin whales, sei whales and NARWs are likely to occur in the Action Area, and sperm whales 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. While mitigation measures reduce the risk of PTS or injury to discountable levels for baleen whales (and sperm whales had no exposures), exposure to noise from pile driving exceeding behavioral thresholds may occur and cause adverse effects. All other sources of noise leading to PTS or behavioral disturbance (G&G surveys, cable laying, dredging, UXO detonation) were found to be discountable, insignificant, or have no effect on fin whales, sei whales, NARWs, or sperm whales.

Project vessel traffic could increase vessel strike risk for ESA-listed marine mammals; however, vessel strikes would be unlikely to occur given the measures in place to avoid or minimize vessel strikes, including speed restrictions, minimum separation distances, and vessel strike avoidance procedures. 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 or discountable as they would be short-term, localized, unlikely to occur, or would not be measurable or measurably change risk.

Repair and maintenance activities would be similar to activities evaluated for other 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, and oil spills, would be extremely unlikely to occur, making their effects discountable.

Given that underwater noise has the potential to result in behavioral effects, the Proposed Action **may affect and is likely to adversely affec**t 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 that only includes vessel transits to and from the Gulf of Mexico and was discounted from further analysis. Potential effects on this species would be limited to vessel traffic effects (e.g., vessel strike, vessel noise, and vessel discharges) and were considered extremely unlikely to occur given the patchy distribution of hawksbill sea turtles, the low expected volume of vessel traffic traveling at slow speeds, and the mitigation measures in places to avoid vessel interactions. 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, including near the Project area, 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 (Table 8.4-1). The green and Kemp's ridley turtles have low enough population numbers in the Project area that effects from noise associated with the Proposed Action were deemed extremely unlikely to occur and thus discountable; however, noise from pile driving has the potential to result in injury or behavioral effects for the more abundant leatherback (PTS and behavioral disturbance) and loggerhead (behavioral disturbance only) sea turtles. All other sources of noise leading to PTS or behavioral disturbance (G&G surveys, cable laying, dredging, UXO detonation) were found to be discountable, insignificant, or have no effect for ESA-listed sea turtles.

Project vessel traffic could increase vessel strike risk for sea turtles, but this increase is 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 the Kemp's ridley sea turtle and a decrease in foraging opportunities, as well as increased entanglement risk in recreational fishing gear, turbidity effects, species avoidance or displacement, behavioral disruption, EMF and heat effects, or lighting effects for all ESA-listed sea turtles. However, such effects are expected to be insignificant or discountable as they would be short-term, localized, unlikely to occur/co-occur with species presence, or would not be measurable or measurably change risk.

Repair and maintenance activities would be similar to activities evaluated for other 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. While such a gear shift is not expected, the effects of fishing activity displacement are more likely to adversely affect leatherback and loggerhead sea turtles than Kemp's ridley and green sea turtles due to foraging strategies and presence in the pelagic Lease Area; however, such a gear shift is not expected, and effects of displacement would be discountable as they are extremely likely to occur due to the low population size and patchy distribution of sea turtles in the Project area. Unexpected/unanticipated events, including vessel collisions or allisions, WTG failure, and oil spills would be extremely unlikely to occur, making their effects discountable.

Given that underwater noise has the potential to result in injury and/or behavioral effects, the Proposed Action **may affect, likely to adversely affect** leatherback and loggerhead sea turtles. However, based on their comparatively lower abundances in the Project area, the Proposed Action **may affect, not likely to adversely affect** Kemp's ridley and green sea turtles.

8.3 Fish

Eight ESA-listed fish species may occur in the Action Area of the Proposed Action. However, Atlantic salmon, giant manta ray, Gulf sturgeon, Nassau grouper, oceanic whitetip shark, and smalltooth sawfish would be limited to portions of the Action Area that only include vessel transits to ports in the Gulf of Mexico or Canada. Shortnose sturgeon would be primarily confined to river systems; vessels transiting to and from potential ports that may be used during the construction phase in the Delaware River (New Jersey Wind Port) and Hudson River (Port of Coeymans) may encounter shortnose sturgeon. Potential effects on these seven species would be limited to those related to vessel traffic (e.g., vessel strike, vessel noise, and vessel discharges) and were considered extremely unlikely to occur given the lack of spatial overlap in habitat preferences of each species and Project activities, the low expected volume and speed of vessel traffic traveling to these ports, and the mitigation measures in places to avoid vessel interactions with sea life. Therefore, seven of the eight species that could occur in the Action Area were discounted from further analysis. The Proposed Action **may affect, not likely to adversely affect** Atlantic salmon, giant manta ray, Gulf sturgeon, Nassau grouper, oceanic whitetip shark, shortnose sturgeon, and smalltooth sawfish.

Atlantic sturgeon is the only ESA-listed fish species that is likely to occur in the Action Area and near the Project area, 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 (Table 8.4-1). Noise associated with the Proposed Action has the potential to result in injury or behavioral effects in Atlantic sturgeon but was considered extremely unlikely to occur (discountable) or its effects would be so small that they would not be measurable or detected (insignificant).

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 on the OCS and the limited trips anticipated by Project vessels within rivers. 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. The risk of capture or entanglement from fisheries and habitat surveys, however, may impact Atlantic sturgeon and cannot be discounted.

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, and oil spills, would be extremely unlikely to occur, making their effects discountable. Given that fishery/habitat surveys have the potential to result in injury or behavioral effects, the Proposed Action **may affect, 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.

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

IPF or Stressor	Marine Mammals					Sea Turtles				Fish
	Blue Whale	Fin Whale	[1]NARW	Sei Whale	Sperm Whale	Green	Kemp's Ridley	Leatherback	[1]Loggerhead	[1]Atlantic Sturgeon
Noise – Impact & Vibratory Pile-Driving – Injury (PTS)	No effect	NLAA Discountable	NLAA Discountable	NLAA Discountable	No effect	NLAA Discountable	NLAA Discountable	**LAA**	NLAA Discountable	NLAA Discountable
Noise – Impact & Vibratory Pile-Driving – Behavioral Disturbance (BD)	NLAA Discountable	LAA	LAA	LAA	LAA	NLAA Discountable	NLAA Discountable	LAA	LAA	NLAA Discountable
Noise – G&G Surveys	**PTS:** No effect **BD:** NLAA Insignificant					**PTS:** NLAA Insignificant **BD:** NLAA Discountable				**PTS:** NLAA Discountable **BD:** NLAA Insignificant
Noise – Cable Laying	**PTS:** No effect **BD:** NLAA Insignificant					**PTS:** No effect **BD:** NLAA Insignificant				**PTS:** NLAA Discountable **BD:** NLAA Insignificant
Noise – Dredging	**PTS:** No effect **BD:** NLAA Insignificant					**PTS:** No effect **BD:** NLAA Insignificant				**PTS:** NLAA Discountable **BD:** NLAA Insignificant
Noise – UXO Detonation	**PTS:** NLAA Discountable **BD:** NLAA Insignificant					**PTS:** NLAA Discountable **BD:** NLAA Insignificant				**PTS:** NLAA Discountable **BD:** NLAA Discountable
Noise – Vessels	**PTS:** No effect **BD:** NLAA Insignificant					**PTS:** No effect **BD:** NLAA Insignificant				**PTS:** NLAA Discountable **BD:** NLAA Discountable

IPF or Stressor	Marine Mammals					Sea Turtles				Fish
	Blue Whale	Fin Whale	[1]NARW	Sei Whale	Sperm Whale	Green	Kemp's Ridley	Leatherback	[1]Loggerhead	[1]Atlantic Sturgeon
Noise – Helicopter & Drones	**PTS:** NLAA Discountable **BD:** NLAA Discountable					**PTS:** NLAA Discountable **BD:** NLAA Discountable				**PTS:** NLAA Discountable **BD:** NLAA Discountable
Noise – WTGs	**PTS:** NLAA Discountable **BD:** NLAA Insignificant					**PTS:** NLAA Discountable **BD:** NLAA Insignificant				**PTS:** NLAA Discountable **BD:** NLAA Insignificant
Risk of Vessel Strike	NLAA Insignificant					NLAA Insignificant				NLAA Insignificant
Vessel Discharges	NLAA Insignificant					NLAA Insignificant				NLAA Insignificant
G&G Surveys	No effect					NLAA Insignificant				NLAA Insignificant
Fisheries Surveys – Risk of Capture and Entanglement	NLAA Discountable					NLAA Insignificant				**LAA**
Fisheries Surveys – Effects on Prey and/or Habitat	NLAA Insignificant					NLAA Insignificant				NLAA Insignificant
Habitat Conversion and Loss – Foundations and Scour Protection	NLAA Insignificant					NLAA Insignificant				NLAA Insignificant
Habitat Conversion and Loss – Cable Emplacement	NLAA Insignificant					NLAA Insignificant				NLAA Insignificant

IPF or Stressor	Marine Mammals					Sea Turtles				Fish
	Blue Whale	Fin Whale	[1]NARW	Sei Whale	Sperm Whale	Green	Kemp's Ridley	Leatherback	[1]Loggerhead	[1]Atlantic Sturgeon
Habitat Conversion and Loss – Spuds and Anchors	NLAA Insignificant					NLAA Insignificant				NLAA Insignificant
Turbidity	NLAA Insignificant					NLAA Insignificant				NLAA Insignificant
Dredging – Direct Effects	No effect					NLAA Discountable				NLAA Discountable
Dredging – Impacts on Prey	No effect					No effect	NLAA Insignificant	No effect	No effect	NLAA Insignificant
Trenching	No effect					No effect				No effect
Presence of WTGs on Atmospheric / Oceanographic Conditions	No effect	NLAA Insignificant	NLAA Insignificant	NLAA Insignificant	No effect	NLAA Insignificant				NLAA Insignificant
Physical Presence of WTGs on Listed Species	NLAA Discountable					NLAA Insignificant				NLAA Insignificant
EMF and Heat from Cables	NLAA Insignificant					NLAA Insignificant				NLAA Insignificant
Lighting and Marking of Structures	NLAA Insignificant					NLAA Insignificant				NLAA Discountable
Offshore Substations – Water Withdrawal and Discharge	NLAA Insignificant					NLAA Insignificant				NLAA Insignificant
Offshore Substations – Impacts on Prey	NLAA Insignificant					NLAA Insignificant				NLAA Insignificant

IPF or Stressor	Marine Mammals					Sea Turtles				Fish
	Blue Whale	Fin Whale	[1]NARW	Sei Whale	Sperm Whale	Green	Kemp's Ridley	Leatherback	[1]Loggerhead	[1]Atlantic Sturgeon
Air Emissions	NLAA Insignificant					NLAA Insignificant				No effect
Port Modifications[2]	Not Applicable									
Repair and Maintenance Activities	NLAA Insignificant					NLAA Insignificant				NLAA Insignificant
Potential Shifts of Ocean Users	NLAA Insignificant					NLAA Discountable				NLAA Insignificant
Vessel Collision/Allision with Foundation	NLAA Discountable					NLAA Discountable				NLAA Discountable
Failure due to Weather Events	NLAA Discountable					NLAA Discountable				NLAA Discountable
Oil / Chemical Spill	NLAA Discountable					NLAA Discountable				NLAA Discountable

[1] Rice's whale, Hawksbill turtle, Atlantic salmon, giant manta ray, Gulf sturgeon, Nassau grouper, oceanic whitetip shark, smalltooth sawfish, and shortnose sturgeon are excluded from this summary table as they were discounted from further analysis in Section 4.9.1.
[2] Critical habitats of these species that occurred within the Action Area (NARW, loggerhead sea turtle, Atlantic sturgeon) were removed from the table as there was determined to be **"no effect"** on any of the physical and biological features of these habitats. Other critical habitats did not occur within the Action Area.
NE = no effect, LAA = likely to adversely affect; N/A = not applicable (not part of the Proposed Action); NLAA = not likely to adversely affect, PTS = permanent threshold shift / auditory injury, BD = behavioral disturbance from noise

9. References

A.I.S. Inc. 2020. AIS Protected Species Observer Report, Mayflower Wind – BOEM Lease OCS-A 0521, 2019 Geotechnical Survey.

Able, K.W. and Fahay, M.P. 2010. Ecology of estuarine fishes. Johns Hopkins University Press.

AECOM. 2020. Mayflower Wind, Military Activity Study.

Albert, L., F. Deschamps, A. Jolivet, F. Olivier, L. Chauvaud, and S. Chauvaud. 2020. A Current Synthesis on the Effects of Electric and Magnetic Fields Emitted by Submarine Power Cables on Invertebrates. Marine Environmental Research 159:104958. DOI: 10.1016/j.marenvres.2020.104958.

Andersson, M. H., Dock-Åkerman, E., Ubral-Hedenberg, R., Öhman, M.,C., & Sigray, P. (2007). Swimming Behavior of Roach (Rutilus rutilus) and Three-spined Stickleback (Gasterosteus aculeatus) in Response to Wind Power Noise and Single-tone Frequencies. Ambio, 36(8), 636-8.

Anderwald, P., A. Brandecker, M. Coleman, C. Collins, H. Denniston, D. Haberlin, M. O'Donovan, R. Pinfield, F. Visser, and L. Walshe. 2013. Displacement responses of a mysticete, an odontocete, and a phocid seal to construction-related vessel traffic. *Endangered Species Research*, 21:231. 10.3354/esr00523.

Atlantic States Marine Fisheries Commission (ASMFC). 1997. Technical Working Papers from a Symposium on Artificial Reef Development. 70pp. Available: www.asmfc.org/uploads/file/sr64SymposiumArtificialReefDevelopment.pdf.

Atlantic States Marine Fisheries Commission (ASMFC). 2012. Habitat Addendum IV to Amendment I to the Interstate Fishery Management Plan for Atlantic Sturgeon. 16pp. Available: http://www.asmfc.org/uploads/file/sturgeonHabitatAddendumIV_Sept2012.pdf.

Atlantic States Marine Fisheries Commission (ASMFC). 2017. Atlantic Sturgeon Benchmark Stock Assessment and Peer Review Report Approved for Management Use by the Atlantic Sturgeon Management Board Sustainably Managing Atlantic Coastal Fisheries. 2017.

Atlantic States Marine Fisheries Commission Technical Committee (ASMFC TC). 2007. Special Report to the Atlantic Sturgeon Management Board: Estimation of Atlantic sturgeon bycatch in coastal Atlantic commercial fisheries of New England and the Mid-Atlantic. August 2007. 95 pp.

Atlantic Sturgeon Status Review Team (ASSRT). 2007. Status Review of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*). Report to National Marine Fisheries Service, Northeast Regional Office. 174 pp.

B.C. Cetacean Sightings Network. 2022. Threats; vessel disturbance. Available at: https://wildwhales.org/threats/vessel-disturbance/

BERR (Department of Business, Enterprise and Regulatory Reform). 2008. Review of Cabling Techniques and Environmental Effects Applicable to the Offshore Wind Farm Industry. Technical Report from BERR to the Department of Enterprise & Regulatory Reforms (BERR) in association with DEFRA. Retrieved October 2020 from: http://webarchive.nationalarchives.gov.uk/+/http://www.berr.gov.uk/files/file43527.pdf.

Bailey, H., S. R. Benson, G. L. Shillinger, S. J. Bograd, P. H. Dutton, S. A. Eckert, S. J. Morreale, F. V. Paladino, T. Eguchi, D. G. Foley, B. A. Block, R. Piedra, C. Hitipeuw, R. F. Tapilatu, and J. R. Spotila. 2012. Identification of distinct movement patterns in Pacific leatherback turtle populations influenced by ocean conditions. *Ecological Applications* 22(3):735–747.

Bain, M. B., N. Haley, D. Peterson, J. R. Waldman, and K. Arend. 2000. Harvest and habitats of Atlantic sturgeon Acipenser oxyrinchus Mitchill, 1815, in the Hudson River Estuary: Lessons for sturgeon conservation. Boletín Instituto Español de Oceanografía 16:43–53.

Bain, M.B. 1997. Atlantic and shortnose sturgeons of the Hudson River: Common and divergent life history attributes. Environmental Biology of Fishes 48:347–358.

Baines, Mick E., and M. Reichelt. 2014. Upwellings, canyons and whales: An important winter habitat for balaenopterid whales off Mauritania, northwest Africa." *J. Cetacean Res. Manag* 14: 57-67.

Balazik, M., M. Barber, S. Altman, K. Reine, A. KAtzenmeyer, A. Bunch, and G. Garman. 2020. Dredging activity and associated sound have negligible effects on adult sturgeon migration to spawning habitat in a large coastal river. PLoS ONE, 15(3): e0230029.

Balazik, M.T., K.J. Reine, A.J. Spells, C.A. Fredrickson, M.L. Fine, G.C. Garman, and S.P. McIninch. 2012. The potential for vessel interactions with adult Atlantic sturgeon in the James River, Virginia. North American Journal of Fisheries Management 32(6):1062–1069.

Bald, J., Hernández, C., Uriarte, A., Castillo, J.A., Ruiz, P. and Ortega, N., 2015. Acoustic characterization of submarine cable installation in the Biscay marine energy platform (BIMEP). *Bilbao Energy Week*, *27*, p.2015.

Barlow, J., M. Kahru, and B. G. Mitchell. "Cetacean biomass, prey consumption, and primary production requirements in the California Current ecosystem." Marine Ecology Progress Series 371 (2008): 285-295.

Barnette, Michael C. "Potential impacts of artificial reef development on sea turtle conservation in Florida." (2017).

Bartol, S. M., and D. R. Ketten. 2006. "Turtle and Tuna Hearing." In Sea Turtle and Pelagic Fish Sensory Biology: Developing Techniques to Reduce Sea Turtle Bycatch in Longline Fisheries, edited by Y. Swimmer and R. Brill, 98-105. NOAA Technical Memorandum. NMFS-PIFSC-7.

Bartol, S. M., and I. K. Bartol. 2011. Hearing Capabilities of Loggerhead Sea Turtles (Caretta caretta) Throughout Ontogeny: an Integrative Approach Involving Behavioral and Electrophysical Techniques. Final Report submitted to the Joint Industries Programme. 35 pp.

Baulch, S., and C. Perry. 2014. Evaluating the Impacts of Marine Debris on Cetaceans. Marine Pollution Bulletin 80:210–221.

Baumgartner, M.F. and Fratantoni, D.M., 2008. Diel periodicity in both sei whale vocalization rates and the vertical migration of their copepod prey observed from ocean gliders. *Limnology and Oceanography*, *53*(5part2), pp.2197-2209.

Baumgartner, M.F., C. A. Mayo, and R.D. Kenney. 2007. Enormous carnivores, microscopic food, and a restaurant that's hard to find. The Urban Whale: North Atlantic Right Whales at the Crossroads. Harvard University Press, Cambridge, MA, pp.138–171.

Baumgartner, M.F., N.S.J. Lysiak, C.S. Schuman, J. Urban-Rich, and F.W. Wenzel. 2011. Diel vertical migration behavior of Calanus finmarchicus and its influence on right and sei whale occurrence. Marine Ecological Progress Series 423:167–184.

Baumgartner, M.F., T.V.N. Cole, R.G. Campbell, G.J. Teegarden, and E.G. Durbin. 2003. Associations between North Atlantic right whales and their prey, Calanus finmarchicus, over diel and tidal time scales. Marine Ecology Progress Series, 264:155-166.

Baumgartner, Mark F., and Bruce R. Mate. "Summertime foraging ecology of North Atlantic right whales." *Marine Ecology Progress Series* 264 (2003): 123-135.

Baumgartner, Mark F., et al. "North Atlantic right whale foraging ecology and its role in human-caused mortality." *Marine Ecology Progress Series* 581 (2017): 165-181.

Bejarano, A. C., J. Michel, J. Rowe, Z. Li, D. French McCay, L. McStay and D. S. Etkin. 2013. Environmental Risks, Fate and Effects of Chemicals Associated with Wind Turbines on the Atlantic Outer Continental Shelf. US Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs. OCS Study BOEM 2013-213.

Bellmann M. A., J. Brinkmann. A. May, T. Wendt, S. Gerlach, and P. Remmers. 2020. Underwater noise during percussive pile driving: Influencing factors on pile-driving noise and technical possibilities to comply with noise mitigation values. Supported by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (Bundesministerium für Umwelt, Naturschutz und nukleare Sicherheit (BMU)), FKZ UM16 881500. Commissioned and managed by the Federal Maritime and Hydrographic Agency (Bundesamt für Seeschifffahrt und Hydrographie (BSH)), Order No. 10036866. Edited by the itap GmbH. Available: https://www.itap.de/media/experience_report_underwater_era-report.pdf

Bellmann, M. A., and K. Betke. 2021. Expert opinion report regarding underwater noise emissions during UXO-clearance activity and possible options for noise mitigation. ITAP GmbH.

Bembenek-Bailey, S.A., Niemuth, J.N., McClellan-Green, P.D., Godfrey, M.H., Harms, C.A., Gracz, H. and Stoskopf, M.K., 2019. NMR metabolomic analysis of skeletal muscle, heart, and liver of hatchling loggerhead sea turtles (Caretta caretta) experimentally exposed to crude oil and/or Corexit. *Metabolites*, *9*(2), p.21.

Bemis, William E., and Boyd Kynard. "Sturgeon rivers: an introduction to acipenseriform biogeography and life history." *Environmental Biology of Fishes* 48 (1997): 167-183.

Berreiros J. P., and V. S. Raykov. 2014. Lethal lesions and amputation caused by plastic debris and fishing gear on the loggerhead turtle Caretta (Linnaeus, 1758). Three case reports from Terceira Island, Azores (NE Atlantic). Marine Pollution Bulletin 86:518–522.

Bigelow, H. B., and W. C. Schroeder. *Fishes of the Gulf of Maine*. No. 592. Fishery Bulletin of the U.S. Fish and Wildlife Service 53.

Bochert, R. and M.L. Zettler. 2006. Effect of electromagnetic fields on marine organisms. In Offshore Wind Energy (pp. 223-234). Springer, Berlin, Heidelberg.

Bolten, A. B., L. B. Crowder, M. G. Dodd, A. M. Lauritsen, J. A. Musick, B. A. Schroeder, and B. E. Witherington. 2019. Recovery Plan for the Northwest Atlantic Population of the Loggerhead Sea Turtle (Caretta caretta). Second Revision. Assessment of Progress Towards Recovery. 21 pp.

Borcuk, J. R., G. H. Mitchell, S. L. Watwood, T.E. Moll, E. M. Oliveira, and E.R. Robinson. 2017. Dive Distribution and Group Size Parameters for Marine Species Occurring in the US Navy's Atlantic and Hawaii-Southern California Training and Testing Study Areas. Naval Undersea Warfare Center, Newport, RI United States.

Boysen, K. A., & Hoover, J. J. (2009). Swimming performance of juvenile white sturgeon (Acipenser transmontanus): training and the probability of entrainment due to dredging. Journal of Applied Ichthyology, 25, 54-59.

Brakes, P., and S. R. X. Dall. 2016. Marine mammal behavior: A review of conservation implications. Frontiers in Marine Science 3. doi:10.3389/fmars.2016.00087

Brandt, M.J., A.C.Dragon, A. Diederichs, A. Schubert, V. Kosarev, G. and Nehls, G. 2016. Effects of offshore pile driving on harbour porpoise abundance in the German Bight. Assessment of Noise Effects. Final Report. June 2016. Prepared for Offshore Forum Windenergie.

British Columbia Ministry of Transportation and Infrastructure (BC MoTI). 2016. *George Massey Tunnel Replacement Project – Part B Underwater Noise Assessment*. Available: https://projects.eao.gov.bc.ca/api/document/589b9bd5343013001d41579d/fetch

Broström, G. 2008. On the influence of large wind farms on the upper ocean circulation." *Journal of Marine Systems* 74.1-2: 585-591.

Brown, J.J. and G.W. Murphy. 2010. Atlantic Sturgeon Vessel-Strike Mortalities in the Delaware Estuary. Fisheries 35: 72-83.

Brown, W., O. Schofield, J. Kohut, J. Wilkin, and W. Boicourt. 2015. The Mid-Atlantic Autumn Cold Pool During GliderPalooza-2013. OCEANS 2015 - MTS/IEEE Washington. Retrieved from: https://ieeexplore.ieee.org/document/7401814

Bryant, P. J., C. M. Lafferty, and S. K. Lafferty. 1984. Reoccupation of Laguna Guerrero Negro, Baja California, Mexico, by gray whales. In: The gray whale *Eschrichtius robustus* (Ed. by Jones, M. L., Swartz, S. L. & Leatherwood, S.), pp. 375-387. San Diego, California: Academic Press.

Buehler, P. E., R. Oestman, J. Reyff, K. Pommerenck, and B. Mitchell. 2015. *Technical Guidance for Assessment and Mitigation of the Hydroacoustic Effects of Pile Driving on Fish*. California Department of Transportation, Division of Environmental Analysis. CTHWANP-RT-15-306.1.1.

Buerkett, C. and B. Kynard. 1993. Sturgeons of the Taunton River and Mt. Hope Bay: Distribution, Habitats, and Movements. Final Report for Project AFC-24-1. Massachusetts Division of Marine Fisheries.

Bugoni, L., L. Krause, and M. V. Petry. 2001. Marine debris and human impacts on sea turtles in southern Brazil. Marine Pollution Bulletin 42(12):1330–1334.

Bureau of Ocean Energy Management (BOEM). 2012. Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf Offshore Rhode Island and Massachusetts: Environmental Assessment. https://repository.library.noaa.gov/view/noaa/29291

Bureau of Ocean Energy Management (BOEM). 2013. Guidelines for Providing Benthic Habitat Survey Information for Renewable Energy Development on the Atlantic Outer Continental Shelf Pursuant to 30 CFR Part 585. [Online] United States Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs. Retrieved from: https://www.boem.gov/uploadedFiles/BOEM/Renewable_Energy_Program/Regulatory_Information/Ha bitat%20Guidelines.pdf [Accessed 12 September 2017].

Bureau of Ocean Energy Management (BOEM). 2014. Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf Offshore Massachusetts. Revised Environmental Assessment. Available: https://www.boem.gov/sites/default/files/renewable-energy-program/State-Activities/MA/Revised-MA-EA-2014.pdf

Bureau of Ocean Energy Management (BOEM). 2017. Atlantic Marine Assessment Program for Protected Species: 2010-2014. OCS Study BOEM 2017-071.

Bureau of Ocean Energy Management (BOEM). 2017. Gulf of Mexico OCS Proposed Geological and Geophysical Activities Western, Central, and Eastern Planning Areas. Final Programmatic Environmental Impact Statement. OCS EIS/EA BOEM 2017-051.

Bureau of Ocean Energy Management (BOEM). 2018a. Biological Assessment: Data Collection and Site Survey Activities for Renewable Energy of the Atlantic Outer Continental Shelf. U.S. Department of the Interior Bureau of Ocean Energy Management, Office of Renewable Energy Programs.

Bureau of Ocean Energy Management (BOEM). 2018c. Geological and Geophysical (G&G) Surveys. Available at: https://www.boem.gov/sites/default/files/about-boem/BOEM-Regions/Atlantic-Region/GandG-Overview.pdf

Bureau of Ocean Energy Management (BOEM). 2019a. National Environmental Policy Act Documentation for Impact-Producing Factors in the Offshore Wind Cumulative Impacts Scenario on the North Atlantic Continental Shelf. U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs, Sterling, VA. OCS Study BOEM 2019-036. May 2019. https://www.boem.gov/sites/default/files/documents/renewable-energy/OREP-Data-Collection-BA-Final.pdf

Bureau of Ocean Energy Management (BOEM). 2019b. Guidelines for Providing Information on Fisheries for Renewable Energy Development on the Atlantic Outer Continental Shelf Pursuant to 30 CFR Part 585.

Bureau of Ocean Energy Management (BOEM). 2020. Information Guidelines for a Renewable Energy Construction and Operations Plan (COP). Version 4.0: May 27, 2020. United States Department of the Interior. https://www.boem.gov/sites/default/files/documents/about-boem/COP%20Guidelines.pdf

Bureau of Ocean and Energy Management (BOEM). 2021. Hydrodynamic Modeling, Particle Tracking and Agent-Based Modeling of Larvae in the U.S. Mid-Atlantic Bight. OCE Study, BOEM 2021-049. Available: https://espis.boem.gov/final%20reports/BOEM_2021-049.pdf.

Bureau of Ocean Energy Management (BOEM). 2021. South Fork Wind Farm and South Fork Export Cable Project Final Environmental Impact Statement. OCS EIS/EA BOEM 2020-057. Available: https://www.boem.gov/renewable-energy/state-activities/sfwf-feis.

Bureau of Ocean Energy Management (BOEM). 2021a. Vineyard Wind 1 Offshore Wind Energy Project Final Environmental Impact Statement. OCS EIS/EA BOEM 2021-0012. Available: https://www.boem.gov/vineyard-wind.

Bureau of Ocean Energy Management (BOEM). 2021c. South Fork Wind Farm and South Fork Export Cable Project Final Environmental Impact Statement. OCS EIS/EA BOEM 2020-057. Available: https://www.boem.gov/renewable-energy/state-activities/sfwf-feis.

Bureau of Ocean Energy Management (BOEM). 2021d. Project Design Criteria and Best Management Practices for Protected Species Associated with Offshore Wind Data Collection. Revised November 22, 2021. Available: https://www.boem.gov/sites/default/files/documents//PDCs20and%20BMPs%20for%20Atlantic%20Data%20Collection%2011222021.pdf.

Bureau of Ocean Energy Management (BOEM). 2021e. Data Collection and Site Survey Activities for Renewable Energy on the Atlantic Outer Continental Shelf. Biological Assessment.

Bureau of Ocean Energy Management (BOEM). 2021f. Guidelines for Lighting and Marking of Structures Supporting Renewable Energy Development.

Bureau of Ocean Energy Management, Bureau of Ocean Energy Management (BOEM). 2023. Revolution Wind Farm and Revolution Wind Export Cable – Development and Operation. Biological Assessment. Prepared for the National Marine Fisheries Services. Seattle, Washington: Confluence Environmental Company. Office of Renewable Energy Programs. January.

Burton, W.H., S.B. Wfisberg, AND E Jacobsen. 1993. Effects of hydraulic dredging in the Delaware River Estuary on striped bass ichthyoplankton. Prepared for the Delaware Basin Fish and Wildlife Management Cooperative, Trenton, New Jersey.

Camacho, M., Luzardo, O.P., Boada, L.D., Jurado, L.F.L., Medina, M., Zumbado, M. and Orós, J., 2013. Potential adverse health effects of persistent organic pollutants on sea turtles: evidences from a cross-sectional study on Cape Verde loggerhead sea turtles. *Science of the total environment*, *458*, pp.283-289.

Carpenter, J.R., L. Merchelbach, U. Callies, S. Clark, L. Gaslikova, and B. Baschek. 2016. Potential impacts of offshore wind farms on North Sea stratification. PLoS ONE 11(8): e0160830. Available: https://doi.org/10.1371/journal.pone.0160830.

Carroll, A.G., R. Przeslawski, A. Duncan, M. Ganning, and B. Bruce. 2016. A critical review of the potential impacts of marine seismic surveys on fish and invertebrates. Marine Pollution Bulletin 114:9–24.

Causon, P.D. and Gill, A.B., 2018. Linking ecosystem services with epibenthic biodiversity change following installation of offshore wind farms. *Environmental Science & Policy*, *89*, pp.340-347.

Cazenave, Pierre William, Ricardo Torres, and J. Icarus Alen. 2016. Unstructured Grid Modelling of Offshore Wind Farm Impacts on Seasonally Stratified Shelf Seas. Progress in Oceanography 145(2016) 25–41. Available: https://www.sciencedirect.com/science/article/pii/S0079661115300379.

Center for Coastal Studies. (CCS). (2020). Water quality monitoring data file. https://coastalstudies.org/cape-cod-bay-monitoring-program/.

Cetacean and Turtle Assessment Program (CETAP). 1981. A characterization of marine mammals and turtles in the mid- and north Atlantic areas of the U.S. outer continental shelf. Cetacean and Turtle Assessment Program, University of Rhode Island. Final Report #AA55 1-CT8-48 to the Bureau of Land Management, Washington, DC.

Charif, Russell A., and C. W. Clark. 2009. Acoustic monitoring of large whales in deep waters north and west of the British Isles: 1996–2005." *Cornell Lab Ornithol* 8: 40.

Chen, Changsheng, R. C. Beardsley, J. Qi and H. Lin. 2016. Use of Finite-Volume Modeling and the Northeast Coastal Ocean Forecast System in Offshore Wind Energy Resource Planning. Final Report to the U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs. BOEM 2016-050. 131p.

Chen, Z., E. Curchitser, R. Chant, and D. Kang. 2018. Seasonal variability of the cold pool over the Mid-Atlantic Bight Continental Shelf. Journal of Geophysical Research: Oceans 123. 10.1029/2018JC014148.

Christiansen, N., U. Daewel, B. Djath, and C. Schrum. 2022. Emergence of Large-Scale Hydrodynamic Structures Due to Atmospheric Offshore Wind Farm Wakes. Front. Mar. Sci. 9:818501. doi: 10.3389/fmars.2022.818501.

Clark, S. L., and J.S. Ward. 1943. The effects of rapid compression waves on animals submerged in water. Surg. Synec. & Obstet., 77:403.

Clarke, D. (2011). Sturgeon Protection. Dredged Material Assessment and Management.

Collie, J.S., S.J. Hall, M.J. Kaiser, and I.R. Poiner. 2000. A quantitative analysis of fishing impacts on shelf-sea benthos. *Journal of animal ecology*, *69*(5), pp.785-798.

Collins, M.R., T.I.J. Smith, W.C. Post, and O. Pashuk. 2000. Habitat utilization and biological characteristics of adult Atlantic sturgeon in two South Carolina rivers. Transactions of the American Fisheries Society 129:982–988.

Comtois, S, C. Savenkoff, M. N. Bourassa, J. C. Brethes, and R. Sears. 2010. Regional distribution and abundance of blue and humpback whales in the Gulf of St. Lawrence. Direction des Sciences, Pêches et Océans Canada, Institut Maurice-Lamontagne.

Conant, T.A., P.H. Dutton, T. Eguchi, S.P. Epperly, C.C. Fahy, M.H. Godfrey, S.L. MacPherson, E.E. Possardt, B.A. Schroeder, J.A. Seminoff, M.L. Snover, C.M. Upite, and B.E. Witherington. 2009. Loggerhead sea turtle (Caretta caretta) 2009 status review under the U.S. Endangered Species Act. Report of the Loggerhead Biological Review Team to the National Marine Fisheries Service, August 2009. 222 pages.

Conn, P. B., and G. K. Silber. 2013. Vessel speed restrictions reduce risk of collision-related mortality for North Atlantic right whales. Ecosphere 4 (4): 43.

Cook, R.R. and P.J. Auster. 2007. A Bioregional Classification of the Continental Shelf of Northeastern North America for Conservation Analysis and Planning Based on Representation. Marine Sanctuaries Conservation Series NMSP-07-03. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Sanctuary Program, Silver Spring, MD.

Coolen, J.W.P. and R.G. Jak. 2018. RECON: Reef Effect Structures in the North Sea, Islands or Connections? Summary Report (No. C074/17A). Wageningen Marine Research.

Crear, D. P., Lawson, D. D., Seminoff, J. A., Eguchi, T., LeRoux, R. A., & Lowe, C. G. (2016). Seasonal shifts in the movement and distribution of green sea turtles Chelonia mydas in response to anthropogenically altered water temperatures. Marine Ecology Progress Series, 548, 219-232.

Cronin, T.W., J.I. Fasick, L.E. Schweikert, S. Johnsen, L.J. Kezmoh, and M.F. Baumgartner. 2017. Coping with copepods: Do right whales (Eubalaena glacialis) forage visually in dark waters? Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences 372, no. 1717. doi: http://dx.doi.org/10.1098/rstb.2016.0067

CSA Ocean Sciences Inc. 2021. Assessment of Impacts to Marine Mammals, Sea Turtles, and Sturgeon. Appendix P1 in Construction and Operations Plan South Fork Wind Farm. Stuart, Florida.

CSA Ocean Sciences Inc. and Exponent (CSA and Exponent). 2019. Evaluation of Potential EMF Effects on Fish Species of Commercial or Recreational Fishing Importance in Southern New England. U.S. Department of the Interior, Bureau of Ocean Energy Management, Headquarters, Sterling, VA. OCS Study BOEM 2019-049. 59 pp.

Curtice, C., Cleary J., Shumchenia E., Halpin P.N. 2019. Marine-life Data and Analysis Team (MDAT) technical report on the methods and development of marine-life data to support regional ocean planning and management. Prepared on behalf of the Marine-life Data Analysis Team (MDAT). Accessed at: http://seamap.env.duke.edu/models/MDAT/MDAT-Technical-Report.pdf.Dadswell, M.J., 2006. A review of the status of Atlantic sturgeon in Canada, with comparisons to populations in the United States and Europe. Fisheries 31(5):218–229.

Daewel, U., N. Akhtar, N. Christiansen, and C. Schrum. 2022. Offshore wind farms are projected to impact primary production and bottom water deoxygenation in the NOrth Sea. Communications Earth & Environmental 3, Article number: 292. doi.org/10.1038/s43247-022-00625-0 | www.nature.com/commsenv

Dähne, M., Gilles, A., Lucke, K., Peschko, V., Adler, S., Krügel, K., Sundermeyer, J. and Siebert, U., 2013. Effects of pile-driving on harbour porpoises (Phocoena phocoena) at the first offshore wind farm in Germany. Environmental Research Letters, *8*(2), p.025002.

Dannheim, J., Bergström, L., Birchenough, S.N., Brzana, R., Boon, A.R., Coolen, J.W., Dauvin, J.C., De Mesel, I., Derweduwen, J., Gill, A.B. and Hutchison, Z.L. 2020. Benthic effects of offshore renewables: identification of knowledge gaps and urgently needed research. *ICES Journal of Marine Science*, *77*(3), pp.1092-1108.

David, J. A. 2006. Likely Sensitivity of Bottlenose Dolphins to Pile-Driving Noise. Water and Environment Journal 20:48–54.

Davis, G. E., M. F. Baumgartner, P. J. Corkeron, J. Bell, C. Berchok, J. M. Bonnell, J. B. Thornton, S. Brault, G. A. Buchanan, D. M. Cholewiak, C. W. Clark, J. Delarue, L. T. Hatch, H. Klinck, S. D. Kraus, B. Martin, D. K. Mellinger, H. Moors-Murphy, S. Nieukirk, D. P. Nowacek, S. E. Parks, D. Parry, N. Pegg, A. J. Read, A. N. Rice, D. Risch, A. Scott, M. S. Soldevilla, K. M. Stafford, J. E. Stanistreet, E. Summers, S. Todd, and S. M. Van Parijs. 2020. Exploring movement patterns and changing distributions of baleen whales in the western North Atlantic using a decade of passive acoustic data. Global Change Biology 26.9: 4812-4840.

Davis, G.E., M.F. Baumgartner, J.M. Bonnell, J. Bell, C. Berchok, J. Bort Thornton, S. Brault, G. Buchanan, R.A. Charif, D. Cholewiak, C.W. Clark, P. Corkeron, J. Delarue, K. Dudzinski, L. Hatch, J. Hildebrand, L. Hodge, H. Klinck, S. Kraus, B. Martin, D.K. Mellinger, H. Moors-Murphy, S. Nieukirk, D.P. Nowacek, S. Parks, A.J. Read, A.N. Rice, D. Risch, A. Širović, M. Soldevilla, K. Stafford, J.E. Stanistreet, E. Summers, S. Todd, A. Warde, and S.M. Van Parijs. 2017. Long-term passive acoustic recordings track the changing distribution of North Atlantic right whales (Eubalaena glacialis) from 2004 to 2014. Scientific Reports 7(1):13460.

De Robertis, A. and N.O. Handegard. 2013. Fish avoidance of research vessels and the efficacy of noise-reduced vessels: a review. ICES Journal of Marine Sciences 70:34–45

Degraer, S., D. Carey, J. Coolen, Z. Hutchison, F. Kerckhof, B. Rumes, and J. Vanaverbeke. 2020. Offshore Wind Farm Artificial Reefs Affect Ecosystem Structure and Functioning: A Synthesis. Oceanography 33(4):48–57.

Depledge, M.H., C.A.J. Godard-Codding, and R.E. Bowen. 2010. "Light Pollution in the Sea.". Marine Pollution Bulletin No. 60: 1383-85.

Dernie, K.M., M.J. Kaiser, E.A. Richardson, and R.M. Warwick. 2003. Recovery of soft sediment communities and habitats following physical disturbance. Journal of Experimental Marine Biology and Ecology, 285-286:415–434.

Dickerson DD, Nelson DA, Banks G. 1990. Alternative dredging equipment and operational methods to minimize sea turtle mortalities. Environmental Effects of Dredging Technical Notes EEDP-09-6. Vicksburg (MS): US Army Engineer Waterways Experiment Station.

Dickerson, C., K. J. Reine, D. G. Clarke, and R. M. Engler. 2001. Characterization of Underwater Sounds Produced by Bucket Dredging Operations.Diederichs, A., M. J. Brandt, and G. Nehls. 2010. Does sand extraction near Sylt affect harbour porpoises. Wadden Sea Ecosystem No. 26. 199-203.

DNV-GL 2021. Navigation and Safety Risk Assessment: Appendix X to the Construction and Operations Plan for SouthCoast Wind. August 27, 2021.

Dodd, C. K. 1988. Synopsis of the biological data on the loggerhead sea turtle Caretta (Linnaeus 1758). Biological Report 88(14). Washington, D.C.: U.S. Fish and Wildlife Service.

Dodge K. L., B. Galuardi, T. J. Miller, M. E. Lutcavage. 2014. Leatherback Turtle Movements, Dive Behavior, and Habitat Characteristics in Ecoregions of the Northwest Atlantic Ocean. PLOS ONE 9(3): e91726. https://doi.org/10.1371/journal.pone.0091726

Donahue, M. J., A. Nichols, C. A. Santamaria, P. E. League-Pike, C. J. Krediet, K. O. Perez, and M. J. Shulman. 2009. Predation risk, prey abundance, and the vertical distribution of three Brachyuran crabs on Gulf of Maine shores. Journal of Crustacean Biology 29:523–531.

Doney, Scott C., D. S. Busch, S. R. Cooley, and K. J. Kroeker. 2020. The impacts of ocean acidification on marine ecosystems and reliant human communities. Annual Review of Environment and Resources 45: 83-112.

Dorrell, R., C. Lloyd, B. Lincoln, T. Rippeth, J. Taylor, C.C. Caulfield, J. Sharples, J. Polton, B. Scannell, D. Greaves, and R. Hall. 2021. Anthropogenic Mixing of Seasonally Stratified Shelf Seas by Offshore Wind Farm Infrastructure. arXiv preprint arXiv:2112.12571.

Dorrell, R.M., C.J. Lloyd, B.J. Lincoln, T.P. Rippeth, J.R. Taylor, C.P. Caulfield, J. Sharples, J.A. Polton, B.D. Scannell, D.M. Greaves, R.A. Hal and J.H. Simpson. 2022. Anthropogenic mixing in seasonally stratified shelf seas by offshore wind farm infrastructure. Frontiers in Marine Science 9:830927.doi: 10.3389/fmars.2022.830927.

Dow Piniak, W. E., S. A. Eckert, C. A. Harms, and E. M. Stringer. 2012. Underwater Hearing Sensitivity of the Leatherback Sea Turtle (Dermochelys coriacea): Assessing the Potential Effect of Anthropogenic Noise. OCS Study BOEM 2012-01156. 35 pp. Herndon, Virginia: U.S. Department of the Interior, Bureau of Ocean Energy Management, Headquarters.

Dunlop, R.A., M.J. Noad, R.D. McCauley, E. Kniest, R. Slade, D. Paton, and D.H. Cato. 2017. The behavioural response of migrating humpback whales to a full seismic airgun array. Proceedings of the Royal Society B: Biological Sciences, 284(1869), p.20171901.

Dunton, K.J., Jordaan, A., McKown, K.A., Conover, D.O., & Frisk, M.G. 2010. Abundance and distribution of Atlantic Sturgeon Acipenser oxyrinchus within the northwest Atlantic Ocean, determined from five fishery independent surveys. US National Marine Fisheries Service Fishery Bulletin, 108, 450–464.

Eckert, K.L., B.P. Wallace, J.R. Spotila and B.A. Bell. 2015. Nesting Ecology and Reproductive Investment of Leatherback Turtles. In: J.R. Spotila and P. Santidrián-Tomillo (Editors), The Leatherback Turtle: Biology and Conservation. Johns Hopkins University Press: 63.

Edwards, R. E., K. J. Sulak, M. T. Randall, and C. B. Grimes. 2003. Movements of Gulf sturgeon (Acipenser oxyrinchus desotoi) in nearshore habitat as determined by acoustic telemetry. Gulf of Mexico Science 21:59–70.

Edwards, R. E., F. M. Parauka, and K. J. Sulak. 2007. New insights into marine migration and winter habitat of Gulf sturgeon. American Fisheries Society Symposium 56:183–196

Edwards, E. F., C. Hall, T. J. Moore, C. Sheredy, and J. V. Redfern. 2015. Global distribution of fin whales B alaenoptera physalus in the post-whaling era (1980–2012). Mammal Review 45.4: 197-214.

Efroymson, R.A., Rose, W.H., Nemeth, S. and Suter II, G.W., 2000. Ecological risk assessment framework for low-altitude overflights by fixed-wing and rotary-wing military aircraft. ORNL/TM-2000/289. Oak Ridge National Laboratory, Oak Ridge, TN.

Eguchi, T., Seminoff, J. A., LeRoux, R. A., Prosperi, D., Dutton, D. L., & Dutton, P. H. (2012). Morphology and growth rates of the green sea turtle (Chelonia mydas) in a northern-most temperate foraging ground. Herpetologica, 68(1), 76-87.

Elliot, J., A. A. Khan, L. Ying-Tsong, T. Mason, J. H. Miller, A. E. Newhall, G. R. Potty, and K. J. Vigness-Raposa. 2019. Field Observations during Wind Turbine Operations at the Block Island Wind Farm, Rhode Island. Final Report to the U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs. OCS Study BOEM 2019-028. Available: https://espis.boem.gov/final%20reports/BOEM_2019-028.pdf.

Engås, A., Haugland, E.K. and Øvredal, J.T. 1998. Reactions of cod (Gadus morhua L.) in the pre-vessel zone to an approaching trawler under different light conditions. In *Advances in Invertebrates and Fish Telemetry* (pp. 199-206). Springer, Dordrecht.

Engås, A., O.A., A.V. Soldal, B. Horvei, and A. Solstad. 1995. Reactions of penned herring and cod to playback of original, frequency-filtered and time-smoothed vessel sound. Fisheries Research 22:243–254

English, P.A., T.I. Mason, J.T. Backstrom, B.J. Tibbles, A.A. Mackay, M.J. Smith, and T. Mitchell. 2017. Improving Efficiencies of National Environmental Policy Act Documentation for Offshore Wind Facilities Case Studies Report. OCS Study BOEM 2017-026. U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs. March.

Epperly, S., L. Avens, L. Garrison, T. Henwood, W. Hoggard, J. Mitchell, J. Nance, J. Poffenberger, C. Sasso, E. Scott-Denton, and C. Yeung. 2002. Analysis of Sea Turtle Bycatch in the Commercial Shrimp Fisheries of Southeast U.S. Waters and the Gulf of Mexico. NOAA Technical Memorandum NMFS-SEFSC-490:1–88.

Erbe, C., Dunlop, R. and Dolman, S., 2018. Effects of noise on marine mammals. In *Effects of anthropogenic noise on animals* (pp. 277-309). Springer, New York, NY.

Erbe, C., Marley, S.A., Schoeman, R.P., Smith, J.N., Trigg, L.E. and Embling, C.B., 2019. The effects of ship noise on marine mammals—a review. *Frontiers in Marine Science*, p.606.

Erbe, Christine. 2013. International regulation of underwater noise. *Acoustics Australia* 41.1.

Ernst, C. H., R. W. Barbour, and J. E. Lovich. 1994. Turtles of the United States and Canada. Washington, D.C.: Smithsonian Institution Press.

Exponent Engineering, P.C. 2018. Deepwater Wind South Fork Wind Farm Onshore Electric and Magnetic Field Assessment. Appendix K2 in the South Fork Wind Farm Construction and Operations Plan. Prepared for Deepwater Wind, LLC.

Federal Geographic Data Committee (FGDC). 2012. Coastal and Marine Ecological Classification Standard. Prepared by the Marine and Coastal Spatial Data Subcommittee. FGDC-STD-018-2012. 343 p

Farmer, N. A., L. P Garrison, C. Horn, M. Miller, T. Gowan, R. D. Kenney, and J. Waldron. 2021. The Distribution of Giant Manta Rays In The Western North Atlantic Ocean Off The Eastern United States.

Fasick, J.I., M.F. Baumgartner, T.W. Cronin, B. Nickle, L.J. Kezmoh. 2017. Visual predation during springtime foraging of the North Atlantic right whale (Eubalaena glacialis). Marine Mammal Science 33(4): 991–1013.

Fay, C., M. Bartron, S. Craig, A. Hecht, J. Pruden, R. Saunders, T. Sheehan, and J. Trial. 2006. Status review for anadromous Atlantic salmon (Salmo salar) in the United States.

Field, C. B., Behrenfeld, M. J., Randerson, J. T., and Falkowski, P. G. 1998. Primary production of the biosphere: integrating terrestrial and oceanic components. Science 281, 237–240. doi: 10.1126/science.281.5374.237

Finkbeiner, E.M., B.P. Wallace, J.E. Moore, R.L. Lewison, L.B. Crowder, and A.J. Read. 2011. Cumulative estimates of sea turtle bycatch and mortality in USA fisheries between 1990 and 2007. Biological Conservation 144(11):2719–2727.

Finneran, J., E. Henderson, D. Houser, K. Jenkins, S. Kotecki, and J. Mulsow. 2017. Criteria and Thresholds for US Navy Acoustic and Explosive Effects Analysis (Phase III). Technical Report by Space and Naval Warfare Systems Center Pacific (SSC Pacific). 183 pp.

Finneran, James J. *Auditory weighting functions and TTS/PTS exposure functions for marine mammals exposed to underwater noise*. Space and Naval Warfare Systems Center Pacific San Diego United States, 2016.

Fisheries Hydroacoustic Working Group, 2008. Memorandum from the Fisheries Hydroacoustic Working Group to Applicable Agency Staff, Regarding Agreement in Principle for Interim Criteria for Injury to Fish from Pile Driving Activities. 3p.

Floeter, J,. T. Pohlmann, A. Harmer, and C. Möllmann. 2022. Chasing the offshore wind farm windwake-induced upwelling/downwelling dipole. Frontiers in Marine Science 9:884943. doi: 10.3389/fmars.2022.8849432022.

Floeter, J., J. E. E. van Beusekom, D. Auch, U. Callies, J. Carpenter, T. Dudeck, S. Eberle, A. Eckhardt, D. Gloe, K. Hänselmann, M. Hufnagl, S. Janßen, H. Lenhart, K. O. Möller, R. P. North, T. Pohlmann, R. Riethmüller, S. Schulz, S. Spreizenbarth, A. Temming, B. Walter, O. Zielinski, and C. Möllmann. 2017. Pelagic effects of offshore wind farm foundations in the stratified North Sea. Progress in Oceanography 156:154–173.

Florida Power and Light. 1995. Assessment of the Impacts of the St. Lucie Nuclear Generating Plant on Sea Turtle Species Found in the Nearshore Waters of Florida. Retrieved from https://www.nrc.gov/docs/ML1722/ML17228B332.pdf.

Florida Power Corporation. 1998. Biological Assessment of Impact to Sea Turtles at Florida Power Corporation's Crystal River Energy Complex. Retrieved from https://www.nrc.gov/docs/ML0300/ML030070232.pdf.

Foley, A.M., K. Singel, R. Hardy, R. Bailey, K. Sonderman, and S. Schaf. 2008. Distributions, relative abundances, and mortality factors for sea turtles in Florida from 1980 through 2007 as determined from strandings. Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute, Jacksonville Field Laboratory.

Foley, A.M., B. A. Stacy, R. F. Hardy, C. P. Shea, K. E. Minch, and B. A. Schroeder. 2019. Characterizing watercraft-related mortality of sea turtles in Florida. Jour. Wild. Mgmt., 83: 1057-1072. https://doi.org/10.1002/jwmg.21665.

Fox, D. A., J. E. Hightower, and F. M. Parauka. 2002. Estuarine and nearshore marine habitat use by Gulf sturgeon from the Choctawhatchee River System, Florida. American Fisheries Society Symposium 28:19–34.

Fuentes, M. M. P. B., and D. Abbs. "Effects of projected changes in tropical cyclone frequency on sea turtles." *Marine Ecology Progress Series* 412 (2010): 283-292.

Gaichas, S. K., J. Hare, M. Pinsky, G. Depiper, O. Jensen, T. Lederhouse, J. Link, D. Lipton, R. Seagraves, J. Manderson, and M. Clark. 2015. Climate change and variability: A white paper to inform the Mid-Atlantic Fishery Management Council on the impact of climate change on fishery science and management. Second Draft. Accessed: August 28, 2020. Available: https://static1.squarespace.com/static511cdc7fe4b00307a2628ac6/t/5c5c8fa9652dea319f3f8fe6/1549569962945/MAFMC-Climate-Change-and-Variability-White-Paper_Apr2015.pdf.

Gall, S. C., and R. C. Thompson. 2015. The impact of marine debris on marine life. Marine Pollution Bulletin 92:170–179.

Gallaway, B. J., C. W. Caillouet Jr., P. T. Plotkin, and W. J. Gazey. 2013. Kemp's ridley stock assessment project final report.

Garrison, L.P., J. Adams, E. M. Patterson, and C. P. Good. 2022. Assessing the risk of vessel strike mortality in North Atlantic right whales along the U.S East Coast. NOAA Technical Memorandum NOAA NMFS-SEFSC-757: 42 p.

Gerstein, E. R., J. E. Blue, and S. E. Forysthe. "The acoustics of vessel collisions with marine mammals." Proceedings of OCEANS 2005 MTS/IEEE. IEEE, 2005.

Gilbert, C. R. 1989. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Mid-Atlantic Bight): Atlantic and shortnose sturgeons. No. 4. Coastal Ecology Group, Waterways Experiment Station, US Army Corps of Engineers.

Gill, A. B. and M. Desender. 2020. Risk to Animals from Electromagnetic Fields Emitted by Electric Cables and Marine Renewable Energy Devices. In A.E. Copping and L.G. Hemery (Eds.), OES-Environmental 2020 State of the Science Report: Environmental Effects of Marine Renewable Energy Development Around the World. Report for Ocean Energy Systems (OES). (pp. 86–103).

Gill, A. B., I. Gloyne-Phillips, K. J. Neal, and J. A. Kimber. 2005. The Potential Effects of Electromagnetic Fields Generated by Sub-Sea Power Cables Associated with Offshore Wind Farm Developments on Electrically and Magnetically Sensitive Marine Organisms – A Review. Report No. COWRIE-EM FIELD 2-06-2004. Final report. Prepared for Collaborative Offshore Wind Energy Research Into the Environment. Cranfield University and the Centre for Marine and Coastal Studies Ltd.

Gill, A.B., M. Bartlett, and F. Thomsen. 2012. Potential interactions between diadromous fishes of U.K. conservation importance and the electromagnetic fields and subsea noise from marine renewable energy developments. Journal of Fish Biology 81(2):664–695.

Gitschlag, G. R. and M. Renaud. 1989. Sea turtles and the explosive removal of offshore oil and gas structures, p. 67-68. In: Eckert, S. A., K. L. Eckert, and T. H. Richardson (Compilers) Proceedings of the Ninth Annual Workshop on Sea Turtle Conservation and Biology. NOM Tech Memo NMFS-SEFC-232, 306 p.

Gitschlag, G. R., and B. A. Herczeg. 1994. Sea turtle observations at explosive removals of energy structures. Marine Fisheries Review 56(2):1–8.

Glass, A. H., T. V. N. Cole, and M. Garron. 2010. Mortality and serious injury determinations for baleen whale stocks along the United States and Canadian Eastern Seaboards, 2004-2008.

Gless, J.M., Salmon, M. and Wyneken, J., 2008. Behavioral responses of juvenile leatherbacks Dermochelys coriacea to lights used in the longline fishery. *Endangered Species Research*, *5*(2-3), pp.239-247.

Gliwicz, Z.M. 1986. "A lunar cycle in zooplankton." Ecology no. 67 (4):883-897.

Golbazi, M., Archer, C. L., & Alessandrini, S. (2022). Surface impacts of large offshore wind farms. Environmental Research Letters, 17(6), 064021.

Goldbogen, J.A., B.L. Southall, S.L. DeRuiter, J. Calambokidis, A.S. Friedlaender, E.L. Hazen, E.A. Falcone, G.S. Schorr, A. Douglas, D.J. Moretti, and C. Kyburg. 2013. Blue whales respond to simulated mid-frequency military sonar. *Proceedings of the Royal Society B: Biological Sciences*, *280*(1765), p.20130657.

Grashorn, S., and E. V. Stanev. 2016. Kármán vortex and turbulent wake generation by wind park piles. Ocean Dyn. 66:1543–1557. doi: 10.1007/s10236-016-0995-2.

Greater Atlantic Regional Fisheries Office (GARFO), Protected Resources Division (PRD) and Bureau of Ocean Energy Management (BOEM). 2021. Offshore Wind Site Assessment and Site Characterization Activities Programmatic Consultation. Available: https://media.fisheries.noaa.gov/2021-12/OSW%20surveys_NLAA%20programmatic_rev%201_2021-09-30%20%28508%29.pdf

Greater Atlantic Regional Fisheries Office (GARFO). 2020. Section 7: Consultation Technical Guidance in the Greater Atlantic Region (web page). National Marine Fisheries Service, 14 Sep 2020. https://www.greateratlantic.fisheries.noaa.gov/protected/section7/guidance/consultation/index.html.

Greaves, F. C., R.H. Draeger, O. A. Brines, J. S. Shaver, and E.L. Corey. 1943. An experimental study of underwater concussion. Underwater Concussion. United States Naval Medical Bulletin, Volume 41, Issue 2.

Gregory, M. R. 2009. Environmental implications of plastic debris in marine settings – Entanglement, ingestion, smothering, hangers-on, hitch-hiking, and alien invasion. Philosophical Transactions of the Royal Society B 364:2013–2025.

Grieve, B.D., J.A. Hare, and V.S. Saba. 2017. Projecting the effects of climate change on Calanus finmarchicus distribution within the U.S. Northeast Continental Shelf. Scientific Reports, 7:6264. doi:10.1038/s41598-017-06524-1.

Guan, S., and R. Miner. 2020. Underwater noise characterization of down-the-hole pile driving activities off Biorka Island, Alaska. *Marine Pollution Bulletin*, *160*, 111664.

Guarinello, M. L., & Carey, D. A. (2022). Multi-modal approach for benthic impact assessments in moraine habitats: a case study at the Block Island Wind Farm. Estuaries and Coasts, 45(4), 1107-1122.

Guarinello, M.L., D.A. Carey, and L.B. Read. 2017. Hard Bottom Post-Construction Surveys Year 1 Report for 2016 Summer Post-Construction Surveys to Characterize Potential Impacts and Response of Hard Bottom Habitats to Anchor Placement at the Block Island Wind Farm (BIWF). Prepared for Deepwater Wind Block Island LLC, Providence, RI, 31 pp.

Guazzo, R. A., D. W. Weller, H. Europe, J. W. Durban, G. D'Spain, and J. Hildebrand. 2019. Migrating eastern North Pacific gray whale call and blow rates estimated from acoustic recordings, infrared camera video, and visual sightings. Scientific Reports 9:12617.

Gudger, E.W. 1922. The most northerly record of the capture in Atlantic waters of the United States of the giant ray, Manta birostris. Science 55(1422):338–340.

Guida, V., A. Drohan, H. Welch, J. McHenry, D. Johnson, V. Kentner, J. Brink, D. Timmons, and E. Estela-Gomez. 2017. Habitat Mapping and Assessment of Northeast Wind Energy Areas. U.S. Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2017-088.

Guilbard, F., J. Munro, P. Dumont, D. Hatin, and R. Fortin. 2007. Feeding ecology of Atlantic sturgeon and lake sturgeon co-occurring in the St. Lawrence estuarine transition zone. American Fisheries Society Symposium 56:85–104.

Guilpin, M., V. Lesage, I. McQuinn, J.A. Goldbogen, J. Potvin, T. Jeanniard-du-Dot, T. Doniol-Valcroze, R. Michaud, M. Moisan, and G. Winkler. 2019. Foraging energetics and prey density requirements of western North Atlantic blue whales in the Estuary and Gulf of St. Lawrence, Canada. Marine Ecology Progress Series, 625:205-223.

HDR. 2020. Benthic and Epifaunal Monitoring During Wind Turbine Installation and Operation at the Block Island Wind Farm, Rhode Island – Project Report. Final Report to the U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs. OCS Study BOEM 2020-044. Volume 1: 263 pp; Volume 2:380 pp.

Hain, J.H.W., M.A.M. Hyman, R.D. Kenney, and H.E. Winn. 1985. The role of cetaceans in the shelf-edge region of the northeastern United States. Marine Fisheries Review 47:13–17.

Haley, N., 1999: A gastric lavage technique for characterizing diets of sturgeons. N. Am. J. Fish. Manage. 18, 978–981.

Hannay, D.E. and M. Zykov. 2022. Underwater Acoustic Modeling of Detonations of Unexploded Ordnance (UXO removal) for Mayflower Wind Farm Construction. Document 02604, Version 4.2. Report by JASCO Applied Sciences for Mayflower Wind.

Hare, J.A., W.E. Morrison, M.W. Nelson, M.M. Stachura, E.J. Teeters, R.B. Griffis, M.A. Alexander, J.D. Scott, L. Alade, R.J. Bell, A.S. Chute, K.L. Curti, T.H. Curtis, D. Kircheis, J.F. Kocik, S.M. Lucey, C.T. McCandless, L.M. Milke, D.E. Richardson, E. Robillard, H.J. Walsh, M. Conor McManus, K.E. Marancik, and C.A. Griswold. 2016. A vulnerability assessment of fish and invertebrates to climate change on the northeast U.S. continental shelf. PLoS One 11(2):e0146756. doi:10.1371/journal.pone.0146756.

Hastings, R. W., L. H. Ogren, and M. T. Marbry. 1976. Observations of Fish fauna associated with offshore platforms in the northeastern Gulf of Mexico. Fisheries Bulletin 74(2):387–402.

Hatch L.T., C.W. Clark, S.M. Van Parijs, A.S. Frankel, and D.W. Ponirakis. 2012. Quantifying loss of acoustic communication space for right whales in and around a U.S. National Marine Sanctuary. Conservation Biology 26:983−994.

Hawkins, A.D., and Popper, A.N., 2017. A sound approach to assessing the impact of underwater noise on marine fishes and invertebrates. *ICES Journal of Marine Science*, *74*(3), pp.635-651.

Hayes, S. A., E. Josephson, K. Maze-Foley, and P. E. Rosel. 2020. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments – 2019. NOAA Tech Memo NMFS-NE 264.

Hayes, S. A., E. Josephson, K. Maze-Foley, P. E. Rosel, and J. Turek. 2021. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments – 2020. NOAA Tech Memo NMFS-NE 271.

Hayes, S.A., Josephson, E., Maze-Foley, K., Rosel, P.E., and J. Wallace. 2022a. U.S Atlantic and Gulf of Mexico Marine Mammal Stock Assessments of 2021. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. Published 03 August 2022, 87 FR 47385. 386 pp.

Hayes, S. A., E. Josephson, K. Maze-Foley, P. E. Rosel, and J. Wallace. 2022b. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments – 2022. Draft. June 2022.

Hays G.C., S. Hochscheid, A.C. Broderick, B.J. Godley, and J.D. Metcalfe. 2000. Diving behaviour of green turtles: dive depth, dive duration and activity levels. Marine Ecology Progress Series 208: 297-298. Available at: https://www.researchgate.net/publication/227943826_Diving_behaviour_of_green_turtles_Dive_depth_dive_duration_and_activity_levels.

Hazel, J., I. Lawler, H. Marsh, and S. Robson. 2007. Vessel speed increases collision risk for the green turtle Chelonia mydas. Endangered Species Research 3:105–113.

Henwood, T.A. and W.E. Stuntz. 1987. Analysis of sea turtle captures and mortalities during commercial shrimp trawling. Fisheries Bulletin 85(4):814–817.

Hoarau, L., L. Ainley, C. Jean, and S. Ciccione. 2014. Ingestion and defecation of marine debris by loggerhead sea turtles, from by-catches in the south-west Indian Ocean. Marine Pollution Bulletin 84:90–96.

Hoover, J. J., Boysen, K. A., Beard, J. A., & Smith, H. (2011). Assessing the risk of entrainment by cutterhead dredges to juvenile lake sturgeon (Acipenser fulvescens) and juvenile pallid sturgeon (Scaphirhynchus albus). Journal of Applied Ichthyology, 27(2), 369-375.

Hopkins, S. R., and J. I. Richardson. 1984. Recovery plan for marine turtles. 363 pp.

Hudak, C.A., Stamieszkin, K. and Mayo, C.A., 2023. North Atlantic right whale *Eubalaena glacialis* prey selection in Cape Cod Bay. Endangered Species Research, 51, pp.15-29.

Hutchison, Z. L., A. B. Gill, P. Sigray, H. He, and J. W. King. 2020. Anthropogenic electromagnetic fields (EMF) influence the behaviour of bottom-dwelling marine species. Scientific Reports 10(1):4219. doi:10.1038/s41598-020-60793-x. Available: https://www.nature.com/articles/s41598-020-60793-x.pdf.

Hutchison, Z. L., P. Sigray, H. He, A. B. Gill, J. King, and C. Gibson. 2018. Electromagnetic Field (EMF) Impacts on Elasmobranch (Shark, Rays, and Skates) and American Lobster Movement and Migration from Direct Current Cables. U.S. Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2018-003. Available: https://espis.boem.gov/final%20reports/5659.pdf.

Illingworth & Rodkin, Inc. 2007. Appendix I. Compendium of pile driving sound data. In Technical Guidance for Assessment and Mitigation of the Hydroacoustic Effects of Pile Driving on Fish. Illingworth & Rodkin, Inc. for the California Department of Transportation, Sacramento, CA, Sacramento, CA. p. 129.

Illingworth & Rodkin, Inc. 2017. Pile-Driving Noise Measurements at Atlantic Fleet Naval Installations: 28 May 2013-28 April 2016. Report by Illingworth & Rodkin, Inc. under contract with HDR Environmental for NAVFAC. 152 p. Available: https://www.navymarinespeciesmonitoring.us/files/4814/9089/8563/Pile-driving_Noise_Measurements_Final_Report_12Jan2017.pdf

INSPIRE Environmental (INSPIRE). 2022. Mayflower Wind – Benthic Habitat Mapping Methodology Memorandum – Benthic Habitat Pop-up Mapper. Prepared for Mayflower Wind Energy LLC. July 2022.

Ishimatsu A., H. Masahiro, and T. Kikkawa. 2008. Fishes in High-CO2, Acidified Oceans. Marine Ecology Progress Series Vol. 373: 295–302. doi: 10.3354/meps07823. Available at: https://www.int-res.com/articles/theme/m373p295.pdf

IUCN. 2020. IUCN Red List of Threatened Species

Jackson, D. C. 1985. Respiration and Respiratory Control in the Green Turtle, Chelonia mydas. Copeia, 1985(3): 664–671. https://doi.org/10.2307/1444760

Jansen, E., and C. de Jong. 2016. Underwater noise measurements in the North Sea in and near the Princess Amalia Wind Farm in operation. In Proceedings of the Inter-Noise 2016 Conference, edited by W. Kropp, O. von Estorff, and B. Schulte-Fortkamp, pp. 7846–7858. Berlin, Germany: Deutsche Gesellschaft Fuer Akustik.

Janzen, F. J. 1994. Climate change and temperature-dependent sex determination in reptiles. Proceedings of the National Academy of Science 91:7487–7490.

Jensen, A. S., and G. K. Silber. 2004. Large Whale Ship Strike Database. NOAA Tech. Memo. NMFS-OPR-25.

Johansson, A.T. and Andersson, M.H. 2012. Ambient underwater noise levels at Norra Midsjöbanken during construction of the Nord Stream Pipeline. Defence and Security, Systems and Technology, Totalförsvarets forskningsinstitut (FOI).

Johnson T. L., J. J. van Berkel, L. O. Mortensen, M. A. Bell, I. Tiong, B. Hernandez, D. B. Snyder, F. Thomsen, and O. Svenstrup Petersen. 2021. *Hydrodynamic Modeling, Particle Tracking and Agent-Based Modeling of Larvae in the U.S. Mid-Atlantic Bight*. US Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2021-049.

Johnson, A. 2018. White Paper on the Effects of Increased Turbidity and Suspended Sediment on ESA Listed Species from Projects Occurring in the Greater Atlantic Region. Greater Atlantic Region Policy Series 18-02. NOAA Fisheries. Available at: https://www.greateratlantic.fisheries.noaa.gov/policyseries/index.php/GARPS/article/view/8/8.

Johnson, C. S. 1967. Sound Detection Thresholds in Marine Mammals. In Marine Bioacoustics Vol. 2: Proceedings of the Second Symposium on Marine Bio-Acoustics Held at the American Museum of Natural History, New York, April 13–15, 1966, edited by W. N. Tavolga, pp. 247–260. New York, New York: Pergamon Press.

Johnson, J.H., D.S. Dropkin, B.E. Warkentine, J.W. Rachlin, and W.D. Andrews. 1997. Food habits of Atlantic sturgeon off the central New Jersey coast. Transactions of the American Fisheries Society 126:166–170.

Jones, I. T., J. A. Stanley, and T. A. Mooney. 2020. Impulsive pile driving noise elicits alarm responses in squid (Doryteuthis pealeii). Marine Pollution Bulletin 150:110792. doi.org/10.1016/j.marpolbul.2019.110792.

Kaplan, B. (2011). Literature synthesis for the north and central Atlantic Ocean. US Dept. of the Interior, Bureau of Ocean Energy Management, Regulation and Enforcement, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study BOEMRE, 12, 447.

Kavet, R., M. T. Wyman, and A. P. Klimley. 2016. Modeling magnetic fields from a DC power cable buried beneath San Francisco Bay based on empirical measurements. *PLoS One* 11.2 (2016): e0148543.

Kellar, N. M., T. R. Speakman, C. R. Smith, S. M. Lane, B. C. Balmer, M. L. Trego, K. N. Catelani, M. N. Robbins, C. D. Allen, R. S. Wells, E. S. Zolman, T. K. Rowles, and L. H. Schwacke. 2017. Low Reproductive Success Rates of Common Bottlenose Dolphins Tursiops truncatus in the Northern Gulf of Mexico Following the Deepwater Horizon Disaster (2010–2015). Endangered Species Research 33:143–158.

Kelley, D. E., J. P. Vlasic, S. W. Brillant. 2021. Assessing the lethality of ship strikes on whales using simple biophysical models. *Mar Mam Sci*. 37: 251– 267. https://doi.org/10.1111/mms.12745

Kendall JR, A.W. and Naplin, N.A., 1981. Diel-depth distribution of summer ichthyoplankton in the Middle Atlantic Bight. Fishery Bulletin, 79(4), p.705

Kenney, R. D., Hyman, M. A., & Winn, H. E. (1985). Calculation of standing stocks and energetic requirements of the cetaceans of the northeast United States outer continental shelf.

Kenney, R. D., Scott, G. P., Thompson, T. J., & Winn, H. E. (1997). Estimates of prey consumption and trophic impacts of cetaceans in the USA northeast continental shelf ecosystem. Journal of Northwest Atlantic Fishery Science, 22.

Kenney, R.D., and H.E. Winn. 1986. Cetacean high-use habitats of the northeast United States continental shelf. Fishery Bulletin 84:345–357.

Kenney, R.D., and K. J. Vigness-Raposa. 2010. Marine Mammals and Sea Turtles of Narragansett Bay, Block Island Sound, Rhode Island Sound, and Nearby Waters: An Analysis of Existing Data for the Rhode Island Ocean Special Area Management Plan. Technical report no. 10. Wakefield (RI): Coastal Resources Management Council.

Ketten, D. R. 1998. Marine Mammal Auditory Systems: A Summary of Audiometric and Anatomical Data and its Implications for Underwater Acoustic Impacts. NOAA Tech Memo NMFS: NOAA-TM-NMFS-SWFSC-256.

Ketten, D. 2004. Experimental measures of blast and acoustic trauma in marine mammals. N000149711030.Kilfoyle, A. K., R. F. Jermain, M.R. Dhanak, J. P. Huston, R. E. Spieler. 2018. Effects of EMF emissions from undersea electric cables on coral reef fish. Bioelectromagnetics 39.1: 35-52.Kipple, B. 2002. Southeast Alaska Cruise Ship Underwater Acoustic Noise. Document Number NSWCCD-71-TR-2002/574. Prepared by Naval Surface Warfare Center, Detachment Bremerton, for Glacier Bay National Park and Preserve. Available: https://www.nps.gov/glba/learn/nature/upload/CruiseShipSoundSignaturesSEAFAC.pdf.

Kipple, B. and C. Gabriele. 2003. Glacier Bay Watercraft Noise. Document Number NSWCCD-71-TR-2003/522. Prepared by Naval Surface Warfare Center – Carderock Division for Glacier Bay National Park and Preserve. Available: https://www.nps.gov/glba/learn/nature/upload/ GBWatercraftNoiseRpt.pdf.

Kirschvink, J.L., 1990. Geomagnetic sensitivity in cetaceans: an update with live stranding records in the United States. In *Sensory Abilities of Cetaceans* (pp. 639-649). Springer, Boston, MA.

Kite-Powell, H.L., Knowlton, A. and Brown, M., 2007. Modeling the effect of vessel speed on right whale ship strike risk. *Project report for NOAA/NMFS Project NA04NMF47202394*, *8*.

Kleiber, M. (1975). The fire of life: An introduction to animal energetics. New York: Robert E. Krieger Publishing Co

Klima, E.F., Gitschlag, G.R. and Renaud, M.L., 1988. Impacts of the Explosive Removal of Offshore Petroleum. *Marine Fisheries Review*, *50*, p.33.

Klimley, A.P., M.T. Wyman, and R. Kavet. 2017. Chinook salmon and green sturgeon migrate through San Francisco Estuary despite large distortions in the local magnetic field produced by bridges. PLoS ONE 12(6):e0169031.

Knowlton, A. R., P. K. Hamilton, M. K. Marx, H. P. Pettis, and S. D. Kraus. 2012. Monitoring North Atlantic right whale Eubalaena glacialis entanglement rates: A 30 year retrospective. *Marine Ecology Progress Series* 466:293–302.

Kraus, S. D., M. W. Brown, H. Caswell, C. W. Clark, M. Fujiwara, P. K. Hamilton, R. D. Kenney, A. R. Knowlton, S. Landry, C. A. Mayo, W. A. Mclellan, M. J. Moore, D. P. Nowacek, D. A. Pabst, A. J. Read, R. M. Rolland. 2005. North Atlantic right whales in crisis. Science 309.5734 (2005): 561-562.

Kraus, S. D., S. Leiter, K. Stone, B. Wikgren, C. Mayo, P. Hughes, R. D. Kenney, C. W. Clark, A. N. Rice, B. Estabrook, and J. Tielens. 2016. Northeast Large Pelagic Survey Collaborative Aerial and Acoustic Surveys for Large Whales and Sea Turtles. Final Report. U.S. Department of the Interior, Bureau of Ocean Energy Management, Sterling, Virginia. OCS Study BOEM 2016-054.

Kraus, S. D., R. D. Kenney, and L. Thomas. 2019. A Framework for Studying the Effects of Offshore Wind Development on Marine Mammals and Turtles. Prepared for the Massachusetts Clean Energy Center and the Bureau of Ocean Energy Management.

Krebs, Justin, et al. 2017. Linking Diet, Habitat Use, and Prey Distribution to Identify Foraging Habitat for Juvenile Atlantic Sturgeon. 24th Biennial CERF Conference. CERF.

Kuehne, Lauren M., Christine Erbe, Erin Ashe, Laura T. Bogaard, Marena Salerno Collins, and Rob Williams. 2020. "Above and below: Military Aircraft Noise in Air and under Water at Whidbey Island, Washington" Journal of Marine Science and Engineering 8, no. 11: 923. https://doi.org/10.3390/jmse8110923

Kynard, B., and M. Horgan. 2002. Ontogenetic behavior and migration of Atlantic sturgeon Acipenser oxyrinchus, and shortnose sturgeon A. brevirostrum, with notes on social behavior. Environmental Biology of Fishes 63:137–150.

Kynard, B., S. Bolden, M. Kieffer, M. Collins, H. Brundage, E.J. Hilton, M. Litvak, M. T. Kinnison, T. King, and D. Peterson. 2016. Life history and status of shortnose sturgeon (Acipenser brevirostrum LeSueur, 1818). Journal of Applied Ichthyology32:208–248.

LaBrecque, E., C. Curtice, J. Harrison, S.M. Van Parijs, and P.N. Halpin. 2015. Biologically important areas for cetaceans within U.S. waters—East coast region. Aquatic Mammals 41(1):17–29.

Laist, D.W., A.R. Knowlton, J.G. Mead, A.S. Collet, and M. Podesta. 2001. Collisions between ships and whales. Marine Mammal Science 17(1):35–75.

Laran, S., Joiris, C., Gannier, A., & Kenney, R. D. (2010). Seasonal estimates of densities and predation rates of cetaceans in the Ligurian Sea, northwestern Mediterranean Sea: an initial examination. J. Cetacean Res. Manage, 11(1), 31-40.

Lentz, S. J. 2017. Seasonal warming of the Middle Atlantic Bight Cold Pool. Journal of Geophysical Research – Ocean 122(2):941–954.

Lesage, V., J. F. Gosselin, M. Hammill, and M. C. S. Kingsley. 2007. Ecologically and Biologically Significant Areas (EBSAs) in the Estuary and Gulf of St. Lawrence, a Marine Mammal Perspective. Canadian Science Advisory Secretariat.

LGL Ecological Research Associates, Inc (LGL). 2022. Petition for incidental take regulations for the construction and operations of the Mayflower wind Project.

Li, Z. and S.L. Denes. 2020. Distances to Acoustic Thresholds for High Resolution Geophysical Sources: Mayflower Wind. Document 2239, Version 1.0. Technical memorandum by JASCO Applied Sciences for Mayflower Wind

Li, X., L. Chi, X. Chen, Y. Ren, and S. Lehner. 2014. SAR observation and numerical modeling of tidal current wakes at the East China Sea offshore wind farm. Journal of Geophysical Research: Oceans 119(8):4958–4971.

Limeburner, R and Beardsley, R.C. 1982. "The seasonal hydrography and circulation over Nantucket Shoals." Journal of Marine Research 40, (S). https://elischolar.library.yale.edu/journal_of_marine_research/1649

Limpert, K.E., S.C. Murphy, E.T. Kusel, H.P. Wecker, S.G. Dufault, K.E. Zammit, M.J. Weirathmueller, M.I. Reeve, and D.G. Zeddies. 2022. Mayflower Wind: Additional Underwater Acoustic Modeling Scenarios. Document 02772, Version 2.0. Technical report y JASCO Applied Sciences for LGL.

Lindeboom, H. J., H. J. Kouwenhoven, M. J. N. Bergman, S. Bouma, S. Brasseur, R. Daan, R. C. Fijn, D. de Haan, S. Dirksen, et al. 2011. Short-term ecological effects of an offshore wind farm in the Dutch coastal zone; a compilation. Environmental Research Letters 6(3):1–13. Available: https://doi.org/10.1088/1748-9326/6/3/035101.

Love, M.S., M.M. Nishimoto, S. Clark, and A.S. Bull. 2016. Renewable Energy in situ Power Cable Observation. OCS Study 2016-008. Camarillo, CA: U.S. Department of the Interior, Bureau of Ocean Energy Management, Pacific OCS Region.

Lovell, J.M., M.M. Findlay, R.M. Moate, J.R. Nedwell, and M.A. Pegg. 2005. The inner ear morphology and hearing abilities of the paddlefish (Polyodon spathula) and the lake sturgeon (Acipenser fulvescens). Comparative Biochemistry and Physiology Part A: Molecular Integrative Physiology 142: 286-289.

Lucey, Sean M., and Janet A. Nye. "Shifting species assemblages in the northeast US continental shelf large marine ecosystem." *Marine Ecology Progress Series* 415 (2010): 23-33.

Lucke, K., P. A. Lepper, B. Hoeve, E. Everaarts, N. van Elk, and U. Siebert. 2007. Perception of Low-Frequency Acoustic Signals by a Harbour porpoise (Phocoena phocoena) in the Presence of Simulated Offshore Wind Turbine Noise. Aquatic Mammals 33 (1):55–68.

Ludewig, E. 2015. On the Effect of Offshore Wind Farms on the Atmosphere and Ocean Dynamics. Cham: Springer International Publishing.

Luschi, P., S. Benhamou, C. Girard, S. Ciccione, D. Roos, J. Sudre, and S. Benvenuti. 2007. Marine Turtles use Geomagnetic Cues during Open Sea Homing. Current Biology 17:126–133. Available: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.572.8884&rep=rep1&type=pdf. Accessed: April 1, 2022.

Lutcavage, M. E., and P. L. Lutz. 1997. Diving Physiology. In The Biology of Sea Turtles. CRC Press; Boca Raton, FL: pp. 277–296.

Lutz, P. L. and J. A. Musick. 1997. The Biology of Sea Turtles. Boca Raton, FL: CRC Press.

Maar, M., Bolding, K., Petersen, J.K., Hansen, J.L. and Timmermann, K., 2009. Local Effects of Blue Mussels Around Turbine Foundations in an Ecosystem Model of Nysted Off-Shore Wind Farm, Denmark. Journal of Sea Research, 62(2-3), pp.159-174.

MacGillivray, A.O. 2014. A model for underwater sound levels generated by marine impact pile driving. Proceedings of Meetings on Acoustics 20(1). https://doi.org/10.1121/2.0000030

Madsen, P. T., M. Wahlberg, J. Tougaard, K. Lucke, and P. Tyack. 2006. Wind Turbine Underwater Noise and Marine Mammals: Implications of Current Knowledge and Data Needs. Marine Ecology Progress Series, Vol. 309:279–295. Available: https://www.researchgate.net/publication/236156710_Wind_turbine_underwater_noise_and_marine_mammals_Implications_of_current_knowledge_and_data_needs.

Malme, C.I. B. Würsig, J.E. Bird, and P. Tyack. 1986. Behavioral responses of gray whales to industrial noise: Feeding observations and predictive modeling.

Marine Mammal Acoustic Technical Guidance (2018). Auditory thresholds for marine mammals (all activities): NMFS (2018). Revision to Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing, Office of Protected Resources, NOAA Technical Memorandum NMFS-OPR-59, April 2018

Martin, J., Q. Sabatier, T. A. Gowan, C. Giraud, E. Gurarie, S. Calleson, J. G. Ortega-Ortiz, C. J. Deutsch, A. Rycyk, and S. M. Koslovsky. 2016. A quantitative framework for investigating risk of deadly collisions between marine wildlife and boats. Methods in Ecology and Evolution 7.1: 42-50.

Martin, K.J., S.C. Alessi, J.C. Gaspard, A.D. Tucker, G.B. Bauer, and D.A. Mann. 2012. Underwater hearing on the loggerhead turtle (Caretta caretta): A comparison of behavioral and auditory evoked potential audiograms. Journal of Experimental Biology 215(17):3001–3009.

Massachusetts Geographic Information System (MassGIS). 2020. North Atlantic Right Whale Core Habitat. Available URL: http://maps.massgis.state.ma.us/czm/moris/metadata/moris_om_n_atl_right_w_core_poly.htm. Accessed June 11, 2020.

Matthews, M.-N. R., D. S. Ireland, R. Brune, Z. D. G., J. R. Christian, G. Warner, T. J. Deveau, H. Frouin-Mouy, S. L. Denes, C. Pyć, V. D. Moulton, and D. E. Hannay. 2018. Determining the Environmental Impact of Marine Vibrator Technology. Final Report.

Maybaum, H.L. 1993. Responses of humpback whales to sonar sounds. J. Acoust. Soc. Am., 94: 1848–1849.

Mayflower Wind Energy LLC (Mayflower Wind). 2022. Mayflower Wind Construction and Operations Plan. Available: https://www.boem.gov/renewable-energy/state-activities/mayflower-wind.

Mayflower-APEM. 2020a. Lease Area OCS-A 0521 Monthly Survey Report: S1_November 2019. Scientific Monthly Report P00003850. 11 pp.

Mayflower-APEM. 2020b. Lease Area OCS-A 0521 Monthly Survey Report: S2_December 2019. Scientific Monthly Report P00003850. 10 pp.

Mayflower-APEM 2020c. Lease Area OCS-A 0521 Monthly Survey Report: S3_January 2020. Scientific Monthly Report P00003850. Mayflower, 28/02/2020, 10 pp.

Mayflower-APEM 2020d. Lease Area OCS-A 0521 Monthly Survey Report: S4_February 2020. Scientific Monthly Report P00003850. Mayflower, 19/02/2020, 10 pp.

Mayflower-APEM 2020e. Lease Area OCS-A 0521 Monthly Survey Report: S5_March 2020. Scientific Monthly Report P00003850. Mayflower, 09/03/2020, 10 pp.

Mayflower-APEM 2020f. Lease Area OCS-A 0521 Monthly Survey Report: S7_April_(02) 2020. Scientific Monthly Report P00003850. Mayflower, 03/08/2020, 10 pp.

Mayflower-APEM 2020g. Lease Area OCS-A 0521 Monthly Survey Report: S9_May_(02) 2020. Scientific Monthly Report P00003850. Mayflower, 09/09/2020, 9 pp.

Mayflower-APEM 2020h. Lease Area OCS-A 0521 Monthly Survey Report: S10_June_ 2020. Scientific Monthly Report P00003850. Mayflower, 28/09/2020, 9 pp.

Mayflower-APEM 2020i. Lease Area OCS-A 0521 Monthly Survey Report: S11_July 2020. Scientific Monthly Report P00003850. Mayflower, 26/10/2020, 15 pp.

Mayflower-APEM. 2020j. Lease Area OCS-A 0521 Monthly Survey Report: S12_August_01 2020. Scientific Monthly Report P00003850. Mayflower, 07/12/2020, 12 pp.

Mayflower-APEM. 2020k. Lease Area OCS-A 0521 Monthly Survey Report: S13_August_02 2020. Scientific Monthly Report P00003850. Mayflower, 07/12/2020, 12 pp.

Mayflower-APEM. 2020l. Lease Area OCS-A 0521 Monthly Survey Report: S14_September 2020. Scientific Monthly Report P00003850. Mayflower, 07/12/2020, 12 pp.

Mayflower-APEM. 2020m. Lease Area OCS-A 0521 Survey Results Mayflower, 10/09/2020.

Mazet, J. A. K., I. A. Gardner, D. A. Jessup, and L. J. Lowenstine. 2001. Effects of Petroleum on Mink Applied as a Model for Reproductive Success in Sea Otters. Journal of Wildlife Diseases 37(4):686–692.

McCauley, R.D., J. Fewtrell, A.J. Duncan, C. Jenner, M.-N. Jenner, J.D. Penrose, R.I.T. Prince, A. Adhitya, J. Murdoch, and K. McCabe. 2000. Marine Seismic Surveys: Analysis and Propagation of Air-gun Signals; and Effects of Air-gun Exposure on Humpback Whales, Sea Turtles, Fishes and Squid. Curtin University of Technology, Centre for Marine Science and Technology, Bentley, Australia. August 2000.

McKenna, M. F., D. Ross, S. M. Wiggins, and J. A. Hildebrand. 2012. Underwater Radiated Noise from Modern Commercial Ships. Journal of the Acoustical Society of America 131(1):92–103.

McKinstry, Caitlin AE, Andrew J. Westgate, and Heather N. Koopman. "Annual variation in the nutritional value of stage V Calanus finmarchicus: implications for right whales and other copepod predators." *Endangered Species Research* 20.3 (2013): 195-204.

McLean, M. F., M. J. Dadswell, and M. J. W. Stokesbury. 2013. Feeding ecology of Atlantic sturgeon, Acipenser oxyrinchus Mitchell, 1815 on the infauna of intertidal mudflats of Minas Basin, Bay of Fundy. Journal of Applied Ichthyology 29:503–509.

McQueen, A., B. Suedel, and J. Wilkens. 2019. Review of the Adverse Biological Effects of Dredging-induced Underwater Sounds. *Journal of Dredging*, 17(1):1-22.

Mel'nichenko, N. A. (2008). The solubility of oxygen in sea water and solutions of electrolytes according to the pulse proton NMR data. Russian Journal of Physical Chemistry A, Focus on Chemistry, 82(9), 1533-1539.

Methratta E. T. & Dardick W. R. (2019) Meta-Analysis of Finfish Abundance at Offshore Wind Farms, Reviews in Fisheries Science & Aquaculture, 27:2, 242-260, DOI: 10.1080/23308249.2019.1584601

Meyer, T.L., R.A. Cooper, K.J. Pecci. 1981. The performance and environmental effects of a hydraulic clam dredge. Marine Fisheries Review 43:14-22.

Michel, J. A., C. Bejarano, C. H. Peterson, and C. Voss. 2013. Review of biological and biophysical impacts from dredging and handling of offshore sand. U.S. Department of the Interior, Bureau of Ocean Energy Management, Herndon, VA. OCS Study BOEM 2013-0119. 258 pp. Available: https://espis.boem.gov/final%20reports/5268.pdf. Accessed: November 16, 2021.

Miles, J., Martin, T., & Goddard, L. 2017. Current and wave effects around windfarm monopile foundations. Coastal Engineering, 121:167–78.

Miller, J. H., and G. R. Potty. 2017. Overview of underwater acoustic and seismic measurements of the construction and operation of the Block Island Wind Farm. Journal of the Acoustical Society of America 141(5):3993. doi:10.1121/1.4989144. Available: https://asa.scitation.org/doi/10.1121/1.4989144. Accessed: April 1, 2022.

Miller, M.H., and C. Klimovich. 2017. Endangered Species Act Status Review Report: Giant Manta Ray (Manta birostris) and Reef Manta Ray (Manta alfredi). Prepared for National Marine Fisheries Service, Office of Protected Resources, Silver Spring, Maryland. September.

Miller, T. J., and Shepherd, G.R. 2011. Summary of discard estimates for Atlantic sturgeon (White paper). NOAA/NMFS, Woods Hole, MA: Population Dynamics Branch. http://www.nefmc.org/monk/cte mtg docs/120403/Summary of Discard Estimates for Atlantic Sturgeon-v3.pd

Milne, S. 2020. Mayflower Fugro Geophysical Survey 2020 Protected Species Observer Report. Boston, MA.

Minerals Management Service (MMS). 2007. Programmatic Environmental Impact Statement for Alternative Energy Development and Production and Alternate Use of Facilities on the Outer Continental Shelf. Available: https://www.boem.gov/Guide-To-EIS/. Accessed: January 1, 2019.

Misund, O.A. and Aglen, A., 1992. Swimming behaviour of fish schools in the North Sea during acoustic surveying and pelagic trawl sampling. *ICES Journal of Marine Science*, *49*(3), pp.325-334.

Mitchelmore, C.L., Bishop, C.A. and Collier, T.K., 2017. Toxicological estimation of mortality of oceanic sea turtles oiled during the Deepwater Horizon oil spill. *Endangered Species Research*, *33*, pp.39-50.

Mitson, R.B. and H.P. Knudsen. 2003. Causes and effects of underwater noise on fish abundance estimation. Aquatic Living Resources 16: 255–263

Mizroch, S.A., Rice, D.W. and Breiwick, J.M., 1984. The sei whale, Balaenoptera borealis. *Marine Fisheries Review*, *46*(4), pp.25-29.

Mohler, J. W. 2003. Culture manual for the Atlantic sturgeon Acipenser oxyrinchus. A Region 5 U.S. Fish & Wildlife Service Publication, Hadley, Massachusetts. 66 pp.

Mohr, F. C., B. Lasely, and S. Bursian. 2008. Chronic Oral Exposure to Bunker C Fuel Oil Causes Adrenal Insufficiency in Ranch Mink. Archive of Environmental Contamination and Toxicology 54:337–347.

Moore, M.J. and J.M. van der Hoop. 2012. The painful side of trap and fixed net fisheries: Chronic entanglement of large whales. Journal of Marine Biology.

Moser, M.L., and S.W. Ross. 1995. Habitat use and movements of shortnose and Atlantic sturgeons in the lower Cape Fear River, North Carolina. Transactions of the American Fisheries Society 24: 225–234.

Moser, M.L., M. Bain, M.R. Collins, N. Haley, B. Kynard, J.C. O'Herron II, G. Rogers, and T.S. Squiers. 2000. A Protocol for Use of Shortnose and Atlantic Sturgeons. NOAA Technical Memorandum-NMFS-PR-18.

Mueller-Blenkle, C., McGregor, P.K., Gill, A.B., Andersson, M.H., Metcalfe, J., Bendall, V., Sigray, P., Wood, D.T. and Thomsen, F., 2010. Effects of pile-driving noise on the behaviour of marine fish.

Murray, K.T. 2006. Estimated Average Annual Bycatch of Loggerhead Sea Turtles(*Caretta caretta*) in U.S. Mid-Atlantic Bottom Otter Trawl Gear 1996–2004. US Dept Commerce Northeast Fish. Sci. Cent. Ref. Doc. 06–19, 26 p

Murray, K.T. 2015. The importance of place and operational fishing factors in estimating and reducing loggerhead (*Caretta caretta*) interactions in U.S. bottom trawl gear. Fisheries Research, 172:440-501

Murray, K.T. 2020. Estimated Magnitude of Sea Turtle Interactions and Mortality in US Bottom Trawl Gear, 2014-2018. NOAA Technical Memorandum NMFS-NE 260. https://doi.org/10.25923/xza2-9c97

Narragansett Bay Fixed-Site Monitoring Network. (NBFSMN). (2018). Mount Hope Bay Marine Buoys [Water Quality Continuous Multiprobe Data Files]. Retrieved from: https://www.mass.gov/info-details/mount-hope-bay-marine-buoy-continuous-probe-data#data-files-for-mount-hope-bay-marine-buoys-.

National Marine Fisheries Service (NMFS). 2003. Final endangered status for a distinct population segment of smalltooth sawfish (Pristis pectinata) in the United States. 68 FR 15674

National Marine Fisheries Service (NMFS). 2010. Final Recovery Plan for the Fin Whale (Balaenoptera physalus). Silver Spring, Maryland: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service.

National Marine Fisheries Service (NMFS). 2011. Final Recovery Plan for the Sei Whale (Balaenoptera borealis). Silver Spring, Maryland: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources.National Marine Fisheries Service (NMFS). 2012a. Final listing determination for two for distinct population segments of Atlantic sturgeon (Acipenser oxyrinchus oxyrinchus) in the Southeast. 77 FR 5914.

National Marine Fisheries Service (NMFS). 2012b. Threatened and endangered status for distinct population segments of Atlantic sturgeon in the Northeast Region. 77 FR 5880.

National Marine Fisheries Service (NMFS). 2014. Endangered Species Act Section 7 Consultation Biological Opinion: Continued Operation of Salem and Hope Creek Nuclear Generating Stations NER-2010-6581. Available at: https://www.nrc.gov/docs/ML1420/ML14202A146.pdf. Accessed March 24, 2021.

National Marine Fisheries Service (NMFS). 2014a. Critical habitat for the Northwest Atlantic Ocean loggerhead sea turtle distinct population segment (DPS) and determination regarding critical habitat for the North Pacific Ocean loggerhead DPS. 79 FR 39856

National Marine Fisheries Service (NMFS). 2015. Critical Habitat for the North Atlantic Right Whale. Endangered Species Act (ESA) Section 4(b)(2) Report. Prepared by National Marine Fisheries Service. Greater Atlantic Regional Fisheries Office and Southeast Regional Office.

National Marine Fisheries Service (NMFS). 2016a. Critical habitat for endangered North Atlantic right whale. 81 FR 4838.

National Marine Fisheries Service (NMFS). 2016b. Endangered Species Act Section 7 Consultation on the Continued Prosecution of Fisheries and Ecosystem Research Conducted and Funded by the Northeast Fisheries Science Center and the Issuance of a Letter of Authorization under the Marine Mammal Protection Act for the Incidental Take of Marine Mammals Pursuant to those Research Activities PCTS ID: NER-2015-12532. Available at: https://media.fisheries.noaa.gov/dam-migration/nefsc_rule2016_biop.pdf.

National Marine Fisheries Service (NMFS). 2016c. Final determination on the proposal to list the Nassau grouper as threatened under the Endangered Species Act. 81 FR 42268.

National Marine Fisheries Service (NMFS). 2017a. Designation of Critical Habitat for the Gulf of Maine, New York Bight, and Chesapeake Bay Distinct Population Segments of the Atlantic Sturgeon. ESA Section 4(b)(2) Impact Analysis and Biological Source Document with the Economic Analysis and Final Regulatory Flexibility Analysis.

National Marine Fisheries Service (NMFS). 2017b. Impacts Analysis of Critical Habitat Designation for the Carolina and South Atlantic Distinct Population Segments of Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*).

National Marine Fisheries Service (NMFS). 2018. Revisions to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts. NOAA Technical Memorandum NMFS-OPR-59. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. 167 p.

National Marine Fisheries Service (NMFS). 2018a. Final rule to list the giant manta ray as threatened under the Endangered Species Act. 83 FR 2916.

National Marine Fisheries Service (NMFS). 2018b. Oceanic Whitetip Shark Recovery Outline. Available at: https://www.fisheries.noaa.gov/resource/document/oceanic-whitetip-shark-recovery-outline.

National Marine Fisheries Service (NMFS). 2018c. Biological Opinion. Deepening and maintenance of the Delaware River Federal navigation channel. NER-2018-15005. 380 pp.

National Marine Fisheries Service (NMFS). 2019a. Endangered status of the Gulf of Mexico Bryde's whale. 84 FR 15446

National Marine Fisheries Service (NMFS). 2019a. Greater Atlantic Regional Fisheries Office Master ESA Species Table – Sea Turtles. Available at https://www.greateratlantic.fisheries.noaa.gov/protected/section7/guidance/maps/garfo_master_esa_species_table_-_sea_turtles_111516.pdf. Accessed January 15, 2019.

National Marine Fisheries Service (NMFS). 2019b. Endangered status of the Gulf of Mexico Bryde's whale. 84 FR 15446

National Marine Fisheries Service (NMFS). 2020. Biological Opinion. New York coastal storm risk management – Beach nourishment projects utilizing the New York Offshore Borrow Areas: Long Beach, Fire Island to Moriches Inlet, East Rockaway, Fire Island to Montauk Point, New York. GARFO-2018-01302.

National Marine Fisheries Service (NMFS). 2020a. Section 7 Effect Analysis: Turbidity in the Greater Atlantic Region: Guidance for action agencies to address turbidity in their Effects Analysis. NOAA Greater Atlantic Regional Fisheries Office. Available: https://www.fisheries.noaa.gov/new-england-mid-atlantic/consultations/section-7-effects-analysis-turbidity-greater-atlantic-region.. Accessed: March 2023.

National Marine Fisheries Service (NMFS). 2021. Sea Turtle Stranding and Salvage Network Public. Annual data reports for Zone 39, in New Jersey. Available: https://grunt.sefsc.noaa.gov/stssnrep/SeaTurtleReportI.do?action=reportquery.

National Marine Fisheries Service (NMFS). 2021a. Endangered Species Act Section 7 Consultation Biological Opinion for the Construction, Operation, Maintenance, and Decommissioning of the South Fork Offshore Energy Project (Lease OCS-A 0517) GARFO-2021-00353 – [Corrected]. Available at: https://media.fisheries.noaa.gov/2021-12/SFW_BiOp_OPR1.pdf.

National Marine Fisheries Service (NMFS). 2021b. Technical corrections for the Bryde's whale (Gulf of Mexico subspecies). 86 FR 47022

National Marine Fisheries Service (NMFS). 2021c. Letter of Concurrence for Offshore Wind Site Assessment Programmatic ESA Consultation. Silver Springs, Maryland. Available: https://media.fisheries.noaa.gov/2021-12/OSW%20surveys_NLAA%20programmatic_rev%201_2021-09-30%20%28508%29.pdf.

National Marine Fisheries Service (NMFS). 2022. 2017–2023 North Atlantic Right Whale Unusual Mortality Event. Available: 2017–2023 North Atlantic Right Whale Unusual Mortality Event | NOAA Fisheries.

National Marine Fisheries Service (NMFS). 2022a. North Atlantic Right Whale (Eubalaena glacialis) 5-Year Review: Summary and Evaluation. https://www.fisheries.noaa.gov/resource/document/north-atlantic-right-whale-5-year-review.

National Marine Fisheries Service (NMFS). 2022b. New York Bight Distinct Population Segment of Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*) 5-Year Review: Summary and Evaluation. Greater Atlantic Regional Fisheries Office, Gloucester, Massachusetts. Available at: https://media.fisheries.noaa.gov/2022-02/Atlantic%20sturgeon%20NYB%205-year%20review_FINAL%20SIGNED.pdf

National Marine Fisheries Service (NMFS). 2022c. Chesapeake Bay Distinct Population Segment of Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*) 5-Year Review: Summary and Evaluation. Greater Atlantic Regional Fisheries Office, Gloucester, Massachusetts. Available at: https://media.fisheries.noaa.gov/2022-02/Atlantic%20sturgeon%20CB%205-year%20review_FINAL%20SIGNED.pdf

National Marine Fisheries Service (NMFS). 2023. Fin Whale *Balaenoptera physalus* Species Page. Accessed March 2023 from: https://www.fisheries.noaa.gov/species/fin-whale.

National Marine Fisheries Service (NMFS). 2023a. North Atlantic Right *Eubalaena glacialis* Species Page. Accessed March 2023 from: https://www.fisheries.noaa.gov/species/north-atlantic-right-whale.

National Marine Fisheries Service (NMFS). 2023b. Sperm Whale *Physeter macrocephalus* Species Page. Accessed March 2023 from: https://www.fisheries.noaa.gov/species/sperm-whale.

National Marine Fisheries Service (NMFS). 2023c. Green Sea Turtle *Chelonia mydas* Species Page. Accessed March 2023 from: https://www.fisheries.noaa.gov/species/green-turtle.

National Marine Fisheries Service (NMFS). 2023d. Kemp's ridley Turtle *Lepidochelys kempii* Species Page. Accessed March 2023 from: https://www.fisheries.noaa.gov/species/kemps-ridley-turtle

National Marine Fisheries Service (NMFS). 2023e. Leatherback Turtle *Dermochelys coriacea* Species Page. Accessed March 2023 from: https://www.fisheries.noaa.gov/species/leatherback-turtle.

National Marine Fisheries Service (NMFS). 2023f. Loggerhead Turtle *Caretta* Species Page. Accessed March 2023 from: https://www.fisheries.noaa.gov/species/loggerhead-turtle.

National Marine Fisheries Service (NMFS). 2023g. Descriptions of Selected Fishery Landings and Estimates of Vessel Revenue from Areas: A Planning-level Assessment. Available: EconReport_Com_auto.knit (noaa.gov).

National Marine Fisheries Service (NMFS). 2023h. North Atlantic Right Whale Critical Habitat Map and GIS Data. https://www.fisheries.noaa.gov/resource/map/north-atlantic-right-whale-critical-habitat-map-and-gis-data. Accessed: August 1, 2023.

National Marine Fisheries Service (NMFS). 2023i. Loggerhead Turtle – Northwest Atlantic Ocean DPS Critical Habitat Map. https://www.fisheries.noaa.gov/resource/map/loggerhead-turtle-northwest-atlantic-ocean-dps-critical-habitat-map. Accessed: August 1, 2023.

National Marine Fisheries Service (NMFS). 2023j. Atlantic Sturgeon Critical Habitat Map and GIS Data. https://www.fisheries.noaa.gov/resource/map/atlantic-sturgeon-critical-habitat-map-and-gis-data. Accessed: August 1, 2023.

National Marine Fisheries Service (NMFS). 2023k. Rice's Whale. https://www.fisheries.noaa.gov/species/rices-whale. Accessed: August 1, 2023.

National Marine Fisheries Service (NMFS). 2023l. Hawksbill Turtle. https://www.fisheries.noaa.gov/species/hawksbill-turtle. Accessed: August 1, 2023

National Marine Fisheries Service (NMFS). 2023m. Gulf Sturgeon. https://www.fisheries.noaa.gov/species/gulf-sturgeon. Accessed: August 3, 2023

National Marine Fisheries Service (NMFS). 2023n. Nassau Grouper. Available: https://www.fisheries.noaa.gov/species/nassau-grouper. Accessed: August 3, 2023

National Marine Fisheries Service (NMFS). 2023o. Smalltooth Sawfish. Available: https://www.fisheries.noaa.gov/species/smalltooth-sawfish. Accessed: August 3, 2023

National Marine Fisheries Service (NMFS). 2023p. Marine Life Viewing Guidelines. https://www.fisheries.noaa.gov/topic/marine-life-viewing-guidelines/overview. Accessed: August 17, 2023.

National Marine Fisheries Service (NMFS) and Greater Atlantic Regional Fisheries Office (GARFO). 2014. Use of sand borrow areas for beach nourishment and hurricane protection, offshore Delaware and New Jersey NER-2014-10904

National Marine Fisheries Service (NMFS) and Greater Atlantic Regional Fisheries Office (GARFO). 2019. Maintenance dredging of the Kennebec River FNP (2019-2029).

National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). 1991. Recovery Plan for U.S. Population of the Atlantic Green Turtle (Chelonia mydas). Washington, D.C.

National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). 1992. Recovery Plan for Leatherback Turtles (Dermochelys coriacea) in the U.S. Caribbean, Atlantic and Gulf of Mexico. Silver Spring, Maryland: National Marine Fisheries Service.

National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). 1993. Recovery Plan for Hawksbill Turtles in the U.S. Caribbean Sea, Atlantic Ocean, and Gulf of Mexico National Marine Fisheries Service, St. Petersburg, Florida.

National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). 2007a. Green Sea Turtle (Chelonia mydas) 5-Year Review: Summary and Evaluation. August.

National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). 2007b. Leatherback Sea Turtle (Dermochelys coriacea) 5-Year Review: Summary and Evaluation. Silver Spring, Maryland: National Marine Fisheries Service, Office of Protected Resources; Jacksonville, Florida: U.S. Fish and Wildlife Service, Southeast Region, Jacksonville Ecological Services Field Office. Available at: https://www.nrc.gov/docs/ML1410/ML14107A352.pdf

National Marine Fisheries Service and U.S. Fish and Wildlife Service (NMFS and USFWS). 2007c. Kemp's ridley Sea Turtle (Lepidochelys kempii) 5-Year Review: Summary and Evaluation. Silver Spring, Maryland: National Marine Fisheries Service, Office of Protected Resources; Albuquerque, New Mexico: U.S. Fish and Wildlife Service, Southwest Region.

National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). 2008. Recovery Plan for the Northwest Atlantic Population of the Loggerhead Sea Turtle (Caretta caretta), Second Revision. Silver Spring, Maryland: National Marine Fisheries Service. Available at: https://repository.library.noaa.gov/view/noaa/3720.

National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). 2010. Proposed listing of nine distinct population segments of loggerhead sea turtles as endangered or threatened. 75 FR 12598.

National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). 2011. Determination of nine distinct population segments of loggerhead sea turtles as threatened or endangered. 76 FR 58868.

National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). 2013. Leatherback Sea Turtle (Dermochelys coriacea) 5-Year Review: Summary and Evaluation. Silver Spring, Maryland, and Jacksonville, Florida. November.

National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). 2015. Citing Heppell, S. S., D. T. Crouse, L. B. Crowder, S. P. Epperly, W. Gabriel, T. Henwood, R. Márquez, and N. B. Thompson. 2005. A population model to estimate recovery time, population size, and management impacts on Kemp's ridley sea turtles. Chelonian Conservation Biology 4:767–773.

National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). 2015. Green Turtle (Chelonia mydas) Status Review under the U.S. Endangered Species Act. Report of the Green Turtle Status Review Team.

National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). 2015a. Kemp's ridley Sea Turtle (Lepidochelys kempii) 5-Year Review: Summary and Evaluation. Silver Spring, Maryland, and Albuquerque, New Mexico. July.

National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). 2015b. Identification and proposed listing of eleven distinct population segments of green sea turtles (Chelonia mydas) as endangered or threatened and revision of current listings. 80 FR 15272.

National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). 2016. Final rule to list eleven distinct population segments of the green sea turtle (Chelonia mydas) as endangered or threatened and revision of current listings under the Endangered Species Act. 81 FR 20058.

National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). 2017. 90-day finding on a petition to identify the Northwest Atlantic leatherback sea turtle as a distinct population segment and list it as threatened under the Endangered Species Act. 82 FR 57565.

National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). 2019. Recovery Plan for the Northwest Atlantic Population of the Loggerhead Sea Turtle (Caretta caretta) Second Revision (2008): Assessment of progress for recovery. December 2019. 21 pp.

National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). 2020. 12-month finding on a petition to identify the Northwest Atlantic leatherback sea turtle as a distinct population segment and list it as threatened under the Endangered Species Act. 85 FR 48332.

National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). 2020a. Endangered Species Act status review of the leatherback turtle (Dermochelys coriacea). Report to the National Marine Fisheries Service Office of Protected Resources and U.S. Fish and Wildlife Service. Available at: https://www.fisheries.noaa.gov/resource/document/status-review-leatherback-turtle-dermochelys-coriacea.

National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service (USFWS), and Secretariat of Environment and Natural Resources (SEMARNAT). 2011. Bi-National Recovery Plan for the Kemp's ridley Sea Turtle (Lepidochelys kempii). Second revision. Silver Spring, Maryland: National Marine Fisheries Service, U.S. Fish and Wildlife Service, and Secretariat of Environment and Natural Resources.

National Oceanic Atmospheric Administration (NOAA), ed. Shigenaka, G. 2010. Oil and Sea Turtles Biology, Planning, and Response. Retrieved June 24, 2022, from https://response.restoration.noaa.gov/sites/default/files/Oil_Sea_Turtles_2021.pdf

National Oceanic and Atmospheric Administration (NOAA). 2015. Endangered and Threatened Species; Critical Habitat for Endangered North Atlantic Right Whale. 50 CFR Part 226

National Oceanic and Atmospheric Administration (NOAA) Fisheries. 2020. Blue Whale (Balaenoptera musculus musculus) Western North Atlantic Stock. https://www.federalregister.gov/documents/2018/10/12/2018-22218/endangered-and-threatened-species-recovery-plan-for-the-blue-whale-and-notice-of-initiation-of-a. Accessed June 9, 2022.

National Oceanic and Atmospheric Administration (NOAA). 2021. Final Environmental Impact Statement, Regulatory Impact Review, and Initial Regulatory Flexibility Analysis for Amending the Atlantic Large Whale Take Reduction Plan: Risk Reduction Rule. Vol. 1. Available at: https://www.greateratlantic.fisheries.noaa.gov/public/nema/apsd/2021FEIS_Volume%20I.pdf

National Oceanic and Atmospheric Administration (NOAA) Fisheries. 2023. Species directory, shortnose sturgeon. Available: https://www.fisheries.noaa.gov/species/shortnose-sturgeon.

National Research Council (NRC). 1990. Decline of the Sea Turtles: Causes and Prevention. Washington, D.C.: National Academy Press. 280 pp. Available at https://nap.nationalacademies.org/catalog/1536/decline-of-the-sea-turtles-causes-and-prevention. Accessed March 28, 2002

National Science Foundation (NSF) and U.S. Geological Survey (USGS). 2011. Final Programmatic Environmental Impact Statement/Overseas Environmental Impact Statement for Marine Seismic Research. Available: https://www.nsf.gov/geo/oce/envcomp/usgs-nsf-marine-seismic-research/nsf-usgs-final-eis-oeis_3june2011.pdf. Accessed: August 20, 2021.

Nedwell, J R and Turnpenny A W H. (1998). The use of a generic weighted frequency scale in estimating environmental effect. Proceedings of the Workshop on Seismics and Marine Mammals, 23rd - 25th June 1998, London. UK

Nedwell, J. and Howell, D., 2004. A review of offshore windfarm related underwater noise sources. *Cowrie Rep*, *544*, pp.1-57.

Nedwell, J. R., et al. "Measurement and interpretation of underwater noise during construction and operation of offshore windfarms in UK waters." *Report for COWRIE, Newbury, UK* (2007).

Nedwell, J., Langworthy, J. and Howell, D., 2003. Assessment of sub-sea acoustic noise and vibration from offshore wind turbines and its impact on marine wildlife; initial measurements of underwater noise during construction of offshore windfarms, and comparison with background noise. Subacoustech Report ref: 544R0423, published by COWRIE, *725*.

NEFSC. 2018a. Ecology of the Northeast US Continental Shelf: Zooplankton. Accessed: July 27, 2018. Available: https://www.nefsc.noaa.gov/ecosys/ecosystem-ecology/zooplankton.html

Nelms, S. E., E. M. Duncan, A. C. Broderick, T. S. Galloway, M. H. Godfrey, M. Hamann, P. K. Lindeque, and B. J. Godley. 2016. Plastic and marine turtles: A review and call for research. ICES Journal of Marine Science 73(2):165–181.

Nelson, M., M. Garron, R.L. Merrick, R.M. Pace III, and T. Cole. 2007. Mortality and serious injury determinations for baleen whale stocks along the United States eastern seaboard and adjacent Canadian Maritimes, 2001 - 2005. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Fisheries Science Center, Woods Hole, Massachusetts.

New England Aquarium. 2020a. Aerial Survey: June 25, 2020, RI/MA Wind Energy Areas.

New England Aquarium. 2020b. Aerial Survey: July 5, 2020, RI/MA Wind Energy Areas.

New England Aquarium. 2020c. Aerial Survey: July 25, 2020, RI/MA Wind Energy Areas.

New England Aquarium. 2020d. Aerial Survey: August 19, 2020, RI/MA Wind Energy Areas.

New England Aquarium. 2020e. Aerial Survey: August 23, 2020, RI/MA Wind Energy Areas.

New England Aquarium. 2020f. Aerial Survey: September 17, 2020, RI/MA Wind Energy Areas.

New England Aquarium. 2020g. Aerial Survey: September 24, 2020, RI/MA Wind Energy Areas.

New England Aquarium. 2020h. Aerial Survey: October 4, 2020, RI/MA Wind Energy Areas.

New England Aquarium. 2020i. Aerial Survey: November 19, 2020, RI/MA Wind Energy Areas.

New England Aquarium. 2020j. Aerial Survey: November 29, 2020, RI/MA Wind Energy Areas.

New England Aquarium. 2020k. Aerial Survey: December 14, 2020, RI/MA Wind Energy Areas.

New England Aquarium. 2020l. Aerial Survey: December 19, 2020, RI/MA Wind Energy Areas.

New England Aquarium. 2020m. Aerial Survey: January 8, 2021, RI/MA Wind Energy Areas.

Newson, S. E., S. Mendes, H. Q. P. Crick, N. K. Dulvy, J. D. R. Houghton, G. C. Hayes, A. M. Huston, C. D. MacLeod, G. J. Pierce, and R. A. Robinson. 2009. Indicators of the impact of climate change on migratory species. Endangered Species Research 7:101–113.

Nieukirk, S. L., K. M. Stafford, D. K. Mellinger, R. P. Dziak, and C. G. Fox. 2004. Low-frequency whale and seismic airgun sounds recorded in the mid-Atlantic Ocean. The Journal of the Acoustical Society of America 115.4: 1832-1843.

Normandeau Associates, Inc. (Normandeau). 2011. Effects of EMFs From Undersea Power Cables on Elasmobranchs and Other Marine Species. OCS Study Report No. BOEMRE 2011-09. Final report prepared for the U.S. Department of the Interior, Bureau of Ocean Energy Management, Pacific OCS Region.

Normandeau Associates, Inc., Exponent, Inc., T. Tricas, and A. Gill. 2011. Effects of EMFs from Undersea Power Cables on Elasmobranchs and Other Marine Species. Final Report. U.S. Department of the Interior, Bureau of Ocean Energy Management, Regulation and Enforcement, Pacific OCS Region, Camarillo, CA. OCS Study BOEMRE 2011-09.

Northeast Gateway (Northeast Gateway Energy Bridge, L.P.). 2012. Environmental Impact Assessment for the Northeast Gateway Deepwater Port. Prepared by Tetra Tech, Inc. March 2012. 129 pp. Available: https://www.regulations.gov/document/USCG-2005-22219-0494

Northeast Fisheries Science Center U.S. (NEFSC) 2022. State of the Ecosystem 2022: Mid-Atlantic. https://doi.org/10.25923/5s5y-0h81

Northeast Fisheries Science Center and Southeast Fisheries Science Center (NEFSC and SEFSC). 2011. Preliminary Summer 2010 Regional Abundance Estimate of Loggerhead Turtles (Caretta caretta) in Northwestern Atlantic Ocean Continental Shelf Waters. Northeast Fisheries Science Center Reference Document 11-03. On file, National Marine Fisheries Service, Woods Hole, Massachusetts. April.

Northeast Fisheries Science Center and Southeast Fisheries Science Center (NEFSC and SEFSC). 2011. Annual Report of a Comprehensive Assessment of Marine Mammal, Marine Turtle, and Seabird Abundance and Spatial Distribution in US waters of the Western North Atlantic Ocean – AMAPPS II. https://www.fisheries.noaa.gov/resource/publication-database/atlantic-marine-assessment-program-protected-species

Northeast Fisheries Science Center and Southeast Fisheries Science Center (NEFSC and SEFSC). 2012. Annual Report of a Comprehensive Assessment of Marine Mammal, Marine Turtle, and Seabird Abundance and Spatial Distribution in US waters of the Western North Atlantic Ocean – AMAPPS II. https://www.fisheries.noaa.gov/resource/publication-database/atlantic-marine-assessment-program-protected-species

Northeast Fisheries Science Center and Southeast Fisheries Science Center (NEFSC and SEFSC). 2013. Annual Report of a Comprehensive Assessment of Marine Mammal, Marine Turtle, and Seabird Abundance and Spatial Distribution in US waters of the Western North Atlantic Ocean – AMAPPS II. https://www.fisheries.noaa.gov/resource/publication-database/atlantic-marine-assessment-program-protected-species

Northeast Fisheries Science Center and Southeast Fisheries Science Center (NEFSC and SEFSC). 2014. 2013 Annual report of a comprehensive assessment of marine mammal, marine turtle, and seabird abundance and spatial distribution in US waters of the western North Atlantic Ocean – AMAPPS II. https://www.fisheries.noaa.gov/resource/publication-database/atlantic-marine-assessment-program-protected-species

Northeast Fisheries Science Center and Southeast Fisheries Science Center (NEFSC and SEFSC). 2015. 2014 Annual report of a comprehensive assessment of marine mammal, marine turtle, and seabird abundance and spatial distribution in US waters of the western North Atlantic Ocean – AMAPPS II. https://www.fisheries.noaa.gov/resource/publication-database/atlantic-marine-assessment-program-protected-species

Northeast Fisheries Science Center and Southeast Fisheries Science Center (NEFSC and SEFSC). 2016. 2015 Annual report of a comprehensive assessment of marine mammal, marine turtle, and seabird abundance and spatial distribution in US waters of the western North Atlantic Ocean – AMAPPS II. https://www.fisheries.noaa.gov/resource/publication-database/atlantic-marine-assessment-program-protected-species

Northeast Fisheries Science Center and Southeast Fisheries Science Center (NEFSC and SEFSC). 2017. 2016 Annual report of a comprehensive assessment of marine mammal, marine turtle, and seabird abundance and spatial distribution in US waters of the western North Atlantic Ocean – AMAPPS II. https://www.fisheries.noaa.gov/resource/publication-database/atlantic-marine-assessment-program-protected-species

Northeast Fisheries Science Center and Southeast Fisheries Science Center (NEFSC and SEFSC). 2018. 2017 Annual Report of a Comprehensive Assessment of Marine Mammal, Marine Turtle, and Seabird Abundance and Spatial Distribution in US waters of the Western North Atlantic Ocean – AMAPPS II. https://www.fisheries.noaa.gov/resource/publication-database/atlantic-marine-assessment-program-protected-species

Northeast Ocean Data. 2022. Chlorophyll, Gammarid Amphipods, Avian Abundance, North Atlantic Right Whale. Available: https://easterndivision.s3.amazonaws.com/Marine/MooreGrant/Chlorophylla.zip; https://easterndivision.s3.amazonaws.com/Marine/MooreGrant/Zooplankton.zip; https://seamap.env.duke.edu/models/mdat/Avian/MDAT_AvianModels_Abundance.zip; and https://easterndivision.s3.amazonaws.com/Marine/MooreGrant/Chlorophylla.zip. Accessed October 2022.

Novak, A.J., Carlson, A.E., Wheeler, C.R., Wippelhauser, G.S. and Sulikowski, J.A. 2017. Critical foraging habitat of Atlantic sturgeon based on feeding habits, prey distribution, and movement patterns in the Saco River estuary, Maine. Transactions of the American Fisheries Society146(2): 308–317.

Nowacek, D.P., Thorne, L.H., Johnston, D.W. and Tyack, P.L., 2007. Responses of cetaceans to anthropogenic noise. Mammal Review, *37*(2), pp.81-115.

Nowacek, D. P., M. P. Johnson, and P. L. Tyack. 2004. North Atlantic right whales (Eubalaena glacialis) ignore ships but respond to alerting stimuli. Proceedings. Biological sciences, 271(1536), 227–231. Available: https://doi.org/10.1098/rspb.2003.2570

O'Brien, O., K. McKenna, D. Pendleton, and J. Redfern. 2021. Megafauna aerial surveys in the wind energy areas of Massachusetts and Rhode Island with emphasis on large whales: Interim Report Campaign 6A, 2020. Sterling (VA): US Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2021-054. 32p.

O'Brien, O., K. McKenna, D. Pendleton, and J. Redfern. 2022. Megafauna Aerial Surveys in the Wind Energy Areas of Massachusetts and Rhode Island with Emphasis on Large Whales: Final Report Campaign 6B, 2020-2021. Boston (MA): Massachusetts Clean Energy Center. 40 p.

O'Brien, O., Pendleton, D.E., Ganley, L.C., McKenna, K.R., Kenney, R.D., Quintana-Rizzo, E., Mayo, C.A., Kraus, S.D. and Redfern, J.V., 2022a. Repatriation of a historical North Atlantic right whale habitat during an era of rapid climate change. Scientific Reports, 12(1), pp.1-10.Office for Coastal Management. 2022. Nationwide Automatic Identification System 2019, https://www.fisheries.noaa.gov/inport/item/62733. Accessed: May 5, 2022.

O'Keeffe, D. J., & G. A. Young. 1984. Handbook on the Environmental Effects of Underwater Explosions. Silver Spring, MD: U.S. Navy, Naval Surface Weapons Center (Code R14).

Orr, T. L., S. M. Herz, and D. L. Oakley. 2013. Evaluation of Lighting Schemes for Offshore Wind Facilities and Impacts to Local Environments. Bureau of Ocean Energy Management, Office of Renewable Energy Programs, Herndon, VA. OCS Study BOEM 2013-0116. 429 pp. Available: https://espis.boem.gov/final%20reports/5298.pdf. Accessed: November 18, 2021.

Pace, R. M., and G. K. Silber. 2005. Simple Analysis of Ship and Large Whale Collisions: Does Speed Kill? Presentation at the Sixteenth Biennial Conference on the Biology of Marine Mammals, San Diego, CA, December 2005.

Pace, R.M. and Merrick, R.L., 2008. North Atlantic Ocean habitats important to the conservation of North Atlantic right whales (Eubalanea glacialis).

Pace, R.M., Corkeron, P.J., Kraus, S.D. (2017). State–space mark–recapture estimates reveal a recent decline in abundance of North Atlantic right whales. Ecol Evo. 1-12

Pace, R. M. 2021. Revisions and Further Evaluations of the Right Whale Abundance Model: Improvements for Hypothesis Testing. NOAA Technical Memorandum NMFS-NE 269. Available: https://apps-nefsc.fisheries.noaa.gov/rcb/publications/tm269.pdf.

Pacific Marine Environmental Laboratory (PMEL). 2020. Ocean Acidification: The Other Carbon Dioxide Problem. Available: https://www.pmel.noaa.gov/CO2/story/Ocean+Acidification. Accessed: February 11, 2020.

Palka, D. L., S. Chavez-Rosales, E. Josephson, D. Cholewiak, H. L. Haas, L. Garrison, M. Jones, D. Sigourney, G. Waring (retired), M. Jech, E. Broughton, M. Soldevilla, G. Davis, A. DeAngelis, C. R. Sasso, M. V. Winton, R. J. Smolowitz, G. Fay, E. LaBrecque, J. B. Leiness, K. Dettloff, M. Warden, K. Murray, and C. Orphanides. 2017. Atlantic Marine Assessment Program for Protected Species: 2010–2014. OCS Study BOEM 2017-071. Washington, D.C.: U.S. Department of the Interior, Bureau of Ocean Energy Management, Atlantic OCS Region. Available: https://espis.boem.gov/final%20reports/5638.pdf.

Palka D., L. Aichinger Dias, E. Broughton, S. Chavez-Rosales, D. Cholewiak, G. Davis, A. DeAngelis, L. Garrison, H. Haas, J. Hatch, K. Hyde, M. Jech, E. Josephson, L. Mueller-Brennan, C. Orphanides, N. Pegg, C. Sasso, D. Sigourney, M. Soldevilla, and H. Walsh. 2021. Atlantic Marine Assessment Program for Protected Species: FY15 – FY19. Washington DC: US Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2021-051. 330 pp.

Pangerc, T., Theobald, P.D., Wang, L.S., Robinson, S.P. and Lepper, P.A., 2016. Measurement and characterisation of radiated underwater sound from a 3.6 MW monopile wind turbine. The Journal of the Acoustical Society of America, 140(4), pp.2913-2922

Parks, S.E., D. R. Ketten, J. T. O'Malley, and J. Arruda. 2007. Anatomical predictions of hearing in the North Atlantic right whale. Anat Rec, 290: 734-744. https://doi.org/10.1002/ar.20527

Paskyabi, M. B., I. and Fer. 2012. Upper Ocean Response to Large Wind Farm Effect in the Presence of Surface Gravity Waves, in Selected papers from Deep Sea Offshore Wind R&D Conference, Vol. 24, (Trondheim):45–254. doi: 10. 1016/j.egypro.2012.06.106.

Patenaude, N. J., W. J. Richardson, M. A. Smultea, W. R. Koski, G. W. Miller, B. Würsig, and C. R. Greene, Jr. 2002. Aircraft Sound and Disturbance to Bowhead and Beluga Whales During Spring Migration in the Alaskan Beaufort Sea. Marine Mammal Science 18(2):309–335. Available: https://doi.org/10.1111/j.1748-7692.2002.tb01040.x.

PCCS (Provincetown Center for Coastal Studies). 2005. Toward an ocean vision for the Nantucket Shelf Region Part I. Review of the environmental characteristics of the Nantucket Shelf Region. Part II. Management options for resource protection and sustainable uses. Provincetown Center for Coastal Studies Coastal Solutions Initiative, Provincetown, MA.

Pendleton, R. M., C. R. Standley, A. L. Higgs, G. H. Kenney, P. J. Sullivan, S. A. Sethi, and B. P. Harris. 2019. Acoustic telemetry and benthic habitat mapping inform the spatial ecology of shortnose sturgeon in the Hudson River, New York, USA. Transactions of the American Fisheries Society 148:35–47.

Pettis, H.M., Pace, R.M. III, Hamilton, P.K. 2022. North Atlantic Right Whale Consortium 2021 Annual Report Card. Report to the North Atlantic Right Whale Consortium.

Pezy, J. P., A. Raoux, and J. C. Dauvin. 2018. An ecosystem approach for studying the impact of offshore wind farms: A French case study. ICES Journal of Marine Science 77(3):1238–1246.

Piniak W. E. D., D. A. Mann, C. A. Harms, T. T. Jones, S. A. Eckert. 2016. Hearing in the Juvenile Green Sea Turtle (*Chelonia mydas*): A Comparison of Underwater and Aerial Hearing Using Auditory Evoked Potentials. PLOS ONE 11(10): e0159711. https://doi.org/10.1371/journal.pone.0159711

Piniak, W.E.D., D.A. Mann, S.A. Eckert, and C.A. Harms. 2012a. Amphibious hearing in sea turtles. p. 83–88. In: A.N. Popper and A. Hawkins (eds.) The Effects of Noise on Aquatic Life. Springer, New York. 695 p.

Piniak, W.E.D., S.A. Eckert, C.A. Harms, and E.M. Stringer. 2012b. Underwater Hearing Sensitivity of the Leatherback Sea Turtle (Dermochelys coriacea): Assessing the Potential Effect of Anthropogenic Noise. U.S. Department of the Interior, Bureau of Ocean Energy Management, Headquarters, Herndon, VA. OCS Study BOEM 2012-01156. 35 p.

Pirotta E., B. E. Laesser, A. Hardaker, N. Riddoch, M. Marcoux, and D. Lusseau. 2013. Dredging displaces bottlenose dolphins from an urbanised foraging patch. *Marine Pollution Bulletin,* 2013 Sep 15;74(1):396-402. doi: 10.1016/j.marpolbul.2013.06.020. Epub 2013 Jun 29. PMID: 23816305.

Popper, A. N., Halvorsen, M. B., Kane, A., Miller, D. L., Smith, M. E., Song, J., … Wysocki, L. E. 2007. The effects of high-intensity, low-frequency active sonar on rainbow trout. The Journal of the Acoustical Society of America, 122(1), 623–635. https://doi.org/10.1121/1.2735115

Popper, A.N. 2005. A Review of Hearing by Sturgeon and Lamprey. Submitted to the U.S. Army Corps of Engineers, Portland District. Available: http://pweb.crohms.org/tmt/documents/FPOM/2010/2013_FPOM_MEET/ 2013_JUN/ms-coe%20Sturgeon%20Lamprey.pdf.

Popper, A. N., A. D. Hawkins, R. R. Fay, D. A. Mann, S. Bartol, T. J. Carlson, S. Coombs, W. T. Ellison, R. L. Gentry, M. B. Halvorsen, S. Løkkeborg, P. H. Rogers, B. L. Southall, D. G. Zeddies, and W. N. Tavolga. 2014. Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI. ASA S3/SC1.4 TR-2014. Technical report.

Prieto, R., M. A. Silva, G. T. Waring, and J. M. A. Gonǰalves. 2014. Sei whale movements and behaviour in the North Atlantic inferred from satellite telemetry. Endangered Species Research 26: 103–113.

Purser, J. and Radford, A.N., 2011. Acoustic noise induces attention shifts and reduces foraging performance in three-spined sticklebacks (Gasterosteus aculeatus). *PloS one*, *6*(2), p.e17478.

Quintana-Rizzo, E., D. A. Mann, and R. S. Wells. 2006. Estimated Communication Range of Social Sounds Used by Bottlenose Dolphins (Tursiops truncatus). Journal of the Acoustical Society of America 120:1671–1683. doi: 10.1121/1.2226559.

Quintana-Rizzo, E., S. Leiter, T. V. N. Cole, M. N. Hagbloom, A. R. Knowlton, P. Nagelkirk, O. O. Brien, C.B. Khan, A.G. Henry, P.A. Duley, and L.M. Crowe. 2021. Residency, Demographics, and Movement Patterns of North Atlantic Right Whales Eubalaena glacialis in an Offshore Wind Energy Development in Southern New England, USA. Endangered Species Research 45:251–268.

Ramirez, A, C. Y. Kot, and D. Piatkowski. 2017. Review of sea turtle entrainment risk by trailing suction hopper dredges in the US Atlantic and Gulf of Mexico and the development of the ASTER decision support tool. Sterling (VA): US Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2017-084. 275 pp.

Raoux, A., S. Tecchio, J. P. Pezy, G. Lassalle, S. Degraer, S. Wilhelmsson, M. Cachera, B. Ernande, C. Le Guen, M. Haraldsson, K. Grangere, F. Le Loc'h, J. C. Dauvin, and N. Niquil. 2017. Benthic and fish aggregation inside an offshore wind farm: Which effects on the trophic web functioning? Ecological Indicators 72:33–46.

Read A. J., P. Drinker, and S. Northridge. 2006. Bycatch of Marine Mammals in U.S. and Global Fisheries. Conservation Biology 20(1):163–169. Available: https://conbio.onlinelibrary.wiley.com/doi/abs/10.1111/j.1523-1739.2006.00338.x?sid=nlm%3Apubmed.

Record, N. R., J. A. Runge, D. E. Pendleton, W. M. Balch, K. T. A. Davies, A. J. Pershing, C. L. Johnson, K. Stamieszkin, R. Ji, Z. Feng, S. D. Kraus, R. D. Kenney, C. A. Hudak, C. A. Mayo, C. Chen, J. E. Salisbury, and C. R. S. Thompson. 2019. Rapid climate-driven circulation changes threaten conservation of North Atlantic right whales. Oceanography 32:163–169.

Reilly G. P. 1950. The seagoing hopper dredge. International Conference on Coastal Engineering.

Reine, K. J., & Clarke, D. G. 1998. Entrainment by hydraulic dredges – A review of potential impacts, Technical Note DOER-E1 (pp. 1-14). U.S. Army Corps of Engineers, Engineer Research and Development Center,Vicksburg, MS.

Reiser, C.M., D.W. Funk, R. Rodrigues, and D.E. Hannay. 2010. *Marine mammal monitoring and mitigation during open water seismic exploration by Shell Offshore, Inc. in the Alaskan Chukchi Sea, July–October 2009: 90-day report*. Report Number P1112-1. Technical report by LGL Alaska Research Associates Inc. and JASCO Research Ltd. for Shell Offshore Inc, National Marine Fisheries Service, and US Fish and Wildlife Services. 104 pp, plus appendices.

Reiser, C.M., D.W. Funk, R. Rodrigues, and D.E. Hannay. 2011. *Marine mammal monitoring and mitigation during marine geophysical surveys by Shell Offshore, Inc. in the Alaskan Chukchi and Beaufort seas, July–October 2010: 90-day report*. Report Number P1171E–1. Report by LGL Alaska Research Associates Inc. and JASCO Applied Sciences for Shell Offshore Inc, National Marine Fishery Services, and US Fish and Wildlife Services. 240 + appendices p.

Rhode Island Coastal Resources Management Council (RICRMC). 2010. Rhode Island Ocean Special Area Management Plan, Volume 1. Available at: https://seagrant.gso.uri.edu/oceansamp/documents. html. Accessed August 23, 2021.

Rhode Island Department of Environmental Management (RIDEM). 2005. Final Total Maximum Daily Load. The Sakonnet River – Portsmouth Park and The Cove – Island Park. March 2005. http://www.dem.ri.gov/programs/benviron/water/quality/rest/pdfs/sakonnet.pdf. Accessed on July 30, 2021

Rhode Island Department of Environmental Management (RIDEM). 2021. State Of Rhode Island. 2018-2020 Impaired Waters Report. February 2021. http://dem.ri.gov/programs/benviron/water/quality/pdf/iwr1820.pdf. Accessed July 30, 2021

Richardson JI. 1990. The sea turtles of the King's Bay area and the endangered species observer program associated with construction dredging of the St. Marys entrance ship channel. In: Dickerson DD, Nelson DA, editors. Proceedings of the national workshop on methods to minimize dredging impacts on sea turtles, 11 and 12 May 1988, Jacksonville, FL Miscellaneous Paper EL-90-5. Jacksonville (FL): US Army Corps of Engineers, Environmental Laboratory. p. 32-46.

Richardson, W. J., B. Würsig, and C. R. Greene. 1990. Reactions of bowhead whales, Balaena mysticetus, to drilling and dredging noise in the Canadian Beaufort sea. *Marine Environmental Research*, 29 (1990): 135-160.

Richardson, W. J., C. R. Greene, Jr., C. I. Malme, and D. H. Thomson. 1995. Marine Mammals and Noise. San Diego, CA: Academy Press. Available: https://www.elsevier.com/books/marine-mammals-and-noise/richardson/978-0-08-057303-8. Accessed: September 9, 2020.

Richmond, D.R., J.T. Yelverton, and E.R. Fletcher. 1973. Far-field underwater-blast injuries produced by small charges. Lovelace foundation for medical education and research. Contract No. DASA-01-71-C-0013

Rikardsen, A. H., D. Righton, J. F. Strøm, E. B. Thorstad, P. Gargan, T. Sheehan, and K. Aarestrup. 2021. Redefining the oceanic distribution of Atlantic salmon. Scientific Reports 11(1):1–12.

Roberts, J.J., B.D. Best, L. Mannocci, E. Fujioka, P.N. Halpin, D.L. Palka, L.P. Garrison, K.D. Mullin, T.V.N. Cole, et al. 2016. Habitat-based cetacean density models for the U.S. Atlantic and Gulf of Mexico. Scientific Reports 6. https://doi.org/10.1038/srep22615.

Roberts J.J., Mannocci L., Schick R.S., Halpin P.N. 2018. Final Project Report: Marine Species Density Data Gap Assessments and Update for the AFTT Study Area, 2017-2018 (Opt. Year 2). Document version 1.2 - 2018-09-21. Report prepared for Naval Facilities Engineering Command, Atlantic by the Duke University Marine Geospatial Ecology Lab, Durham, NC.

Roberts, J.J., B. McKenna, L. Ganley, and S. Mayo. 2021a. Right Whale Abundance Estimates for Cape Cod Bay in December. Version 3. Report by the Duke University Marine Geospatial Ecology Lab, Durham, NC, USA. https://seamap-dev.env.duke.edu/seamap-modelsfiles/Duke/EC/North_Atlantic_right_whale/Docs/CCB_December_Estimates_v3.pdf

Roberts, J. J., R. S. Schick, and P. N. Halpin. 2021b. Final Project Report; Marine Species Density Data Gap Assessments and Update for the AFTT Study Area, 2020 (Option Year 4). Document version 1.0 (DRAFT). Report prepared for Naval Facilities Engineering Command, Atlantic by the Duke University Marine Geospatial Ecology Lab, Durham, NC.

Roberts J. J., T. M. Yack, and P. N. Halpin. 2022a. Density Model for Blue whale (Balaenoptera musculus) for the U.S. East Coast, Version 2, 2022-06-20. Prepared for Naval Facilities Engineering Command, Atlantic by the Duke University Marine Geospatial Ecology Lab, Durham, NC.

Roberts J. J., T. M. Yack, and P. N. Halpin. 2022b. Density Model for Fin Whale (Balaenoptera physalus) for the U.S. East Coast, Version 12, 2022-06-20. Prepared for Naval Facilities Engineering Command, Atlantic by the Duke University Marine Geospatial Ecology Lab, Durham, NC.

Roberts J. J., T. M. Yack, and P. N. Halpin. 2022c. Density Model for Sei Whale (Balaenoptera borealis) for the U.S. East Coast, Version 10, 2022-06-20. Prepared for Naval Facilities Engineering Command, Atlantic by the Duke University Marine Geospatial Ecology Lab, Durham, NC.

Roberts J. J., T. M. Yack, and P. N. Halpin. 2022d. Density Model for Sperm Whale (*Physeter macrocephalus*) for the U.S. East Coast, Version 8, 2022-06-20. Prepared for Naval Facilities Engineering Command, Atlantic by the Duke University Marine Geospatial Ecology Lab, Durham, NC.

Roberts J. J., T. M. Yack, and P. N. Halpin. 2022e. Density Model for North Atlantic Right Whale (*Eubalena glacialis*) for the U.S. East Coast, Version 12, 2022-02-14. Prepared for Naval Facilities Engineering Command, Atlantic by the Duke University Marine Geospatial Ecology Lab, Durham, NC.

Robinson, S.P., P.D. Theobald, G. Hayman, L.-S. Wang, P.A. Lepper, V.F. Humphrey, and S. Mumford. 2011. *Measurement of Underwater Noise Arising from Marine Aggregate Dredging Operations: Final Report*. Document Number 09/P108. Marine Environment Protection Fund (MEPF). https://webarchive.nationalarchives.gov.uk/20140305134555/http://cefas.defra.gov.uk/alsf/projects/direct-and-indirect-effects/09p108.aspx.

Rockwood R. C., J. Calambokidis, J. Jahncke. 2017. High mortality of blue, humpback and fin whales from modeling of vessel collisions on the U.S. West Coast suggests population impacts and insufficient protection. PLOS ONE 12(8): e0183052. https://doi.org/10.1371/journal.pone.0183052

Rolland, R.M., S.E. Parks, K.E. Hunt, M. Castellote, P.J. Corkeron, D.P. Nowacek, S.K. Wasser, and S.D. Kraus. 2012. Evidence that ship noise increases stress in right whales. Proceedings of the Royal Society B: Biological Sciences 279(1737):2363–2368. doi:10.1098/rspb.2011.2429.

Rosel, P.E., Wilcox, L.A., Yamada, T.K. and Mullin, K.D., 2021. A new species of baleen whale (Balaenoptera) from the Gulf of Mexico, with a review of its geographic distribution. Marine Mammal Science, 37(2), pp.577-610.

Ross, S. T., W. T. Slack, R. J. Heise, M. A. Dugo, H. Rogillio, B. R. Bowen, P. Mickle, and R. W. Heard. 2009. Estuarine and coastal habitat use of Gulf sturgeon (Acipenser oxyrinchus desotoi) in the North-Central Gulf of Mexico. Estuaries and Coasts.

Ross, S. T., W. T. Slack, R. J. Heise, M. A. Dugo, H. Rogillio, B. R. Bowen, P. Mickle, and R. W. Heard. 2009. Citing Sulak, K. J., and J. P. Clugston. 1999. Recent advances in life history of Gulf of Mexico sturgeon, Acipenser oxyrinchus desotoi, in the Suwannee River, Florida: A synopsis. Journal of Applied Ichthyology 18:519–528.

Rosman, I., G. S. Boland, L. Martin, and C. Chandler. 1987. Underwater Sightings of Sea Turtles in the Northern Gulf of Mexico. U.S. Dept. of the Interior, Minerals Management Service. OCS Study/1VIIVIS 87/0107. 37 pp.

Rothermel, E.R., Balazik, M.T., Best, J.E., Breece, M.W., Fox, D.A., Gahagan, B.I., Haulsee, D.E., Higgs, A.L., O'Brien, M.H., Oliver, M.J. and Park, I.A., 2020. Comparative migration ecology of striped bass and Atlantic sturgeon in the US Southern mid-Atlantic bight flyway. *PloS one*, *15*(6), p.e0234442.

Russel, D. J. F., S. M. J. M. Brasseur, D. Thompson, G. D. Hastie, V. M. Janik, G. Aarts, B. T. McClintock, J. Matthiopoulos, S. E. W. Moss, and B. McConnel. 2014. Marine Mammals Trace Anthropogenic Structures at Sea. Current Biology 24(14):R638–R639.

Russell, D. J. F., G. D. Hastie, D. Thompson, V. M. Janik, P. S. Hammond, L. A. S. Scott-Hayward, J. Matthiopoulos, E. L. Jones, and B. J. McConnell. 2016. Avoidance of Wind Farms by Harbour Seals Is Limited to Pile Driving Activities. Journal of Applied Ecology doi:10.1111/1365-2664.12678.

Samuel, Y., S. J. Morreale, C. W. Clark, C. H. Greene, and M. E. Richmond. 2005. Underwater, Low-frequency Noise in a Coastal Sea Turtle Habitat. Journal of the Acoustical Society of America 117(3):1465–1472.

Sand, O., H.E. Karlsen, and F.R. Knudsen. 2008. Comment on “Silent research vessels are not quiet.” Journal of the Acoustical Society of America 123:1831–1833.

Sarà, G., Dean, J.M., d’Amato, D., Buscaino, G., Oliveri, A., Genovese, S., Ferro, S., Buffa, G., Martire, M.L. and Mazzola, S., 2007. Effect of boat noise on the behaviour of bluefin tuna Thunnus thynnus in the Mediterranean Sea. *Marine Ecology Progress Series*, *331*, pp.243-253.

Sasso, C.R. and S.P. Epperly. 2006. Seasonal sea turtle mortality risk from forced submergence in bottom trawls. Fisheries Research 81: 86-88.

Savoy, T. 2007: Prey eaten by Atlantic sturgeon in Connecticut waters. Am. Fish. Soc. Symp. 56, 157–165.

Scales, K. L., Miller, P. I., Hawkes, L. A., Ingram, S. N., Sims, D. W., and Votier, S. C. 2014. On the Front Line: frontal zones as priority at-sea conservation areas for mobile marine vertebrates. J. Appl. Ecol. 51, 1575–1583. doi: 10.1111/1365- 2664.12330

Scheidat, M., Tougaard, J., Brasseur, S., Carstensen, J., van Polanen Petel, T., Teilmann, J. and Reijnders, P., 2011. Harbour porpoises (Phocoena phocoena) and wind farms: a case study in the Dutch North Sea. *Environmental Research Letters*, *6*(2), p.025102.

Schultze, L. K. P., L. M. Merckelbach, J. Horstmann, S. Raasch, and J. R. Carpenter. 2020. Increased Mixing and Turbulence in the Wake of Offshore Wind Farm Foundations. J. Geophys. Res. Oceans 125:e2019JC015858. doi: 10.1029/ 2019JC015858.

Schuyler, Q. A., C. Wilcox, K. Townsend, B. D. Hardesty, and N. J. Marshall. 2014. Mistaken identity? Visual similarities of marine debris to natural prey items of sea turtles. BMC Ecology 14(14). doi:10.1186/1472-6785-14-14.

Schwartz, M. L. 2021. Chapter 8. Estuarine Habitat of Narragansett Bay In An Ecological Profile of the Narragansett Bay National Estuarine Research Reserve. Available: https://coast.noaa.gov/data/docs/nerrs/Reserves_NAR_SiteProfile_Ch8-13.pdf.

Scott, W. B., and E. J. Crossman. 1973. Freshwater fishes of Canada. Fisheries Research Board of Canada Bulletin 184: 92–95.

Sears, R. and Calambokidis, J. 2002. Update COSEWIC status report on the blue whale, Balaenoptera musculus, in Canada. In COSEWIC assessment and update status report on the blue whale, Balaenoptera musculus, in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, 32 p.

Sears, R., and Larsen, F. 2002. Long range movements of a blue whale (Balaenoptera musculus) between the Gulf of St. Lawrence and West Greenland. Mar. Mamm. Sci. 18: 281–285.

Segtnan, O. H. and Christakos, K. 2015. Effect of offshore wind farm design on the vertical motion of the ocean. Energy Procedia, 80, 213-222.

Seminoff, J.A., C.D. Allen, G.H. Balazs, P.H. Dutton, T. Eguchi, H.L. Haas, S.A. Hargrove, M.P. Jensen, D.L. Klemm, A.M. Lauritsen, S.L. MacPherson, P. Opay, E.E. Possardt, S.L. Pultz, E.E. Seney, K.S. Van Houtan, R.S. Waples. 2015. Status Review of the Green Turtle (Chelonia mydas) Under the U.S. Endangered Species Act. NOAA Technical Memorandum, NOAANMFS-SWFSC-539.

Shelledy, K., Phelan, B. and Stanley, J., 2018, August. Behavioral Effects of Sound Sources from Offshore Renewable Energy Construction on the Black Sea Bass (Centropristis striata). In *148th Annual Meeting of the American Fisheries Society*. AFS.

Sherk, J.A., J.M. O'Connor, D.A. Neumann, R.D. Prince, and K.V. Wood. 1974. Effects of suspended and deposited sediments on estuarine organisms, Phase II. Reference No. 74-20, Natural Resources Institute, University of Maryland, College Park, Maryland.

Shoop, C. R., and R. D. Kenney. 1992. Seasonal distribution and abundances of loggerhead and leatherback sea turtles in waters of the northeastern United States. Herpetological Monograph 6:43–67.

Slater, M., A Shultz, and R. Jones. 2010. Estimated ambient electromagnetic field strength in Oregon's coastal environment. Prepared by Science Applications International Corp. for the Oregon Wave Energy Trust.

Slavik, K., Lemmen, C., Zhang, W., Kerimoglu, O., Klingbeil, K. and Wirtz, K.W., 2019. The large-scale impact of offshore wind farm structures on pelagic primary productivity in the southern North Sea. *Hydrobiologia*, *845*(1), pp.35-53.

Smith, C. R., T. K. Rowles, L. B. Hart, F. I. Townsend, R. S. Wells, E. S. Zolman, B. C. Balmer, B. Quigley, M. Ivnacic, W. McKercher, M. C. Tumlin, K. D. Mullin, J. D. Adams, Q. Wu, W. McFee, T. K. Collier, and L. H. Schwacke. 2017. Slow Recovery of Barataria Bay Dolphin Health Following the Deepwater Horizon Oil Spill (2013–2014) with Evidence of Persistent Lung Disease and Impaired Stress Response. Endangered Species Research 33:127–142.

Smith, H. R., D. P. Zitterbart, T. F. Norris, M. Flau, E. L. Ferguson, C. G. Jones, O. Boebel, V. D. Moulton. 2020. A field comparison of marine mammal detections via visual, acoustic, and infrared (IR) imaging methods offshore Atlantic Canada. Marine Pollution Bulletin, 154, 111026.

Smith, M. E., Coffin, A. B., Miller, D. L., & Popper, A. N. 2006. Anatomical and functional recovery of the goldfish (*Carassius auratus*) ear following noise exposure. *Journal of Experimental Biology*, *209*(21), 4193–4202. https://doi.org/10.1242/jeb.02490

Smith, T.I.J. 1985. The fishery, biology, and management of Atlantic sturgeon, Acipenser oxyrhynchus, in North America. Environmental Biology of Fishes. 14:61–72.

Smith, T.S. 1985. The fishery, biology, and management of Atlantic sturgeon, Acipenser oxyrhynchus in North America. pp. 61–72. In: F.P. Binkowski & S.I. Doroshov (ed.) North American Sturgeons: Biology and Aquaculture Potential, Dr W. Junk Publishers, Dordrecht.

Snoek, R., R. de Swart, K. Didderen, W. Lengkeek, and M. Teunis. 2016. Potential effects of electromagnetic fields in the Dutch North Sea. Final report submitted to Rijkswaterstaat Water, Verkeer en Leefmgeving. 95 pp. Available: https://www.buwa.nl/fileadmin/buwa_upload/Bureau_Waardenburg_rapporten/16-101_BuWareport_potential_effects_of_electromagnetic_fields_in_the_dutch_north_sea.pdf. Accessed: April 1, 2022.

Southall, B.L., A.E. Bowles, W.T. Ellison, J.J. Finneran, R.L. Gentry, C.R. Greene, Jr., D. Kastak, D.R. Ketten, J.H. Miller, P.E. Nachtigall, W.J. Richardson, J.A. Thomas, and P.L. Tyack. 2007. Marine mammal noise exposure criteria: Initial scientific recommendations. Aquatic Mammals 33(4):411–521.

Sparling, C., Seitz, A. C., Masden, E., & Smith, K. (2020). Collision risk for animals around turbines. Chapter 3. In A. E. Copping & L. G. Hemery (Eds.), OES-environmental 2020 state of the science report: environmental effects of marine renewable energy development around the world. Report for Ocean Energy Systems (OES).

Stadler, J. and Woodbury, D., 2009, August. Assessing the effects to fishes from pile driving: Application of new hydroacoustic criteria. In *INTER-NOISE and NOISE-CON Congress and Conference Proceedings* (Vol. 2009, No. 2, pp. 4724-4731). Institute of Noise Control Engineering.

Staudinger, M. D., H. Goyert, J. J. Suca, K. Coleman, L. Welch, J. K. Llopiz, D. Wiley, I. Altman, A. Applegate, P. Auster, H. Baumann, J. Beaty, D. Boelke, L. Kaufman, P. Loring, J. Moxley, S. Paton, K. Powers, D. Richardson, J. Robbins, J. Runge, B. Smith, C. Spiegel, H. Steinmetz. 2020. The role of sand lances (*Ammodytes* sp.) in the Northwest Atlantic Ecosystem: A synthesis of current knowledge with implications for conservation and management. *Fish*. 2020; 21: 522– 556. https://doi.org/10.1111/faf.12445

Stein, A.B., K.D. Friedland, and M. Sutherland. 2004. Atlantic sturgeon marine bycatch and mortality on the continental shelf of the northeast United States. North American Journal of Fisheries Management 24(1):171–183.

Stöber, U. and F. Thomsen. 2021. How could operational underwater sound from future offshore wind turbines impact marine life? Journal of the Acoustical Society of America 149(3):1791–1795.

Stone, K.M., Leiter, S.M., Kenney, R.D., Wikgren, B. C., Thompson, J. L., Taylor, J. K. D. & Kraus, S. D. (2017). Distribution and abundance of cetaceans in a wind energy development area offshore of Massachusetts and Rhode Island. J Coast Conserv 21: 527–543. Doi: 10.1007/s11852-017-0526- 4.

Sullivan, L., T. Brosnan, T. K. Rowles, L. Schwacke, C. Simeone, and T. K. Collier. 2019. Guidelines for Assessing Exposure and Impacts of Oil Spills on Marine Mammals. NOAA Tech. Memo. NMFS-OPR62, 82 pp.

Tagliabue, A., Kwiatkowski, L., Bopp, L., Butenschön, M., Cheung, W., Lengaigne, M., & Vialard, J. 2021. Persistent uncertainties in ocean net primary production climate change projections at regional scales raise challenges for assessing impacts on ecosystem services. Frontiers in Climate, 3.

Takeshita, R., L. Sullivan, C. Smith, T. Collier, A. Hall, T. Brosnan, T. Rowles, and L. Schwacke. 2017. The Deepwater Horizon Oil Spill Marine Mammal Injury Assessment. Endangered Species Research 33:96–106.

Taormina, B., J. Bald, A. Want, G. Thouzeau, M. Lejart, N. Desroy, and A. Carlier. 2018. A review of potential impacts of submarine power cables on the marine environment: Knowledge gaps, recommendations and future directions. Renewable and Sustainable Energy Reviews 96: 380–391.

Taylor, A.C. 1990. The hopper dredge. In: Dickerson, D.D and D.A. Nelson (Comps.); Proceedings of the National Workshop of Methods to Minimize Dredging Impacts on Sea Turtles, 11-12 May 1988, Jacksonville, Florida. Miscellaneous Paper EL-90-5. Department of the Army, U.S. Army Engineer Waterways Experiment station, Vicksburg, MS. February, 1990. Pp. 59-63.

Teilmann, J., and J. Cartensen. 2012. Negative Long-Term Effects on Harbour Porpoises from a Large Scale Offshore Wind Farm in the Baltic—Evidence of Slow Recovery. Environmental Resource Letters 7(4):045101.

Tennessen, J. B. and S. E. Parks. 2016. Acoustic propagation modeling indicates vocal compensation in noise improves communication range for North Atlantic right whales. Endangered Species Research, 30: 225-237

TerraSond. 2019. Volume II-C Appendix II-AB 2019 Geophysical Operations Report.

Tetra Tech and LGL. 2019. Annual Survey Report Year 2 for New York Bight Whale Monitoring Aerial Surveys March 2018 – February 2019. Technical Report produced By Tetra Tech and LGL for NYSDEC under contract C009926.

Tetra Tech and LGL. 2020. Final Comprehensive Report Years 1-3 for New York Bight Whale Monitoring Aerial Surveys March 2017 – February 2020. Technical Report produced By Tetra Tech and LGL for NYSDEC under Tetra Tech contract C009926.

Tetra Tech and Normandeau Associates, Inc. 2023. SouthCoast Wind – National Pollutant Discharge Elimination System (NPDES) Permit Application. Prepared for SouthCoast Wind Energy LLC. April 2023.

Tetra Tech and Smultea Sciences. 2018. Annual Survey Report Year 1 for New York Bight Whale Monitoring Aerial Surveys March 2018 – February 2018. Technical Report produced by Tetra Tech and Smultea Sciences for NYSDEC under contract C009926.

Tetra Tech. 2014. *Hydroacoustic Survey Report of Geotechnical Activities Virginia Offshore Wind Technology Advancement Project (VOWTAP)*.

ThayerMahan (ThayerMahan Inc.). 2023. Assessing Advanced Technology to Support an Option for Nighttime Monopile Installation. Prepared for Orsted/Eversource by ThayerMahan, Inc. Groton, CT.

Thomás, J., R. Guitart, R. Mateo, and J. A. Raga. 2002. Marine debris ingestion in loggerhead turtles, Caretta, from the Western Mediterranean. Marine Pollution Bulletin 44:211–216.

Thomsen, F., A. Gill, M. Kosecka, M. Andersson, M. André, S. Degraer, T. Folegot, J. Gabriel, A. Judd, T. Neumann, A. Norro, D. Risch, P. Sigray, D. Wood, and B. Wilson. 2015. MaRVEN-Environmental Impacts of Noise, Vibrations and Electromagnetic Emissions from Marine Renewable Energy(Report No. RTD-K3-2012-MRE). Report by Danish Hydraulic Institute (DHI). Report for European Commission.

Todd, V.G.L., I.B. Todd, J.C. Gardiner, E.C.N. Morin, N.A. MacPherson, and F. Thomsen. 2015. A review of impacts of marine dredging activities on marine mammals. ICES Journal of Marine Science 72(2):328–340.

Tougaard, J., Carstensen, J., Teilmann, J., Skov, H., & Rasmussen, P. (2009). Pile driving zone of responsiveness extends beyond 20 km for harbor porpoises (Phocoena (L.)). The Journal of the Acoustical Society of America, 126(1), 11–14. https://doi.org/10.1121/1.3132523

Tougaard, J., J. Carstensen, J. Teilmann, H. Skov, and P. Rasmussen. 2009b. Pile driving zone of responsiveness extends beyond 20 km for harbour porpoises (Phocoena phocoena). Journal of the Acoustical Society of America 126:11–14.

Tougaard, J., L. Hermannsen, and P. T. Madsen. 2020. How loud is the underwater noise from operating offshore wind turbines? Journal of the Acoustical Society of America 148(5):2885–2893.

Tougaard, J., O. D. Henriksen, and L. A. Miller. 2009a. Underwater noise from three types of offshore wind turbines: Estimation of impact zones for harbor porpoises and harbor seals. Journal of the Acoustical Society of America 125(6):3766–3773. doi:10.1121/1.3117444.

Townsend, D.W., Thomas, A.C., Mayer, L.M., Thomas, M.A., and Quinlan, J.A. 2006. Oceanography of the Northwest Atlantic continental shelf (1, W). Chapter 5 in A.R. Robinson and 76 K.H. Brink (Eds) The Sea: The Global Coastal Ocean: Interdisciplinary Regional Studies and Syntheses. Harvard University Press.

Trites, A.W., Pauly D. 1998. Estimating mean body masses of marine mammals from maximum body lengths. Canadian Journal of Zoology 76, 886-896.

Turner-Tomaszewicz, C., & Seminoff, J. A. (2012). Turning off the heat: impacts of power plant decommissioning on green turtle research in San Diego Bay. Coastal Management, 40(1), 73-87.

U.S. Army Corps of Engineers (USACE). 2019. FUDS (Formerly Used Defense Sites Program) Annual Report to Congress—2019. Available: https://ags03.sec.usace.army.mil/portal/apps/webappviewer/index.html?id=5a541ac5c0064c01a685a72f16854fbf&extent=-14812053.749%2C2547413.7926%2C-6500597.0414%2C6940402.6822%2C102100&showLayers=fuds_1797%3Bfuds_3582%3Bfuds_5270. Accessed: June 27, 2022

U.S. Army Corps of Engineers (USACE). 2020. South Atlantic Regional Biological Opinion for Dredging and Material Placement Activities in the Southeast United States. 646 pp. Available: https://media.fisheries.noaa.gov/dam-migration/sarbo_acoustic_revision_6-2020-opinion_final.pdf. Accessed: November 16, 2021.

U.S. Coast Guard (USCG). 2020. The Areas Offshore of Massachusetts and Rhode Island Port Access Route Study. Final Report. Docket Number USCG-2019-0131. May 14, 2020. Available: https://downloads.regulations.gov/USCG-2019-0131-0101/content.pdf. Accessed: May 4, 2022.

U.S. Department of the Army, Office of the Surgeon General (OSG). 1991. Conventional warfare: ballistic, blast, and burn injuries. Washington DC; 241-270

U.S. Department of Energy and U.S. Department of Interior (USDOE and USDOI). 2016. National Offshore Wind Strategy. Facilitating the Development of the Offshore Wind Industry in the United States.

U.S. Department of the Navy (U.S. Navy). 2012. Commander Task Force 20, 4th, and 6th Fleet Navy marine species density database. Technical report for Naval Facilities Engineering Command Atlantic, Norfolk, VA.

U.S. Department of the Navy (U.S. Navy). 2017. U.S. Navy marine species density database phase III for the Atlantic Fleet training and testing study area. NAVFAC Atlantic Final Technical Report. Naval Facilities Engineering Command Atlantic, Norfolk, VA

U.S. Department of the Navy (U.S. Navy). 2017a. Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III). Technical Report. Space and Naval Warfare Systems Center Pacific. 194 pp

U.S. Department of the Navy (U.S. Navy). 2018. Hawaii-Southern California Training and Testing EIS/OEIS. Available: https://www.hstteis.com/Documents/2018-Hawaii-Southern-California-Training-and-Testing-Final-EIS-OEIS/Final-EIS-OEIS#71201-by-volume. Accessed: August 2023.

U.S. Environmental Protection Agency (USEPA). 2015. National Coastal Condition Assessment 2010. EPA-841-R-15-006. Washington, DC: Office of Water and Office of Research and Development. December. Available at: https://www.epa.gov/national-aquatic-resource-surveys/ncca. Accessed: December 10, 2018.

U.S. Environmental Protection Agency (USEPA). 2020. NEPAAssist Mapping Layer Descriptions – Impaired Water Points, Impaired Streams, Impaired Water Bodies. Office of Water ATTAINS Geospatial Data. Accessed June 2, 2022.

US Geological Survey (USGS). 2019. Water Quality Samples for USA: Sample Data https://nwis.waterdata.usgs.gov/nwis/qwdata. Accessed on June 24, 2021.

U.S. Atlantic Salmon Assessment Committee (USASAC). 2020. Annual Report. Report No. 33-2020 Activities.

U.S. Fish and Wildlife Service (USFWS). 1967. Native fish and wildlife. Endangered species. 32 FR 4001.

U.S. Fish and Wildlife Service (USFWS). 1970. List of endangered foreign fish and wildlife. 35 FR 18319.

U.S. Fish and Wildlife Service and National Oceanic and Atmospheric Administration (USFWS and NOAA). 1991. Threatened Status for the Gulf Sturgeon; 56 FR 49653 49658.

U.S. Fish and Wildlife Service & National Marine Fisheries Service (USFWS and NMFS). 1998. Consultation Handbook: Procedures for Consultation and Conference Activities Under Section 7 of the Endangered Species Act (US Fish and Wildlife Service and National Marine Fisheries Service, Washington, DC, Final 1998).

U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS). 2019. Recovery Plan for the Gulf of Maine Distinct Population Segment of Atlantic Salmon (*Salmo salar*).

U.S. Nuclear Regulatory Commission (USNRC). 2010. Citing National Oceanic and Atmospheric Administration (NOAA). 2010. Green turtle (Chelonia mydas). Available: http://www.nmfs.noaa.gov/pr/species/turtles/green.htm. Accessed: November 15, 2010van Berkel, J., H. Burchard, A. Christensen, L. O. Mortensen, O. S. Petersen, and F. Thomsen. 2020. The effects of offshore wind farms on hydrodynamics and implications for fishes. Oceanography 33(4):108–117.

van Dalfsen, J.A. and Essink, K., 2001. Benthic community response to sand dredging and shoreface nourishment in Dutch coastal waters. *Senckenbergiana maritima*, *31*(2), pp.329-332.

Van Houtan, K.S., Smith, C.M., Dailer, M.L. and Kawachi, M., 2014. Eutrophication and the dietary promotion of sea turtle tumors. PeerJ, 2, p.e602.

Vanderlaan, A. S. M., and C. T. Taggart. 2007. Vessel Collisions with Whales: The Probability of Lethal Injury Based on Vessel Speed. Marine Mammal Science 23(1):144–156. Available: https://www.phys.ocean.dal.ca/ ~taggart/Publications/Vanderlaan_Taggart_MarMamSci23_2007.pdf.

Vanhellemont, Q. and K. Ruddick. 2014. Turbid wakes associated with offshore wind turbines observed with Landsat 8. Remote Sensing of Environment 145:105-115.

Vargo, S., Lutz, P., Odell, D., Van Vleet, E. and Bossart, G. 1986. Effects of Oil on Marine Turtles. Volume 1. Executive Summary. Volume 2. Technical Report. Florida Institute of Oceanography. Final Report MMS NO 14-12-0001-30063

Vasconcelos R.O., M.C.P. Amorim, and F. Ladich. 2007. Effects of ship noise on the detectability of communication signals in the Lusitanian toadfish. Journal of Experimental Biology 210:2104–2112

Verfuss, U. K., D. Gillespie, J. Gordon, T. A. Marques, B. Miller, R. Plunkett, J. A. Theriault, D. J. Tollit, D. P. Zitterbart, P. Hubert, and L. Thomas. 2018. Comparing methods suitable for monitoring marine mammals in low visibility conditions during seismic surveys. Marine Pollution Bulletin 126:1-18

Viada, S.T., Hammer, R.M., Racca, R., Hannay, D., Thompson, M.J., Balcom, B.J. and Phillips, N.W. 2008. Review of potential impacts to sea turtles from underwater explosive removal of offshore structures. *Environmental impact assessment review*, *28*(4-5), pp.267-285.

Víkingsson G.A. 1997. Feeding of fin whales (Balaenoptera physalus) off Iceland–diurnal and seasonal variation and possible rates. Journal of Northwest Atlantic Fisheries Science 22: 77–89.

Visser, Fleur, et al. "Timing of migratory baleen whales at the Azores in relation to the North Atlantic spring bloom." *Marine Ecology Progress Series* 440 (2011): 267-279.

Vladykov, V. D., AND J. R. Greely. 1963. Order Acipenseridae, p. 24-60. In: Fishes of the western North Atlantic. Sears Found. Mar. Res. Mem. 1 (Pt. 3).

Walker, M.M., C.E. Diebel, and J.L. Kirschvink. 2003. Detection and Use of the Earth's Magnetic Field by Aquatic Vertebrates. Pages 53–74 in S.P. Collin and N.J. Marshall (eds.), Sensory Processing in Aquatic Environments. Spriner-Verlag, New York.

Walkuska, G., & Wilczek, A. (2010). Influence of Discharged Heated Water on Aquatic Ecosystem Fauna. Polish Journal of Environmental Studies, 19(3).

Wang, J., X. Zou, W. Yu, D. Zhang, and T. Wang. 2019. Effects of established offshore wind farms on energy flow of coastal ecosystems: A case study of the Rudong offshore wind farms in China. Ocean & Coastal Management 171:111–118.

Warden, M.L. 2011. Modeling loggerhead sea turtle (*Caretta caretta*) interactions with US Mid-Atlantic bottom trawl gear for fish and scallops, 2005-2008. Biol Conserv 144:2202-2212

Waring, G.T., E. Josephson, K. Maze-Foley, and P.E. Rosel (eds.). 2011. US Atlantic and Gulf of Mexico Marine Mammal Stock Assessments – 2010. NOAA Technical Memorandum NMFS-NE-219. Woods Hole, Massachusetts: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Fisheries Science Center. June.

Watkins, W.A., Daher, M.A., Fristrup, K.M., Howald, T.J. and Di Sciara, G.N., 1993. Sperm whales tagged with transponders and tracked underwater by sonar. *Marine mammal science*, *9*(1), pp.55-67.

Watwood, S. L., and D. M. Buonantony. 2012. Dive distribution and group size parameters for marine species occurring in navy training and testing areas in the north Atlantic and north Pacific oceans. Naval Undersea Warfare Center, Newport, RI.

Weilgart, L. 2018. The Impact of Ocean Noise Pollution on Fish and Invertebrates. Oceancare and Dalhousie University. Available: https://www.oceancare.org/wp-content/uploads/2017/10/OceanNoise_FishInvertebrates_May2018.pdf.

Weilgart, L. S. 2007. "The Impacts of Anthropogenic Ocean Noise on Cetaceans and Implications for Management." Canadian Journal of Zoology 85:1091–1116. Available: http://whitelab.biology.dal.ca/lw/publications/Weilgart%202007%20CJZ%20noise%20review.pdf.

Wenzel, F., D. K. Mattila, and P. J. Clapham.1988. Balaenoptera musculus in the Gulf of Maine. Marine Mammal Science 4.2: 172-175.

Werner, S., A. Budziak, J. van Franeker, F. Galgani, G. Hanke, T. Maes, M. Matiddi, P. Nilsson, L. Oosterbaan, E. Priestland, R. Thompson, J. Veiga, and T. Vlachogianni. 2016. Harm Caused by Marine Litter. MSFD GES TG Marine Litter - Thematic Report; JRC Technical report; EUR 28317 EN. doi:10.2788/690366.

White, T. P., & Veit, R. R. (2020). Spatial ecology of long-tailed ducks and white-winged scoters wintering on Nantucket Shoals. Ecosphere, 11(1), e03002.

Whitt, A. D., K. Dudzinski, and J. R. Laliberté. 2013. North Atlantic right whale distribution and seasonal occurrence in nearshore waters off New Jersey, USA, and implications for management. Endangered Species Research 20(1):50–69.

Wilber, D.H., and D.G. Clarke. 2001. Biological effects of suspended sediments: A review of suspended sediment impacts on fish and shellfish with relation to dredging activities in estuaries. North American Journal of Fisheries Management 21:855–875.

Wiley, D. N., Mayo, C. A., Maloney, E. M., & Moore, M. J. 2016. Vessel strike mitigation lessons from direct observations involving two collisions between noncommercial vessels and North Atlantic right whales (Eubalaena glacialis). Marine Mammal Science, 32(4), 1501-1509.

Wilkin, J. L. 2006. The Summertime Heat Budget and Circulation of Southeast New England Shelf Waters, *Journal of Physical Oceanography*, *36*(11), 1997-2011.

Witt, M. J., L. A. Hawkes, M. H. Godfrey, B. J. Godley, and A. C. Broderick. 2010. Predicting the impacts of climate change on a globally distributed species: The case of the loggerhead turtle. The Journal of Experimental Biology 213:901–911.

Woods Hole Oceanographic Institution. 2022. https://www.whoi.edu/press-room/news-release/woods-hole-oceanographic-institution-led-study-explores-effects-of-noise-on-marine-life.

Wyman, M.T., A.P. Klimley, R.D Battleson, T.V. Agosta, E.D. Chapman, P.J. Haverkamp, M.D. Pagel, and R. Kavet. 2018. Behavioral responses by migrating juvenile salmonids to a subsea high-voltage DC power cable. Marine Biology 165(8):134.

Wynne, K., and M. Schwartz. 1999. Guide to Marine Mammals & Turtles of the U.S. Atlantic & Gulf of Mexico. Fairbanks: University of Alaska Press.

Wysocki, L.E., Davidson III, J.W., Smith, M.E., Frankel, A.S., Ellison, W.T., Mazik, P.M., Popper, A.N. and Bebak, J., 2007. Effects of aquaculture production noise on hearing, growth, and disease resistance of rainbow trout Oncorhynchus mykiss. *Aquaculture*, *272*(1-4), pp.687-697.

Zydlewski, G. B., M. T. Kinnison, P. E. Dionne, J. Zydlewski, and G. S. Wippelhauser. 2011. Shortnose sturgeon use small coastal rivers: The importance of habitat connectivity. Journal of Applied hthyology 27:41–44.

Appendix A: SouthCoast Wind National Pollutant Discharge Elimination System Permit Application

SouthCoast Wind – National Pollutant Discharge Elimination System (NPDES) Permit Application

Submitted – October 2022
Revised – December 2022 to include updates based on EPA feedback
Revised – April 2023 to include updates based on EPA comments received 3/10/2023

Presented To:

U.S. Environmental Protection Agency, Region 1
5 Post Office Square, Suite 100
Boston, MA 02109

Presented By:

SouthCoast Wind Energy LLC.
101 Federal St., Suite 1900
Boston, MA 02110

Prepared By:

Tetra Tech, Inc.
10 Post Office Square, Suite 1100
Boston, MA 02109

Normandeau Associates, Inc.
25 Nashua Rd.
Bedford, NH 03110

TETRA TECH

Table of Contents

List of Tables

List of Figures

Appendices

Acronyms/Abbreviations

ΔT	temperature delta, temperature change from ambient temperature
µg/L	micrograms per liter
AIF	actual intake flow
BOEM	Bureau of Ocean Energy Management
BTA	Best Technology Available
°C	degrees Celsius
CFR	Code of Federal Regulations
cm	centimeters
CMECS	Coastal and Marine Ecological Classification Standard
COP	Construction and Operations Plan
CORMIX	mixing zone model
CWIS	cooling water intake structure
DIF	design intake flow
DPS	Distinct Population Segment
EcoMon	Ecosystem Monitoring
EFH	essential fish habitat
EPA	United States Environmental Protection Agency
ESA	Endangered Species Act
°F	degrees Fahrenheit
FMP	fishery management plan
ft	feet
ft/s	feet per second
GBS	gravity-base structure
GLOBEC	Global Ocean Ecosystems Dynamics
gpm	gallons per minute
HRG	high-resolution geophysical survey
HVAC	high-voltage alternating-current
HVDC	high-voltage direct-current
HZI	Hydraulic Zone of Influence
in	inches
kg	kilograms

km	kilometers
knots	nautical miles per hour
Lease Area	Lease Area OCS-A0521
m	meters
m^3	cubic meters
MA DMF	Massachusetts Division of Marine Fisheries
MARMAP	Marine Resources Monitoring, Assessment, and Prediction program
MassDEP	Massachusetts Department of Environmental Protection
SouthCoast Wind	SouthCoast Wind Energy LLC
MBES	multibeam echosounder
mg/L	milligrams per liter
MGD	million gallons per day
mi	miles
MLLW	mean lower low water
mm	millimeters
MSIR	Marine Site Investigation Report
NAD1983	North American Datum of 1983
NaOCl	Sodium Hypochlorite
NCCA	National Coastal Condition Assessment
NDBC	National Data Buoy Center
NEFMC	New England Fishery Management Council
NEFSC	Northeast Fisheries Science Center
NFR	near-field region
nm	nautical miles
NOAA	National Oceanic and Atmospheric Administration
NOAA Fisheries	National Oceanic and Atmospheric Administration Fisheries unit
NPDES	National Pollutant Discharge Elimination System
OCS	Outer Continental Shelf
Offshore Project Area	Lease Area and offshore export cable corridor
OSP	offshore substation platform
POI	point of interconnection
ppm	parts per million

Project	SouthCoast Wind Project
PV	plan view
RI DEM	Rhode Island Department of Environmental Management
RSDs	rippled scour depressions
SL	standard length
SPI	sediment profile imaging
TL	total length
TOC	Total Organic Content
US DOC	United States Department of Commerce
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey
UTM	Universal Transverse Mercator
WEA	Wind Energy Area
WTG	wind turbine generator

1.0 INTRODUCTION

This application provides the required supplemental information in support of the National Pollutant Discharge Elimination System (NPDES) permit application for the discharge of water into United States federal waters during the operation of the SouthCoast Wind (formerly Mayflower Wind)[1] Offshore Wind Project (the Project). This permit application is filed specifically for discharge at the cooling water intake structure (CWIS) at the high voltage direct current (HVDC) converter located at an offshore substation platform (OSP) in the SouthCoast Wind Outer Continental Shelf Lease Area OCS-A 0521 (Lease Area). The information contained herein addresses the NPDES permit application requirements at 40 Code of Federal Regulations (CFR) §122.21(r)(2) through (r)(4), as well as compliance with §125.80 to 125.89. The layout of this document is organized to follow those requirements outlined in the regulations[2] cited herein (as links to the electronic Code of Federal Regulations – eCFR), where applicable.

The Project will comply with §316(a) and §316(b) Phase I Rule requirements for new power generating facilities by meeting the best technology available (BTA) standards to minimize the impacts of impingement and entrainment on the marine environment. Section 2 describes the characteristics of the source water physical data. Section 3 provides a detailed summary of the intakes and discharges. Section 4 provides a biological characterization of the source water. Section 5 provides information relevant to ocean discharge criteria. Section 6 includes the “Track-1” requirements under §125.84. This application also includes three appendices (Appendix A: SouthCoast Wind CORMIX Mixing Zone Results, Appendix B: Construction and Operations Plan References, and Appendix C: NPDES Application Form 1 and form 2D) that are referenced in the applicable sections of the document.

In accordance with §125.84 the owner or operator of a new power generation facility must comply with either “Track I” or “Track 2” requirements. SouthCoast Wind intends to comply with “Track I” requirements defined at §125.84 and inclusive of §316(b) Phase I Rule for new power generating facilities.

Under the Phase I 316(b) Rule of 2001, later amended in 2003, the §122.21(r) submittals accompany the facility’s NPDES application. The Project is located in federal waters, approximately 26 nautical miles (nm, 48 kilometers[km]) south of Martha’s Vineyard and 20 nm (37 km) south of Nantucket (see **Figure 1**) Massachusetts, which does not have delegated authority under the Clean Water Act, therefore the permit application and associated materials are submitted to U.S. Environmental Protection Agency (EPA) Region 1.

The Phase I Rule establishes categorical requirements under section 316(b) of the Clean Water Act for new power generating facilities that have a design intake flow threshold of greater than 2 million gallons per day (MGD) and that withdraw at least 25 percent of the water exclusively for cooling purposes. While the Phase I Rule was intended for power generating facilities, a pre-consultation

[1] SouthCoast Wind Energy LLC
[2] **§122.21** – Permit Application and Special NPDES Program Requirements. Application for a permit; https://www.ecfr.gov/current/title-40/chapter-I/subchapter-D/part-122/subpart-B
§125.84 – As an owner or operator of a new power generating facilities, what must I do to comply with this subpart?; https://www.ecfr.gov/current/title-40/chapter-I/subchapter-D/part-125/subpart-I/section-125.84
§125.86 – As an owner or operator of a new power generating facilities, what must I collect and submit when I apply for my new or reissued NPDES permit?; https://www.ecfr.gov/current/title-40/chapter-I/subchapter-D/part-125/subpart-I/section-125.86

meeting with EPA Region 1 indicated that the type of offshore converter station proposed in this Project will be permitted similarly to other offshore energy facilities within EPA Region 1, such as the Northeast Gateway Offshore LNG Project, located approximately 13 miles (21 km) offshore of Massachusetts.

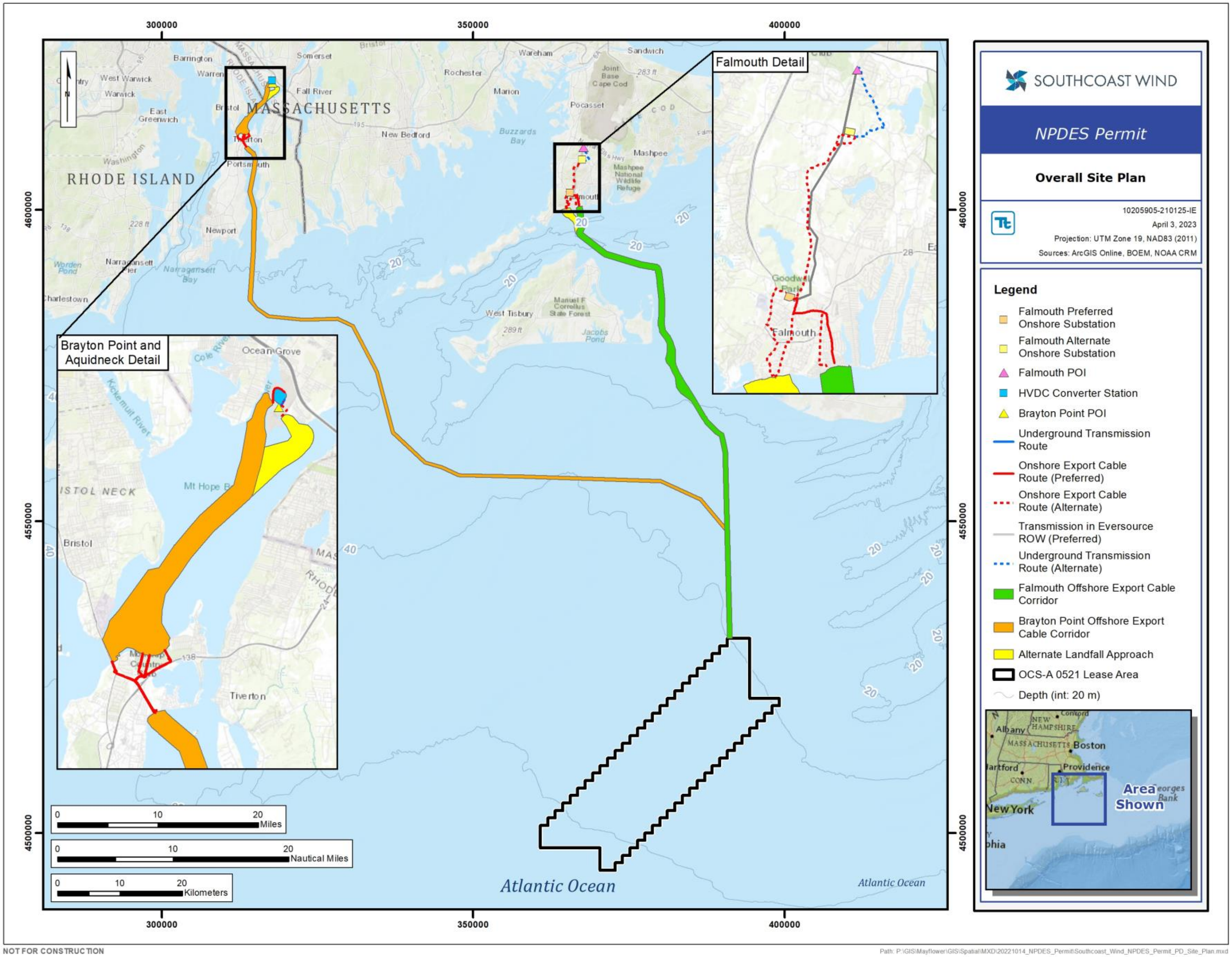


Figure 1. SouthCoast Wind Project Location

2.0 SOURCE WATER PHYSICAL DATA – SECTION §122.21(r)(2)

2.1 Description – (r)(2)(i)

SouthCoast Wind proposes an offshore wind renewable energy generation project (Project) located in federal waters off the southern coast of Massachusetts in the Outer Continental Shelf (OCS) Lease Area OCS-A 0521 (the Lease Area). There will be up to 149 positions in the Lease Area to be occupied by wind turbine generators (WTGs) and offshore substation platforms (OSPs). The 149 positions will conform to 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 Massachusetts Rhode Island Wind Energy Area (MA/RI WEA), as agreed upon by SouthCoast Wind and the other MA/RI WEA leaseholders. WTGs and OSPs will be connected via inter-array cables within the Lease Area. The Project will deliver electricity to the regionally administered transmission system via export cables with landfalls and Points of Interconnection (POIs) in Falmouth, Massachusetts (MA) and at Brayton Point in Somerset, MA.

SouthCoast Wind is considering up to five offshore substation platform (OSP) designs, but only one OSP design will include an HVDC converter station to be located on the same 1 nm x 1 nm (1.9 km x 1.9 km) grid layout as the WTGs. Each OSP design includes a topside, which will house the electrical equipment, and a foundation substructure, which will support the topside. The parameters under consideration for the proposed Project's OSPs vary depending on design, construction, and installation strategies and are discussed further in Section 3.3.3 of the SouthCoast Wind Construction and Operations Plan (COP). The proposed HVDC converter OSP will convert electric power from high voltage alternating current (HVAC) to high voltage direct current (HVDC) for transmission to the onshore grid system. This OSP could serve as a gathering platform for inter-array cables and then convert power from HVAC to HVDC or it could be connected to one or more HVAC gathering units and serve to convert power from HVAC to HVDC. Connection from another gathering OSP would be achieved via submarine cables. For separate HVAC gathering unit(s), they would be like those of the Modular and Integrated OSP platforms described in COP Sections 3.3.3.1 and 3.3.3.2. This NPDES Permit Application is for the first HVDC converter OSP to be installed within the SouthCoast Wind Lease Area. Additional NPDES Permits that will be required for future HVDC converter OSPs will be permitted under separate cover in the future.

The HVDC converter OSP will be installed on either a piled jacket or a gravity-base structure (GBS). A jacket substructure to support this large substation will have up to nine legs with up to three piles per leg. If a GBS structure is used, the GBS will be placed directly on the seabed. As compared to a jacket substructure, a GBS has a larger footprint, but does not require pile driving. A GBS foundation could be built as a single unit with the topside integrated with the substructure and installed at the same time, rather than installation of the substructure first and topside after.

Source water for the Project is the Atlantic Ocean. The Project, for the purposes of this NPDES permit application, is the HVDC Offshore Converter Station located at the Offshore Substation Platform (OSP). **Figure 2** shows the location of the Project in reference to the source water, physiographic features, and general layout of the facility. The Project's Lease Area (OCS-A 0521) is bordered by Lease Area OCS-A 0520 (Beacon Wind) to the northeast and OCS-A 0522 (Copenhagen Infrastructure Partners/Vineyard Wind) to the southeast. This portion of the Atlantic Ocean is part of the Northeast

U.S. Continental Shelf Large Marine Ecosystem, located between Nantucket Shoals and the Nantucket to Ambrose Safety Fairway. The water depths, in relation to Mean Lower Low Water (MLLW), within the Lease Area range from 121.7 feet (ft , 37.1 meters[m]) to 208.3 ft (63.5 m), with deeper waters in the southwestern portion. The average depth is 164.0 ft (50.0 m), as depicted in **Figure 2**.

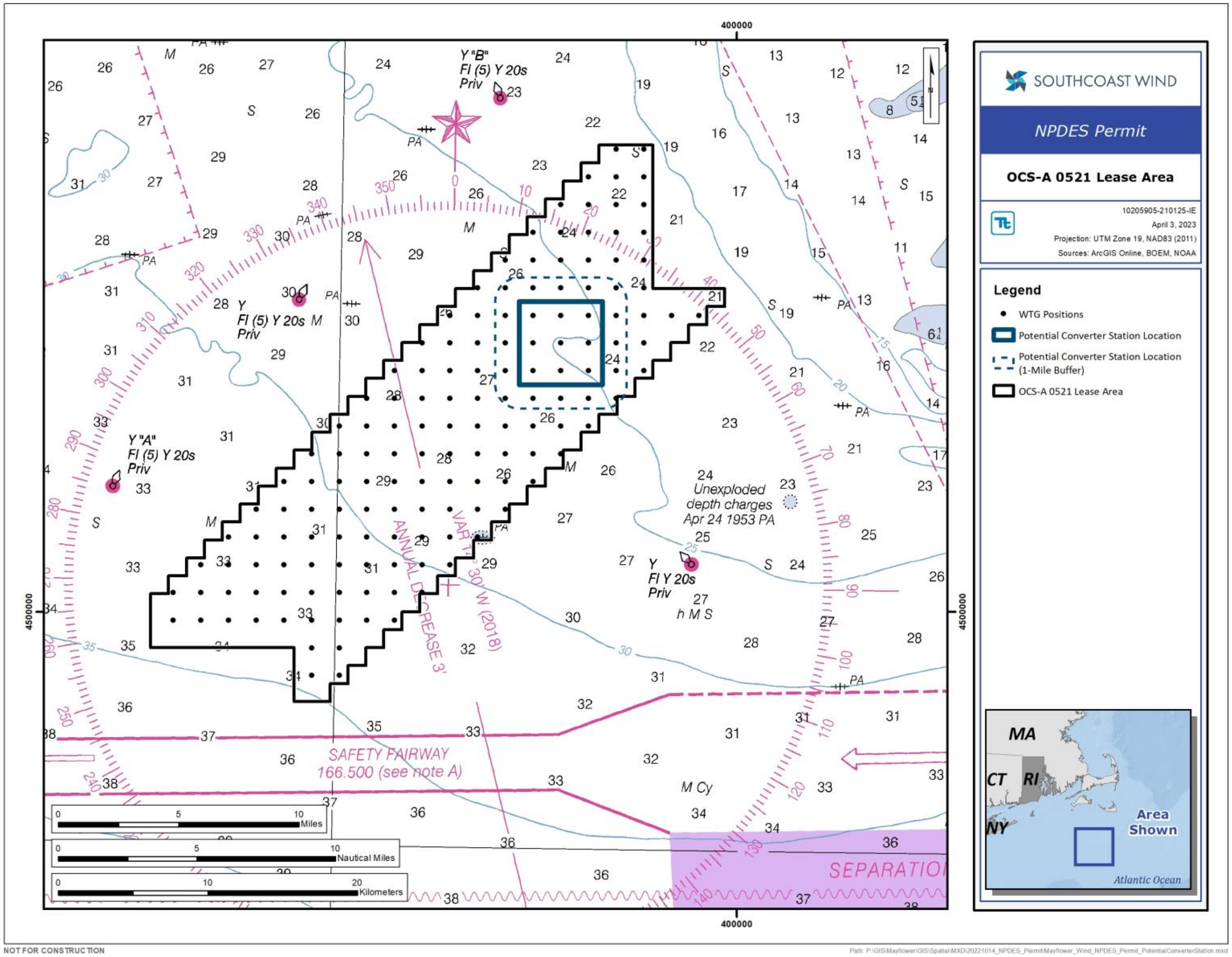


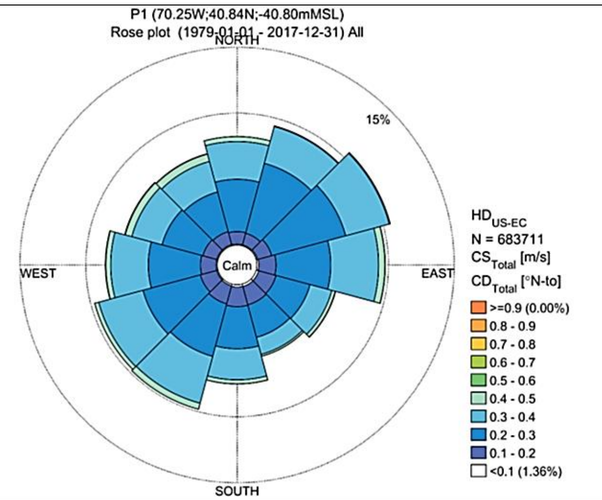
Figure 2. Approximate Location of the Offshore Substation Platform with Converter Station, within the Lease Area (at one of the existing positions, shown as black dots)

2.2 Hydrological and Geomorphological Features – (r)(2)(ii)

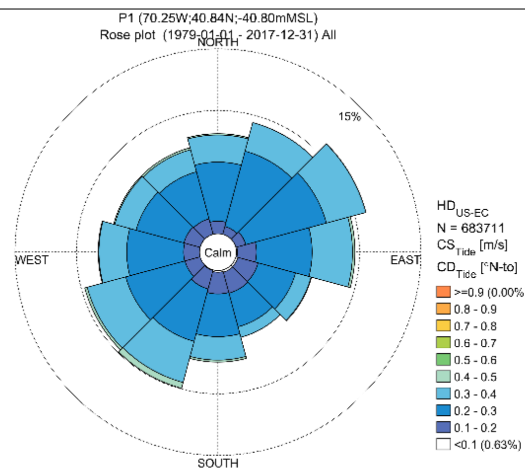
2.2.1 Hydrological Features

The tide is semi-diurnal in the Offshore Project Area (includes the Lease Area and offshore export cable corridors), with a tidal range of approximately two to three ft (0.6 to 0.9 m) in Nantucket Sound. Tidal currents are highest in Muskeget Channel as Nantucket Sound flows into the Atlantic Ocean, with speeds exceeding 3.5 nautical miles per hour (knots, 6.5 kilometers per hour; BOEM 2018).

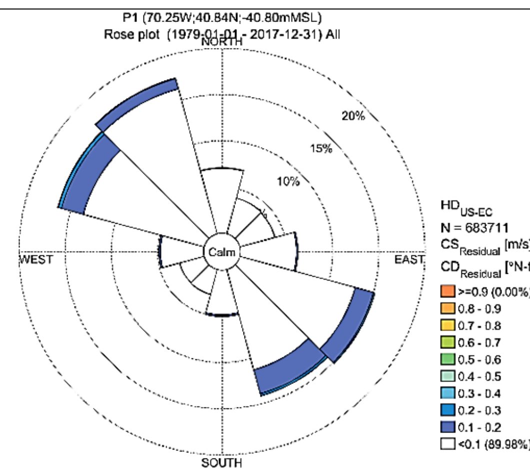
Rose plots showing model-estimated depth-averaged current direction and speeds in the Lease Area are depicted in **Figure 3**. The direction is indicated by the position of the shaded "spokes" on the compass rose. The percentage of time flow is from the spoke direction and is indicated by the concentric circles. The magnitude is indicated by colors. Depth-averaged currents are tidally dominated with residual components mainly aligned in the north-western and south-easterly directions.



A. Rose Plot of the Total Depth-Averaged Current Speed (Given as coming from °N)



B. Tidal Component

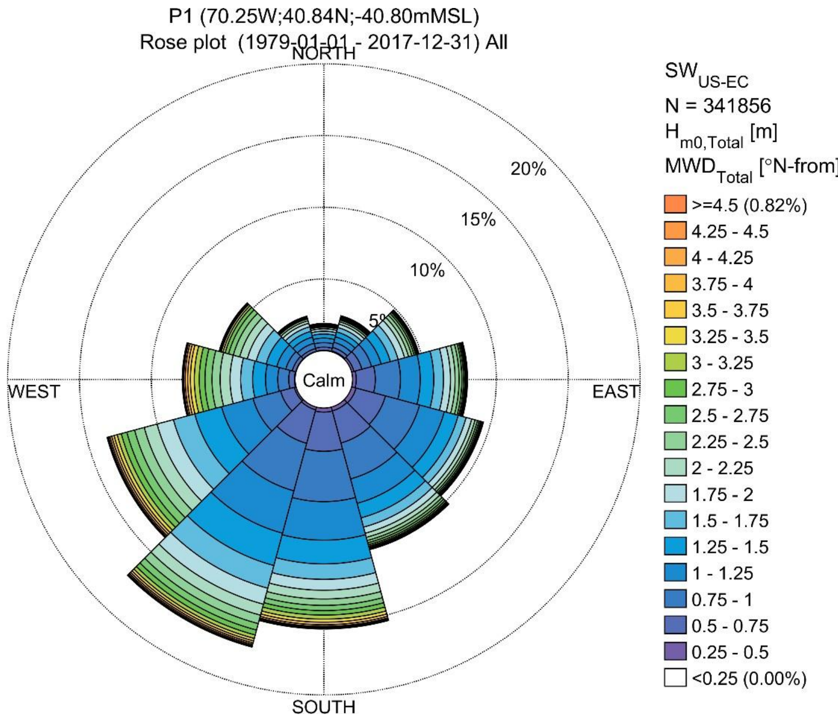


C. Residual (Non-tidal) Component

Source: DHI 2020

Figure 3. Rose Plots Depicting Model-Estimated Depth-Averaged Currents—Tidal and Non-Tidal Components

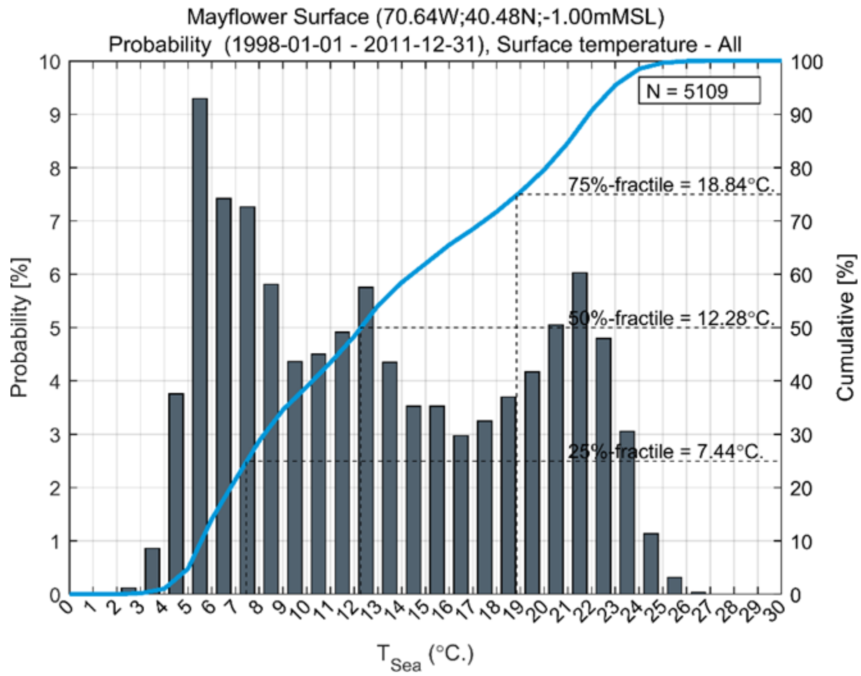
Swells are typically generated from hurricanes or tropical storm low-pressure systems occurring in the southern part of the Atlantic Ocean (Gleen 1992). Swells in the Lease Area occur mainly from the south and southwesterly directions. In **Figure 4** the total estimated sea swell in the Lease Area was visualized on a rose-plot using data spanning 1979 to 2017.



Source: DHI 2020

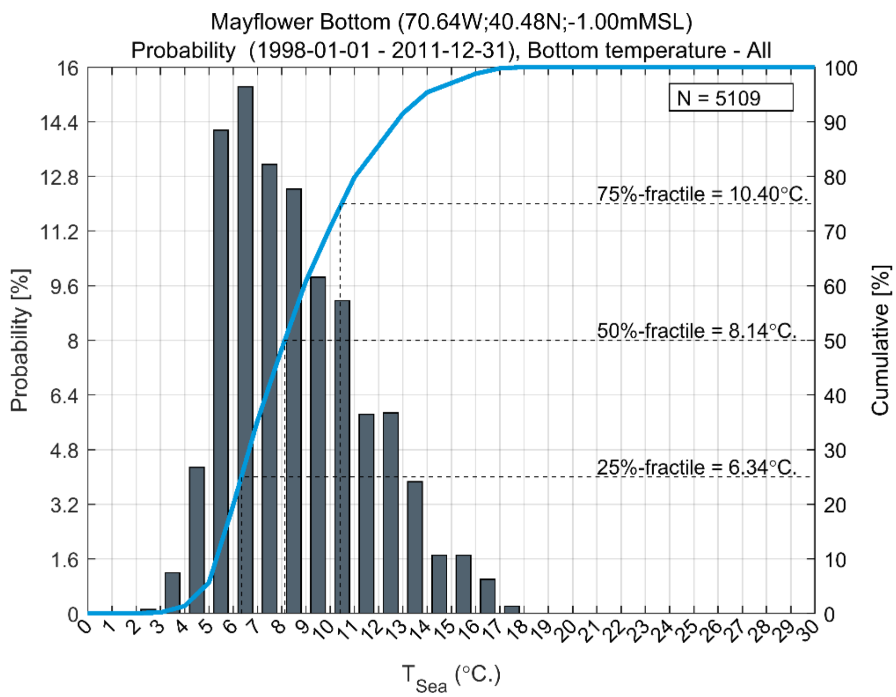
Figure 4. Rose-plot of swell height according to mean wave direction

Water temperatures across the Lease Area display large variations near the surface from 35.6° to 80.6° Fahrenheit (F) (2° to 27° Celsius [C]) with a 50 percentile of 54.1°F (12.3°C). Closer to the seafloor at water depths of 196.9 ft (60 m), water temperatures range from 35.6°F to 64.4°F (2°C to 18°C) with a 50 percentile of 46.4°F (8°C). **Figure 5** shows the distribution of water temperature on the sea surface, and **Figure 6** shows the distribution of water temperature near the seafloor for the Lease Area.



Source: DHI 2020

Figure 5. Sea surface water temperature in the Lease Area



Source: DHI 2020

Figure 6. Seafloor water temperature in the Lease Area

The predominant wind direction in the Offshore Project Area is from the west-southwest, as depicted in the wind rose chart in **Figure 7**. Wind direction and speeds can change dramatically during "Nor'easter" storms, when the wind direction is from the north-northeast.

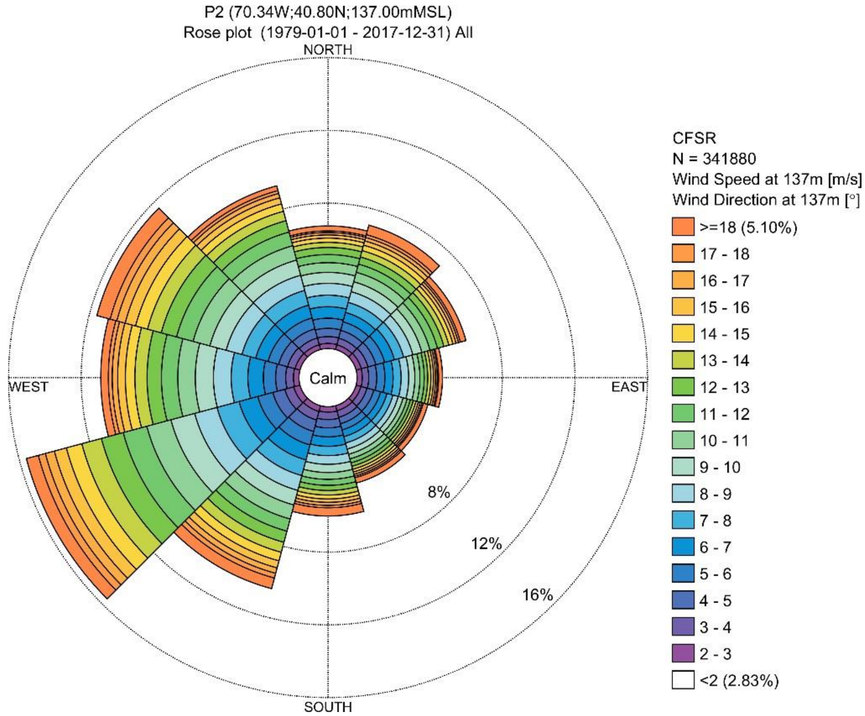


Figure 7. Lease Area Wind rose based on 39 years of data from 1979 to 2017 (DHI 2020)

2.2.2 Water Quality

This section summarizes available water quality data from within coastal and offshore marine waters in the vicinity of the proposed Project that have been collected by government and private entities, including the Northeast Fisheries Science Center (NEFSC), National Oceanic and Atmospheric Administration (NOAA) and EPA. Additional water quality data is available from the U.S. Geological Survey (USGS), and Massachusetts Department of Environmental Protection (MassDEP); however, those data are inshore and not applicable to this facility.

2.2.2.1 Northeast Fisheries Science Center

The NEFSC data, collected between 1963 and 2019 (NEFSC 2020a), includes salinity and temperature measurements from the bottom and surface of the water column. These data were collected during seasonal multispecies bottom trawl surveys occurring in the spring, fall, and winter. Sampling locations are displayed in **Figure 8** and the measurements are detailed in **Table 1**.

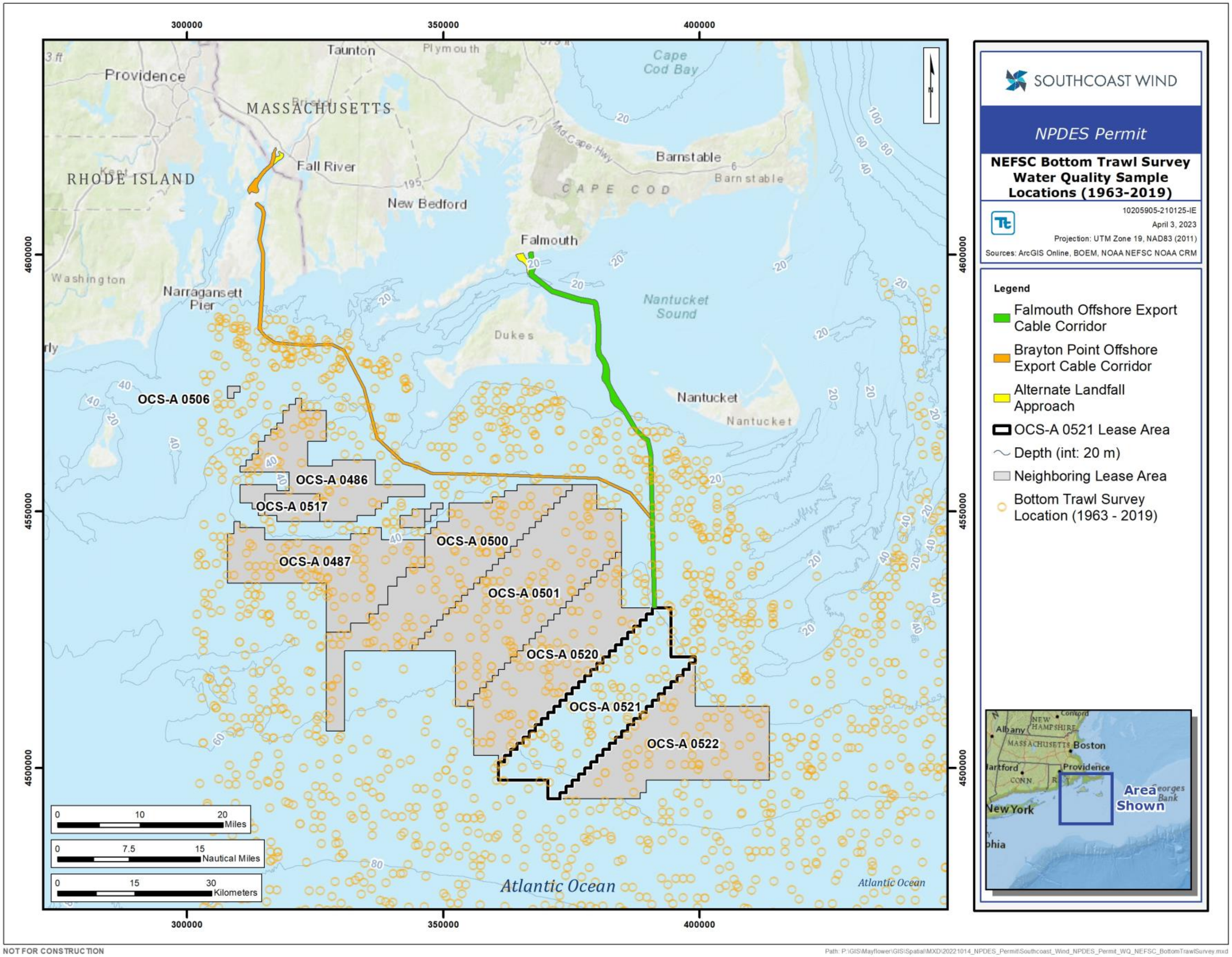


Figure 8. Bottom Trawl Survey – Water Quality Sample Locations (1963-2019)

Table 1. Mean and Standard Deviation for Seasonal Water Temperature and Salinity Data from the NEFSC Multispecies Bottom Trawl Surveys (1963-2019)

Season a/	Average Water Depth (ft [m])	Layer	Water Temperature (°C) b/	Salinity (psu) b/
Winter (n=355) c/	292.7 (89.2)	Bottom	6.9 ±3.5	33.5 ±1.2
		Surface	5.2 ±1.7	32.7 ±0.5
Spring (n=1621) c/	278.2 (84.8)	Bottom	6.7 ±3.2	33.3 ±1.2
		Surface	5.7 ±1.8	32.7 ±0.6
Fall (n=1704) c/	285.1 (86.9)	Bottom	12.7 ±2.4	33.4 ±1.4
		Surface	16.5 ±3.6	32.9 ±1.3

Notes:
a/ Summer data not collected in this survey.
b/ Results show mean ± 1 standard deviation.
c/ n= number of samples (not all samples were analyzed for all parameters).
psu = practical salinity units

2.2.2.2 National Oceanic and Atmospheric Administration National Data Buoy Center

Long-term water temperature data are available via the NOAA National Data Buoy Center (NDBC) for two buoys located in the vicinity of the Offshore Project Area. Station 44020 is in Nantucket Sound at a water depth of 46.9 feet (14.3 m) and Station 44097 is located near Block Island at a water depth of 158 feet (48.16 m). Water temperature data were downloaded from the NDBC website (NOAA NDBC 2020) for the period from 2009 through 2019 with seasonal values summarized in **Table 2** for Station 44020 and **Table 3** for Station 44097, with locations shown in **Figure 9**.

Table 2. Mean and Standard Deviation for Seasonal Water Temperature Data from NOAA NDBC Station 44020 (2009-2019)

Season	Number of Samples	Water Temperature (°C) a/
Spring	35,207	7.9 ± 3.9
Summer	45,520	20.9 ± 3.2
Fall	45,395	15.7 ± 4.8
Winter	33,529	3.9 ± 2.3

Note:
a/ Results show mean ± 1 standard deviation

Table 3. Mean and Standard Deviation for Seasonal Water Temperature Data from NOAA NDBC Station 44097 (2009-2019)

Season	Number of Samples	Water Temperature (°C) a/
Spring	39,154	7.6 ± 3.3
Summer	39,122	19.6 ± 3.3
Fall	32,521	17.0 ± 2.9
Winter	34,735	8.2 ± 2.8

Note:
a/ Results show mean ± 1 standard deviation.

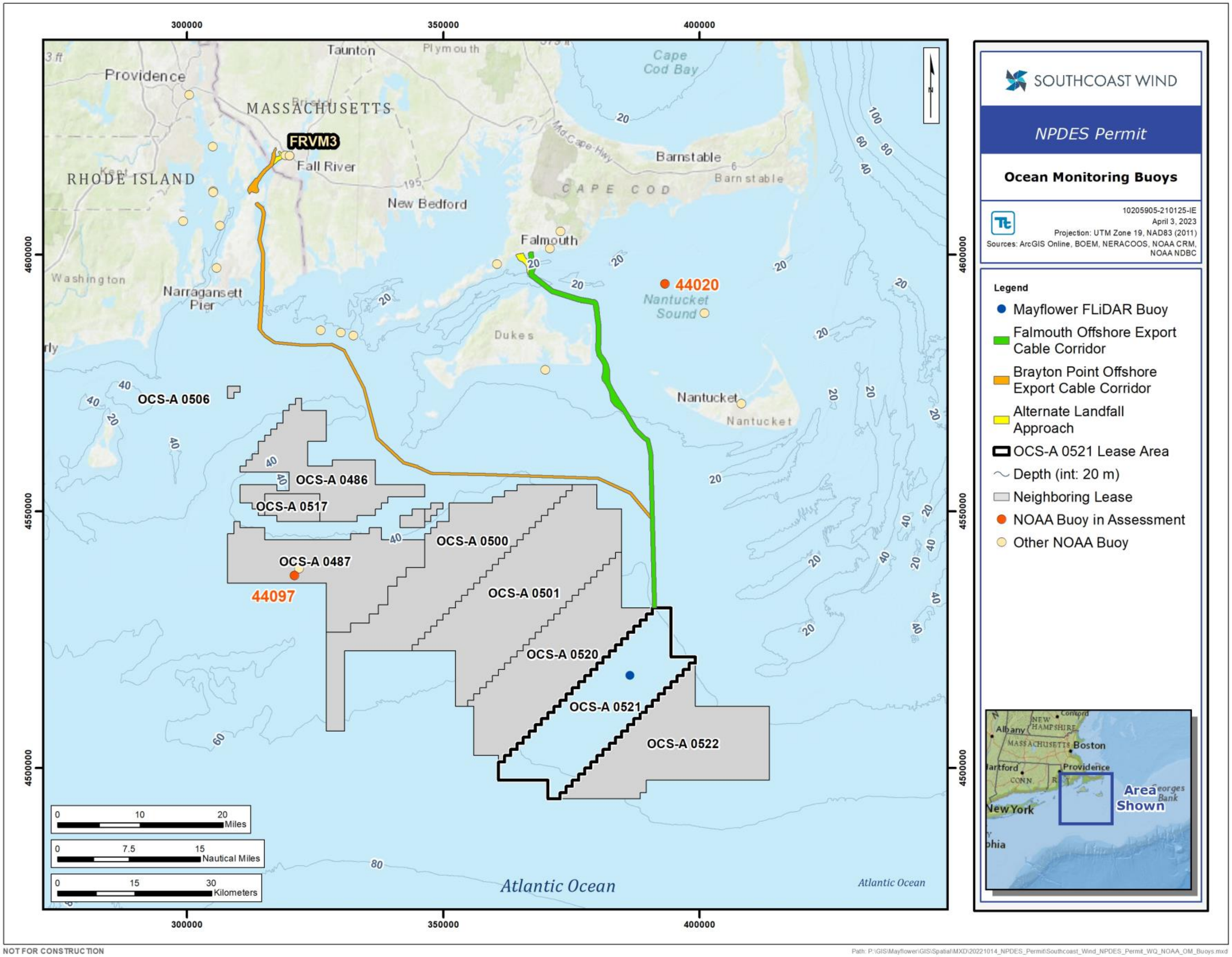


Figure 9. Location of Ocean Monitoring Buoys 44020, 44097, and FRVM3

2.2.2.3 Environmental Protection Agency

The condition of coastal water was assessed by the EPA in the 2010 National Coastal Condition Assessment (NCCA; EPA 2015). Water quality data from the 2010 NCCA are available for eight stations within Nantucket Sound. This assessment included chlorophyll *a*, dissolved inorganic nitrogen, dissolved inorganic phosphorus, dissolved oxygen at the bottom of the water column, and light transmissivity measurements. Water quality results for the Nantucket Sound data set are provided in **Table 4**. Four NCCA water quality sample locations were identified along the Brayton Point export cable corridor.

Table 4. Mean and Standard Deviation for Water Quality Parameters Measured in the 2010 NCCA

Area	Chlorophyll *a* (ug/L) a/	Dissolved Inorganic Nitrogen (mg/L) a/	Dissolved Inorganic Phosphorus (mg/L) a/	Dissolved Oxygen (mg/L) a/	Light Transmissivity (% at 1 m depth) a/
Nantucket Sound (n=8) b/	3.9 ± 1.1	0.019 ± 0.002	0.017 ± 0.003	6.5 ± 1.3	63.1 ± 5.1

Notes:
a/ Results show mean ± 1 standard deviation. mg/L = milligrams per liter; µg/L = micrograms per liter
b/ n= number of samples (not all samples were analyzed for all parameters)

2.2.3 Thermal Plume Modeling

The thermal plume associated with the discharge of cooling water from the OSP was modeled for this Project, summarized in this section and with additional detail included in Appendix A (SouthCoast Wind CORMIX Mixing Zone Results). A thermal mixing zone analysis was performed using CORMIX v12.0GTD Advanced Tools, to predict and analyze the temperature changes in the Atlantic Ocean during critical tidal and temperature conditions in fall, winter, spring, and summer months. The Metocean data were provided by SouthCoast Wind to identify and calculate the velocity, temperature, and salinity model input parameters for the CORMIX mixing zone model. Data outputs from the data-assimilative hybrid isopycnal-sigma-pressure (generalized) coordinate ocean model (called Hybrid Coordinate Ocean Model or HYCOM) were also used to help support defining the ambient condition and hydrodynamic characteristics for each season and tidal condition (HYCOM 2002). A mixing zone analysis was performed at the discharge location of the OSP (see **Figure 2**) into the Atlantic Ocean under a variety of conditions to evaluate the rise in temperatures of the receiving water in the vicinity of the discharge.

The EPA mixing zone regulations require that the “zone of initial dilution” be of a regularly shaped area, either circular or rectangular, surrounding the discharge structure (Doneker and Jirka 2021). According to Section 301 (h) of the Clean Water Act, the mixing zones from the industrial and other dischargers discharging into the coastal ocean are labeled as zones of initial dilution (Doneker and Jirka 2021); this same terminology is used to refer to the regulatory mixing zone in this document.

The CORMIX results were interpreted to identify the extent of the thermal plume, at the edge of the near-field region (NFR), a region controlled by the discharge conditions in a plume, within the context of a mixing zone. The plume dynamics were evaluated during minimum and maximum tidal conditions during four separate seasons to determine potential zones of initial dilution during those periods.

Table 5 and **Table 6** summarize the key numerical results of each CORMIX scenario, including the Atlantic Ocean temperature and the location and dimensions of the plume when the temperature delta is 1.8°F (1°C). Results were also analyzed at the edge of the NFR because this region is representative of strong initial mixing and is controlled by the discharge conditions. Appendix A (SouthCoast Wind CORMIX Mixing Zone Results) includes both plan view and profile view figures to depict the results visually, as follows:

- the 1.8°F (1°C) temperature delta isoline figures for the critical tidal conditions (scenarios 1 through 8),
- the 1.8°F (1°C) temperature delta isoline figures for the maximum temperature delta (scenarios 9 through 12), and
- the excess temperature thermal plume figures (scenarios 1 through 12).

Summary tables of CORMIX results are included in this section for critical tidal conditions and maximum temperature delta, with full detail (including figures) in Appendix A (SouthCoast Wind CORMIX Mixing Zone Results). The input values and resulting CORMIX modeling data are available as part of this permit application.

2.2.3.1 Critical Tidal Conditions

For the maximum current speed scenarios (Scenarios 1, 3, 5, and 7), the temperature delta at the edge of the NFR was less than 0.5°F. The NFR occurred between 266 ft and 312 ft away from the outfall (**Table 5**). The 1.8°F delta was met between 86 ft and 124 ft from the outfall. The plume widths were narrow, less than 10 ft.

For the minimum current speed scenarios (Scenarios 2, 4, 6, and 8), the temperature details were 1.6°F in the fall and summer and 2.4°F in the winter and spring (**Table 5**). The edge of the NFR occurred around 1,300 ft away from the outfall except for the summer scenario, which occurred 626 ft away from the outfall. For the fall and summer periods, the 1.8°F delta was met 1,137 ft and 541 ft away from the discharge pipe, respectively. For the winter and spring scenarios, the 1.8°F delta was met 13,384 ft and 11,879 ft away from the discharge pipe, respectively. Scenarios 2, 4, 6, and 8 utilize the absolute lowest current speeds observed during each season, and therefore should not be considered typical of thermal plume characteristics, since it is only representative of a small fraction (< 0.0025%) of conditions during each season, but rather an exceptionally rare 'worst-case' scenario.

The plumes in the minimum current speed winter and spring scenario have a strong upstream intrusion against ambient current. The upstream intrusion is likely caused by the small ambient current speed (0.03 miles/hr [0.015 m/sec]) combined with the strong buoyancy of the effluent and higher effluent discharge velocity. According to the metocean depth averaged hourly current speed from January 1, 2000, through December 31, 2017, an ambient current speed of 0.03 miles/hr [0.015 m/sec] occurred for 4 hours (0.0025%) in the spring and winter months, so the occurrence of these scenarios is exceptionally rare.

Table 5. CORMIX Results for Critical Tidal Condition Scenarios for SouthCoast Wind

Parameter	Scenario 1: Fall Max. Current Speed	Scenario 2: Fall Min. Current Speed	Scenario 3: Winter Max. Current Speed	Scenario 4: Winter Min. Current Speed	Scenario 5: Spring Max. Current Speed	Scenario 6: Spring Min. Current Speed	Scenario 7: Summer Max. Current Speed	Scenario 8: Summer Min. Current Speed
Edge of NFR								
Atlantic Ocean Temperature at the edge of NFR, °F (°C)	55.8 (13.2)	59.0 (15.0)	45.4 (7.4)	43.2 (6.2)	43.5 (6.4)	45.0 (7.2)	65.1 (18.4)	62.7 (17.1)
Temperature delta at the edge of NFR in the Atlantic Ocean, °F (°C)	0.3 (0.7)	1.7 (0.9)	0.4 (0.2)	2.5 (1.4)	0.5 (0.3)	2.4 (1.3)	0.3 (0.2)	1.6 (0.9)
Dilution ratio at the edge of NFR in the Atlantic Ocean	109.6	19.4	105.7	19.9	103.8	20.0	99.0	18.0
NFR distance[a/], feet (meters)	309 (94)	1,178 (359)	275 (84)	1,313 (400)	265 (81)	1,333 (406)	291 (89)	628 (191)
Plume where temperature delta is 1.8°F (1°C)								
Atlantic Ocean temperature at the edge of the plume, °F	57.3 (14.1)	59.1 (15.1)	46.8 (8.2)	42.5 (5.8)	44.9 (7.2)	44.4 (6.9)	66.6 (19.2)	62.9 (17.2)
Dilution ratio at the edge of the plume	19.2	18.8	25.0	27.4	26.1	26.3	14.0	16.9
Plume Length[a/], feet (meters)	46 (14)	1,149 (350)	126 (38)	33,806 (10,304)	129 (39)	11,907 (3,629)	90 (27)	561 (171)
Plume Width (maximum), feet (meters)	6 (2)	2,327 (709)	7 (2)	4,615 (1,407)	7 (2)	4,400 (1,341)	6 (2)	1,219 (372)
Plume Area, ft^2 ($meter^2$)	110 (10)	2,470,282 (229,497)	869 (81)	62,154,457 (5,774,338)	877 (81)	23,546,600 (2,187,551)	607 (56)	584,672 (54,318)

Notes:
a/ Distance from the outfall

2.2.3.2 Maximum Temperature Delta

The edge of the NFR ranged between 58 ft and 140 ft for the maximum temperature delta scenarios (**Table 6**). The temperature delta was 1.2°F or less at the edge of the NFR, and the 1.8°F delta was met less than 100 ft from the outfall for all four seasonal scenarios. The plume widths were narrow and ranged between 11 and 13 feet. These results indicate that impacts to the ocean temperature are minimal when the maximum temperature deltas occur.

Table 6. CORMIX Results for Maximum Temperature Delta Scenarios for SouthCoast Wind

Parameter	Scenario 9: Fall Max. Current Speed	Scenario 10: Winter Max. Current Speed	Scenario 11: Spring Max. Current Speed	Scenario 12: Summer Max. Current Speed
Edge of NFR				
Atlantic Ocean Temperature at the edge of NFR, °F (°C)	55.4 (13)	40.2 (4.6)	39.6 (4.2)	52.4 (11.3)
Temperature delta at the edge of NFR in the Atlantic Ocean, °F (°C)	1.4 (0.8)	0.7 (0.4)	1.0 (0.6)	1.2 (0.7)
Dilution ratio at the edge of NFR in the Atlantic Ocean	26.0	77.4	52.6	33.6
NFR distance[a], feet (meters)	56 (17)	155 (47)	93 (28)	65 (20)
Plume where temperature delta is 1.8°F (1°C)				
Atlantic Ocean temperature at the edge of the plume, °F	55.9 (13.3)	41.4 (5.2)	40.4 (4.7)	53.1 (11.7)
Dilution ratio at the edge of the plume	20.0	28.0	28.6	22.0
Plume Length[a/], feet (meters)	44 (13)	102 (31)	75 (23)	51 (16)
Plume Width (maximum), feet (meters)	30 (9)	9 (3)	11 (3)	21 (6)
Plume Area, ft^2 ($meter^2$)	455 (42)	898 (83)	816 (76)	537 (50)

Notes:
a/ Distance from the outfall

The area of influence (hydraulic zone of influence [HZI]) of the cooling water intake structure (CWIS) is described in Section 6.4.4.

Additional detail on the methods and results associated with the CORMIX modeling are included in Appendix A (SouthCoast Wind CORMIX Mixing Zone Results).

2.2.4 Geomorphological Features

The seafloor within the Lease Area is generally flat with slopes ranging from very gentle (less than 1°) to gentle (1° to 4.9°) (COP Appendix E, Marine Site Investigation Report [MSIR]). Lease Area water depths range from 121.7 ft (37.1 m) below MLLW at the north to 208.3 ft (63.5 m) below MLLW at the southernmost end. The central portion of the Lease Area has ridges with moderate slopes (5.0° to 9.9°) associated with shallow channels (**Figure 10**). No large-scale seabed topographic features or bedforms larger than ripples are present within the Lease Area. Multibeam echosounder (MBES) bathymetry data collected during the 2019 and 2020 High Resolution Geophysical (HRG) survey campaigns within the Lease Area are depicted in **Figure 11**. Sediment profile imaging and plan view

(SPI/PV) data collected as part of the benthic surveys indicates varying levels of surficial sediment mobility throughout the Lease Area, evidenced by the ubiquitous presence of bedforms (ripples) both large and small. The deeper shelf waters of the Lease Area and export cable corridors are characterized by predominantly rippled sand and soft bottoms.

Sediments were characterized using the NOAA Coastal and Marine Ecological Classification Standard (CMECS). Within the Lease Area, sediments were characterized as CMECS Subclass Fine Unconsolidated (i.e., less than 5 percent gravel) (**Figure 11**) during the Spring survey. Two samples (113 and 115) during the Summer survey were classified Coarse Unconsolidated – Gravelly – Gravelly Muddy Sand, as shown in **Figure 12**. The remaining Group classifications were mostly Mud, Sandy Mud, and Muddy Sand. A few stations (Spring [061] and Summer [062, 068, 078, 121 and 122]) were Sand with Subgroup Fine/Very Fine Sand. The Lease Area is mostly homogenous with little relief. The Lease Area is considered Soft Bottom habitat with no complex features. Total Organic Content (TOC) was generally less than 1 percent.

Figure 10 shows the distribution of seafloor morphological types within the Lease Area and at the Project location that are a mix of irregular small-scale pitting and mobile bedforms/ripples (wave-generated). Small-scale pitting describes a subtle texture comprising smooth seafloor with a relatively high density of small pits, probably of biotic origin, and typically 6.6 ft (2 m) in diameter and 0.3 ft (0.1 m) to 0.7 ft (0.2 m) deep. The texture is unlikely to indicate the presence of any sort of constraint on the proposed Project. Negative relief “rippled scour depressions” (RSDs) are a common and distinctive feature of shallow continental shelves with a low sediment supply, low tidal currents, and high wave energy. The generally random directionality of the RSDs and lack of consistent asymmetry supports an origin related to oscillatory bottom currents rather than any aggregate or net current flow or sediment transport. The wave-generated origin of the ripples within RSDs is also evidenced by their symmetrical profile and time-variable strike in response to passing storms. Wave generated ripples have a typical wavelength of 2.3 ft (0.7 m) to 4.9 ft (1.5 m) and trough-to-peak height of 0.07 ft (0.02 m) to 0.3 ft (0.10 m). Their morphology can be described as two-and-a-half dimensional or 2.5 D (i.e., generally straight crestlines but also slightly curvilinear and discontinuous).

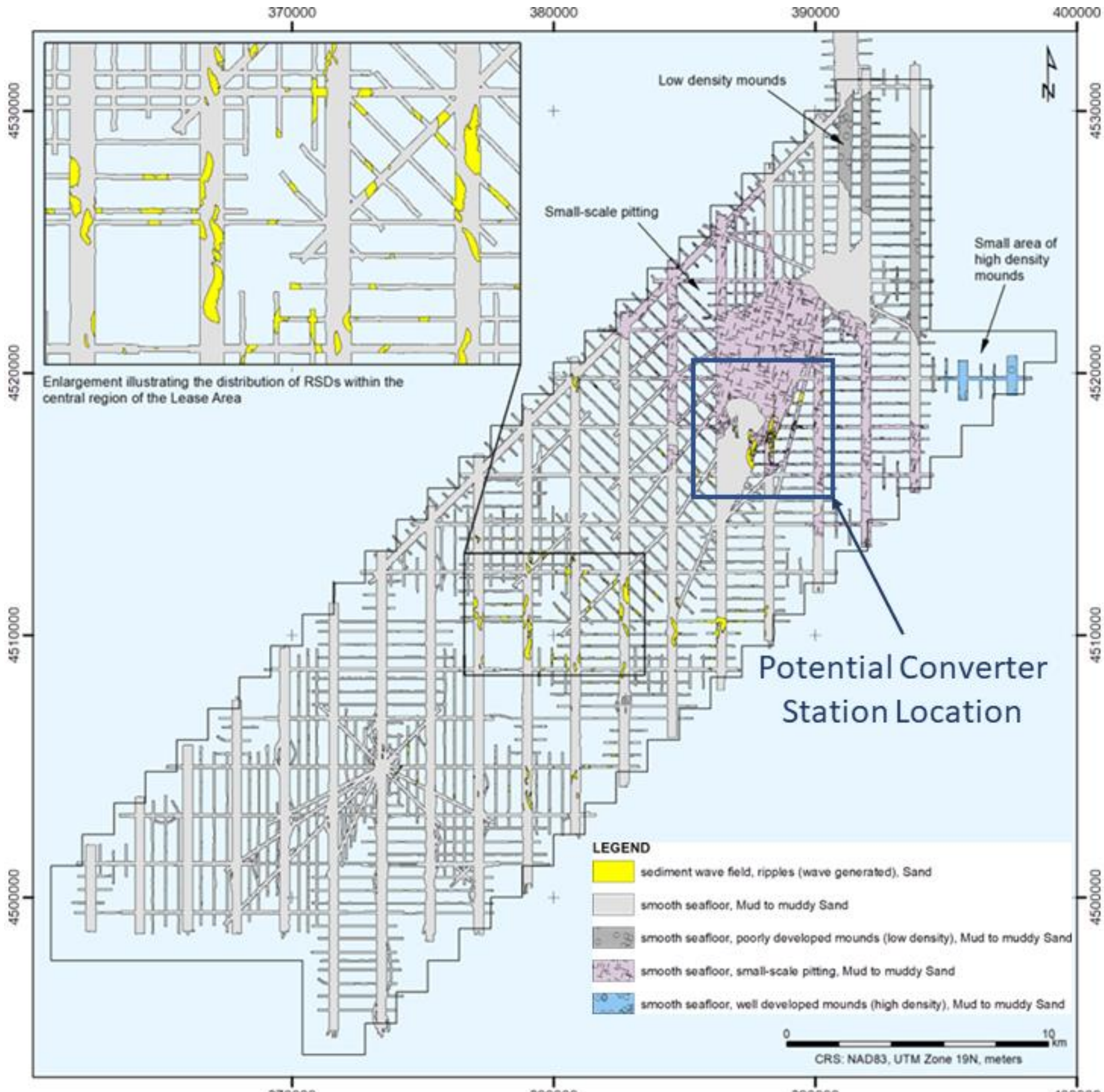


Figure 10. Seafloor geomorphology within the Lease Area

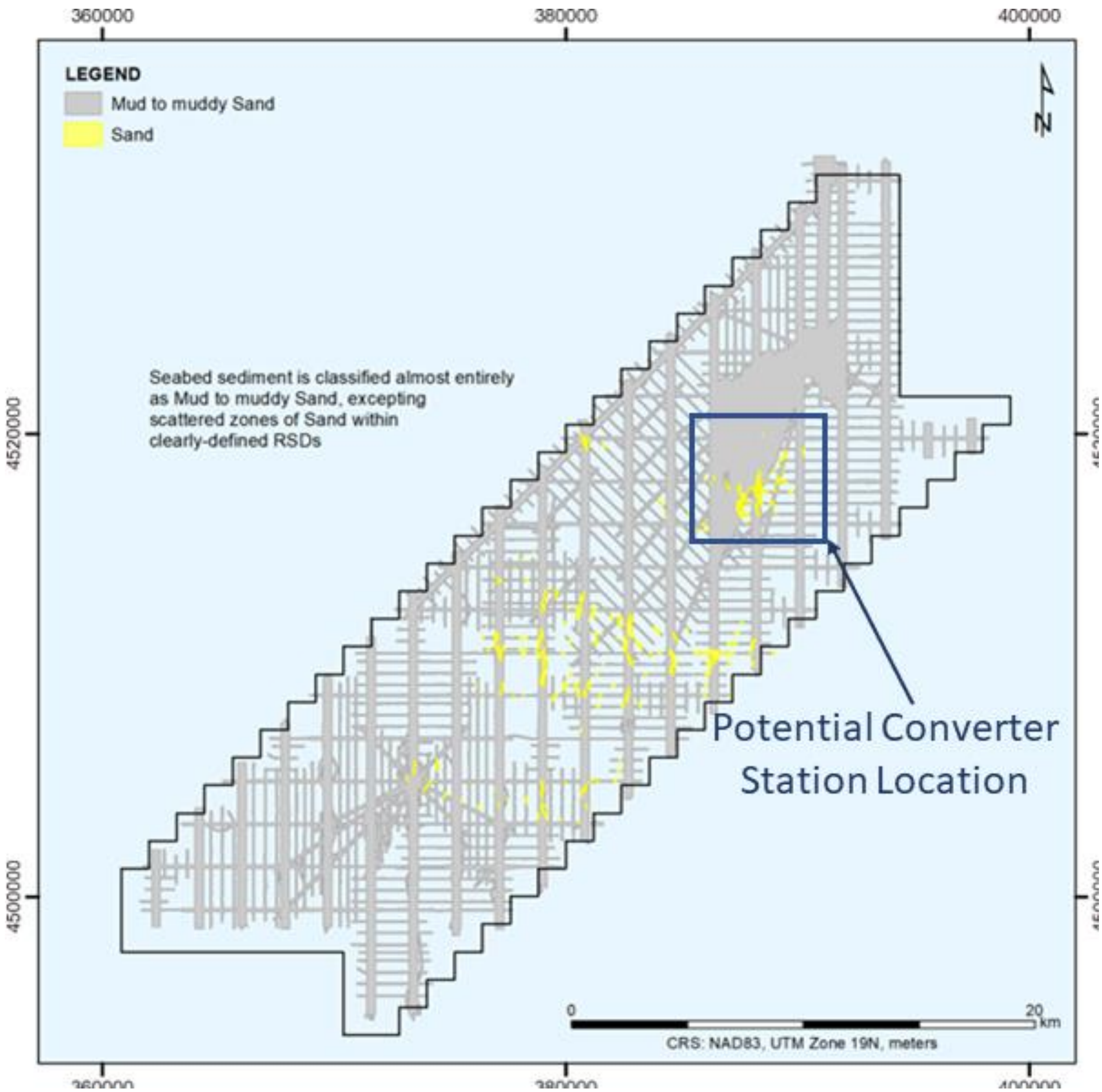


Figure 11. Seabed Sediment Type within the Lease Area

Unconsolidated sediments make up the top-most layer of the seabed, which has been further characterized and quantified by geophysical data and ground-truthed by grab samples taken of the uppermost 0.16 to 0.33 ft (0.05 to 0.10 m) of the seabed. Sediment from grab samples were analyzed using the Simplified Folk scheme (Long 2006). Under this scheme, surficial sediments within the Lease Area fall into either sand and muddy sand or coarse sediment classifications. The surficial seabed sediment comprises sand and muddy sand, except for a few distinct areas of more coarse sediment found in well-defined rippled scoured depressions. No boulder fields nor individual boulders have been mapped within the Lease Area based on the 2020 and 2021 HRG data.

The shallow subsurface of the Lease Area is characterized by a thick sequence of alternating Quaternary-aged deposits of coarse-grained and fine-grained sediments, overlying older pre-

Quaternary age Coastal Plain Deposits. The Coastal Plain Deposits are interpreted to be between approximately 148 ft and 263 ft (45 and 80 m) below seafloor beneath the southwest portion of the Lease Area. Ravinement surfaces and associated channelized units infilled with transgressive deposits have been mapped across the Lease Area. The sediment type within these channels consists of both fine-grained clays and silts, as well as coarser-grained sands.

2.2.5 Benthic Habitat Features

Benthic habitat features were assessed in a seasonal benthic survey campaign between 2020-2021 (COP Appendix M: Benthic and Shellfish Resources Characterization Report), which utilized grab samples and SPI/PV seafloor imagery. SPI/PV data collected as part of the benthic surveys indicates varying levels of surficial sediment mobility throughout the Lease Area, evidenced by the ubiquitous presence of bedforms (ripples) both large and small. The deeper shelf waters of the Lease Area are characterized by predominantly rippled sand and soft bottoms.

The dominant benthic habitat type observed in the Lease Area was Sand and Muddy Sand. A small swath of Coarse Sediment was present south of stations 084 and 094 (**Figure 12**), associated with an area of Wave Generated Ripples. Areas of Low Density Mounds were observed at the northernmost portion. Organisms found in the Lease Area included many typically found in Sand and Muddy Sand habitats, such as bivalves (e.g., clams), polychaetes and tube-forming amphipods. The complete classification of the seafloor in the Offshore Project Area is provided in COP Appendix E, MSIR.

Seafloor conditions in the Lease Area align with the findings at nearby leases showing low complexity, homogeneous, fine sand to silt with little relief (Epsilon Associates, Inc. 2018). Based on the NOAA Deep-Sea Coral Data Portal, there are no live bottom areas (e.g., reef type habitat near the Lease Area (NOAA 2020a). The closest live bottom areas are stony coral habitats observed approximately 19 mi (30 km) north and southwest of the Lease Area. Results of the benthic community structure analysis of Spring and Summer 2020 samples within the Lease Area confirmed the softbottom substrate was habitat for common benthic Soft Sediment Fauna with benthic infaunal assemblages dominated by tube-dwelling amphipods such as Ampelisca species (spp.), bivalves, and surface burrowing worm species (e.g., Cossuridae and Paraonidae).

Physical habitat characteristics were also interpreted from the SPI/PV and geophysical survey data. The SPI/PV images, grain size data from benthic survey grab samples, and images (grab camera) were used to identify the CMECS Substrate Components in terms of habitat type and substrate class/subclass/group/subgroup, where applicable. Within the Lease Area, the sediment was CMECS Subclass Fine Unconsolidated (i.e., less than 5 percent gravel) (**Figure 12**) during the Spring survey. Two samples (113 and 115, shown in (**Figure 12**) during the summer survey were classified Coarse Unconsolidated – Gravelly – Gravelly Muddy Sand. The remaining Group classifications were mostly Mud, Sandy Mud, and Muddy Sand. A few stations (Spring [061] and Summer [062, 068, 078, 121 and 122], shown in (**Figure 12**) were Sand with Subgroup Fine/Very Fine Sand. The Lease Area is mostly homogenous with little relief. The Lease Area is considered Soft Bottom habitat with no complex features. TOC was generally less than 1 percent.

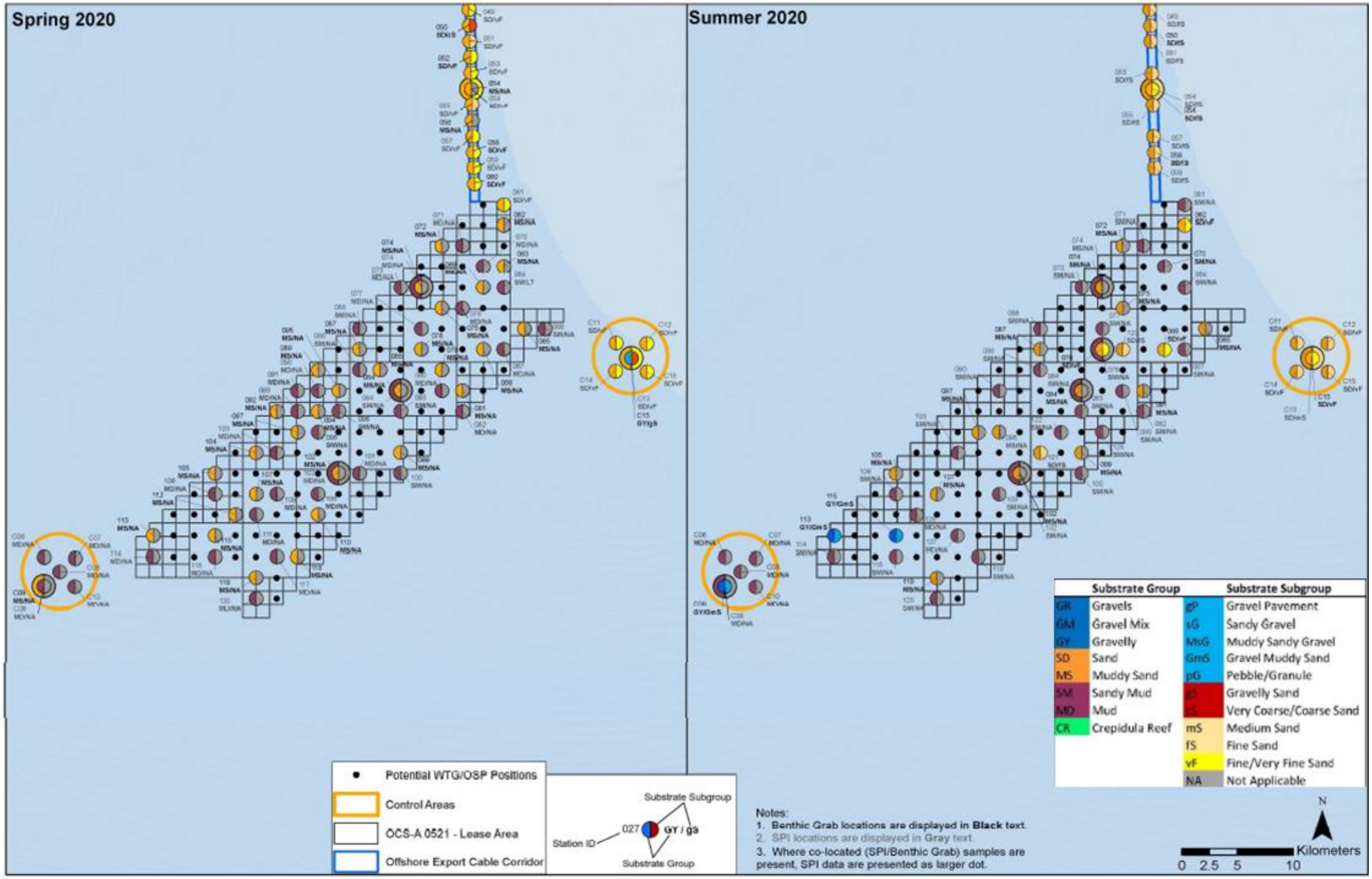


Figure 12. Sediment Types Observed during the Spring and Summer 2020 Benthic Surveys

Epifauna/megafauna and epiflora observed included macroalgae (red, green and brown), sponges, bryozoans, hydroids, barnacles, tunicates, anemones, gastropods, bivalves, nudibranchs, urchins, brittle stars, starfish, sand dollars, crabs (hermit, brachyuran, spider), amphipods, isopods, shrimp, squid, skates, and some finfish.

The Lease Area is classified as Fine Unconsolidated material, generally homogeneous and considered soft bottom habitat with no complex features. Epifauna/megafauna found in the Lease Area were classified as Soft Sediment Fauna, predominantly organisms living on the surface (i.e. crabs, sand dollars, gastropods) or burrowing into the sediment (i.e. anemones, amphipods, polychaetes).

Consistent with observations of epifauna, the dominant infaunal biotic subclass in the Lease Area was Soft Sediment Fauna (**Figure 13** and **Figure 14**). The biotic and co-occurring biotic groups found in the Lease Area in both Spring and Summer were typical of soft sediment environments and included clam beds (Nucula beds), larger tube-building fauna (Ampelisca, Corophium, and Leptocheirus amphipod beds), and small surface-burrowing fauna (Paraonidae and Cossuridae polychaetes).

Detailed information on the benthic habitat features of the Lease Area can be found in COP Appendix M, Benthic and Shellfish Resources Characterization Report.

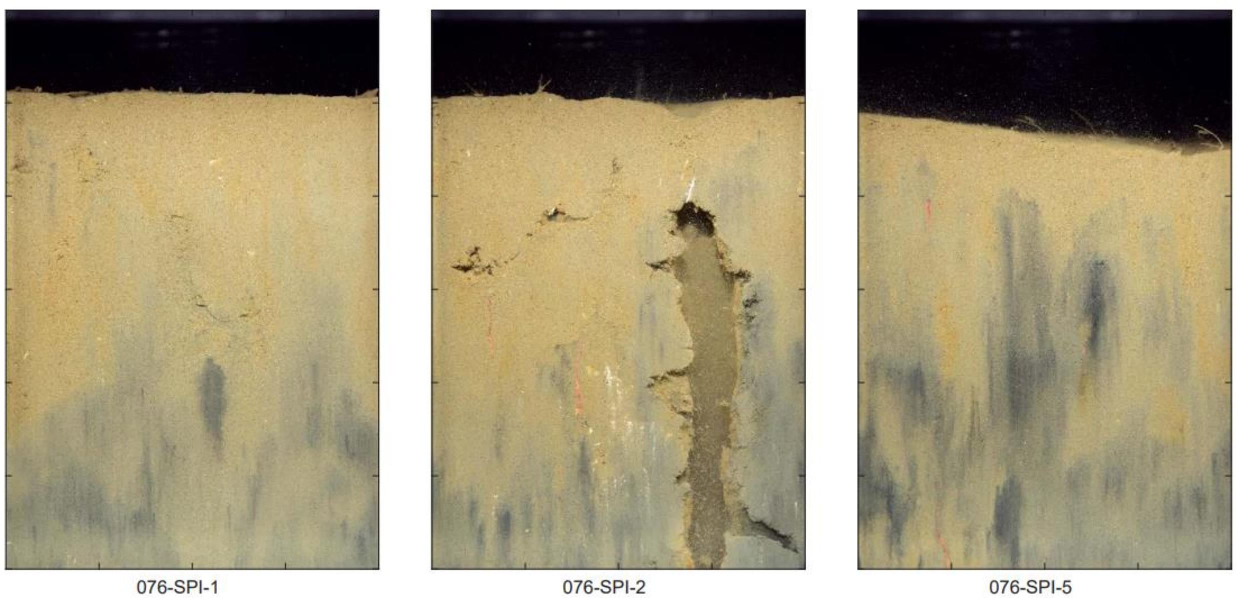
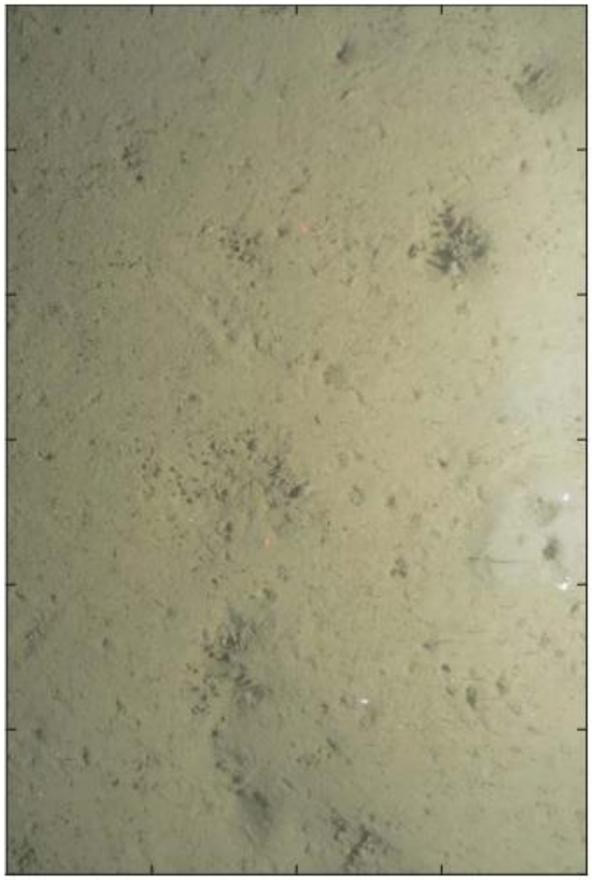


Figure 13. Representative SPI images from Station 076 (upper panel = May 2020, lower panel = August 2020).



076-PV-5

Figure 14. Representative PV image from Station 076.

2.3 Locational Maps – (r)(2)(iii)

Figure 1 and **Figure 2** (see Section 1.0) provide the location of the Project in reference to the source water, physiographic features, and general layout of the facility.

3.0 COOLING WATER INTAKE STRUCTURE DATA – SECTION §122.21(r)(3)

3.1 Configuration – (r)(3)(i)

The facility's CWIS will utilize a vertical pipe intake attached to the OSP jacketed or gravity-based foundation structure located in approximately 151.6 ft (46.2 m) of water (**Figure 15**). There are no traveling water screens associated with the facility. The CWIS does not contain a curtain wall or any type of debris handling system, besides the, bar rack and inline pump filter screens. There is no dedicated debris/fish return system since there are no traveling screens.

Table 7 provides an overview of the characteristics of the CWIS. Engineering design drawings to be provided, once information is available from OSP supplier.

Table 7. Characteristics of the CWIS at the SouthCoast Wind OSP Converter Station

Configuration Parameter	SouthCoast Wind OSP CWIS
Water Source	Atlantic Ocean
Cooling Water Intake System	Non-contact, once-through cooling
Configuration of intake	Up to three, approximately 3.3 ft (1 m) diameter vertical-shaft intake pipes, with flared ends to accommodate intake velocity requirements, set perpendicular to the seafloor, located within the jacketed or gravity-based foundation structure. The intake structure will include the following instrumentation: • temperature & water conductivity monitoring devices installed at the seawater lift pump intake. • the intake seawater flowline has an inline flow meter installed upstream of the seawater filter at the topside of the converter station. • temperature and flow monitoring devices are installed at the feed line and at the discharge outlet of the seawater heat exchanger. • mechanical sampling connections located at the return line of seawater. The samples are taken as required per NPDES permit conditions, to a laboratory for the analysis of pH and the total residual oxidant concentration. See schematic representations in **Figure 16** and **Figure 17**
Configuration of discharge	One or two, approximately 3.3 ft (1 m) diameter vertical-shaft discharge caisson, set perpendicular to the/composite seafloor, located within the jacketed or gravity-based foundation structure. The exact depth and location of discharge location will be based on the experience of previous projects in ensuring sufficient distance is maintained between the lift pump caisson and the overboard water caisson. See schematic representations in **Figure 15** and **Figure 16**.
Trash/debris bar rack	Each intake pipe will be equipped with a bar rack (either super duplex stainless steel or plastic/composite) to minimize entrapment of debris or marine organisms within the intake pipe. SouthCoast will consult with EPA and other agencies to ensure appropriate spacing of bars is protective of marine organisms, as applicable within engineering constraints (e.g., flow velocity, biofouling, etc.). Design would include either parallel bars or perforated plate.
Pump Screens/Strainers	Each seawater intake pipe is equipped with a dedicated filter (mesh size ranging from 250 µm to 25 mm), 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.
Number of traveling screens/ screen wells	N/A – no traveling screens
Water Depth of withdrawal, below surface at MLLW	Ranges from approximately 25 to 115 ft (7.6 to 35.0 m) below the surface
Water Depth of withdrawal, above seafloor	Approx. 32.8 ft (10 m) above the seafloor
Through-screen velocity (calculated from DIF)	Intake velocity will not exceed 0.5 ft/s for velocity-based impingement compliance option. A maximum velocity of 0.5 ft/s will be integrated into the engineering design of the CWIS to ensure compliance, as described in Section 6.2. The details of how the velocity is calculated will be determined during the detailed design phase and shared with EPA when available.
Circulating water intake pumps (seawater lift pumps)	Up to three, approximately 5,315 gpm raw seawater vertical lift pumps, each with a rated maximum flow of 7.7 MGD (approx. 75% of total CWIS flow requirements). Only two of the three pumps would be used under normal operating conditions, with the third pump serving as a spare/backup. Internal cooling flow is controlled with the use of a 3-way valve while maintaining a constant speed with seawater open loop cooling. See **Figure 18** for example of typical seawater vertical lift pump
Maximum Discharge Temperature	90°F (32.2°C), with maximum anticipated temperature change (ΔT) of 18°F (10°C) from ambient water

Configuration Parameter	SouthCoast Wind OSP CWIS
Total DIF	The system will be designed for a maximum flow of 10.2 MGD (DIF). Two of the seawater lift pumps will each provide 50% of that capacity during normal operating conditions (e.g., 5.1 MGD each, or 50% each of DIF). The design capacity/rating of a single seawater lift pump is 7.7 MGD. During normal operating conditions, each individual seawater lift pump will provide a maximum of 5.1 MGD out of its 7.7 MGD capacity (approx. 66% of the design rated design capacity), to ensure reliable, safe operating conditions at the unmanned OSP. Since it is not recommended to run seawater lift pumps continuously at 100% rated capacity, SouthCoast Wind determined the 10.2 MGD flow rate to be the maximum DIF necessary to operate the OSP. Seawater Lift Pump settings can be controlled with or without VFD. Internal cooling flow is controlled by use of a 3-way valve while maintaining a constant speed with the seawater open loop cooling. 7.7 MGD = rated design flow on each seawater lift pump (75% of total platform flow requirements). 10.2 MGD = max. average flow of 2 seawater lift pumps running at 50% each to provide the design 100% total platform flow (SouthCoast Wind is seeking 10.2 MGD maximum design intake flow in NPDES permit).
Actual Intake Flow (AIF)	To be determined based on average CWIS operational conditions. Per §125.92(a), AIF represents the average volume of water withdrawn on an annual basis by the cooling water intake structures over the past three years. After October 14, 2019, AIF means the average volume of water withdrawn on an annual basis by the cooling water intake structures over the previous five years.
Flow Reduction from Design Capacity	While 10.2 MGD is the DIF, a 50% flow reduction potential from DIF could be achieved by use of single-pump operation (5.1 MGD), or dual-pumps each operating at reduced capacity during certain metocean conditions (see Section 6.4.1).
Closed-cycle recirculating cooling	None. Closed-cycle cooling utilizing air or seawater is not an available technology for this type of unmanned offshore facility (see Section 6.4).
Chlorination System	The CWIS is equipped with an anti-fouling 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 (NaOCl) 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 ppm equivalent free chlorine concentration in the seawater intake lines. This method of continuous injection into the pump caisson is preferred because at a low dosage of NaOCl (i.e., 2 mg/l, 95 kg/day), the residual free chlorine at the outlet would be negligible and oxidized in the water with no negative impact.

Notes:
All specifications are approximate, subject to updates as the engineering design is developed.
AIF = Actual Intake Flow; DIF = Design Intake Flow; ft/s = feet per second; ft = feet; in = inch; gpm = gallons per minute; hp = horsepower; MGD = million gallons per day

The CWIS is located within the jacketed or gravity-based structure associated with the OSP (**Figure 15**). The jacketed or gravity-based structure offers protection from large debris, vessel traffic, or other hazards from contacting the to the intake pump shafts. Raw seawater for the facility will be withdrawn from the Atlantic Ocean from approximately 25 to 115 ft (7.6 to 35.0 m) below the surface. This depth of withdrawal, well below the water surface, is expected to substantially reduce the intake of floating debris, or otherwise entrainable buoyant eggs/larvae, from entering the CWIS, compared to a surface withdrawal.

There will be up to 3 seawater supply lines, each with a debris/bar rack, vertical pipe shaft attached to the jacketed or gravity-based structure, a seawater lift pump, an inline seawater filter (mesh size ranging from 250 µm to 25 mm) that screens debris and organisms from the pump shaft, and a seawater heat exchanger, in series with each of the lines capable of operating independently of the others. The seawater filters are self-cleaning with automated backwash cycles. From the filters, the seawater is routed to the seawater heat exchangers, where the non-contact cooling water allows for heat rejection to the discharge. After circulating through the heat exchanger, the non-contact seawater flows into the return header where it is routed to the seawater discharge caisson (see **Figure 16**).

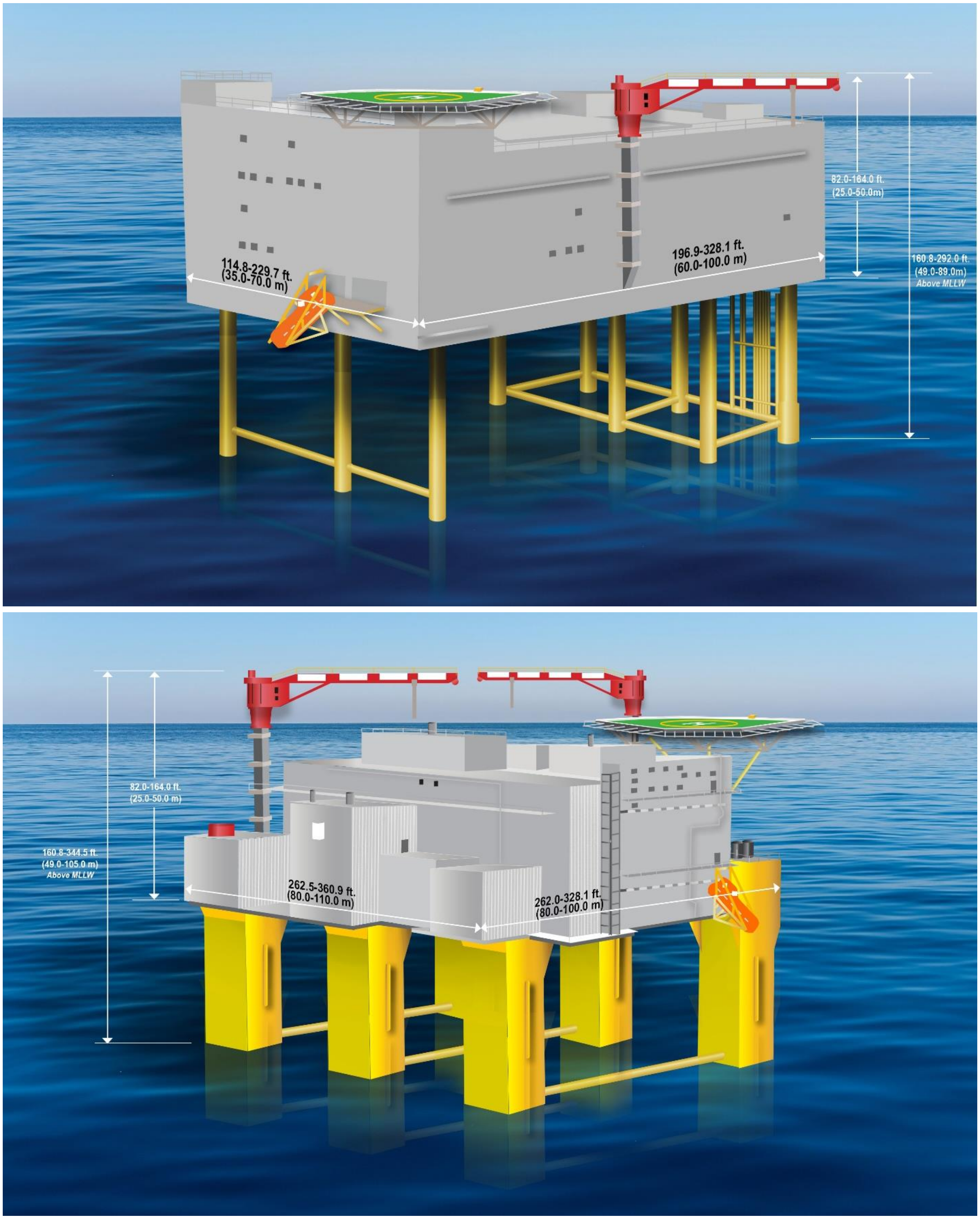


Figure 15. Indicative piled jacket OSP (top) and gravity-based OSP (bottom) where the HVDC Converter Station will be located

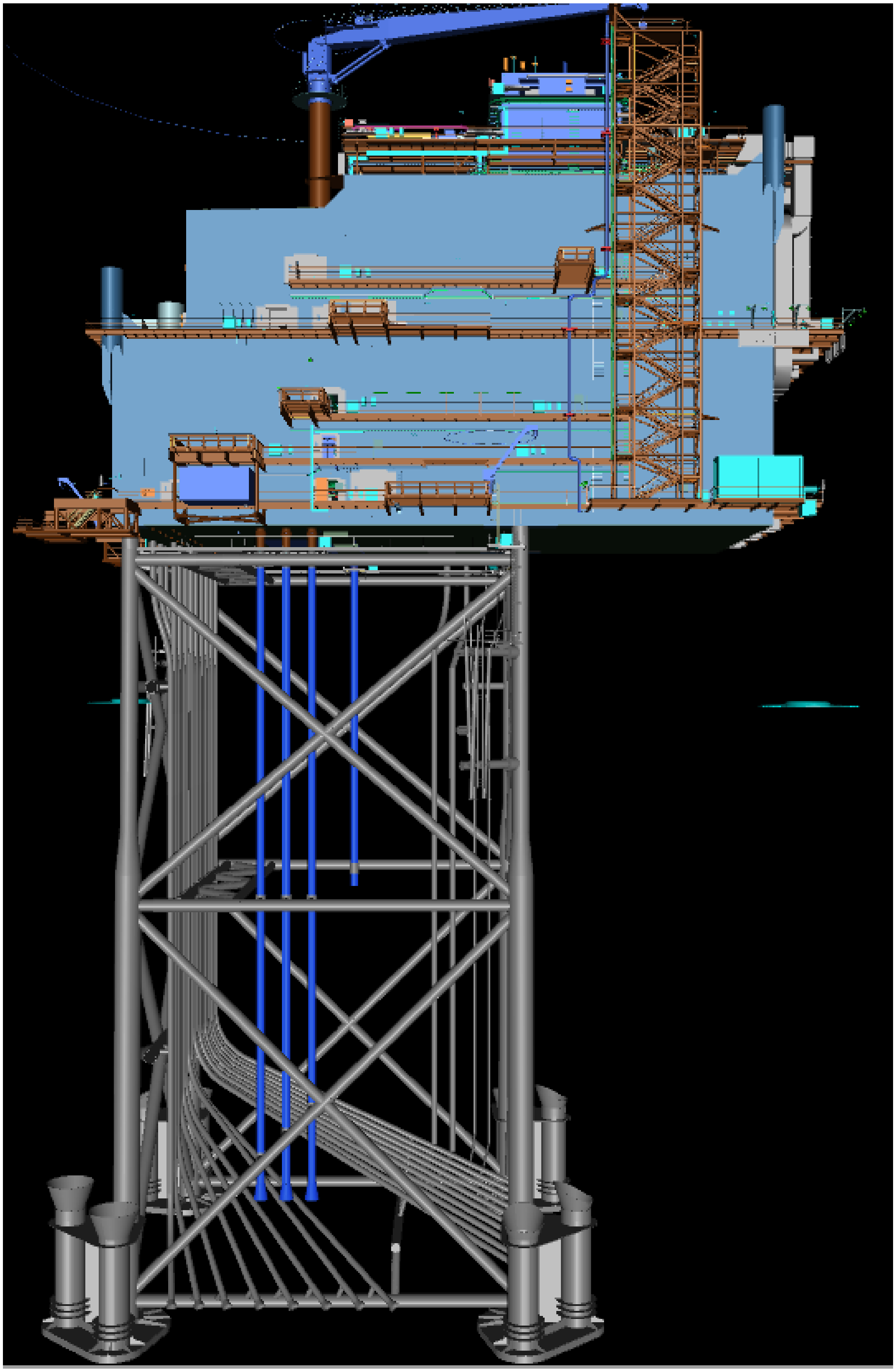


Figure 16. Indicative representation of the cooling water intake (3 longer blue pipes) and discharge caisson (single shorter blue pipe)

Each seawater lift pump is installed within a dedicated pump caisson. Locations and elevation depths of the pump caissons will be offset with that of the seawater discharge caisson to minimize commingling/re-circulation of warm discharge water with the seawater intake at the pump caissons. This will further serve to minimize the potential for re-entrainment of planktonic organisms in the water column, by physically separating the intake from the discharge. The seawater lift pump risers will be designed to ensure sufficient water flow to avoid accumulation of sediments and consequent pipe or equipment blocking.

Intake velocity requirements of 0.5 ft/s will be achieved by incorporating a flared (or bell-mount) pipe opening (see **Figure 17**) sized accordingly to ensure intake velocities across the bar rack do not exceed the 0.5 ft/s maximum velocity, as a preferred impingement compliance option (see Section 6.2)

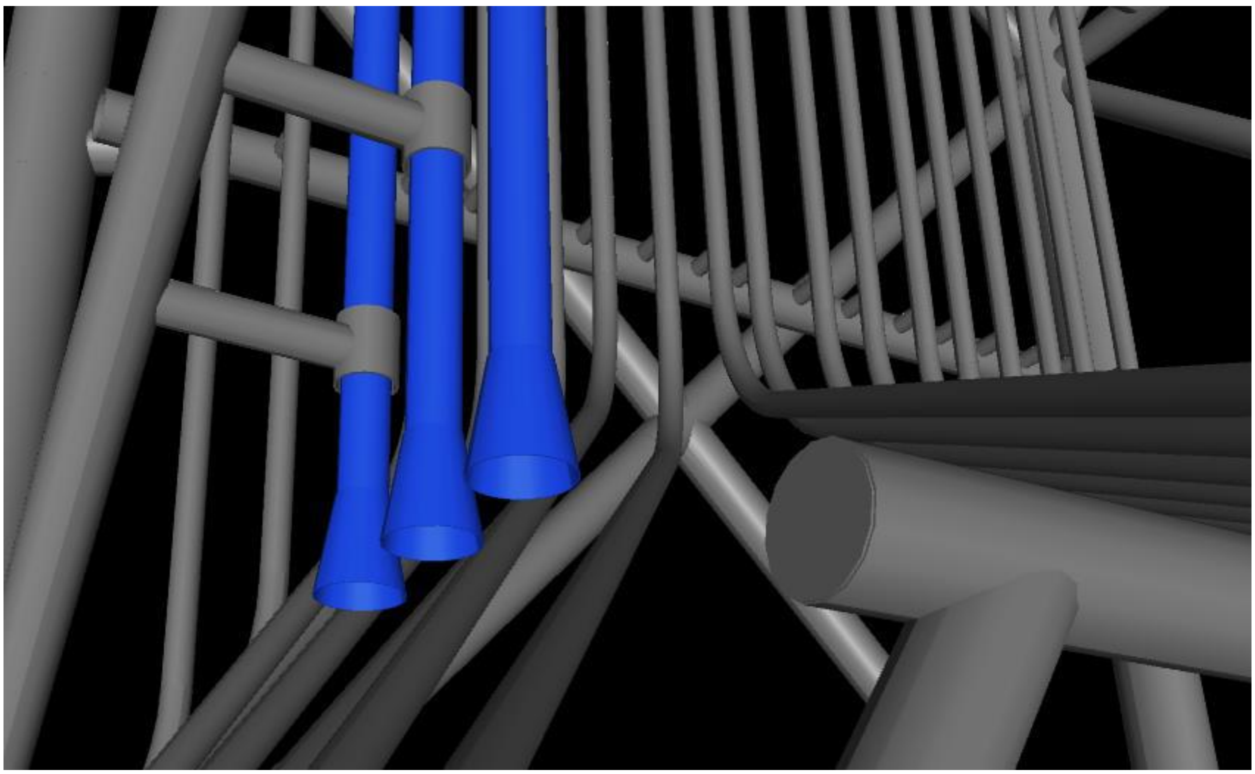


Figure 17. Indicative representation of the cooling water intake pipes, with flared/bell-mount openings sized to achieve intake velocity requirements

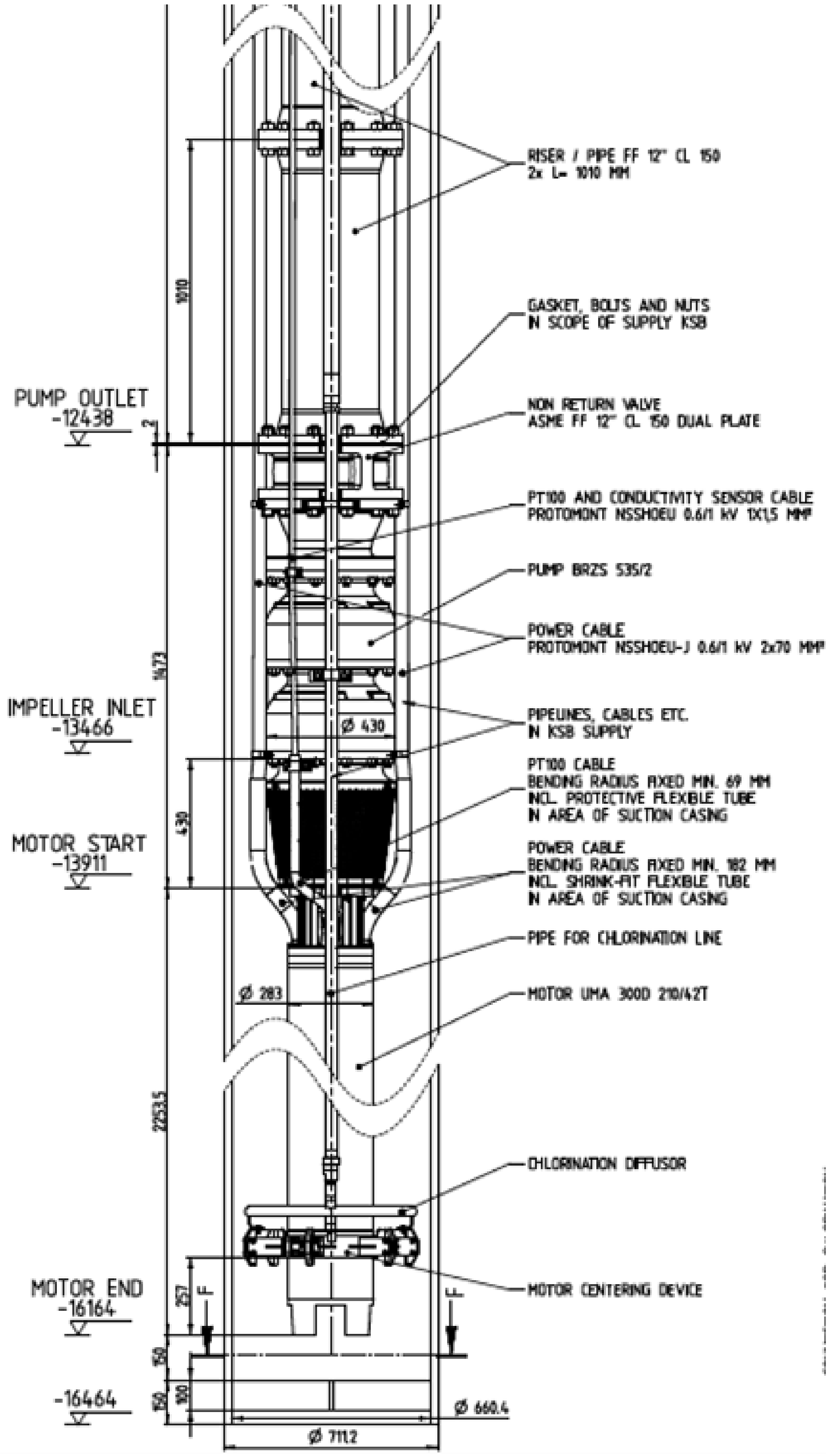


Figure 18. Typical seawater lift pump for the CWIS

3.2 Latitude and Longitude – (r)(3)(ii)

The CWIS to be used by the new facility will be located at the OSP to be sited within one of the nine positions shown in **Figure 2**, centered at approximately 40.805045 N, -70.324838 W, based on Northing (4517960 m) and Easting (388250 m) Universal Transverse Mercator (UTM) Zone 19N, North American Datum 1983 (NAD1983).

3.3 Operation of Cooling Water Intake Structure – (r)(3)(iii)

The CWIS providing non-contact once-through cooling water to the converter station will be operated 24 hours per day, 365 days per year, with the exception of scheduled outages and maintenance periods. At any time, either one or two pumps would be expected to be in operation simultaneously, with the third pump serving as a backup.

3.4 Flow Distribution and Water Balance – (r)(3)(iv)

Figure 19 depicts the facility's flow distribution and water balance. At the intake, several systems are being considered, but the most common system would be a Sodium Hypochlorite (NaOCl) Generator. There would be other expected waste streams being discharged, such as; stormwater run-off from the top deck, excluding the water from any equipment, and water from the oil/water separator, monitored using an online oil-in-water monitor. Collection tanks will be used for grey water, black water, and spill containment, for off-site (onshore) disposal via appropriate waste streams.

Additional detail of the flow distribution and water balance is not available at this time and will be provided as a supplemental filing at a later date, once information is known from OSP suppliers.

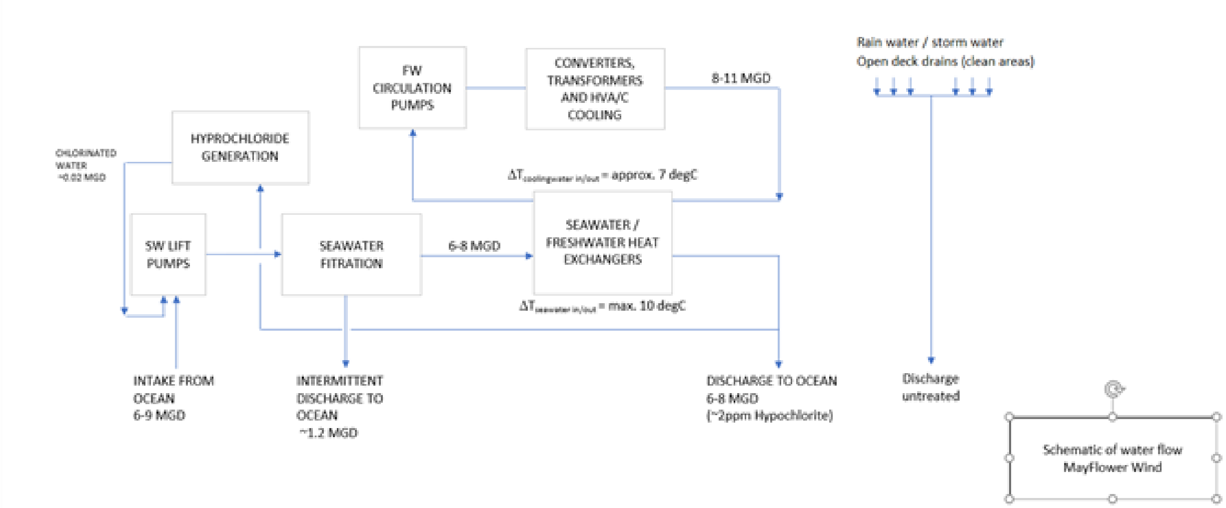


Figure 19. Flow distribution and water balance diagram for the OSP

3.5 Engineering Drawings – (r)(3)(v)

Engineering design drawings to be provided as a supplemental filing at a later date, once information is known from OSP suppliers.

4.0 SOURCE WATER BASELINE BIOLOGICAL CHARACTERIZATION DATA – SECTION §122.21(r)(4)

The intake for SouthCoast Wind's offshore HVDC converter station will be located in the marine waters of southern New England, about 25 miles (40 km) south of Martha's Vineyard. The water depth at this location is approximately 164.0 ft (50.0 m) and the seawater intake used for cooling water purposes will most likely be positioned approximately 32.8 ft (10 m) off the sea floor. Exact screen size and intake screen velocity have not been specified, but velocity will be at or less than 0.5 feet per second.

Biological characteristics of this area are typical of the neritic zone, the shallow marine environment extending from mean low water to about 656 ft (200 m) (generally equating to the continental shelf), including fish species categorized as pelagic (e.g., herrings and menhaden), demersal (e.g., flounder and gadids), and highly migratory (e.g., tunas and sharks). These temperate waters are considered highly productive, with an extensive array of plant and animal species ranging from phytoplankton to whales.

4.1 List of Data Not Available – (r)(4)(i)

No site-specific studies have been done to characterize the local composition of species that are susceptible to impacts of impingement and entrainment by SouthCoast Wind's cooling water intake structure (CWIS). No data are available to provide annual estimates of entrainment and impingement, as the CWIS has not yet been installed. Information for §122.21(r)(4)(ii)–(vi) was obtained from public data sets and the literature, upon which inferences on potential impingement and entrainment impacts are based.

4.2 Species and Lifestages – (r)(4)(ii)

Species or relevant taxa and life stages and their relative abundance in the vicinity of the cooling water intake were determined from several publicly available data sets including EcoMon plankton sampling (US DOC/NOAA Fisheries Northeast Fisheries Science Center 2019), the Rhode Island Department of Environmental Management (RI DEM 2022), Massachusetts Division of Marine Fisheries (MA DMF 2021) inshore trawl surveys, NOAA-NEFSC Spring/Fall bottom trawl surveys, and the literature review from the SouthCoast Wind COP(AECOM et al. 2021).

4.2.1 MARMAP/EcoMon Plankton Surveys

The Marine Resources Monitoring, Assessment, and Prediction program (MARMAP) collected zooplankton and ichthyoplankton abundance data on the U.S. Northeast continental shelf extending from North Carolina to Nova Scotia from 1977 through 1987. This survey used 505-micron mesh bongo nets following standardized protocols. The Ecosystem Monitoring (EcoMon) program continued the core part of MARMAP from 1992 to present using 333-micron mesh bongo nets. The herring-sand lance survey (1988–1994) and Georges Bank Global Ocean Ecosystems Dynamics survey (GLOBEC 1995–1999) also provided additional ichthyoplankton data. Ichthyoplankton density data compiled from these four surveys from 1997 through 2019 were obtained from the EcoMon plankton data that are publicly available from U.S. Department of Commerce (US DOC)/NOAA Fisheries Northeast Fisheries Science Center (2019).

The publicly available EcoMon plankton data set is a standardized subset of data that only contained ichthyoplankton from larval stages of common taxa. Taxa included in this EcoMon data set were based on a time series mean abundance greater than 100 per 100 m^3 and occurrence in greater than 5% of samples (US DOC/NOAA Fisheries Northeast Fisheries Science Center 2019). With randomized sampling stations per strata each year, the data set has limitations for representing the complete species and life stage composition immediately in the vicinity of the offshore converter station.

For providing an assessment of species and abundance of ichthyoplankton susceptible to entrainment at the offshore converter station, the EcoMon data were subset for fish taxa at 43 unique stations in closest proximity (10 miles [16 km]) to the SouthCoast Wind offshore converter station between 1977 and 2019 (**Figure 20**). Over the course of the 42-year time frame 30 unique fish taxa were identified and when combined, had a larval mean density of 603.3 larvae/100 m^3 (**Table 8**). However, a large majority (82.1%) of the fish collected in this data set were identified only as "class Pisces". The only taxa representing more than 1% of the overall larvae density were Atlantic herring (*Clupea harengus;* 4.6%), hakes (*Urophycis spp*; 46%), sand lances (*Ammodytes spp*; 4.1%), and summer flounder (*Paralichthys dentatus*; 1.6%).

To help better understand the ichthyoplankton abundance and composition in recent years in the vicinity of the SouthCoast Wind intake site, a subset of the 42-year data set was used to characterize fish taxa occurring in the most recent 10 years of data (2010-2019). This resulted in 8 unique stations with samples collected in March, May, August, October, and November, which makes this data likely to miss spring spawning fish species (**Table 9**). Given the timing of the cruises and randomization of sampling stations, sampling effort within 10 miles (16 km) of the anticipated location for the offshore converter station was limited. See Walsh et al. (2015) and Richardson et al. (2020) for additional details on these survey methods.

Data from the 8 selected stations from 2010 through 2019 included 17 unique fish taxa with a total larval mean density of 1,274.9 larvae/100m^3. Fish larvae with the most relatively abundant species identified within 10 miles (16 km) of the proposed intake location from 2010 through 2019 were unidentified hakes, summer flounder, and silver hake (*Merluccius bilinearis*).

A large majority (83.9%) of the fish collected in this data set were still identified only as "class Pisces" and were therefore limited in creating a complete list of species, though it can be assumed that the majority of the larvae were specimens of the species already identified which were too damaged to identify or not selected for identification in the laboratory. Still, this data allows for confirmation of presence of fish larvae from species with essential fish habitat (see Section 4.2.3) near the intake.

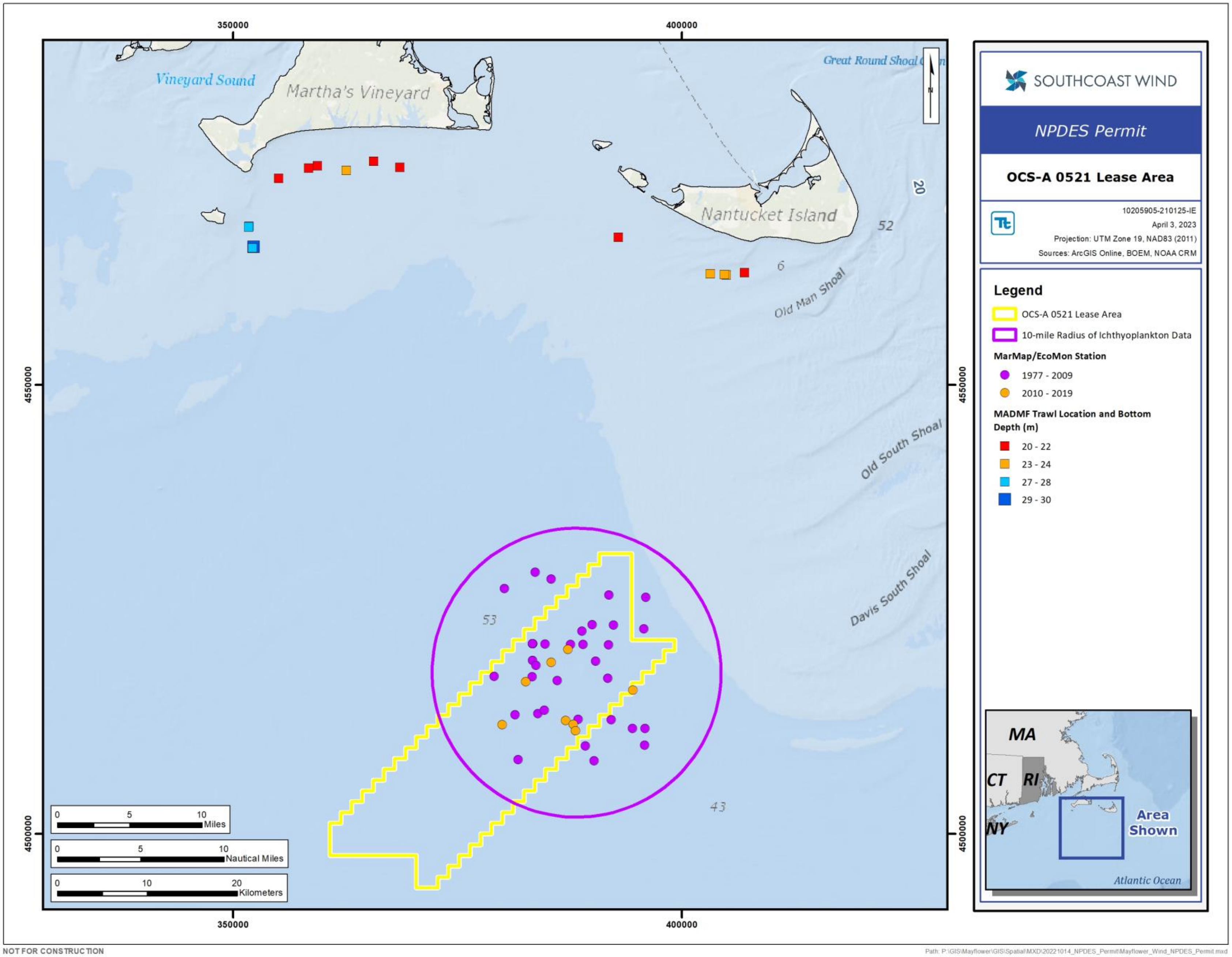


Figure 20. Location of select MARMAP/EcoMon ichthyoplankton bongo tows (US DOC/NOAA Fisheries Northeast Fisheries Science Center 2019) and MA DMF trawl locations with associated bottom depths in relation to the Project

Table 8. Monthly mean larval density (n/100m³) of abundant fish taxa collected in the EcoMon program within 10 miles (16 km) of the SouthCoast Wind offshore HVDC converter station during 1977-2019

Taxon		Jan (n=5)	Feb (n=4)	Mar (n=5)	Apr (n=2)	May (n=3)	Jun (n=2)	Jul (n=2)	Aug (n=2)	Sep (n=3)	Oct (n=4)	Nov (n=8)	Dec (n=3)	Mean	%
American Plaice	*Hippoglossoides platessoides*	0.0	0.0	0.4	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<0.1	<0.1
Atlantic Cod	*Gadus morhua*	1.0	0.8	3.5	2.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.1
Atlantic Croaker	*Micropogonias undulatus*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	<0.1	<0.1
Atlantic Herring	*Clupea harengus*	19.6	0.8	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.6	310.1	27.9	4.6
Atlantic Mackerel	*Scomber scombrus*	0.0	0.0	0.0	0.0	2.2	3.1	0.5	0.0	0.0	0.0	0.0	0.0	0.5	0.1
Atlantic Menhaden	*Brevoortia tyrannus*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.4	0.0	0.4	0.1
Butterfish	*Peprilus spp*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.1	2.1	0.6	0.0	0.0	1.2	0.2
Cunner	*Tautogolabrus adspersus*	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
Fish (unidentified)	*Pisces*	132.8	244.6	131.7	0.0	159.4	784.5	1,592.5	2,005.3	283.0	352.9	0.0	258.3	495.4	82.1
Fourbeard Rockling	*Enchelyopus cimbrius*	0.0	0.0	0.0	0.0	0.7	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.1	<0.1
Fourspot Flounder	*Hippoglossina oblonga*	0.0	0.0	0.0	0.0	0.0	0.0	0.5	24.6	1.5	1.9	0.0	0.0	2.4	0.4
Frigate tunas	*Auxis spp*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	<0.1	<0.1
Grubby	*Myoxocephalus aenaeus*	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<0.1	<0.1
Gulf Stream Flounder	*Citharichthys arctifrons*	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	18.3	12.5	0.1	0.0	2.6	0.4
Haddock	*Melanogrammus aeglefinus*	0.0	0.0	0.2	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.1	<0.1
Hakes	*Urophycis spp*	0.0	0.0	0.0	0.0	0.0	0.0	10.4	275.6	19.1	26.4	4.6	0.0	28.0	4.6
Large-tooth Flounders	*Etropus spp*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.8	0.0	0.0	0.1	<0.1
Longhorn Sculpin	*Myoxocephalus octodecemspinosus*	0.0	0.8	0.4	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	<0.1

Taxon		Jan (n=5)	Feb (n=4)	Mar (n=5)	Apr (n=2)	May (n=3)	Jun (n=2)	Jul (n=2)	Aug (n=2)	Sep (n=3)	Oct (n=4)	Nov (n=8)	Dec (n=3)	Mean	%
Monkfish	*Lophius americanus*	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	<0.1	<0.1
Offshore Hake	*Merluccius albidus*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	0.0	0.0	0.2	<0.1
Pollock	*Pollachius virens*	0.1	1.1	1.8	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	<0.1
Rock Gunnel	*Pholis gunnellus*	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	<0.1
Sand Lances	*Ammodytes spp*	52.1	99.3	59.3	86.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	24.8	4.1
Sea Robins	*Prionotus spp*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.3	0.0	0.0	0.0	0.0	0.3	0.0
Silver Hake	*Merluccius bilinearis*	0.2	0.0	0.0	0.0	0.0	0.0	0.0	21.8	6.3	6.9	7.6	0.0	3.6	0.6
Summer Flounder	*Paralichthys dentatus*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	77.0	23.9	17.4	0.8	9.9	1.6
Windowpane	*Scophthalmus aquosus*	0.0	0.0	0.0	0.0	0.4	0.0	0.0	3.3	26.3	2.0	1.7	0.0	2.8	0.5
Winter Flounder	*Pseudopleuronectes americanus*	0.0	0.0	6.3	0.0	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.1
Witch Flounder	*Glyptocephalus cynoglossus*	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	<0.1
Yellowtail Flounder	*Limanda ferruginea*	0.0	0.0	0.0	0.0	7.0	3.6	0.5	0.6	0.0	0.0	0.0	0.0	1.0	0.2
	Total	**206.0**	**347.4**	**204.1**	**89.9**	**172.7**	**793.3**	**1,606.5**	**2,347.0**	**433.9**	**429.7**	**39.6**	**569.1**	**603.3**	**100.0**

Note:
n = number of EcoMon samples collected during each month, within a 10-mile (16-km) radius of the Project

Table 9. Monthly mean larval density (n/100m^3) of abundant fish taxa collected in the EcoMon program within 10 miles (16 km) of the SouthCoast Wind offshore HVDC converter station during 2010-2019.

Taxon		Mar (n=1)	May (n=1)	Aug (n=1)	Oct (n=1)	Nov (n=4)	Mean	%
Atlantic Croaker	*Micropogonias undulatus*	0.0	0.0	0.0	0.0	0.4	0.1	0.0
Atlantic Herring	*Clupea harengus*	0.0	0.0	0.0	0.0	5.7	1.1	0.1
Atlantic Menhaden	*Brevoortia tyrannus*	0.0	0.0	0.0	0.0	8.8	1.8	0.1
Butterfish	*Peprilus spp*	0.0	0.0	24.2	0.0	0.0	4.8	0.4
Fish (unidentified)	*Pisces*	0.0	0.0	4,010.7	1,336.7	0.0	1,069.5	83.9
Fourbeard Rockling	*Enchelyopus cimbrius*	0.0	2.0	0.0	0.0	0.0	0.4	0.0
Fourspot Flounder	*Hippoglossina oblonga*	0.0	0.0	49.3	7.5	0.0	11.4	0.9
Frigate tunas	*Auxis spp*	0.0	0.0	0.9	0.0	0.0	0.2	0.0
Hakes	*Urophycis spp*	0.0	0.0	546.6	88.6	9.0	128.9	10.1
Offshore Hake	*Merluccius albidus*	0.0	0.0	0.0	7.5	0.0	1.5	0.1
Pollock	*Pollachius virens*	0.8	0.0	0.0	0.0	0.0	0.2	0.0
Sand Lances	*Ammodytes spp*	45.5	0.0	0.0	0.0	0.0	9.1	0.7
Sea Robins	*Prionotus spp*	0.0	0.0	6.5	0.0	0.0	1.3	0.1
Silver Hake	*Merluccius bilinearis*	0.0	0.0	43.7	13.7	13.6	14.2	1.1
Summer Flounder	*Paralichthys dentatus*	0.0	0.0	0.0	92.4	31.0	24.7	1.9
Windowpane	*Scophthalmus aquosus*	0.0	0.0	6.5	2.4	3.4	2.5	0.2
Winter Flounder	*Pseudopleuronectes americanus*	12.3	4.9	0.0	0.0	0.0	3.4	0.3
	Total	**58.6**	**6.9**	**4,688.4**	**1,548.9**	**71.9**	**1,274.9**	**100.0**

Note:
n = number of EcoMon samples collected during each month, within a 10-mile (16-km) radius of the Project

4.2.2 State Trawl Surveys

The Rhode Island Department of Environmental Management (RI DEM) and Massachusetts Division of Marine Fisheries (MA DMF) each conduct bi-annual (spring and fall) inshore trawl surveys in state waters to characterize fish abundance. Site-specific data for south of Martha's Vineyard and Nantucket were available from the MA DMF survey, but the RI DEM data included all state waters. Both data sets include sites of similar depth (approx. 164 ft [50 m]) in a reasonable proximity to the SouthCoast Wind intake site and the relative abundance data is therefore likely to represent the species composition for adult fish and invertebrates selected by the trawl gear in the area (**Figure 20**).

The most abundant species present in both surveys for the most recent year available (2021) was scup (*Stenotomus chrysops*; RI DEM 2022, MA DMF 2021). RI DEM's publicly available data does not differentiate between spring and fall surveys, but after scup, the top species were longfin squid, bay anchovy (*Anchoa mitchilli*), weakfish (*Cynoscion regalis*), and Atlantic moonfish (*Selene setapinnis*; **Table 10**), and total of 64 species were captured in 2021 (RI DEM 2022).

Table 10. Abundance and relative abundance of top ten species from Rhode Island Department of Environmental Management trawl survey 2021.

Common Name	Scientific Name	Abundance	Relative Abundance
Scup	*Steotomus chrysops*	58,719	28.00%
Longfin Squid	*Doryteuthis pealeii*	35,910	17.62%
Bay Anchovy	*Anchoa mitchilli*	26,865	13.18%
Weakfish	*Cynoscion regalis*	21,677	10.63%
Atlantic Moonfish	*Selene setapinnis*	13,446	6.60%
Butterfish	*Peprilus triacanthus*	12,456	6.11%
Atlantic Silverside	*Menidia menidia*	11,140	5.46%
Atlantic Menhaden	*Brevoortia tyrannus*	10,492	5.15%
Alewife	*Alosa pseudoharengus*	6,375	3.13%
Atlantic Herring	*Clupea harengus*	1,646	0.81%

For the MA DMF survey, data were obtained for the 12 stations closest to the proposed SouthCoast Wind intake site, in state waters south of Martha's Vineyard and Nantucket (**Table 11**). In the MA DMF spring survey, scup represented 17% of the catch followed by little skate (*Leucoraja erinacea*) and Atlantic cod (*Gadus morhua*; both 16%), and northern sand lance (*Ammodytes dubius*; 14%; **Table 11**). In the MA DMF fall survey, scup made up 73% of the catch, followed by longfin squid (*Loligo pealeii*) at 17% (**Table 11**). The total fish at these stations in the fall survey (4,632) vastly outnumbered the total for spring (2,894), driven by the large catch (32,366) of scup.

Table 11. Abundance and relative abundance of fish and invertebrates from Massachusetts Division of Marine Fisheries spring and fall bottom trawl survey stations closest to the proposed SouthCoast Wind intake for 2018 2019, and 2021.

Species (Common Name)	Abundance		Relative Abundance (%)		Overall Abundance	Overall Relative Abundance (%)
	Spring	Fall	Spring	Fall		
Stenotomus chrysops (Scup)	484	31,882	16.72	73.07	32,366	69.57
Loligo pealeii (Longfin Squid)	168	7,508	5.81	17.21	7,676	16.5
Peprilus triacanthus (Butterfish)	26	2,670	0.9	6.12	2,696	5.79
Ammodytes dubius (Northern Sand Lance)	414	1,156	14.31	2.65	1,570	3.37
Leucoraja erinacea (Little Skate)	472	72	16.31	0.17	544	1.17
Gadus morhua (Atlantic Cod)	461	0	15.93	0	461	0.99
Merluccius bilinearis (Silver Hake)	248	1	8.57	0	249	0.54
Prionotus carolinus (Northern Searobin)	128	44	4.42	0.1	172	0.37
Leucoraja ocellata (Winter Skate)	113	20	3.9	0.05	133	0.29
Cancer irroratus (Atlantic Rock Crab)	86	34	2.97	0.08	120	0.26
Scophthalmus aquosus (Windowpane)	66	9	2.28	0.02	75	0.16
Pseudopleuronectes americanus (Winter Flounder)	60	1	2.07	0	61	0.13
Decapterus punctatus (Round Scad)	0	59	0	0.14	59	0.13
Paralichthys dentatus (Summer Flounder)	33	24	1.14	0.06	57	0.12

Species (Common Name)	Abundance		Relative Abundance (%)		Overall Abundance	Overall Relative Abundance (%)
	Spring	Fall	Spring	Fall		
Urophycis regia (Spotted Hake)	43	2	1.49	0	45	0.1
Centropristis striata (Black Sea Bass)	18	18	0.62	0.04	36	0.08
Ovalipes ocellatus (Lady Crab)	13	19	0.45	0.04	32	0.07
Etropus microstomus (Smallmouth Flounder)	12	12	0.41	0.03	24	0.05
Majidae (unid. spider crab)	1	23	0.03	0.05	24	0.05
Mustelis canis (Smooth Dogfish)	1	21	0.03	0.05	22	0.05
Hippoglossina oblonga (Fourspot Flounder)	15	2	0.52	0	17	0.04
Alosa pseudoharengus (Alewife)	13	2	0.45	0	15	0.03
Selene setapinnis (Atlantic Moonfish)	0	13	0	0.03	13	0.03
Euspira heros (Northern Moonsnail)	5	1	0.17	0	6	0.01
Lagocephalus laevigatus (Smooth Puffer)	0	6	0	0.01	6	0.01
Menticirrhus saxatilis (Northern Kingfish)	0	6	0	0.01	6	0.01
Morone saxatilis (Striped Bass)	0	6	0	0.01	6	0.01
Myoxocephalus octodecemspinosus (Longhorn Sculpin)	6	0	0.21	0	6	0.01
Anchoa mitchilli (Bay Anchovy)	0	5	0	0.01	5	0.01
Decapterus macarellus (Mackerel Scad)	0	3	0	0.01	3	0.01
Arctica islandica (Ocean Quahog)	1	1	0.03	0	2	0
Brevoortia tyrannus (Atlantic Menhaden)	1	1	0.03	0	2	0
Hemitripterus americanus (Sea Raven)	2	0	0.07	0	2	0
Homarus americanus (American Lobster)	1	1	0.03	0	2	0
Selar crumenophthalmus (Bigeye Scad)	0	2	0	0	2	0
Caranx crysos (Blue Runner)	0	1	0	0	1	0
Conger oceanicus (Conger Eel)	1	0	0.03	0	1	0
Cynoscion regalis (Weakfish)	0	1	0	0	1	0
Dasyatis sabina (Atlantic Stingray)	0	1	0	0	1	0
Limulus polyphemus (Horseshoe Crab)	0	1	0	0	1	0
Prionotus evolans (Striped Searobin)	0	1	0	0	1	0
Sphoeroides maculatus (Northern Puffer)	0	1	0	0	1	0
Stephanolepis hispida (Planehead Filefish)	0	1	0	0	1	0
Syngnathus fuscus (Northern Pipefish)	0	1	0	0	1	0
Urophycis chuss (Red Hake)	1	0	0.03	0	1	0
Zoarces americanus (Ocean Pout)	1	0	0.03	0	1	0
Total	**2,894**	**43,632**	**100**	**100**	**46,526**	**100**

4.2.3 NOAA Fisheries EFH Mapper

The NOAA Fisheries Essential Fish Habitat (EFH) Mapper (EFH Mapper) was used to determine EFH species present at the proposed SouthCoast Wind intake site. The EFH Mapper for this location produced a list of 18 species with eggs or larvae (and often additional life stages; NMFS 2021). These are presented in **Table 12**.

Table 12. List of EFH species, life stage, management council, and fishery management plan (FMP) for EFH species identified using the NOAA Fisheries EFH mapper.

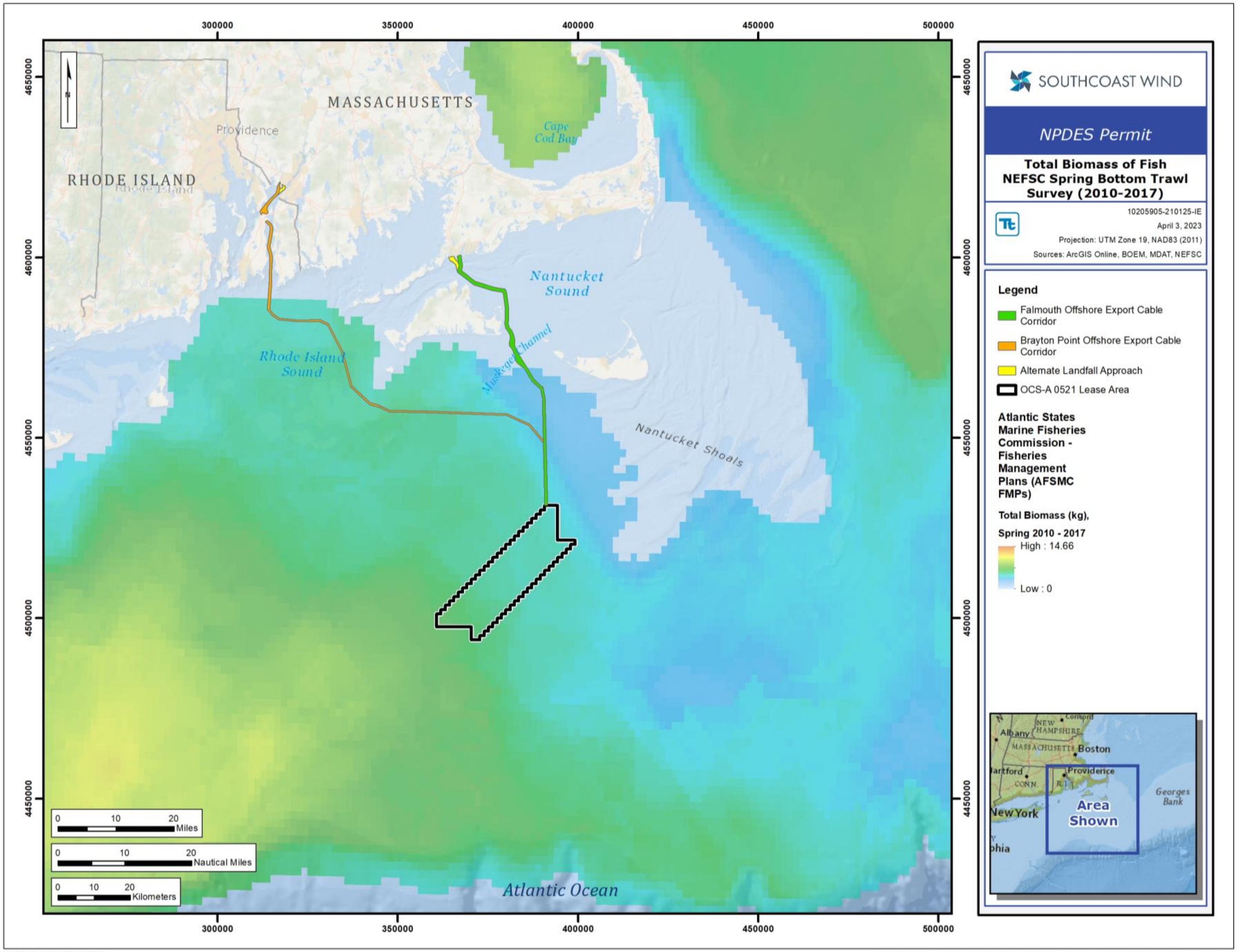
Common Name	Lifestage(s) Found at Location	Management Council	FMP
Atlantic Sea Scallop	ALL	New England	Amendment 14 to the Atlantic Sea Scallop FMP
Haddock	Juvenile	New England	Amendment 14 to the Northeast Multispecies FMP
	Adult		
	Larvae		
Ocean Pout	Adult	New England	Amendment 14 to the Northeast Multispecies FMP
	Eggs		
Atlantic Herring	Juvenile	New England	Amendment 3 to the Atlantic Herring FMP
	Larvae		
Atlantic Cod	Larvae	New England	Amendment 14 to the Northeast Multispecies FMP
	Adult		
	Eggs		
Silver Hake	Juvenile	New England	Amendment 14 to the Northeast Multispecies FMP
	Eggs/Larvae		
	Adult		
Red Hake	Adult	New England	Amendment 14 to the Northeast Multispecies FMP
	Eggs/Larvae/Juvenile		
Yellowtail Flounder	Adult	New England	Amendment 14 to the Northeast Multispecies FMP
	Juvenile		
	Larvae		
	Eggs		
Monkfish	Adult	New England	Amendment 4 to the Monkfish FMP
	Eggs/Larvae		
	Juvenile		
Windowpane Flounder	Adult	New England	Amendment 14 to the Northeast Multispecies FMP
	Larvae		
	Juvenile		
Witch Flounder	Adult	New England	Amendment 14 to the Northeast Multispecies FMP
	Larvae		
	Eggs		
Winter Flounder	Juvenile	New England	Amendment 14 to the Northeast Multispecies FMP
	Larvae/Adult		
American Plaice	Larvae	New England	Amendment 14 to the Northeast Multispecies FMP
Offshore Hake	Larvae	New England	Amendment 14 to the Northeast Multispecies FMP
Pollock	Eggs	New England	Amendment 14 to the Northeast Multispecies FMP
	Larvae		

Common Name	Lifestage(s) Found at Location	Management Council	FMP
Atlantic Mackerel	Eggs	Mid-Atlantic	Atlantic Mackerel, Squid,& Butterfish Amendment 11
	Larvae		
	Juvenile		
	Adult		
Atlantic Butterfish	Eggs	Mid-Atlantic	Atlantic Mackerel, Squid,& Butterfish Amendment 11
	Larvae		
	Adult		
	Juvenile		
Summer Flounder	Eggs	Mid-Atlantic	Summer Flounder, Scup, Black Sea Bass
	Larvae		
	Adult		

Source: *NOAA Fisheries 2021*

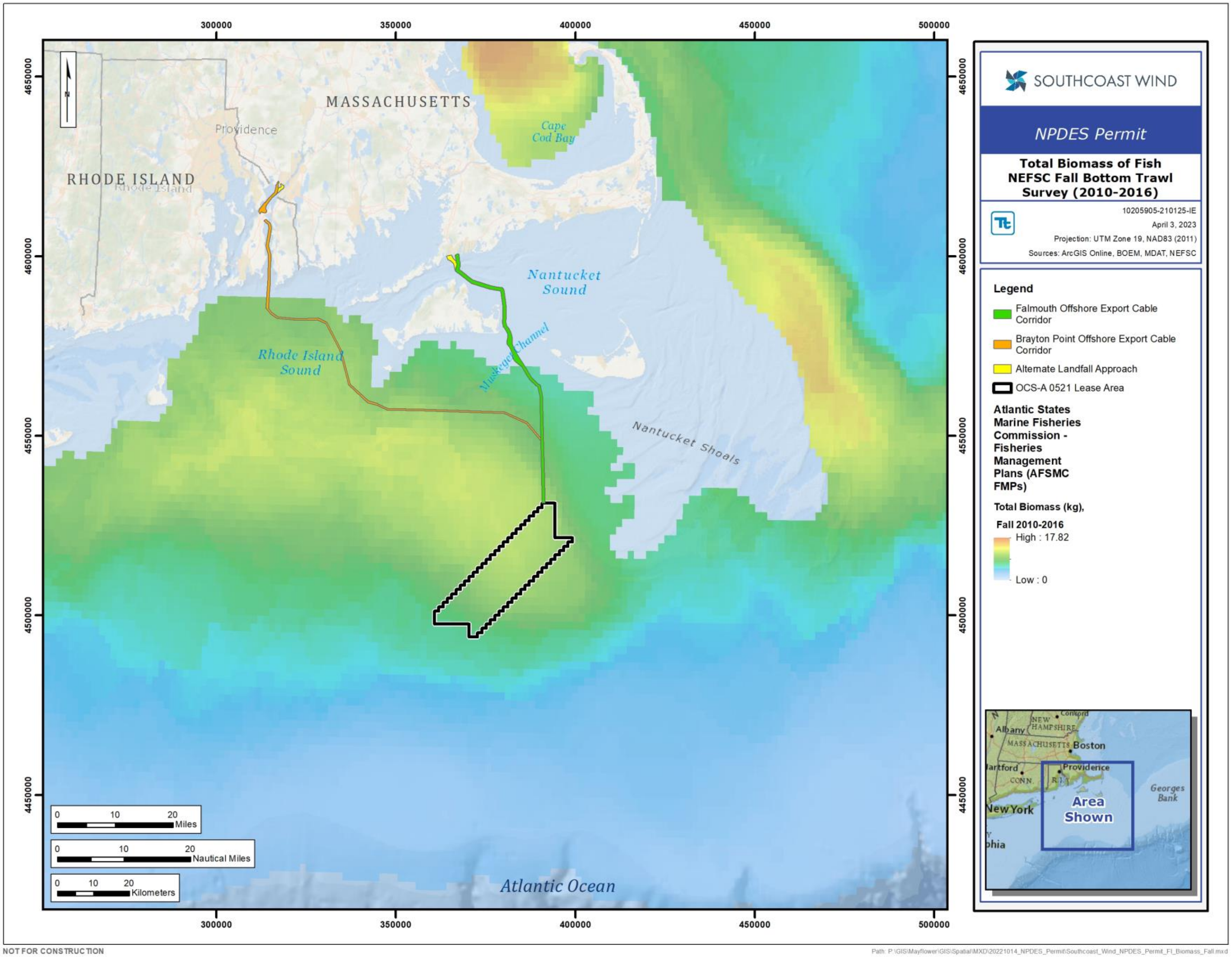
4.2.4 NOAA Fisheries NEFSC Spring and Fall Bottom Trawl Surveys

Since 1963, NOAA Fisheries Northeast Fisheries Science Center (NEFSC) has conducted standardized bottom trawl surveys during spring (March–April) and fall (September–October) along the US northeastern continental shelf based on a stratified random sampling design. The COP presents spatial information on fish biomass and diversity from recent data collected by the NEFSC trawl surveys, as shown in **Figure 21** through **Figure 24**. The 2010–2017 NEFSC bottom trawl survey data indicate fish biomass during spring was lower in the OCS-A 0521 Lease Area compared to Cape Cod Bay and outer Cape Cod waters. In the fall, when fish move inshore, fish biomass in the Offshore Project Area is less than areas within Cape Cod Bay and Great South Channel, higher than outer Cape Cod waters and similar to other adjacent offshore wind lease areas. During spring, species richness of fish collected in 2010–2017 NEFSC bottom trawl surveys were relatively low in the northeastern half of the Offshore Project Area compared to waters in the other offshore wind areas to the west and waters offshore of Cape Cod, however in the southeastern half of the Offshore Project Area, species richness of fish was relatively high. Species richness of fish in the Offshore Project Area was higher during the fall compared to spring and was similar to adjacent areas during both seasons. The NEFSC survey data is suitable for characterizing spatial distribution and species composition of juvenile and adult fish exposed to impingement. Species present in these surveys during their respective spawning seasons may also be a reasonable surrogate for the species richness associated with ichthyoplankton in the water column that might be subject to entrainment through the OSP.



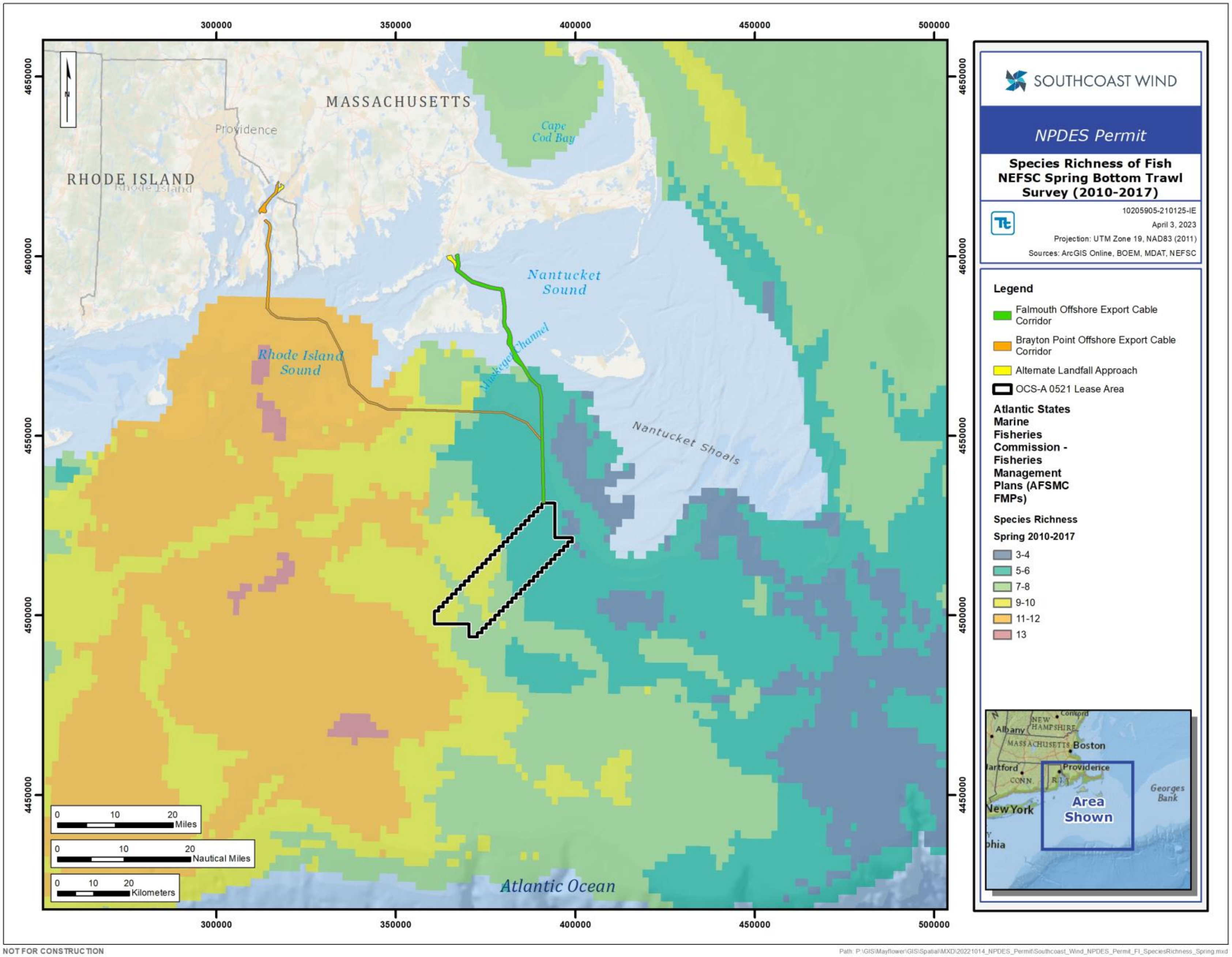
Source: NEFSC 2020b

Figure 21. Total Biomass in kilograms (kg) Results of NEFSC Spring Bottom Trawl Surveys (2010 – 2017)



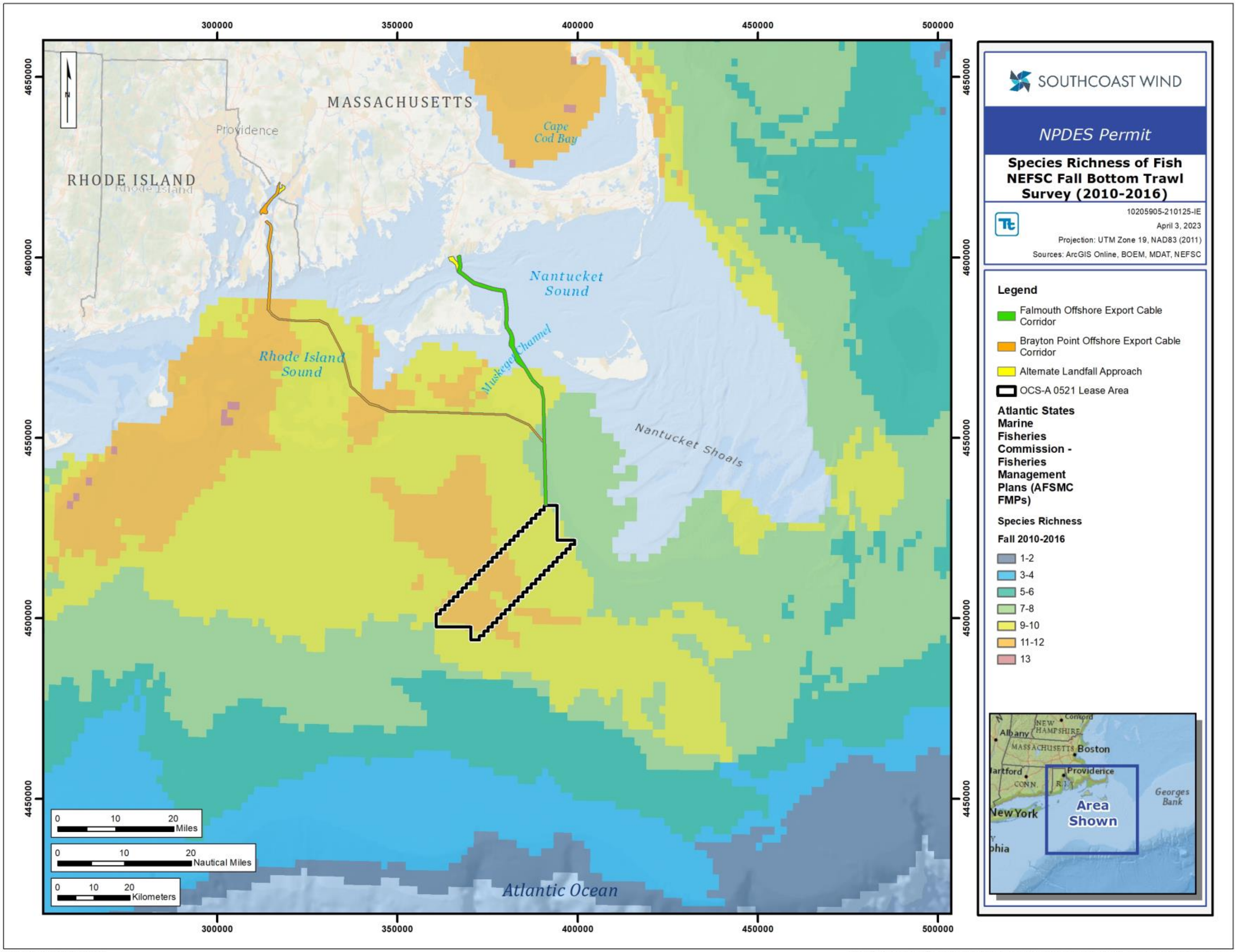
Source: NEFSC 2020b

Figure 22. Total Biomass (kg) Results of NEFSC Fall Bottom Trawl Surveys (2010 – 2016)



Source: NEFSC 2020b

Figure 23. Species Richness Results of NEFSC Spring Bottom Trawl Surveys (2010 – 2017)



Source: NEFSC 2020b

Figure 24. Species Richness Results of NEFSC Fall Bottom Trawl Surveys (2010 – 2016)

4.2.5 Other Sources

The SouthCoast Wind COP included a review of the literature to determine the fish species likely to be present at the Offshore Project Area. It found that the bi-annual resource trawl surveys conducted in Nantucket Sound between 1978 and 2004 included 122 species (ESS Group, Inc. and Battelle 2006). A multiyear fishery independent survey (2009 to 2012) in Rhode Island and Block Island Sounds identified 101 species (Malek et al. 2014). A full list of all fish and macroinvertebrate taxa from these studies and their Endangered Species Status (ESA) is presented in **Table 13**.

Table 13. List of species identified for the Offshore Project Area of SouthCoast Wind in the Construction and Operations Plan.

Group	Common_Name	Species	ESA Status
Marine bony fish	Albacore tuna	*Thunnus alalunga*	none
	American Plaice	*Hippoglossoides platessoides*	none
	Butterfish	*Peprilus triacanthus*	none
	Atlantic Cod	*Gadus morhua*	none
	Atlantic Herring	*Clupea harengus*	none
	Atlantic Mackerel	*Scomber scombrus*	none
	Atlantic Wolffish	*Anarhichas lupus*	none
	Black Sea Bass	*Centropristis striata*	none
	Bluefin Tuna	*Thunnus thynnus*	none
	Bluefish	*Pomatomus saltatrix*	none
	Haddock	*Melanogrammus aeglefinus*	none
	Monkfish	*Lophius americanus*	none
	Ocean Pout	*Macrozoarces americanus*	none
	Offshore Hake	*Merluccius albidus*	none
	Pollock	*Pollachius pollachius and P. virens*	none
	Red Hake	*Urophycis chuss*	none
	Scup	*Stenotomus chrysops*	none
	Silver Hake	*Merluccius bilinearis*	none
	Skipjack Tuna	*Katsuwonus pelamis*	none
	Summer Flounder	*Paralichthys dentatus*	none
	White Hake	*Urophycis tenuis*	none
	Windowpane Flounder	*Scophthalmus aquosus*	none
	Winter Flounder	*Glyptocephalus cynoglossus*	none
	Yellowfin Tuna	*Thunnus albacares*	none
	Yellowtail Flounder	*Pleuronectes ferruginea*	none
Anadromous fish	Atlantic Sturgeon	*Acipenser oxyrinchus oxyrinchus*	ESA endangered (NY Bight DPS)
	Shortnose Sturgeon	*Acipenser brevirostrum*	ESA endangered
Elasmobranchs	Barndoor Skate	*Dipturus laevis*	none
	Little Skate	*Leucoraja erinacea*	none
	Winter Skate	*Leucoraja ocellata*	none
	Basking Shark	*Cetorhinus maximus*	none
	Blue Shark	*Prionace glauca*	none

Group	Common_Name	Species	ESA Status
	Common Thresher Shark	*Alopias vulpinus*	none
	Dusky Shark	*Carcharhinus obscurus*	none
	Great White Shark	*Carcharodon carcharias*	none
	Porbeagle Shark	*Lamna nasus*	none
	Sand Tiger Shark	*Carcharias taurus*	none
	Sandbar Shark	*Carcharhinus plumbeus*	none
	Shortfin Mako Shark	*Isurus oxyrinchus*	ESA candidate
	Smoothhound Shark	*Mustelus canis*	none
	Spiny Dogfish	*Squalus acanthias*	none
	Tiger Shark	*Galeocerdo cuvier*	none
Macroinvertebrates	Atlantic Sea Scallop	*Placopecten magellanicus*	none
	Atlantic Surfclam	*Spisula solidissima*	none
	Longfin Inshore Squid	*Doryteuthis pealeii*	none
	Northern Shortfin Squid	*Illex illecebrosus*	none
	Ocean Quahog	*Arctica islandica*	none

Source: AECOM et al. 2021
Note: DPS = Distinct Population Segment.

4.3 Impingement and Entrainment Susceptibility – (r)(4)(iii)

No site-specific studies on impingement or entrainment have been conducted. Impingement and entrainment susceptibility was determined from publicly available data sets and the literature.

The CWIS is expected to withdraw cooling water from the ocean at rate of approximately 8 to 10 MGD and maintain an intake velocity of less than 0.5 ft/s, as discussed in Section 3. The EPA considers intake velocities less than 0.5 ft/s 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 for an unmanned offshore facility. Since impingement compliance is obtained through meeting the 0.5 ft/s velocity requirement, and there are no traveling screens on which a fish could become impinged, therefore impingement impacts should not be considered further.

The species and life stages most susceptible to entrainment are fish eggs and larvae from species that spawn in the proximity of the proposed intake structure. Based on the EFH Mapper results in conjunction with MarMap/EcoMon ichthyoplankton samples and MA DMF trawl surveys, these would include haddock (*Melanogrammus aeglefinus*) larvae, ocean pout (*Zoarces americanus)* eggs, Atlantic herring (*Clupea harengus*) larvae, Atlantic cod (*Gadus morhua*) eggs and larvae, silver hake (*Merluccius bilinearis)* eggs and larvae, red hake (*Urophycis chuss*) eggs and larvae, yellowtail flounder (*Pleuronectes ferruginea)* eggs and larvae, monkfish (*Lophius americanus)* eggs and larvae, windowpane (*Scophthalmus aquosus)* larvae, witch flounder (eggs and larvae), winter flounder (*Pseudopleuronectes americanus)* larvae, American plaice (*Hippoglossoides platessoides*) larvae, silver/offshore hake (*Merluccius bilinearis/albidus*)(larvae), pollock (*Pollachius virens*) eggs and larvae, Atlantic mackerel (*Scomber scombrus)* eggs and larvae, butterfish (*Peprilus triacanthus*) eggs and larvae, and summer flounder (*Paralichthys dentatus*) eggs and larvae. While not all of these species were represented in the data set of fish larvae from MARMAP/EcoMon (Section 4.2.1; **Table 8** and

Table 9), many of them were, leading to further likelihood of their presence near the proposed SouthCoast Wind intake site.

In absence of site-specific ichthyoplankton densities, EcoMon plankton data from 1977–2019 was used to estimate entrainment abundance from cooling water withdrawal by the CWIS at the offshore converter station. 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 km) of the CWIS location over the full time series were used to extrapolate the range of entrainment abundance assuming a water withdrawal rate of 10 MGD. 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 (**Table 14**). 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; **Table 15**). Larval density data Excel files from the EcoMon plankton dataset used to generate Table 9, Table 14, and, **Table 15** are available as part of this permit application.

While data used here is the best available and most applicable to this assessing entrainment and impingement susceptibility, there remain some considerable assumptions and uncertainties. Entrainment estimates presented here 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, these estimates assume the 1977–2019 time series is representative of the current and future species composition, and that abundance will remain constant each year. Environmental conditions, life-history characteristics, seasonality, population dynamics, natural mortality, and natural variability in presence and abundance of larvae are not considered here. The data also represents sampling of ichthyoplankton at various depths, whereas the CWIS intake will withdraw water from a discrete depth in the water column (10 m [32.8 ft] 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 CWIS intake flow.

Table 14. Estimated (flow-based projections) monthly and annual abundance of fish larvae entrained by cooling water withdrawn at a rate of 10 MGD for SouthCoast Wind's Offshore HVDC Converter Station CWIS, based on monthly mean larval densities observed by EcoMon within 10 miles (16 km) during 1977-2019.

Month	Number of Samples	Min	Mean	Max
Jan	5	45,694	2,416,884	7,763,051
Feb	4	125,720	3,682,448	7,080,416
Mar	5	687,704	2,395,401	4,156,759
Apr	2	241,680	1,020,810	1,799,910
May	3	80,507	2,026,966	5,633,103
Jun	2	11,700	9,009,000	18,006,240
Jul	2	2,328,193	18,852,030	35,375,743
Aug	2	66,092	27,541,578	55,016,878
Sep	3	446,340	4,927,740	10,646,490
Oct	4	181,970	5,042,026	18,175,765
Nov	8	10,920	450,270	2,521,290
Dec	3	4,183,016	6,678,361	10,029,306
Annual Total	**43**	**8,409,536**	**84,043,514**	**176,204,951**

Table 15. Estimated (flow-based projections) monthly and annual abundance of fish larvae by taxon entrained by cooling water withdrawn at a rate of 10 MGD for SouthCoast Wind's Offshore HVDC converter station CWIS, based on monthly mean larval densities observed by EcoMon within 10 miles (16 km) during 1977-2019.

Taxon	Jan (n=5)	Feb (n=4)	Mar (n=5)	Apr (n=2)	May (n=3)	Jun (n=2)	Jul (n=2)	Aug (n=2)	Sep (n=3)	Oct (n=4)	Nov (n=8)	Dec (n=3)	Annual (n=43)
American Plaice			4,154		2,511								6,665
Atlantic Cod	12,090	8,736	41,137	24,210									86,173
Atlantic Croaker											2,100		2,100
Atlantic Herring	229,989	8,484	4,154								40,650	3,638,594	3,921,871
Atlantic Mackerel					26,257	35,220	6,107						67,584
Atlantic Menhaden											50,100		50,100
Butterfish								141,825	23,520	6,789			172,134
Cunner							11,873						11,873
Fish (unidentified)	1,558,928	2,592,100	1,545,102		1,870,106	8,909,190	18,688,009	23,532,038	3,213,750	4,141,321		3,030,839	69,081,383
Fourbeard Rockling					7,688		6,107						13,795
Fourspot Flounder							6,107	289,106	16,830	22,134			334,177
Frigate tunas								5,487					5,487
Grubby			2,077										2,077
Gulf Stream Flounder							5,766		208,380	146,785	1,350		362,281
Haddock			2,759			5,850							8,609
Hakes							121,954	3,233,672	217,410	309,752	52,560		3,935,348
Large-tooth Flounders									3,090	9,114			12,204
Longhorn Sculpin		8,400	4,154	5,910									18,464
Monkfish						5,850							5,850
Offshore Hake										22,134			22,134
Pollock	1,736	11,704	20,987		3,813								38,240
Rock Gunnel				11,880									11,880
Sand Lances	611,847	1,053,024	696,446	978,810									3,340,127
Sea Robins								38,223					38,223
Silver Hake	2,294							256,370	71,730	80,507	86,250		497,151
Summer Flounder									873,930	280,209	197,670	8,928	1,360,737

Taxon	Jan (n=5)	Feb (n=4)	Mar (n=5)	Apr (n=2)	May (n=3)	Jun (n=2)	Jul (n=2)	Aug (n=2)	Sep (n=3)	Oct (n=4)	Nov (n=8)	Dec (n=3)	Annual (n=43)
Windowpane					5,022			38,223	299,100	23,281	19,590		385,216
Winter Flounder			74,431		29,171								103,602
Witch Flounder						11,760							11,760
Yellowtail Flounder					82,398	41,130	6,107	6,634					136,269
Total	**2,416,884**	**3,682,448**	**2,395,401**	**1,020,810**	**2,026,966**	**9,009,000**	**18,852,030**	**27,541,578**	**4,927,740**	**5,042,026**	**450,270**	**6,678,361**	**84,043,514**

Note:
n = number of EcoMon samples collected during each month, within a 10-mile (16-km) radius of the Project

4.4 Reproduction, Recruitment, and Peak Abundance – (r)(4)(iv)

Relevant taxa were defined as those species with EFH for eggs and larvae present at the proposed SouthCoast Wind intake location. This approach was conservative considering the available data does not include all of these species actually being present at the sites sampled closest to the proposed intake location. Available information on the primary period of reproduction, recruitment, and peak abundance is included for each species in the following subsections. This information is also summarized in **Table 16**.

Table 16. Period of peak reproduction, recruitment, and abundance for EFH species likely to be present near the proposed intake site for SouthCoast Wind

Species	Reproduction	Recruitment	Abundance a/	Source(s)
Haddock	January–June	February–August	March, June	NOAA 2022a; NEFMC 2017; Laurence 1978; Fahay 1983
Ocean Pout	September–October	N/A	N/A	NOAA 2020a; NEFMC 2017; Clark and Livingstone 1982; Methven and Brown 1991
Atlantic Herring	October–November	Spring	December	NOAA 2022b; NEFMC 2017; Graham et al. 1972
Atlantic Cod	Late winter–early spring	Spring	March	NEFMC 2021; Zemeckis et al. 2014; NEFMC 2017; Fahay 1983; Lough et al. 1989; Colette and Klein-McPhee 2002
Silver/Offshore Hake	May–June	Autumn	August	NOAA 2022d; NEFMC 2017; NEFSC 1999a; NEFSC 1999b; Colette and Klein-McPhee 2002
Red Hake	May–June	October–November	August	NEFMC 2016b; NEFMC 2017; NEFSC 1999c; Collette and Klein-McPhee 2002
Yellowtail Flounder	March–August	Summer–Fall	May	NEFSC 1999d; NEFMC 2016b; Fahay 1983
Monkfish	February–October	Early Summer	June	NOAA 2022f; NEFSC 1999e; NEFMC 2016b; NEFMC 1998; NEFMC 2017; Fahay 1983,
Windowpane	April–May; October–November	July–October	September	NOAA 2022g; NEFSC 1999f; Colette and Klein-McPhee 2002; Morse and Able 1995
Witch Flounder	March–November	June–July	June	NOAA 2020b; NEFSC 1999g; Colette and Klein-McPhee 2002
American Plaice	March–June	Late Summer	March–April	NEFMC 2016b; Morgan 2001; Collette and Klein-McPhee 2002
Atlantic Pollock	November–February	Spring-Summer	March	NOAA 2022h; NEFSC 1999h
Atlantic Mackerel	April–May	Summer-Fall	June	NOAA 2022i; NEFSC 1999i; Collette and Klein-McPhee 2002
Butterfish	June–July	Autumn	August	NOAA 2022j; NEFMC 2017; NEFSC 1999j; Collette and Klein-McPhee 2002
Summer Flounder	September-December	Spring, Summer, Fall	September	NOAA 2022k; NEFSC 1999k; Collette and Klein-McPhee, 2002

Note:
a/ Period of peak abundance taken from MarMap/EcoMon data.

4.4.1 Haddock (*Melanogrammus aeglefinus)*

4.4.1.1 Reproduction

Haddock spawn yearly between January and June in and around the vicinity of Nantucket Shoals where substrates consist of rock, gravel, sand, or mud bottoms (NOAA 2022a; NEFMC 2017). Female haddock can produce between 850,000 to three million eggs per year releasing unfertilized eggs in large batches on the seafloor. After fertilization by males, eggs become buoyant and remain pelagic for approximately two weeks before hatching (NEFSC 2005a). Upon hatching at 2 to 5 millimeters (mm), larvae will remain pelagic for 2 to 3 months drifting with ocean currents both inshore and out to coastal waters before settling to the ocean floor (NOAA 2022a). Haddock eggs and larvae are primarily found at depths ranging from 30 to 150 m (NEFSC 2005a).

4.4.1.2 Recruitment

Haddock larvae metamorphose into juveniles in roughly 30 to 42 days at lengths of 2 to 3 centimeters (cm), making the expected period of larval recruitment from February to August (Fahay 1983; Laurence 1978). Early juveniles remain in the upper water column for several months until reaching lengths around three to 10 cm, when they begin feeding and eventually settling to the ocean floor (NEFSC 2005a; NOAA 2022a).

4.4.1.3 Peak Abundance

Haddock larvae were identified in MarMap/EcoMon bongo net samples from March and June over the 42-year sample period from 1977 to 2019.

4.4.2 Ocean Pout *(Zoarces americanus)*

4.4.2.1 Reproduction

Ocean pout migrate inshore, including to bays and estuaries, in the fall to spawn from September to October (NOAA 2020b; NEFMC 2017). Females deposit and guard their eggs on substrates or rocky crevices for approximately 2 to 3 months until they hatch. Once hatched, ocean pout remain in benthic habitat throughout adulthood (NOAA 2020b).

4.4.2.2 Recruitment

Ocean pout larvae remain on or near the bottom and are not susceptible to capture in ichthyoplankton surveys. They are about 30 mm long at hatching and relatively advanced in development, suggesting a very brief larval phase and no susceptibility to an intake placed in the water column (Clark and Livingstone 1982; Methven and Brown 1991).

4.4.2.3 Peak Abundance

Ocean pout larvae were not identified in samples from MarMap/EcoMon subset for stations within a 10-mile (16-km) radius of the proposed SouthCoast Wind intake between 1977 and 2019.

4.4.3 Atlantic Herring *(Clupea harengus)*

4.4.3.1 Reproduction

Atlantic herring spawn in the fall from October to November (NOAA 2022b). Eggs are deposited on the seafloor at depths of 5 to 90 meters on substrates consisting of rock, gravel, or coarse sand or attached to macrophytes (NEFSC 2005b). Schools of spawning herring create a large, dense carpet of eggs that stick to the benthic substrates, with each female depositing 30,000 to 200,000 eggs (NEFSC 2005b; NOAA 2022b). Egg predation and unfavorable environmental conditions often cause a high rate of egg mortality. Hatching occurs at approximately two weeks, and larvae are found throughout the water column in depths ranging from 10 to 250 m (NEFSC 2005b).

4.4.3.2 Recruitment

Atlantic herring have a very long larval stage lasting 4-8 months. Larvae are transported to inshore and estuarine waters where they metamorphose into early-stage juveniles in the spring (Graham et al. 1972).

4.4.3.3 Peak Abundance

Atlantic herring larvae were identified in samples from MarMap/EcoMon subset for stations within a 10-mile (16-km) radius during the months of November, December, January, February, and March, with peak abundance in December over the 42-year sample period.

4.4.4 Atlantic Cod *(Gadus morhua)*

4.4.4.1 Reproduction

Atlantic cod spawning occurs year-round, peaking in late winter to early spring, on the ocean floor of rocky inshore habitats and offshore banks (NEFMC 2021; Zemeckis et al. 2014). Females can produce three to nine million eggs and perform broadcast spawning at regular intervals throughout the spawning season (NOAA 2022c; Zemeckis et al. 2014). Eggs are fertilized by males immediately upon release by females, becoming buoyant and pelagic and drifting in ocean currents for 2-3 weeks before hatching (NEFMC 2021; Zemeckis et al. 2014). Larvae are pelagic and occupy the water column from the surface to depths of about 75 m (NEFMC 2021).

Studies on spawning dynamics have identified primary Southern New England spawning areas in the northeastern region of Georges Bank, with some scattered areas across western Georges Bank, Nantucket Shoals, and areas offshore Rhode Island and Southern Massachusetts, such as Cox's Ledge (DeCelles et al. 2017; Zemeckis et al. 2014). There are no known Atlantic cod spawning grounds near the proposed OSP location, though entrainment of cod eggs and larvae may occur as a result of larval transport to the vicinity of the Project Area. Near-surface ocean circulation patterns in New England waters are suspected of transporting cod eggs and larvae from spawning sites in both Georges Bank and the Gulf of Maine to waters near the Project Area (Zemeckis et al 2014).

4.4.4.2 Recruitment

Transformation of Atlantic cod larvae to the juvenile stage occurs at sizes greater than 20 mm, followed by recruitment to bottom habitats at 2 to 6 cm, generally after a pelagic duration of no more than 2 months (Colette and Klein-McPhee 2002; Fahay 1983; Lough et al. 1989).

4.4.4.3 Peak Abundance

Atlantic cod larvae were identified from January through April in samples from MarMap/EcoMon subset for stations within a 10-mile (16-km) radius of the proposed SouthCoast Wind intake between 1977 and 2019. The peak abundance was in March.

4.4.5 Silver/Offshore Hake *(Merluccius bilinearis/albidus)*

4.4.5.1 Reproduction

Silver and offshore hake spawn late spring to early summer (May to June) and are considered serial spawners, producing and depositing up to three batches of eggs in a single spawning season (NOAA 2022d). Eggs and larvae from both species are pelagic and are dispersed by ocean currents in coastal and offshore regions of continental shelf (NEFMC 2017). While eggs have been found over large expanses on the continental shelf, silver hake primary spawning grounds occur between Cape Cod and Montauk Point, on the southern regions of Georges Bank, and the region north of Cape Cod to Cape Ann (NEFMC 2016a). Plankton surveys have captured both silver and offshore hake eggs and larvae in depths ranging from 10 to 1250 m, but primarily in depths of 50 to 150 m (NEFSC 1999a; NEFSC 1999b).

4.4.5.2 Recruitment

Silver hake exist as pelagic larvae for about 2 months and at about 17-20 mm long recruit to the benthos as juveniles, generally in the fall (Colette and Klein-McPhee 2002). Growth and recruitment of silver and offshore hake of New England and mid-Atlantic are presumed to be similar (NEFSC 1999b).

4.4.5.3 Peak Abundance

Silver and offshore hake larvae were identified in samples from MarMap/EcoMon subset for stations within a 10-mile (16-km) radius of the proposed SouthCoast Wind intake between 1977 and 2019 in the months of August through November and January, peaking in August.

4.4.6 Red Hake *(Urophycis chuss)*

4.4.6.1 Reproduction

Red hake spawn late spring to fall, peaking in June to July (NEFMC 2016b). Spawning occurs primarily on continental shelf waters of the mid-Atlantic and southern New England, but eggs been found in waters from the Gulf of Maine through offshore Cape Hatteras (NEFMC 2016b). Eggs, larvae, and ripe adult females have also been found in higher salinity regions of coastal bays, primarily in New England states (NEFMC 2016b). Eggs and larval red hake are buoyant and found in the upper water column, mainly in surface waters (NEFSC 1999c).

4.4.6.2 Recruitment

Transformed juveniles remain pelagic until reaching lengths of around 25 to 30 mm total length (TL). Red hake begin recruitment to the benthos at lengths of approximately 35 to 40 mm in September through December, with the peak in October-November (Collette and Klein-McPhee 2002; NEFSC 1999c).

4.4.6.3 Peak Abundance

The MarMap/EcoMon data did not distinguish between red hake and spotted hake (*Urophycis regalis*). Larvae for *Urophycis spp* were present in July through November with the peak abundance in August between 1977 and 2019.

4.4.7 Yellowtail Flounder *(Pleuronectes ferruginea)*

4.4.7.1 Reproduction

Yellowtail flounder spawn in the spring and summer (March to August) (NEFSC 1999d). Eggs are deposited on the ocean floor and float to the surface upon fertilization (NOAA 2022e). Eggs are primarily found in the upper water column and towards the surface—from 30 to 90 m—in waters of Georges Bank, Cape Cod Bay, and the continental shelf of southern New England south to Delaware Bay (NEFMC 2016b; NEFSC 1999d). Larvae are also pelagic and drift in surface waters from 10 to 90 m, though have been found as deep as 1250 m (NEFSC 1999d).

4.4.7.2 Recruitment

Yellowtail flounder larvae begin to inhabit benthic habitats once they transform to the juvenile stage at 11.6-16 mm standard length (SL) (Fahay 1983; NEFSC 1999d).

4.4.7.3 Peak Abundance

The subset MarMap/EcoMon data from 1977 to 2019 identified yellowtail flounder larvae in samples from May through August, with a peak in May.

4.4.8 Monkfish *(Lophius americanus)*

4.4.8.1 Reproduction

Monkfish spawn between February to October, peaking in late spring to early summer months, in waters across the continental shelf throughout New England and the mid-Atlantic (NOAA 2022f; NEFMC 2016b; NEFMC 1998). Females deposit eggs in large, buoyant mucoidal egg “veils” which can contain more than one million eggs (NOAA 2022f). Egg veils float near the surface and are dispersed by ocean currents and wind for a few weeks until they disintegrate and larvae hatch (NEFMC 2016a; NEFMC 1998). Larvae are pelagic and found at a wide range of depths from 25 to over 1000 m, though most abundantly from 30 to 90 m (NEFMC 2016b; NEFSC 1999e).

4.4.8.2 Recruitment

Larval recruitment of monkfish occurs at 5-10 cm TL when the elongate fins and body gradually assume the adult form and generally peaks in early summer (NEFSC 1999e; Fahay 1983).

4.4.8.3 Peak Abundance

Monkfish larva was only identified in June in samples from the subset MarMap/EcoMon data from 1977 to 2019.

4.4.9 Windowpane *(Scophthalmus aquosus)*

4.4.9.1 Reproduction

Windowpane spawn in the spring (April to May) and fall (October to November) with peak spawning occurring in the fall (NOAA 2022g). Eggs are pelagic and occur throughout the water column, primarily at depths of less than 70 m (NEFSC 1999f). Eggs hatch within approximately 8 days and larvae remain pelagic, drifting in surface waters (NOAA 2022g; NEFSC 1999f). Peak densities of recently spawned larvae (2-4 mm TL) occur in the southern Mid-Atlantic Bight in May and November, and on Georges Bank in July-October (Morse and Able 1995).

4.4.9.2 Recruitment

Windowpane larvae settle to the bottom at approximately 10 mm TL, though planktonic larval specimens have been collected on Georges Bank up 20 mm in length (Colette and Klein-McPhee 2002; NEFSC 1999f). Spring-spawned windowpane larvae settle in both estuaries and on the continental shelf and grow more rapidly, reaching 11 to 19 cm TL by September (NEFSC 1999f). Fall-spawned fish only settle on the continental shelf and have slower growth rates, reaching an estimated 18 to 21 cm TL by the following fall (Morse and Able 1995; NEFSC 1999f). Juveniles and adults generally occur in shallower water habitats of less than 110 m (NEFSC 1999f).

4.4.9.3 Peak Abundance

Windowpane larvae were identified in samples from MarMap/EcoMon subset for stations within a 10-mile (16-km) radius of the proposed SouthCoast Wind intake between 1977 and 2019 in the months of May and August through November, peaking in September.

4.4.10 Witch Flounder *(Glyptocephalus cynoglossus)*

4.4.10.1 Reproduction

Witch flounder gather in dense aggregations to spawn in areas of cold water at or near the ocean floor during March through November, with peak spawning occurring during the summer months (NOAA 2020c). Witch flounder are typically found in deep waters, down to approximately 1500 m (NEFSC 1999g). Eggs are pelagic and found water column, most commonly observed from 30 to 150 m, but as deep as 1250 m (NEFSC 1999g).

4.4.10.2 Recruitment

The pelagic larval stage is lengthy, lasting 4–6 months, potentially up to one year (Colette and Klein-McPhee 2002; NEFSC 1999g). Recruitment to the benthos peaks around mid-winter (presuming a peak spawning period of June to July). The size at which larvae transform to juveniles and begin to inhabitant the bottom can vary greatly, ranging from 20-68 mm (NEFSC 1999g).

4.4.10.3 Peak Abundance

Witch flounder larvae were identified only June in samples from MarMap/EcoMon subset for stations within a 10-mile (16-km) radius of the proposed SouthCoast Wind intake site between 1977 and 2019.

4.4.11 American Plaice *(Hippoglossoides platessoides)*

4.4.11.1 Reproduction

American plaice are batch spawners, depositing eggs every few days during the spawning season, which lasts from around March through June and peaking in April and May in the Gulf of Maine and Georges Bank (Morgan 2001; NEFMC, 2016b). Eggs are deposited on the ocean floor by females typically at depths greater than 56 m, down to over 165 m (NEFSC 2004). Once fertilized the eggs float towards surface waters where they remain pelagic (30 to 90 m) for approximately 2 weeks until hatching (NOAA 2021a; NEFSC 2004; NEFMC 2016b). Larvae are also pelagic and are dispersed by ocean currents in surface waters (NEFSC 2004). Surveys have indicated that high abundance of American plaice larvae occurs in the spring throughout Georges Bank and the Great South Channel at 50 to 110 m depths (NEFSC 2004).

4.4.11.2 Recruitment

Metamorphosis of American plaice larvae is complete by 30 to 40 mm TL, and they drift deeper as they grow until they find suitable habitat on the seafloor. This period of recruitment generally peaks in late summer (Collette and Klein-McPhee 2002).

4.4.11.3 Peak Abundance

American plaice were identified in samples from MarMap/EcoMon subset for station within a 10-mile (16-km) radius of the proposed SouthCoast Wind intake site between 1977 and 2019 in March and April.

4.4.12 Atlantic Pollock *(Pollachius virens)*

4.4.12.1 Reproduction

Atlantic pollock spawn over hard, stony, or rocky benthic substrates multiple times per season, generally peaking in late fall through winter (November through February) (NOAA 2022h; NEFSC 1999h). Spawning grounds span throughout the Gulf of Maine and western Georges Bank (NEFMC 2016b). Fertilized eggs and larvae are both buoyant and pelagic and found at depths ranging from 20 to 270 m and deeper, though most have been observed in the 50 to 90 m range (NEFMC 2016b; NEFSC 1999h).

4.4.12.2 Recruitment

Pollock reach juvenile stages after 3 to 4 months; at which time they inhabit pelagic and benthic habitats from intertidal inshore waters in Long Island Sound and Narraganset Bay to 180 m or deeper on the continental shelf in the Gulf of Maine and Georges Bank (NEFMC 2016b; NEFSC 1999h).

4.4.12.3 Peak Abundance

Pollock larvae were identified in samples from MarMap/EcoMon subset for stations within a 10-mile (16-km) radius of the proposed SouthCoast Wind intake site between 1977 and 2019 in December through May, peaking in March.

4.4.13 Atlantic Mackerel *(Scomber scombrus)*

4.4.13.1 Reproduction

Atlantic mackerel are batch spawners, spawning around five to seven times per season and exhibiting fecundity of between 285,000 to almost two million eggs (NOAA 2022i). Spawning peaks in the spring (April to May) in the Mid-Atlantic Bight, approximately 10 to 30 miles offshore, and progressively later through June and early July moving north (NEFSC 1999i). Eggs hatch within five to seven days, and larvae are pelagic, found throughout the water column from 10 to 130 m (NEFSC 1999i).

4.4.13.2 Recruitment

Larvae transform to swimming juvenile stage fish within 2 months (during Summer and Fall) at lengths around 50 mm, when schooling behavior begins (Collette and Klein-McPhee 2002; NEFSC 1999i). Juveniles are generally present in depths ranging from 20 to 70 m down to 340 m, depending on season (NEFSC 1999i).

4.4.13.3 Peak Abundance

Atlantic mackerel larvae were identified in the MarMap/EcoMon subset data in May through July, peaking in June between 1977 and 2019.

4.4.14 Butterfish *(Peprilus triacanthus)*

4.4.14.1 Reproduction

Butterfish spawn in the summer months, mainly June and July (NOAA 202022j). Eggs and larvae are buoyant and pelagic, occurring over wide expanses of the Mid-Atlantic Bight from high salinity areas of estuaries to the outer continental shelf. Eggs and larvae are dispersed by ocean currents as they generally occur in the upper 200 m of the water column in deeper waters, and throughout the water column in waters shallower than 200 m (NEFSC 1999j). Larvae may undergo diel vertical migrations, as survey catches have showing increased abundance in the upper 4 m of the water column at night (NEFSC 1999j). Larvae and juveniles are also commonly associated with jellyfish, *Sargassum*, and other flotsam in the open ocean (NEFSC 1999j).

4.4.14.2 Recruitment

Larvae reaching sizes of 10 to 15 mm are able to swim, often associating with patches of flotsam (NEFSC 1999j). Larval butterfish may undergo diel vertical migrations, potentially congregating near the surface at night (NEFSC 1999j). Butterfish grow rapidly, and reach juvenile stage at approximately 16 mm, and assume adult schooling behavior at about 60 mm, generally by Fall (Collette and Klein-McPhee 2002).

4.4.14.3 Peak Abundance

Butterfish larvae were identified in samples from MarMap/EcoMon subset for stations within a 10-mile (16-km) radius of the proposed SouthCoast Wind intake site in August through October, peaking in August between 1977 and 2019.

4.4.15 Summer Flounder (*Paralichthys dentatus*)

4.4.15.1 Reproduction

Summer flounder spawning occurs during offshore migration to wintering grounds on southern New England and mid-Atlantic continental shelf from September through December (NEFSC 1999k). Spawning occurs later into the winter and spring in southern mid-Atlantic regions (NEFSC 1999k). Fecundity is size-dependent, females can produce between 460,000 to more than four million eggs (NOAA 2022k). Eggs are buoyant and pelagic and occur at various depths depending on season: 30 to 70 m in the fall, over 100 m in the winter, and 10 to 30 m in the spring. When hatched, larvae drift with currents towards coastal areas, occurring most abundantly within 85 km from shore and in depths around 10 to 70 m (NEFSC 1999k).

4.4.15.2 Recruitment

Summer flounder post-larvae migrate inshore during metamorphosis and settle in estuaries, generally in spring, fall, and summer; with many juveniles overwintering in estuaries, as well (Collette and Klein-McPhee 2002; NEFSC 1999k).

4.4.15.3 Peak Abundance

Summer flounder larvae were identified in the MarMap/EcoMon subset near the proposed SouthCoast Wind intake site in September through December, peaking in September between 1977 and 2019.

4.5 Seasonal and Diel Patterns – (r)(4)(v)

Seasonal and diel patterns in biological organisms in the vicinity of the CWIS were determined from publicly available data and the literature, in lieu of site-specific ichthyoplankton data.

Seasonality of biological organisms in the neritic zone is generally determined by species life history, including migrations for spawning and feeding. Similarly, zooplankton like the copepods prevalent in this area (see Section 4.2.1) exhibit seasonal fluctuations due to the availability of phytoplankton and other nutrients (e.g., Head and Pepin 2010).

During the winter months, finfish biodiversity in the area near the intake location is expected to decrease. In the spring anadromous species passing through the area on their way to the coastal zone increases diversity (Mattocks et al. 2017; Schtickzelle and Quinn 2007). Additionally, seasonal and highly migratory finfish species that use the Offshore Project Area for spawning and foraging in the spring and summer months. Seasonal patterns of fish larvae and eggs are based on spawning season, which varies by species (see Section 4.4.), and diel patterns of larvae may include vertical migrations to feed at night.

4.6 Threatened, Endangered, and Protected Species – (r)(4)(vi)

4.6.1 Fishes

There are two bony fish species listed in the federal ESA that are known to occur in the Offshore Project Area: Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*) and Shortnose Sturgeon (*Acipenser brevirostrum*) (Greater Atlantic Regional Fisheries Office 2019). With exception of the Atlantic Sturgeon from Gulf of Maine Distinct Population Segment (DPS) which are threatened, all other subpopulations or DPSs are listed as endangered. The Shortnose Sturgeon is listed as threatened. Both species spawn in freshwater rivers throughout the Northeast where larvae remain until they reach the subadult life stage (Bain 1997), and therefore they are not susceptible to entrainment at an intake structure located offshore. Impingement of these sturgeon species is improbable given the expected intake configuration and operation at SouthCoast Wind's offshore HVDC converter station.

Other threatened or endangered species that may be present around the SouthCoast Wind's CWIS include the Oceanic Whitetip Shark (*Carcharhinus longimanus*; threatened), Giant Manta Ray (*Manta birostris*; threatened) and Shortfin Mako Shark (*Isurus oxyrinchus*; ESA candidate for listing, NOAA 2021b). These species also employ reproductive or other life history strategies (gives birth to live young, highly migratory; Castro 2010) that make them unsusceptible to impingement and entrainment.

4.6.2 Marine Mammal Forage Species

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 North Atlantic right whale (*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 North Atlantic right whale, 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 North Atlantic right whales 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 SouthCoast 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 North Atlantic right whale 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 also be considered negligible.

4.7 Agency Consultation – (r)(4)(vii)

As part of the development of the COP for this Project, SouthCoast Wind has participated in numerous agency consultations and public participation activities, which are documented in COP Section 1.6, containing a description of SouthCoast Wind's approach to agency/stakeholder engagement. COP Appendix A (Agency Correspondence) contains a full list of SouthCoast Wind's correspondences with federal, state, and local agencies to-date.

In addition, SouthCoast Wind also held an initial consultation meeting with EPA Region 1 on May 23 2022. Additional NPDES-specific consultations are expected with EPA Region 1, Bureau of Ocean Energy Management (BOEM), NOAA Fisheries, and other agencies/stakeholders upon submittal of the application.

5.0 OCEAN DISCHARGE CRITERIA – SECTION §125, SUBPART M

Under §125 Criteria and Standards for the NPDES, Subpart M guidelines for issuance NPDES permits are established for the discharge of pollutants from a point source into the territorial seas, the contiguous zone, and the oceans. It is required under §125.122(a) that the director determine whether a discharge will cause unreasonable degradation of the marine environment, and that discharges in compliance with section 301(g), 301(h), or 316(a) variance requirements or state water quality standards shall be presumed not to cause unreasonable degradation of the marine environment, for any specific pollutants or conditions specified in the variance or the standard. Under §125, Subpart M, the director shall determine whether a discharge will cause unreasonable degradation of the marine environment based on consideration of the parameters and criteria listed in **Table 17**, which includes a cross-walk of where that information can be found in this application and supporting materials, such as the COP. Each of these criteria are addressed within this permit application or within the COP (and related assessments) submitted separately as part of the federal permitting dashboard[3] associated with this Project, with the resulting assessment that no reasonable alternatives to ocean discharge exist, and that ocean discharge will not result in unreasonable degradation of the marine environment.

[3] https://www.permits.performance.gov/permitting-project/southcoast-wind-energy-llc-southcoast-wind

Table 17. Ocean Discharge Criteria and Applicability

Ocean Discharge Criteria	Applicability to the SouthCoast Wind OSP	Location of Information
The quantities, composition and potential for bioaccumulation or persistence of the pollutants to be discharged	The OSP will not discharge any bioaccumulating pollutants. All pollutants to be discharged are documented in the application.	NPDES Application, Form 2D
The potential transport of such pollutants by biological, physical or chemical processes		
The composition and vulnerability of the biological communities which may be exposed to such pollutants, including the presence of unique species or communities of species, the presence of species identified as endangered or threatened pursuant to the Endangered Species Act, or the presence of those species critical to the structure or function of the ecosystem, such as those important for the food chain	Biological communities are characterized, per §122.21(r)(4), with additional information in the COP	NPDES Application Narrative, Section 4 COP – Volume 2: Section 6.6 through 6.9
The importance of the receiving water area to the surrounding biological community, including the presence of spawning sites, nursery/forage areas, migratory pathways, or areas necessary for other functions or critical stages in the life cycle of an organism		
The existence of special aquatic sites including, but not limited to marine sanctuaries and refuges, parks, national and historic monuments, national seashores, wilderness areas and coral reefs	None of these features are proximate to the OSP	COP Appendix L1 – Offshore Designated Protected Areas Report
The potential impacts on human health through direct and indirect pathways	No impacts to human health anticipated	COP – Volume 2: Section 15 – Public Health and Safety
Existing or potential recreational and commercial fishing, including finfishing and shellfishing	Impacts to fish and shellfish are characterized, per §122.21(r)(4)	COP – Volume 2: Section 11 – Commercial and Recreational Fisheries and Fishing Activity COP – Appendix V – Commercial and Recreational Fisheries and Fishing Activity Technical Report
Any applicable requirements of an approved Coastal Zone Management plan	Applicability of Coastal Zone Management Act Consistency are documented	COP – Appendix D1 – Massachusetts Coastal Zone Management Act Consistency Certification – Falmouth POI COP – Appendix D2 – Massachusetts Coastal Zone Management Act Consistency Certification – Brayton Point POI COP – Appendix D3 – Rhode Island Coastal Zone Management Act Consistency Certification – Brayton Point POI
Such other factors relating to the effects of the discharge as may be appropriate	Documentation of the extent of the thermal plume/mixing zone	Appendix A: Thermal Plume Modeling

Ocean Discharge Criteria	Applicability to the SouthCoast Wind OSP	Location of Information
Marine water quality criteria developed pursuant to section 304(a)(1)	No site-specific water quality criteria	NPDES Application Narrative, Section 2.2.2 COP – Volume 2: Section 5.2 - Water Quality

6.0 COMPLIANCE WITH TRACK I REQUIREMENTS – SECTION §125, SUBPART I

Although the offshore converter station CWIS facility proposed by SouthCoast Wind is not itself considered to be a new power generating facility, it is operationally part of a new power generating facility. Despite this type of converter station facility not being specifically identified in the Phase I Rule, it is assumed to be subject to this subpart since it meets the following criteria in §125.81:

- It is a point source that uses or proposes to use a cooling water intake structure;
- It has at least one cooling water intake structure that uses at least 25 percent of the water it withdraws for cooling purposes as specified in paragraph (c) of this section; and
- It has a design intake flow greater than two (2) MGD.

The SouthCoast Wind offshore converter station CWIS is a new facility and may choose to comply with Track I or Track II requirements. Based on anticipated flow requirements and intake configuration, SouthCoast Wind expects to comply with a maximum design intake velocity of 0.5 ft/s, and chooses to comply with Track I requirements, as outlined below.

6.1 Intake Flow – Section §125.84(b)(1)

The CWIS described in Section 3 is designed to withdraw a maximum design intake flow of 10.2 MGD of once-through non-contact cooling water. As an unmanned facility, the OSP is not equipped to accommodate closed-cycle recirculating cooling water system (e.g., cooling towers), and there is currently no market-availability for this technology on unmanned OSPs, therefore it is not feasible to reduce flow to a level commensurate with that of a closed-cycle recirculating cooling water system. For this reason, a closed-cycle recirculating cooling water system is not considered for further evaluation.

Since closed-cycle recirculating cooling is not an available option for this unmanned facility, SouthCoast Wind did not conduct a detailed analysis. However, three OSP suppliers were queried as to whether a closed cycle-cooling system would be possible and all three responded that while some developers have shown interest in the concept, they had not designed one before. The SouthCoast Wind team is therefore proceeding with the existing options from OSP suppliers, with the intent of selecting a proven existing system design. A newly-developed and unproven closed-cycle cooling option (even if feasible) introduces unacceptable risk, with a concern that new design solution may lead to a reduction in reliability and availability for the unmanned facility, given the critical nature of the cooling system.

6.2 Intake Velocity – Section §125.84(b)(2)

The CWIS described in Section 3 is designed to withdraw a maximum design intake flow of 10.2 MGD, and will be in compliance with a maximum through-screen design intake velocity of 0.5 ft/s. The details of how the velocity is calculated will be determined during the detailed design phase and shared with EPA when available.

Supporting documentation and engineering calculations will be provided as design details become available.

6.3 Tidal Prism – Section §125.84(b)(3)

Although the offshore converter station facility is located in a tidal system, the Atlantic Ocean, it is not located in an estuary or tidal river. The open-ocean nature of the source waterbody, rather than an enclosed estuary or tidal river, results in the total design intake flow over one tidal cycle of ebb and flow of far less than 1 percent of the volume of the water column during one tidal excursion at the mean low water level. Since this type of calculation is applicable only to ocean inlets, estuaries, rivers, lagoons, etc. (USACE 1976) it is not considered for this facility.

6.4 Select and Implement Design and Construction Technologies for Minimizing Impingement Mortality and Entrainment – Section §125.84(b)(4) and (5)

A preliminary screening of design and construction technologies or operational measures has been conducted as part of this Application to determine which alternatives offer the greatest potential for minimizing impingement mortality or entrainment impacts at the proposed converter station facility and therefore may warrant further discussion in this section (**Table 18**). Technologies and operational measures were screened based upon feasibility for implementation at the facility, biological effectiveness (i.e., ability to achieve reductions in either impingement mortality or entrainment), and cost of implementation (including capital, installation, and annual operations and maintenance costs). The information included in this section is applicable to the BTA for reducing impingement mortality or entrainment impacts at the SouthCoast Wind converter station CWIS facility. Such technologies and operational measures are further described with extensive detail on feasibility (including examples of case studies) by the Electric Power Research Institute's *Fish Protection Technology Manual* (EPRI 2012) and EPA's support documents for the Phase I Cooling Water Intake Rule (EPA 2001).

Table 18. Technology, Operation, or Design Features Considered for the SouthCoast Wind OSP Converter Station

Category	Technology, Operation, or Design Feature	Status at SouthCoast Wind OSP	Fish Protection Potential		Feasible for Consideration
			Impingement Mortality	Entrainment	
Flow Reduction, from design intake flow (DIF)	Single pump operation	Part of design	MAYBE	YES	YES – referenced in text
	Closed cycle re-circulating cooling (cooling towers)	Not part of the design	MAYBE	YES	NO – As an unmanned facility, the OSP is not equipped to accommodate closed-cycle recirculating cooling water system (e.g., cooling towers), and there is currently no market-availability for this technology on unmanned OSPs, therefore not considered for further evaluation.
	Circulating pumps with variable frequency drives	Part of the design	MAYBE	YES	YES – referenced in text

Category	Technology, Operation, or Design Feature	Status at SouthCoast Wind OSP	Fish Protection Potential		Feasible for Consideration
			Impingement Mortality	Entrainment	
	The use of fresh water or grey water for cooling	Not part of the design	MAYBE	YES	NO – adequate fresh or grey water supply does not exist, therefore not considered for further evaluation.
	Scheduled Outages during periods of peak impingement mortality & entrainment	Not part of the design	MAYBE	YES	NO – seasonal outages not anticipated, therefore not considered for further evaluation.
	The use of air cooling	Not part of the design	YES	YES	NO – configuration of facility not equipped for air cooling, therefore not considered for further evaluation.
Physical Barriers	Depth of withdrawal (pipe depth)	Part of the design	MAYBE	YES	YES – referenced in text
	Barrier Net/Marine life exclusion system	Not part of the design	YES	YES	NO – not a proven technology in open ocean settings, therefore not considered for further evaluation.
Behavioral Barriers	Velocity cap intake	Not part of the design	YES	NO	NO – not a proven technology in OSP applications, therefore not considered for further evaluation. Furthermore, the low intake velocity of 0.5 ft/s meets impingement mortality compliance standards.
	Strobe light, acoustic deterrents, air bubble curtains (only effective for certain target species)	Not part of the design	MAYBE	NO	NO – not a proven technology in open ocean settings, therefore not considered for further evaluation.
Collection/ Diversion Systems	Modified traveling screens with standard mesh, slot mesh or fine mesh (including Ristroph features [e.g., buckets, fish return, etc.])	Not part of the design	YES	MAYBE	NO – configuration of facility not equipped for traveling screens. The low intake velocity of 0.5 ft/s meets impingement mortality compliance standards.
	Cylindrical wedge wire screens	Not part of the design	YES	YES	NO – not a proven technology on this type of unmanned offshore platform, with engineering constraints, biofouling, and maintenance as primary concerns (as described in EPRI 2012), therefore not considered for further evaluation.

Note:
Technologies/operational measures presented does not imply that a particular technology/operational measure will be implemented at the SouthCoast Wind offshore converter station facility. ‘MAYBE’ refers to impingement mortality or entrainment reduction potential under certain conditions.

As summarized in **Table 18**, there are several technologies or operational measures that are capable of reducing impingement mortality or entrainment at a conventional power generating station or manufacturing facility, where implementation is appropriate. Many of these technologies or operational measures however, are not available for implementation at the SouthCoast Wind offshore converter station CWIS facility due to the configuration of the facility, limited space at the facility's footprint, unproven implementation in open ocean applications, and other reasons. Also, some of the technologies or operational measures may reduce impingement mortality, but SouthCoast Wind is choosing to comply with impingement mortality standards by maintaining a maximum intake velocity of 0.5 ft/s. Several of the technologies or operational measures listed in **Table 18** (e.g., closed-cycle cooling, air cooling, fresh/grey water, seasonal outages, barrier net, traveling screens, velocity cap, behavioral barriers) were not considered feasible for the SouthCoast Wind offshore converter station CWIS facility primarily due to the engineering constraints of these measures and space limitations on the limited footprint of an un-manned offshore platform. Furthermore, in developing the Phase I Rule, EPA recognized that the total estimated annualized compliance costs of the Phase I Rule is $48 million for up to 121 new facilities estimated to begin operation between 2001 and 2020 (EPA 2001).

At this stage of Project, SouthCoast Wind has limited engineering design for the facility that will be used to inform the design and construction technologies or operational measures for minimizing impingement mortality and entrainment. SouthCoast Wind intends to comply with Track I requirements for new facilities in either §125.84(b) or §125.84(c), depending on whether the converter station will withdraw 10 MGD or greater, or 2 to 10 MGD, respectively. The information presented in this section, and throughout this document, will be supplemented when engineering design, calculations, drawings, and estimates are sufficiently advanced to meet the Design and Construction Technology Plan information outlined in §125.86(b)(4), if required.

Technologies or operational measures in the following sections are considered feasible for further consideration into the design and operation of the cooling water intake/discharge for the SouthCoast Wind offshore converter station facility.

6.4.1 Single Pump Operation

The SouthCoast Wind offshore converter station facility is designed to operate at maximum efficiency during normal operating conditions using two pumps, each operating at 66 percent of their rated capacity to achieve maximum design intake flow of 10.2 MGD, or 5.1 MGD from each pump (see **Table 7**). However, the system is also capable of operating using only one pump at 5.1 MGD, or two pumps at 2.55 MGD each. However, this may only be achievable under certain metocean conditions (e.g., during times of colder source water).

From an engineering basis, a 50 percent flow reduction potential from DIF would be achieved by using a single pump when the required cooling for the dissipated heat load is halved (e.g., instead of two transformers operating, only one transformer is operating). Consequently, in this scenario, one lift pump flow can fulfill the HVDC converter station equipment cooling requirement. However, at this time, SouthCoast Wind cannot determine the frequency of such operating conditions that would result in a 50 percent flow reduction from DIF. To provide additional perspective on pump capacities vs. operational requirements and DIF, each seawater lift pump's rated design capacity is 7.7 MGD, but continuous operation at this maximum capacity is not recommended for efficiency, cost, maintenance, and other factors to consider at this unmanned OSP. Therefore, during normal operating conditions, each seawater lift pump operates at approximately 66 percent of its maximum rated capacity, or 5.1 MGD (50 percent of total platform flow).

The cooling water intake would be designed to maintain intake velocities of 0.5 ft/s or less using either one or two pumps. Utilizing a single pump instead of two pumps at full capacity results in an effective cooling water intake flow reduction of 50 percent, with an equivalent reduction in entrainment expected since entrainment is directly proportional to intake flow volume. However, for system operational redundancy and reliability, two pumps running at 50 percent capacity would be the more likely scenario than single pump operation.

Total intake flow could be reduced by reducing flow when the design flow is not needed to meet the NPDES discharge temperature limits (under certain Metocean or operational conditions). This flow reduction could be accomplished by limiting the number (or capacity) of operating pumps. While single pump operation results in reduced levels of entrainment, this may result in an increased temperature of the discharge water, with proportional impacts to the characteristics of the mixing zone. See Appendix A for thermal plume modeling.

6.4.2 Circulating Pumps with Variable Frequency Drives

The SouthCoast Wind offshore converter station CWIS facility is designed to incorporate variable frequency drives on the circulating pumps. Variable frequency drives are sometimes used in cooling water intake systems as a means to control flow or minimize the total flow volume required. As such, safe operational parameters are still maintained and a proportional flow reduction may result, similar to that described for single pump or reduced pump capacity operation in Section 6.3.1. Variable frequency drives for the circulating water pumps may allow efficient reduction in circulating water flow during periods when the facility is not operating at full-rate capacity or when ocean water temperatures are low enough to permit flow reduction without substantially reducing operational capabilities of the OSP. Installation of variable frequency drive controls for each existing circulating water pump may allow flow reductions at lower capacities. This would result in reduction of entrainment due to reduction in cooling water flow. With this technology it may be possible to vary the speed of the motor across a range within the safe operating capabilities of the circulating pump. However, pump operational characteristics may limit the achievable pump motor set speed range and the reduction in flow that could be achieved using variable frequency drive controls.

The configuration of the intake structure will be designed to utilize variable frequency drives on the pump motor. Each seawater lift pump has a VFD motor which allows it to speed up and down, with proportional increases/decreases in flow, allowing for control of intake velocity. The primary purpose of the VFDs is control of temperature differential across the seawater/cooling water heat exchangers. Therefore, as cooling demand increases, and more flow is required to satisfy the cooling water system (within the limits of the 10.2 MGD DIF), the VFD would ramp up the pump flow to match the demand. The high flow alarm on the flowmeter at each seawater pump discharge can be set at appropriate flow levels to allow for operators to intercede remotely, if the velocity through the screen approaches 0.5 ft/s.

6.4.3 Depth of Withdrawal

The SouthCoast 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. This is a favorable location for avoiding the higher concentrations of entrainable ichthyoplankton closer to the surface, as well as avoiding entrainable plankton taxa associated with benthic habitats (Kendall and Naplan 1981;), particularly for buoyant egg and larval stages (Hare et al. 2006). Studies have shown that the majority of ichthyoplankton occurs within the top 200 m of the ocean (Ahlstrom 1959; Sassa et al. 2002), with observations of decreased species diversity and richness with increased depth (Wang et al. 2021). Even with observed behaviors such as diel vertical migration or varying depth preferences based on seasonal temperature differences or different horizontal transport mechanisms, the majority of ichthyoplankton species maintain a depth range located within the upper layers of the ocean (Huebert et al. 2010; Hare and Govoni 2005). The results of studies designed to specifically explore how depth relates to ichthyoplankton presence indicate that catches dramatically decrease with increased depths (Wang et al. 2021).

Depth of withdrawal has been suggested as a factor that may influence ichthyoplankton entrainment potential at conventional generation facilities located in coastal marine environments. At Mystic Station in Boston Harbor, Shaw Environmental (2006) observed ichthyoplankton densities at the intake withdrawal depth of 2.1 m (7 ft) below the surface (17.4 ±34.52 eggs per 100 m^3) were substantially higher than ichthyoplankton densities at the surface (139.3 ±334.49 eggs per 100 m^3), primarily due to buoyant eggs at the surface which exhibited substantially lower levels of entrainment. This observation was primarily influenced by seasonal patterns of high densities of buoyant eggs such as tautog and cunner (Labridae).

While data is limited for direct comparison of water withdrawal depths on entrainment densities, in general a non-surface water intake withdrawing water from the middle portion of the water column is more favorable to minimize entrainment impacts.

6.4.4 Hydraulic Zone of Influence

The Area of Influence (40 CFR 122.21(r)(2)(ii)), also referred to as the Hydraulic Zone of Influence (HZI), is the portion of a source water body that is hydraulically influenced by the withdrawal of source water by a CWIS. Outside of the HZI, water flow is no longer influenced by the CWIS, but rather driven by ambient factors such as ocean currents, winds, and other factors not associated with the CWIS. The maximum downstream distance to the stagnation point limit of the HZI is determined using stream function theory (by equating the ambient current velocity to the velocity that would be induced by the intake).

$$u_r = \frac{Q}{4\pi r^2} \tag{1}$$

$$u_{rh} = u_r \cos arctan\left(\frac{z}{r}\right) \tag{2}$$

$$u_{rv} = u_r \sin arctan\left(\frac{z}{r}\right) \tag{3}$$

where:	**r**	Radius of hydraulic zone of influence (meters)
	Q	Design Intake Flow (cubic feet per second)
	Θ	Measure of shoreline angle (360° in this case, since the intake is in the open ocean)
	π	Constant (3.14159...)
	h	Constant; total water depth (feet)
	V	Ambient mean velocity (feet per second)
	μ_r	radial component of the intake velocity, where: $r = \sqrt{x^2 + y^2 + z^2}$
	z	location in the water column (e.g., intake = 0 ft, seafloor = 33 ft [below intake])

Conceptually, the HZI-line is the dividing streamline between water that flows into the intake and water that flows past the intake. The impact of transverse diffusion is accommodated by making the probability transition zone perpendicular to the HZI line and the local direction of flow wider in the upstream direction. Far up-current or up-wind, the probability of hydraulically influencing organisms becomes uniform throughout the water column cross-section; this probability equals the ratio of the intake flow to the ocean current discharge.

Since this HZI calculation is typically done using historical data, which is not available for this proposed OSP facility, the available data from the SouthCoast Wind Metocean buoy were used. The input values and resulting calculations from the above equations are available as part of this permit application. The dimensions of the HZI (radial distance from intake, depth from intake, depth above bottom, and area) were calculated for eight critical tidal condition scenarios and four maximum temperature delta scenarios shown in

Table 19.

Table 19. Extent of Hydraulic Zone of Influence

Scenario Category	Scenario Description	Radial Distance from intake (feet)	Depth from intake (feet)	Minimum depth above bottom (feet)	Area (feet^2)
Critical Tidal Conditions	Fall Maximum Current Speed (F2)	3.5	2	31	14
	Fall Minimum Current Speed (F3)	7.5	4	29	67
	Winter Maximum Current Speed (W1)	5	3	30	31
	Winter Minimum Current Speed (W2)	6.5	4	29	47
	Spring Maximum Current Speed (SP2)	10.5	6	27	128
	Spring Minimum Current Speed (SP3)	11	7	26	138
	Summer Maximum Current Speed (S1)	4.5	2	31	22
	Summer Minimum Current Speed (S2)	10.5	7	26	128
Maximum Temperature Delta	Fall Maximum Temperature Delta (F1)	8	5	28	75
	Winter Maximum Temperature Delta (W3)	5	3	30	28
	Spring Maximum Temperature Delta (SP1)	5.5	3	30	41
	Summer Maximum Temperature Delta (S3)	10.5	6	27	128

Under all ocean current and intake flow conditions, the entire 360° area surrounding the intake pipe (on the horizontal and vertical axis) is assumed to be within the HZI. The location and extent of the HZI within the Atlantic Ocean is bound by the lateral distance, vertical distance, and area shown for each of the 12 scenarios modeled. Within those boundaries, these dimensions will change with ocean current flow and intake flow, and therefore, with time. The exact location/dimensions of the HZI at any time will depend on the ratio of the intake flow to the current flow. Under low-flow hydrologic conditions (in this case the minimum annual current flow conditions), the HZI will extend further away from the intake. Consequently, the HZI for the SouthCoast Wind OSP intake with a maximum design intake flow of 10.2 MGD represents an approximate area inclusive of the dimensions defined above.

6.5 Section §125.84(b)(6) through (8)

As part of this application, SouthCoast Wind is submitting the relevant application information required in §122.21(r) and §125.84(b). The required information is located in the following sections in this document:

- **§122.21(r)(2) (except (r)(2)(iv)), (3), and (4)** – see Section 2, Section 3, and Section 4 of this document.

- **§125.86(b)** – see Section 6.1 for flow reduction information; see Sections 6.2 and 3.0 for intake velocity information; see Section 2.0 for source waterbody flow information (although, note that the facility is not located in a freshwater stream, lake/reservoir, estuary, or tidal river.
- **§125.87** – not included in this application, as monitoring requirements will be determined by the Director and implemented accordingly, pending receipt of the Final NPDES Permit.
- **§125.88** – not included in this application, as recordkeeping requirements will be implemented pending receipt of the Final NPDES Permit.

7.0 REFERENCES

AECOM, Tetra Tech, Inc., and DNV Energy USA, Inc. 2021. *Construction and Operations Plan, SouthCoast Wind Energy LLC*. Submitted to the Bureau of Ocean Energy Management. October 2021.

Ahlstrom, E. H. 1959. "Vertical distribution of pelagic fish eggs and larvae off California and Baja California." *Fish. Bull.* 60, 107–146. Available online at: https://spo.nmfs.noaa.gov/sites/default/files/pdf-content/fish-bull/ahlstrom.pdf

Bain, M. B. 1997. "Atlantic and shortnose sturgeons of the Hudson River: common and divergent life history attributes." *Environmental Biology of Fishes* 78:347–358.

Barlow, J., M. Kahru, and B.G. Mitchell. 2008. "Cetacean biomass, prey consumption and primary production requirements in the California Current ecosystem." *Marine Ecology Progress Series* 371: 285-295

BOEM (Bureau of Ocean Energy Management). 2018. V*ineyard Wind Offshore Wind Energy Project Draft Environmental Impact Statement*. December 2018

Castro, J. I. 2010. *The Sharks of North America*. Oxford University Press.

Clark, S.H. and R. Livingstone, Jr. 1982. "Ocean pout Macrozoarces americanus." In Grosslein, M.D. and T.R. Azarovitz eds. *Fish distribution*. p. 76-79. MESA New York Bight Atlas Monograph 15, N.Y. Sea Grant Institute, Albany, NY.

Collette, B., and G. Klein-MacPhee. 2002. *Bigelow and Schroeder's Fishes of the Gulf of Maine, 3rd edition*. Smithsonian Institution Press, Washington, D.C.

DeCelles, G. R., D. Martins, D.R. Zemeckis, S.X. Cadrin, and B. Neis. 2017. "Using Fishermen's Ecological Knowledge to map Atlantic cod spawning grounds on Georges Bank." *ICES Journal of Marine Science*, 74(6), 1587-1601. doi:10.1093/icesjms/fsx031

DHI (Danish Hydraulic Institute). 2020. *SouthCoast Pre-FEED and FEED Metocean Conditions.*

EPA (U.S. Environmental Protection Agency). 2001a. *Technical Development Document for the Final Regulations Addressing Cooling Water Intake Structures for New Facilities.* EPA-821-R-01-036. Washington, DC. November 2001. Available online at: https://www.epa.gov/sites/default/files/2015-04/documents/cooling-water_phase-1_tdd_2001.pdf

EPA. 2015. *National Coastal Condition Assessment 2010*. Office of Water and Office of Research and Development. EPA 841-R-15-006. Available online at: https://www.epa.gov/national-aquatic-resourcesurveys/ncca.

EPRI (Electric Power Research Institute). 2012. *Fish Protection Technology Manual*. Product ID #3002000231. 618 pp. Available online at: https://www.epri.com/research/products/000000003002000231

Epsilon Associates, Inc. 2018. *Vineyard Wind Draft Construction and Operations Plan, Volume III.* March 15, 2018.

ESS Group, Inc. and Battelle. 2006. *Cape Wind Energy Project. Appendix 3.8-B: Draft Fisheries Report*. Prepared for Cape Wind Associates, LLC. September 2006.

Fahay, M.P. 1983. "Guide to the early stages of marine fishes occurring in the western North Atlantic Ocean, Cape Hatteras to the southern Scotian Shelf." *J. Northwest Atl. Sci.* 4: 1-423.

Gleen, D.H. 1992. "Measurement of long-period, low amplitude Swell in the Western North Atlantic." *Journal of Atmospheric and Oceanic Technology*, vol. 9, pp. 645-658

Graham, J.J., S.B. Chenoweth, and C.W. Davis. 1972. "Abundance, distribution, movements, and lengths of larval herring along the western coast of the Gulf of Maine." *Fish. Bull.*, U.S. 70:307–321.

Greater Atlantic Regional Fisheries Office. 2019. *The Greater Atlantic Region ESA Section 7 Mapper (vers. 2.0).* Retrieved October 2020 from: https://noaa.maps.arcgis.com/apps/webappviewer/index.html?id=1bc332edc5204e03b250ac11f9914a27.

Hare, J.A. and J.J. Govoni. 2005. "Comparison of average larval fish vertical distributions among species exhibiting different transport pathways on the southeast Unites States continental shelf." *Fishery Bulletin* 103(4): 728-736. Available online at: https://aquadocs.org/bitstream/handle/1834/26210/hare.pdf?sequence=1&isAllowed=y Hare, J.A., H.J. Walsh, and M.J. Wuenschel. 2006. "Sinking rates of late-stage fish larvae: Implications for larval ingress into estuarine nursery habitats." *Journal of Experimental Marine Biology and Ecology* 330(2): 493–504. Available online at: https://doi.org/10.1016/j.jembe.2005.09.011.

Head, E. J. H., and P. Pepin. 2010. "Spatial and inter-decadal variability in plankton abundance and composition in the Northwest Atlantic (1958–2006)." *Journal of Plankton Research* 32(12):1633–1648.

Huebert, K.B., S. Sponaugle, and R.K. Cowen. 2010. "Predicting the vertical distributions of reef fish larvae in the Straits of Florida from environmental factors." *Canadian Journal of Fisheries and Aquatic Science*. 67: 1755-1767. DOI:10.1139/F10-116.

HYCOM 2022. Hybrid Coordinate Ocean Model (HYCOM) User's Manual, Code Version 2.0.01, Manual Version 2.0.01, March 4, 2002

R.L. Doneker and G.H. Jirka. 2021. *CORMIX User Manual. A Hydrodynamic Mixing Zone Model and Decision Support System for Pollutant Discharges into Surface Waters*. EPA-823-K-07-001 December 2007 (Updated July 2021).

Kendall, A.W. and N.A. Naplin. 1981. "Diel-depth distribution of summer ichthyoplankton in the middle Atlantic Bight." *Fishery Bulletin*. 79 (4): 705-725.

Kenney, R.D., M.A.M. Hyman, and H.E. Winn. 1985. *Calculation of Standing Stocks and Energetic Requirements of the Cetaceans of the Northeast United States Outer Continental Shelf*. NOAA Technical Memorandum NMFS-F/NEC-41. Woods Hole, MA: National Marine Fisheries Service. iv + 99 pp.

Kenney, R.D., M.A.M. Hyman, R.E. Owen, G.P. Scott, and H.E. Winn. 1986. “Estimation of prey densities required by western North Atlantic right whales.” *Marine Mammal Science* 2: 1–13

Kenney, R.D., G.P. Scott, T.J. Thompson, and H.E. Winn. 1997. “Estimates of prey consumption and trophic impacts of cetaceans in the USA northeast continental shelf ecosystem.” *Journal of Northwest Atlantic Fisheries Science* 22: 155–171

Kleiber, M. 1975. *The Fire of Life: An Introduction to Animal Energetics, third edition.* Huntington, NY: R.E. Kreiger Publishing Co. 478 pp

Laran, S., C. Joiris, A. Gannier, and R.D. Kenney. 2010. “Seasonal estimates of densities and predation rates of cetaceans in the Ligurian Sea, northwestern Mediterranean Sea: an initial examination.” *Journal of Cetacean Research and Management* 11(1): 31-40.

Laurence, G.C. 1974. “Growth and survival of haddock (*Melanogrammus aeglefinus*) larvae in relation to planktonic prey concentration.” *J. Fish. Res. Board Can.* 31: 1415-1419.

Long, D. 2006. *BGS detailed explanation of seabed sediment modified Folk classification.* Available online at: https://www.researchgate.net/publication/284511408_BGS_detailed_explanation_of_seabed_sediment_modified_folk_classification.

Lough, R.G., P.C. Valentine, D.C. Potter, P.J. Auditore, G. R. Bolz, J.D. Neilson, and R.I. Perry. 1989. “Ecology and distribution of juvenile cod and haddock in relation to sediment type and bottom currents on eastern Georges Bank.” *Mar. Ecol. Prog. Ser.* 56: 1-12

MA DMF (Massachusetts Division of Marine Fisheries). 2021. *Massachusetts Fishery Resource Assessment*. 2019 Annual Performance Report.

Malek, A.J., J.S. Colllie, and J. Gartland. 2014. “Fine-scale spatial patterns in the demersal fish and invertebrate community in a northwest Atlantic ecosystem.” *Estuarine and Coastal Shelf Science,* 147,1-10.

Mattocks, S., C.J. Hall, and A. Jordaan. 2017. “Damming, Lost Connectivity, and the Historical Role of Anadromous Fish in Freshwater Ecosystem Dynamics.” *BioScience* 67 (8). 713–728. DOI: 10.1093/biosci/bix069

Methven, D.A. and J.A. Brown. 1991. “Time of hatching affects development, size, yolk volume, and mortality of newly hatched Macrozoarces americanus (Pisces: Zoarcidae).” *Can. J. Zool*. 69: 2161-2167.

Morgan, M.J. 2001. “Time and location of spawning of American plaice in NAFO Divisions 3LNO.” *Journal of Northwest Atlantic Fishery Science*, *29*.

Morse , W.W. and K.W. Able. 1995. “Distribution and life history of windowpane, *Scophthalmus aquosus*, off the northeastern United States.” *Fish. Bull. (U.S.)* 93:675-693.

NEFMC (New England Fishery Management Council). 1998. *Monkfish Fishery Management Plan*. Available online at: https://s3.us-east-1.amazonaws.com/nefmc.org/MonkForPDF.FMP.pdf.

NEFMC. 2016a. *Omnibus Habitat Amendment 2, Vol I.* Available online at: https://s3.us-east-1.amazonaws.com/nefmc.org/OA2-FEIS_Vol_1_FINAL_161208.pdf.

NEFMC. 2016b. *Omnibus Habitat Amendment 2, Vol II.* Available online at: https://s3.us-east-1.amazonaws.com/nefmc.org/OA2-FEIS_Vol_2_FINAL_171025.pdf.

NEFMC. 2017. *Final Omnibus Essential Fish Habitat Amendment 2 Volume 2: EFH and HAPC Designation Alternatives and Environmental Impacts*. Available online at: https://www.habitat.noaa.gov/protection/efh/efhmapper/oa2_efh_hapc.pdf

NEFMC. 2021. *Northeast Multispecies Fishery Management Plan, Amendment 23.* Available online at: https://s3.us-east-1.amazonaws.com/nefmc.org/210809_Groundfish_A23_FEIS_final_submission_corrected_220107_220113_124340.pdf

NEFSC (Northeast Fisheries Science Center). 1999a. *Essential fish habitat source document. Silver hake, Merluccius bilinearis, life history and habitat characteristics*. Available online at: https://repository.library.noaa.gov/view/noaa/3125

NEFSC. 1999b. *Essential fish habitat source document. Offshore hake, Merluccius albidus, life history and habitat characteristics*. Available online at: https://repository.library.noaa.gov/view/noaa/3116

NEFSC. 1999c. *Essential fish habitat source document. Red hake, Urophycis chuss, life history and habitat characteristics*. Available online at: https://repository.library.noaa.gov/view/noaa/3119

NEFSC. 1999d. *Essential fish habitat source document. Yellowtail flounder, Limanda ferruginea, life history and habitat characteristics*. NOAA technical memorandum NMFS-NE;140. Available online at: https://repository.library.noaa.gov/view/noaa/3137

NEFSC. 1999e. *Essential fish habitat source document. Goosefish, Lophius americanus, life history and habitat characteristics.* NOAA technical memorandum NMFS-NE ; 127. Available online at: https://repository.library.noaa.gov/view/noaa/3104

NEFSC. 1999f. *Essential fish habitat source document. Windowpane, Scophthalmus aquosus, life history and habitat characteristics*. NOAA technical memorandum NMFS-NE ; 137. Available online at: https://repository.library.noaa.gov/view/noaa/3127

NEFSC. 1999g. *Essential fish habitat source document. Witch flounder, Glyptocephalus cynoglossus, life history and habitat characteristics*. NOAA technical memorandum NMFS-NE ; 139. Available online at: https://repository.library.noaa.gov/view/noaa/3136

NEFSC. 1999h. *Essential fish habitat source document. Pollock, Pollachius virens, life history and habitat characteristics*. NOAA technical memorandum NMFS-NE ; 131. Available online at: https://repository.library.noaa.gov/view/noaa/3117

NEFSC. 1999i. *Essential fish habitat source document. Atlantic mackerel, Scomber scombrus, life history and habitat characteristics*. NOAA technical memorandum NMFS-NE ; 141. Available online at: https://repository.library.noaa.gov/view/noaa/3138

NEFSC. 1999j. *Essential fish habitat source document. Butterfish, Peprilus triacanthus, life history and habitat characteristics*. NOAA technical memorandum NMFS-NE ; 145. Available online at: https://repository.library.noaa.gov/view/noaa/3146

NEFSC. 1999k. *Essential fish habitat source document. Summer flounder, Paralichthys dentatus, life history and habitat characteristics*. NOAA technical memorandum NMFS-NE ; 151. Available online at: https://repository.library.noaa.gov/view/noaa/3149

NEFSC. 2004. *Essential fish habitat source document. American plaice, Hippoglossoides platessoides, life history and habitat characteristics, Second edition*. NOAA technical memorandum NMFS-NE ; 187. Available online at: https://repository.library.noaa.gov/view/noaa/4041

NEFSC. 2005a. *Essential fish habitat source document. Haddock, Melanogrammus aeglefinus, life history and habitat characteristics, Second edition.* NOAA technical memorandum NMFS-NE ; 196. Available online at: https://repository.library.noaa.gov/view/noaa/4036.

NEFSC. 2005b. *Essential fish habitat source document. Atlantic herring, Clupea harengus, life history and habitat characteristics, Second edition.* NOAA technical memorandum NMFS-NE ; 192. Available online at: https://repository.library.noaa.gov/view/noaa/4034

NEFSC. 2020a. *Multispecies bottom trawl survey.* Water quality monitoring data files. Available online at: https://catalog.data.gov/dataset/fall-bottom-trawl-survey.

NEFSC. 2020b. *Bottom Trawl Surveys*. Available online at: https://www.fisheries.noaa.gov/inport/item/22557.

NOAA (National Oceanic and Atmospheric Administration). 2020a. *Deep Sea Coral Database*. NOAA Deep Sea Coral Research and Technology Program. Available online at: https://deepseacoraldata.noaa.gov/

NOAA . 2020b. *Ocean Pout*. NOAA Fisheries. Available online at: https://www.fisheries.noaa.gov/species/ocean-pout#seafood

NOAA. 2020c. *Witch Flounder*. NOAA Fisheries. Available online at: https://www.fisheries.noaa.gov/species/winter-flounder#seafood

NOAA. 2021a. *American Plaice*. NOAA Fisheries. Available online at: https://www.fisheries.noaa.gov/species/american-plaice#seafood

NOAA. 2021b. *Endangered and Threatened Wildlife; 90-Day Finding on a Petition to List the Shortfin Mako Shark as Threatened or Endangered Under the Endangered Species Act*. 86 FR 19863.

NOAA. 2022a. *Haddock*. NOAA Fisheries. Available online at: https://www.fisheries.noaa.gov/species/haddock

NOAA. 2022b. *Atlantic Herring*. NOAA Fisheries. Available online at: https://www.fisheries.noaa.gov/species/atlantic-herring#seafood

NOAA. 2022c. *Atlantic Cod*. NOAA Fisheries. Available online at: https://www.fisheries.noaa.gov/species/atlantic-cod#seafood

NOAA. 2022d. *Silver Hake*. NOAA Fisheries. Available online at: https://www.fisheries.noaa.gov/species/silver-hake#seafood

NOAA. 2022e. *Yellowtail Flounder*. NOAA Fisheries. Available online at: https://www.fisheries.noaa.gov/species/yellowtail-flounder#seafood

NOAA 2022f. *Monkfish*. NOAA Fisheries. Available online at: https://www.fisheries.noaa.gov/species/monkfish#seafood

NOAA. 2022g. *Windowpane Flounder*. NOAA Fisheries. Available online at: https://www.fisheries.noaa.gov/species/windowpane-flounder#overview

NOAA. 2022h. *Atlantic Pollock*. NOAA Fisheries. Available online at: https://www.fisheries.noaa.gov/species/atlantic-pollock#seafood

NOAA. 2022i. *Atlantic Mackerel*. NOAA Fisheries. Available online at: https://www.fisheries.noaa.gov/species/atlantic-mackerel

NOAA. 2022j. *Butterfish*. NOAA Fisheries. Available online at: https://www.fisheries.noaa.gov/species/butterfish#overview

NOAA. 2022k. *Summer Flounder*. NOAA Fisheries. Available online at: https://www.fisheries.noaa.gov/species/summer-flounder#seafood

NOAA Fisheries (National Marine Fisheries Service). 2021. *EFH Mapper*. Available online at: https://www.habitat.noaa.gov/apps/efhmapper/

NOAA NDBC (National Oceanic Atmospheric Administration National Data Buoy Center. 2020. *Water quality monitoring data file*. Available online at: https://www.ndbc.noaa.gov/historical_data.shtml.

Northeast Gateway (Northeast Gateway Energy Bridge, L.P.). 2012. *Environmental Impact Assessment for the Northeast Gateway Deepwater Port*. Prepared by Tetra Tech, Inc. March 2012. 129 pp.

Richardson, D.E., L. Carter, K.L. Curti, K.E. Maranik, and M. Castonguay. 2020. "Changes in the spawning distribution and biomass of Atlantic mackerel (*Scomber scombrus*) in the western Atlantic Ocean over 4 decades." *Fishery Bulletin*, 188, 120-134.

RI DEM (Rhode Island Department of Environmental Management). 2022. *Coastal Fishery Resource Assessment Trawl Survey 2021.* Annual Performance Report.

Sassa, C., H.G. Moser, and K. Kawaguchi. 2002. "Horizontal and vertical distribution patterns of larval myctophid fishes in the Kuroshio Current region." *Fish. Oceanogr*. 11, 1–10. DOI: 10.1046/j.1365-2419.2002.00182.x

Schtickzelle, N. and T.P. Quinn. 2007. "A metapopulation perspective for salmon and other anadromous fish." *Fish and Fisheries* 8, 297-314.

Shaw Environmental. 2006. *Mystic I, LLC 306(b) Biomonitoring: Fish Impingement, Fish Entrainment, and Discharge Temperature Monitoring of Unit-7.* Submitted to US EPA Region 1 by Boston Generating, LLC. 105 pp.

Trites, A.W. and D. Pauly. 1998. "Estimating mean body masses of marine mammals from maximum body lengths." *Canadian Journal of Zoology* 76: 886-896

USACE (U.S. Army Corps of Engineers). 1976. *Tidal Prism – Inlet Area Relationships.* James T. Jarrett. General Investigation of Tidal Inlets (GITI) Report #3. February 1976. Available online at: https://usace.contentdm.oclc.org/digital/api/collection/p266001coll1/id/7466/download

US DOC/NOAA/NMFS Northeast Fisheries Science Center. 2019. *Zooplankton and ichthyoplankton abundance and distribution in the North Atlantic collected by the Ecosystem Monitoring (EcoMon) Project from 1977-02-13 to 2019-11-11* (NCEI Accession 0187513). Version 2.2. NOAA National Centers for Environmental Information. Data set. Available online at: https://www.ncei.noaa.gov/archive/accession/0187513.

Walsh, H.J., D.E. Richardson, K.E. Marancik, and J.A. Hare. 2015. "Long-term changes in the distributions of larval and adult fish in the Northeast U.S. Shelf Ecosystem." *PLoS ONE* 10(9):e0137382.

Wang, V.H., C.R. Zapfe, and F.J. Hernandez. 2021. "Assemblage Structure of Larval Fishes in Epipelagic and Mesopelagic Waters of the Northern Gulf of Mexico." *Frontiers in Marine Science.* Available online at: https://www.frontiersin.org/articles/10.3389/fmars.2021.766369/full

Wiegel, R.L. 1964. *Oceanographic Engineering*. Prentice-Hall, Inc, Englewood Cliffs, N.J.

Zemeckis, D.R., M.J. Dean, and S.X. Cadrin. 2014. "Spawning dynamics and associated management implications for Atlantic cod." *North American Journal of Fisheries Management* 34(2): 424-442. DOI: 10.1080/02755947.2014.882456.

APPENDIX A: THERMAL PLUME MODELING

TETRA TECH

MEMO

To:	SouthCoast Wind
Cc:	Brian Dresser, Tetra Tech
From:	Erin Lincoln, PH; Tetra Tech Madhu Akasapu-Smith, PE, CFM; Tetra Tech
Date:	April 10, 2023
Subject:	SouthCoast Wind CORMIX Mixing Zone Results

INTRODUCTION

SouthCoast Wind LLC (SouthCoast Wind) is evaluating the effects of the thermal plume caused by the cooling water from the offshore converter. The facility is in the Atlantic Ocean inside the lease area that is located more than 30 miles south of Martha's Vineyard and 20 miles south of Nantucket. SouthCoast Wind requested that Tetra Tech conduct a mixing zone thermal impact study of their effluent plume using Cornell Mixing Zone Expert System (CORMIX). SouthCoast Wind offshore converter is located outside of Massachusetts state waters and is not subject to state mixing zone regulations.

A thermal mixing zone analysis was performed using CORMIX v12.0GTD Advanced Tools (Design) for the SouthCoast Wind effluent discharge to predict and analyze the temperature changes in the Atlantic Ocean during critical tidal and temperature conditions in fall, winter, spring, and summer months. The fall months were defined from September through November, winter months were defined from December through February, spring months were defined from March through May, and summer months were defined from June through August. Critical tidal conditions are expected to occur during maximum and minimum tidal velocities. Additionally, the highest temperature delta between ambient and effluent conditions for the four seasons was evaluated. This memorandum outlines the CORMIX setup and mixing zone results for the different scenarios evaluated for the thermal impact study.

CORMIX is a comprehensive software system for the analysis, prediction, and design of outfall mixing zones from the discharge of pollutants into diverse water bodies (Doneker 2021). CORMIX serves as a recommended analysis tool in key guidance documents for the permitting of industrial, municipal, thermal, and other point source discharges to receiving waters (Doneker 2021). The program can be used to predict the characteristics of the geometry and dilution of the initial mixing zone to ensure compliance with the water quality regulatory constraints. The program can also be used to study and predict the response of the plumes from the effluent discharges at larger distances (Doneker 2021).

MIXING REGIONS WITHIN A PLUME

The physical mixing processes in a plume can be described by two regions, near-field and far-field, and by the plume boundary interaction. The region controlled by the discharge conditions in a plume is defined as a ***near-field region (NFR)***. The NFR usually ranges from 0.3 feet (0.1 meters) to 328 feet (100 meters) from the discharge source. As the turbulent plume travels further away from the source, the path and dilution of the plume is controlled by the ambient conditions. The region where the plume is controlled by the buoyant spreading and passive diffusion caused by the ambient turbulence is called the ***far-field region (FFR)***. Ambient conditions dominate mixing in the FFR which usually ranges from 32.8 feet (10 meters) to 3,280 feet (1,000 meters) from the discharge source.

TETRA TECH
1899 Powers Ferry Rd, Suite 400, Atlanta, GA 30339
Tel 770.850.0949 Fax 770.850.0950 tetratech.com

The boundary interaction occurs where the plume transitions from near-field to far-field mixing (MixZon 2022). At this boundary, the plume often interacts with a vertical (water surface or bottom) or lateral (bank) boundary, and these interactions control the stability of the plume. The boundary interactions often depend on the ambient geometry, such as the depth of the water, and the properties of the plume.

CORMIX MODEL RESULTS

SOUTHCOAST WIND OUTFALL CONFIGURATION

The effluent from the offshore converter discharges through a submerged pipe into the Atlantic Ocean. Tetra Tech used the CORMIX1 module to represent a system for single port discharges. CORMIX1 is for the analysis of single port sources submerged or above the water surface (Doneker 2021).

The offshore converter outfall was set at 41 feet (12.5 meters) from the water surface (Mayflower Wind 2022). The outfall was fully submerged and perpendicular to the water surface. The outfall was an open pipe with a diameter of 36 inches as shown in Figure 1.

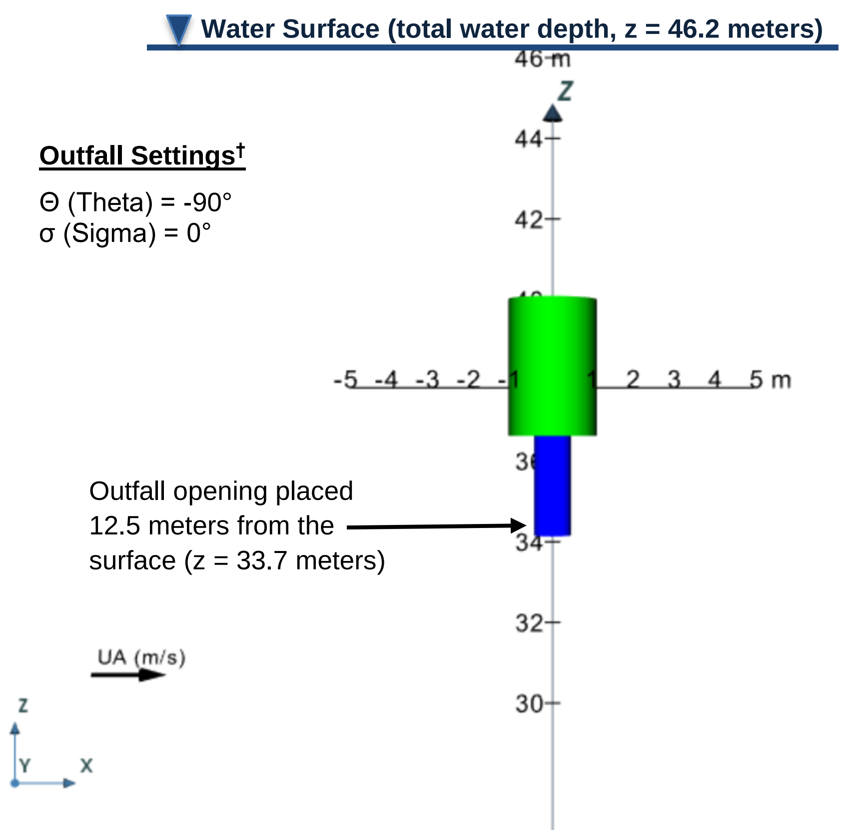


Figure 1: Outfall configuration for the SouthCoast Wind offshore converter

†**θ (Theta)**: Vertical discharge angle, the angle between the port centerline and the horizontal plane.

σ (Sigma): Horizontal angle, the angle measured counterclockwise from the ambient current direction to the plane projection of the port centerline.

EFFLUENT CONDITIONS

A maximum effluent temperature of 90°F as provided by SouthCoast Wind was used in the thermal impact study. A total effluent discharge was estimated at 8 to 10.2 million gallons per day (MGD) by SouthCoast Wind, and the upper limit of the range, 10.2 MGD, was used in the study. The effluent was assumed to be non-freshwater and the same salinity level was applied as the ambient condition for each scenario.

AMBIENT CONDITIONS

Tetra Tech used the site-specific metocean data provided by SouthCoast Wind to identify and calculate the velocity, temperature, and salinity model input parameters for the CORMIX mixing zone model. A summary of the metocean dataset and the years it was available is provided below:

- Hourly surface water temperature and hourly salinity from January 23, 2020, through January 22, 2022
- Hourly water level from January 1, 1979, through December 31, 2021
- Depth averaged hourly current speed and direction from January 1, 2000, through December 31, 2017

Data outputs from the data-assimilative hybrid isopycnal-sigma-pressure (generalized) coordinate ocean model (called Hybrid Coordinate Ocean Model or HYCOM) were also used to help support defining the ambient condition and hydrodynamic characteristics for each season and tidal condition. The 41-layer model outputs were available from January 1, 1994, through present and were paired with the measured hourly temperature, salinity, and current speed data because of the overlapping time periods.

HYCOM evolved from the Miami Isopycnic-Coordinate Ocean Model (MICOM) and is a primitive equation ocean general circulation model (HYCOM 2002). MICOM has undergone multiple validation studies and is one of the premier ocean circulation models (HYCOM 2002). The model provides mixing throughout the entire water column with smooth transition between the vigorous mixing in the surface boundary layer and the relatively weak diapycnal mixing in the ocean interior (HYCOM 2002).

Although the facility is located in a tidally influenced area, CORMIX can only represent steady state conditions. Therefore, in addition to evaluating the temperature plume for the highest seasonal temperature deltas, Tetra Tech evaluated the plume dynamics during minimum and maximum tidal conditions during four separate seasons to determine potential zones of initial dilution during those periods. Based on the water level and depth averaged current velocity data received from SouthCoast Wind at the facility location, the current speed ranges from 1.5 meters per second (m/sec) to 2 m/sec in all directions with no periods of slack tides (Figure 2).

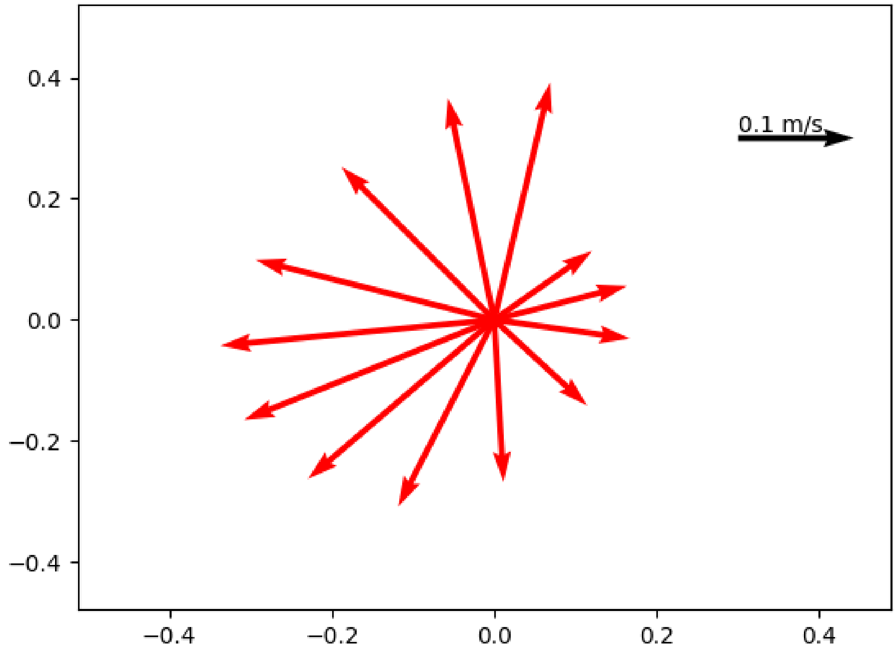


Figure 2: Tidal signature at the discharge location for the SouthCoast Wind

MIXING ZONE ANALYSIS

A mixing zone analysis was performed at the discharge location of SouthCoast Wind into the Atlantic Ocean under a variety of conditions to evaluate the rise in ocean temperatures in the discharge vicinity. The scenarios evaluated the mixing zone size under worse-case conditions for four different seasons: fall, winter, spring, and summer. The fall months were defined from September through November, winter months were defined from December through February, spring months were defined from March through May, and summer months were defined from June through August. The CORMIX results were interpreted to identify the extent of the thermal plume at the edge of the NFR and when the temperature delta is within 1.8°F (1°C).

EVALUATION CRITERIA

Critical Tidal Conditions

Using the SouthCoast Wind metocean ambient velocity (current speed) information from January 1, 2000, through December 31, 2017, Tetra Tech identified eight scenarios that were run to represent the realistic maximum and minimum tidal velocities at the outfall location. These scenarios provided the expected maximum extent of the plume (maximum tidal velocities) and maximum concentrations of the plume (minimum tidal velocities) and determined the potential impact of SouthCoast Wind in the Atlantic Ocean. The measured metocean current speed data were paired with the simulated HYCOM temperature and salinity data.

- Scenario 1: Fall Maximum Current Speed
    - Observed maximum current speed during the fall period, average ocean temperature at the depth of outfall during the day when maximum current speed was observed.

- Scenario 2: Fall Minimum Current Speed
    - Observed minimum current speed during the fall period, average ocean temperature at the depth of outfall during the day when minimum current speed was observed.
- Scenario 3: Winter Maximum Current Speed
    - Observed maximum current speed during the winter period, average ocean temperature at the depth of outfall during the day when maximum current speed was observed.
- Scenario 4: Winter Minimum Current Speed
    - Observed minimum current speed during the winter period, average ocean temperature at the depth of outfall during the day when minimum current speed was observed.
- Scenario 5: Spring Maximum Current Speed
    - Observed maximum current speed during the spring period, average ocean temperature at the depth of outfall during the day when maximum current speed was observed.
- Scenario 6: Spring Minimum Current Speed
    - Observed minimum current speed during the spring period, average ocean temperature at the depth of outfall during the day when minimum current speed was observed.
- Scenario 7: Summer Maximum Current Speed
    - Observed maximum current speed during the summer period, average ocean temperature at the depth of outfall during the day when maximum current speed was observed.
- Scenario 8: Summer Minimum Current Speed
    - Observed minimum current speed during the summer period, average ocean temperature at the depth of outfall during the day when minimum current speed was observed.

Maximum Temperature Delta

Using the SouthCoast Wind metocean ambient temperature information from January 23, 2020, through January 22, 2022, Tetra Tech identified four scenarios that were run to represent the highest temperature delta between ambient and the thermal effluent during the four seasons at the outfall location. These scenarios provided the expected maximum temperature deltas within the plume and determined the potential impact of SouthCoast Wind in the Atlantic Ocean. The measured metocean temperature data were paired with the simulated HYCOM current speed data.

- Scenario 9: Fall Maximum Temperature Delta
    - Observed lowest ambient temperature during the fall period, observed maximum current speed during the day when lowest ambient temperature was observed.
- Scenario 10: Winter Maximum Temperature Delta
    - Observed lowest ambient temperature during the winter period, observed maximum current speed during the day when lowest ambient temperature was observed.
- Scenario 11: Spring Maximum Temperature Delta
    - Observed lowest ambient temperature during the spring period, observed maximum current speed during the day when lowest ambient temperature was observed.
- Scenario 12: Summer Maximum Temperature Delta
    - Observed lowest ambient temperature during the summer period, observed maximum current speed during the day when lowest ambient temperature was observed.

CORMIX SCENARIO INPUT PARAMETERS

Table 1 provides a summary of key scenario assumptions for ambient and effluent conditions for the CORMIX thermal impact study for the critical tidal condition scenarios, and Table 2 provides a summary of the maximum temperature differential scenarios results.

For the critical tidal condition scenarios, maximum and minimum current speeds were selected for each season. Plume characteristics are highly dependent on ambient current speeds. Minimum ambient current speeds may impact the dispersion of the plume whereas, maximum current speeds may influence the dilution within the plume. Additionally, low ambient current speeds may lead to unsteady ambient flow processes causing build-up in the near-field (Donekar 2021). Therefore, it is important to study the behavior of the plume under varying current speeds. Because the availability of the water temperature and salinity datasets did not coincide with the current speeds and water level datasets, outputs from HYCOM, which are available at a 3-hour timestep, were used prescribe the temperature and salinity during the same days as the scenario current speed.

For the maximum temperature delta scenarios, site-specific metocean data was used to estimate the lowest ambient temperature for each season. Only surface ambient temperature was available from metocean data. The outfall was located approximately 12.3 meters from the surface and, therefore, the surface temperatures were used because of the outfall proximity to the surface. Surface metocean data were compared to the HYCOM outputs at the depth of outfall, which are written at a 3-hour timestep. Differences in temperatures were minimal (-2% to 19%), and the metocean temperatures were consistently lower than the HYCOM temperatures. This indicates that using the measured surface metocean temperature data results in a more conservative CORMIX analysis compared to using the HYCOM temperature data outputs at the outfall depth. Because measured current data were not collected when temperature and salinity data were collected, the HYCOM outputs were used to determine the current speeds during this period.

Table 1: Ambient and effluent input parameters for the CORMIX1 model for the eight critical tidal condition scenarios

Model Input	Scenario 1: Fall Max. Current Speed	Scenario 2: Fall Min. Current Speed	Scenario 3: Winter Max. Current Speed	Scenario 4: Winter Min. Current Speed	Scenario 5: Spring Max. Current Speed	Scenario 6: Spring Min. Current Speed	Scenario 7: Summer Max. Current Speed	Scenario 8: Summer Min. Current Speed
Effluent discharge[1] (MGD)	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2
Effluent water temperature (°F)	90	90	90	90	90	90	90	90
Average water depth at Atlantic Ocean[2] (feet)	151.6	151.6	151.6	151.6	151.6	151.6	151.6	151.6
Wind speed, average (mi/hr)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Atlantic Ocean current speed (mi/hr)	1.2	0.03	1.2	0.03	1.2	0.03	1.1	0.05
Date when current speeds were recorded	11/8/2012	10/23/2005	12/27/2010	2/15/2007	3/27/2013	4/16/2009	8/29/2011	8/22/2007
Atlantic Ocean water temperature (°F)	55.5	57.3	45.0	40.7	43.1	42.6	64.8	61.1
Atlantic Ocean salinity (PSU)	32.6	31.9	32.5	32.5	32.9	32.2	31.9	32.4
Temperature delta (°F)	34.5	32.7	45.0	49.3	46.9	47.4	25.2	28.9

[1] Estimated total maximum discharge
[2] The surveyed water depth at BG44

Table 2: Ambient and effluent input parameters for the CORMIX1 model for the four maximum temperature delta scenarios

Model Input	Scenario 9: Fall Max. Temp. Delta	Scenario 10: Winter Max. Temp. Delta	Scenario 11: Spring Max. Temp. Delta	Scenario 12: Summer Max. Temp. Delta
Effluent discharge[1] (MGD)	10.2	10.2	10.2	10.2
Effluent water temperature (°F)	90	90	90	90
Average water depth at Atlantic Ocean[2] (feet)	151.6	151.6	151.6	151.6
Wind speed, average (mi/hr)	0.0	0.0	0.0	0.0
Atlantic Ocean current speed (mi/hr)	0.3	0.8	0.5	0.3
Atlantic Ocean water temperature (°F)	54.1	39.6	38.6	51.3
Atlantic Ocean salinity (PSU)	32.6	32.6	32.4	32.7
Temperature delta (°F)	35.9	50.4	51.4	38.7

[1] Estimated total maximum discharge
[2] The surveyed water depth at BG44

CORMIX RESULTS

Table 3 and Table 4 summarize the key numerical results of each CORMIX scenario, including the Atlantic Ocean temperature and the location and dimensions of the plume when the temperature delta is 1.8°F (1°C). Results were also analyzed at the edge of NFR because this region is representative of strong initial mixing and is controlled by the discharge conditions. Figure 3 through Figure 10 are the 1.8°F (1°C) temperature delta isoline figures for the critical tidal conditions scenarios, Scenario 1 through Scenario 8, and the 1.8°F (1°C) temperature delta isoline figure for the maximum temperature delta scenarios. Scenarios 2, 4, 6, and 8 utilize the absolute lowest current speeds observed during each season, and therefore should not be considered typical of thermal plume characteristics, since it is only representative of a small fraction (< 0.0025%) of conditions during each season.

Scenario 9 through Scenario 12 can be found in Figure 11 through Figure 14. The plan and profile views of the excess temperature from Scenarios 1 through 12 can be found in Section Plume Figures. The figures are created in the CORMIX CorVue package. Due to large upstream intrusion of the plume against the ambient flow in critical tidal conditions scenarios using minimum ambient current speeds, plan and profile view of Scenarios 2 (Fall Min. Current Speed), 4 (Winter Min. Current Speed), 6 (Spring Min. Current Speed), and 8 (Summer Min. Current Speed) could not be developed in CORMIX. However, such conditions are indicative of a worst-case scenario, where minimum ambient current speeds of 0.015 m/sec. occurred for a total of only 4-hours, spread across the 17-year timeseries from 2000 to 2017, which represents approximately 0.0025% of that timeframe.

Table 3: CORMIX results for critical tidal condition scenarios for SouthCoast Wind

Parameter	Scenario 1: Fall Max. Current Speed	Scenario 2: Fall Min. Current Speed	Scenario 3: Winter Max. Current Speed	Scenario 4: Winter Min. Current Speed	Scenario 5: Spring Max. Current Speed	Scenario 6: Spring Min. Current Speed	Scenario 7: Summer Max. Current Speed	Scenario 8: Summer Min. Current Speed
Edge of NFR								
Atlantic Ocean temperature at the edge of NFR, °F	55.8	59.0	45.4	43.2	43.5	45.0	65.1	62.7
Temperature delta at the edge of NFR in the Atlantic Ocean, °F	0.3	1.7	0.4	2.5	0.5	2.4	0.3	1.6
Dilution at the edge of NFR in the Atlantic Ocean	109.6	19.4	105.7	19.9	103.8	20.0	99.0	18.0
NFR distance[1], feet (meters)	309 (94)	1,178 (359)	275 (84)	1,313 (400)	265 (81)	1,333 (406)	291 (89)	628 (191)
Plume where temperature delta is 1.8°F (1°C)								
Atlantic Ocean temperature at the edge of the plume, °F	57.3	59.1	46.8	42.5	44.9	44.4	66.6	62.9
Dilution ratio at the edge of the plume	19.2	18.8	25.0	27.4	26.1	26.3	14.0	16.9
Plume Length[1], feet (meters)	46 (14)	1,149 (350)	126 (38)	33,806 (10,304)	129 (39)	11,907 (3,629)	90 (27)	561 (171)
Plume Width (maximum), feet (meters)	6 (2)	2,327 (709)	7 (2)	4,615 (1,407)	7 (2)	4,400 (1,341)	6 (2)	1,219 (372)
Plume Area, ft^2 ($meter^2$)	110 (10)	2,470,282 (229,497)	869 (81)	62,154,457 (5,774,338)	877 (81)	23,546,600 (2,187,551)	607 (56)	584,672 (54,318)

[1] Distance from the outfall

Table 4: CORMIX results for the maximum temperature delta scenarios for SouthCoast Wind

Parameter	Scenario 9: Fall Max. Temp. Delta	Scenario 10: Winter Max. Temp. Delta	Scenario 11:Spring Max. Temp. Delta	Scenario 12: Summer Max. Temp. Delta
Edge of NFR				
Atlantic Ocean temperature at the edge of NFR, °F	55.4	40.2	39.6	52.4
Temperature delta at the edge of NFR in the Atlantic Ocean, °F	1.4	0.7	1.0	1.2
Dilution ratio at the edge of NFR in the Atlantic Ocean	26.0	77.4	52.6	33.6
NFR distance[1], feet (meters)	56 (17)	155 (47)	93 (28)	65 (20)
Plume where temperature delta is 1.8°F (1°C)				
Atlantic Ocean temperature at the edge of the plume, °F	55.9	41.4	40.4	53.1
Dilution ratio at the edge of the plume	20.0	28.0	28.6	22.0
Plume Length[1], feet (meters)	44 (13)	102 (31)	75 (23)	51 (16)
Plume Width (maximum), feet (meters)	30 (9)	9 (3)	11 (3)	21 (6)
Plume Area, ft^2 ($meter^2$)	455 (42)	898 (83)	816 (76)	537 (50)

[1]: Distance from the outfall

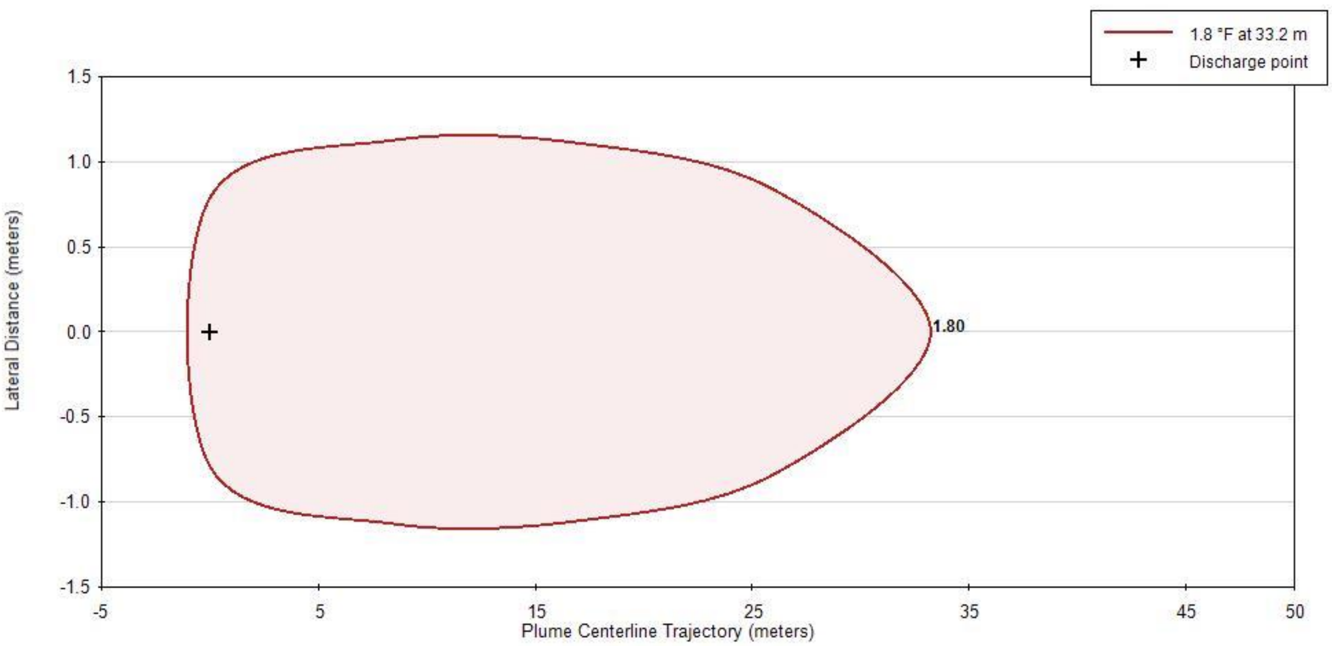


Figure 3: 1.8°F (1°C) temperature delta isoline for Scenario 1: Fall Max. Current Speed

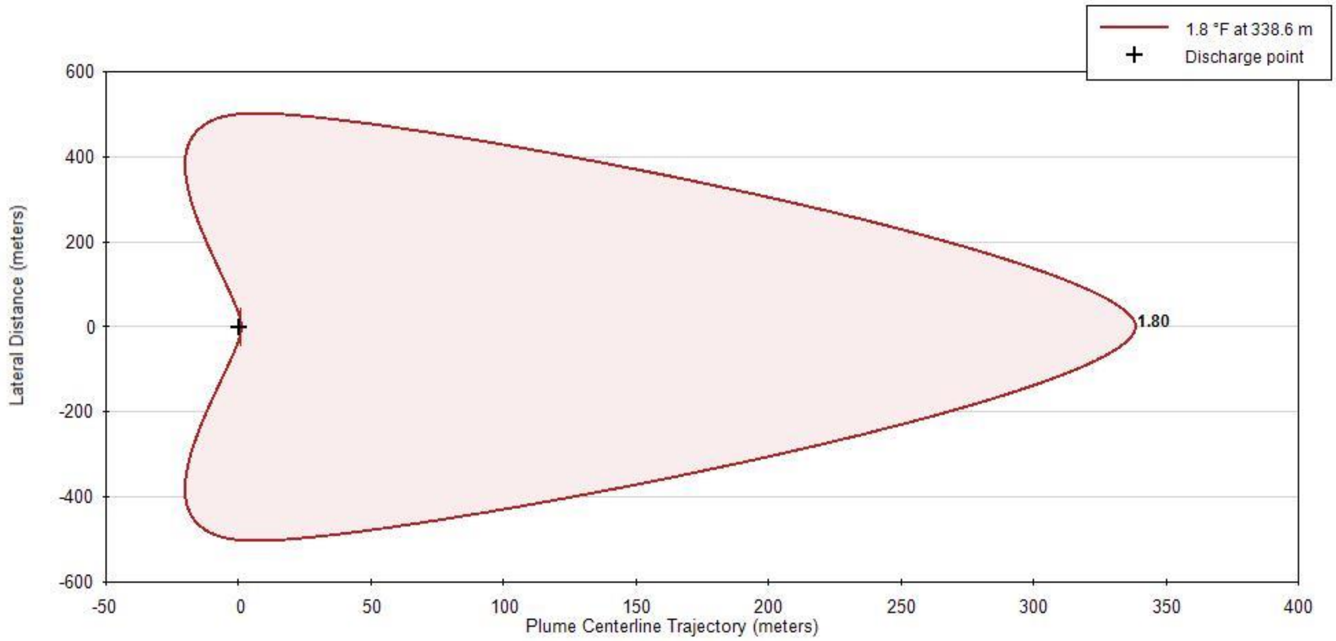


Figure 4: 1.8°F (1°C) temperature delta isoline for Scenario 2: Fall Min. Current Speed

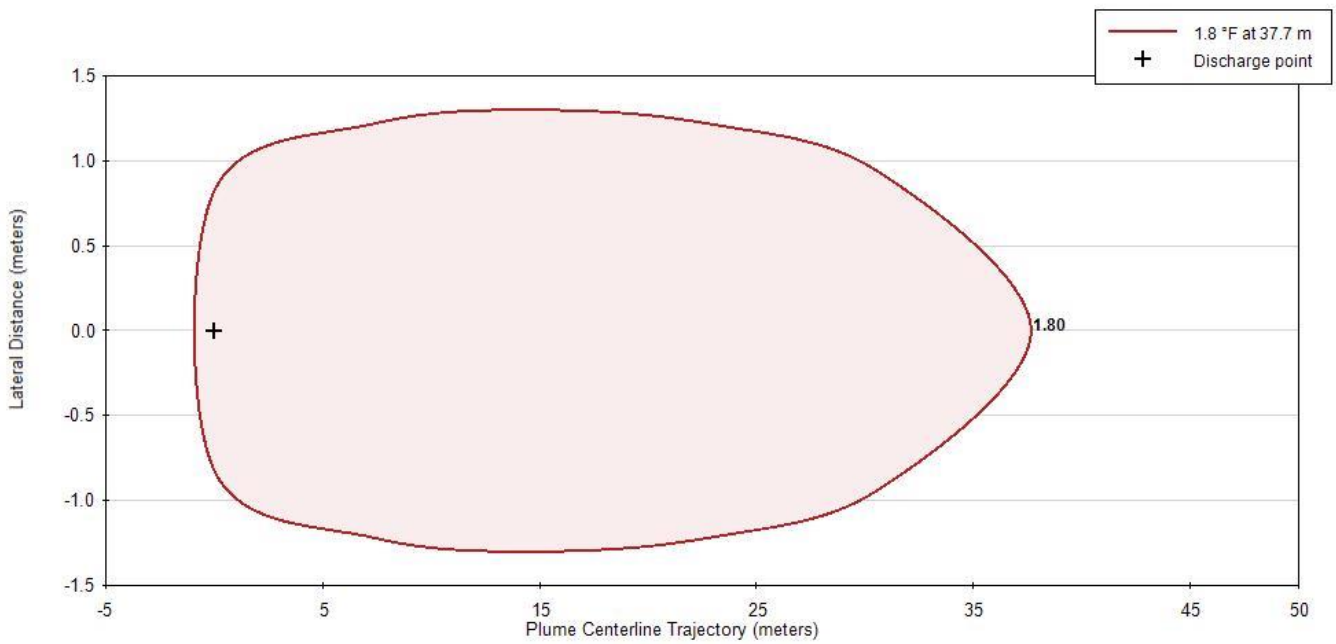


Figure 5: 1.8°F (1°C) temperature delta isoline for Scenario 3: Winter Max. Current Speed

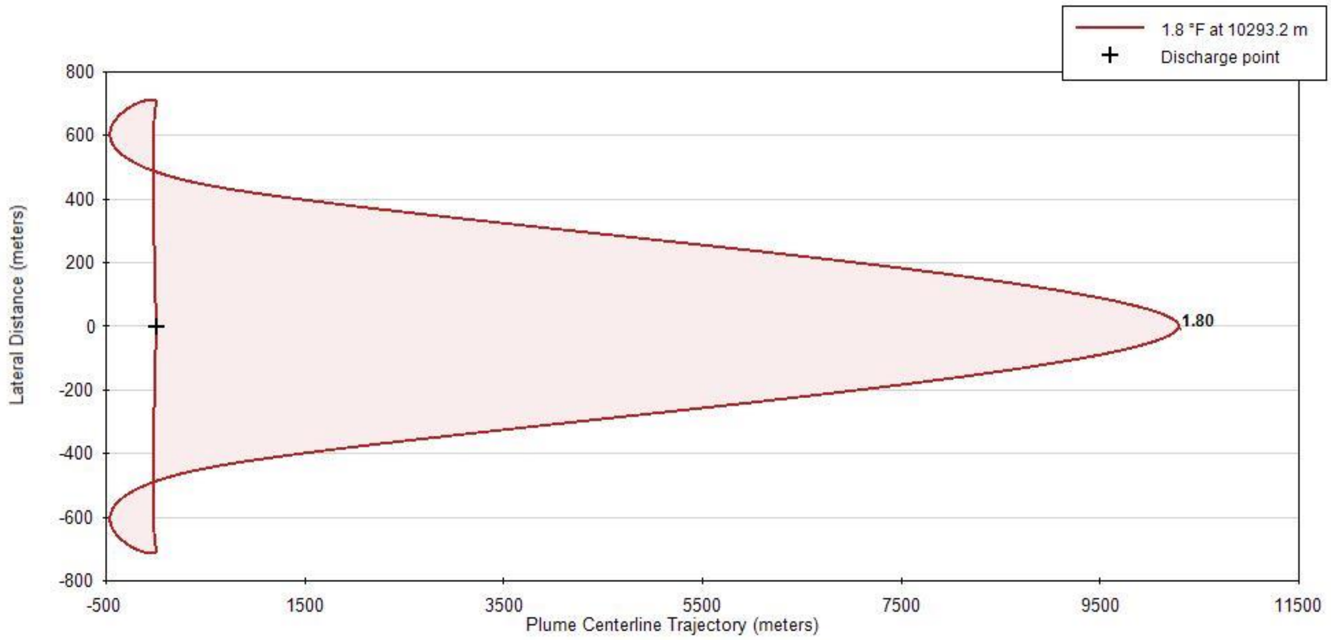


Figure 6: 1.8°F (1°C) temperature delta isoline for Scenario 4: Winter Min. Current Speed

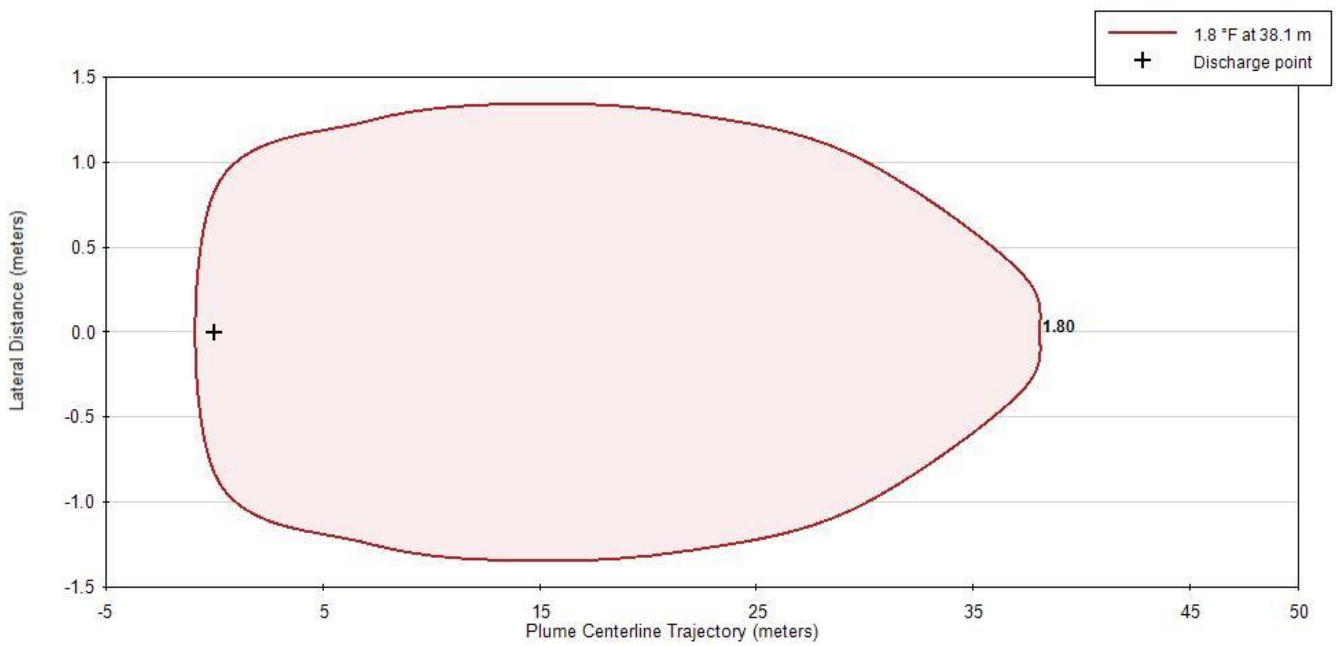


Figure 7: 1.8°F (1°C) temperature delta isoline for Scenario 5: Spring Max. Current Speed

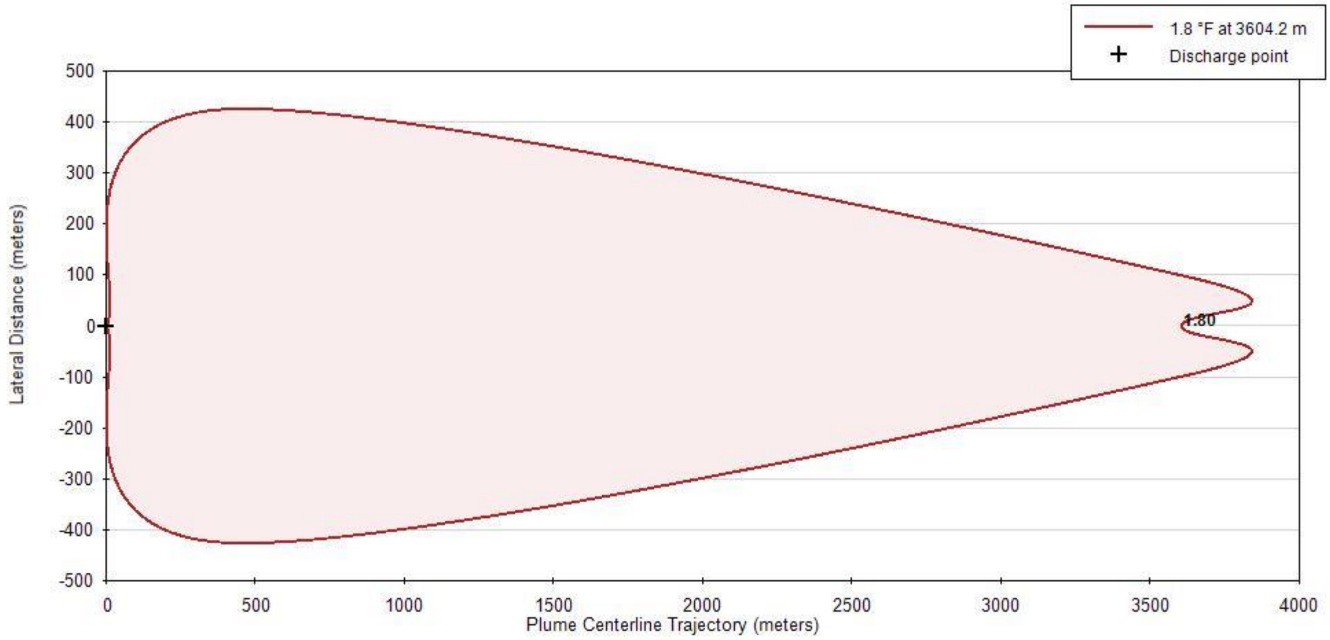


Figure 8: 1.8°F (1°C) temperature delta isoline for Scenario 6: Spring Min. Current Speed

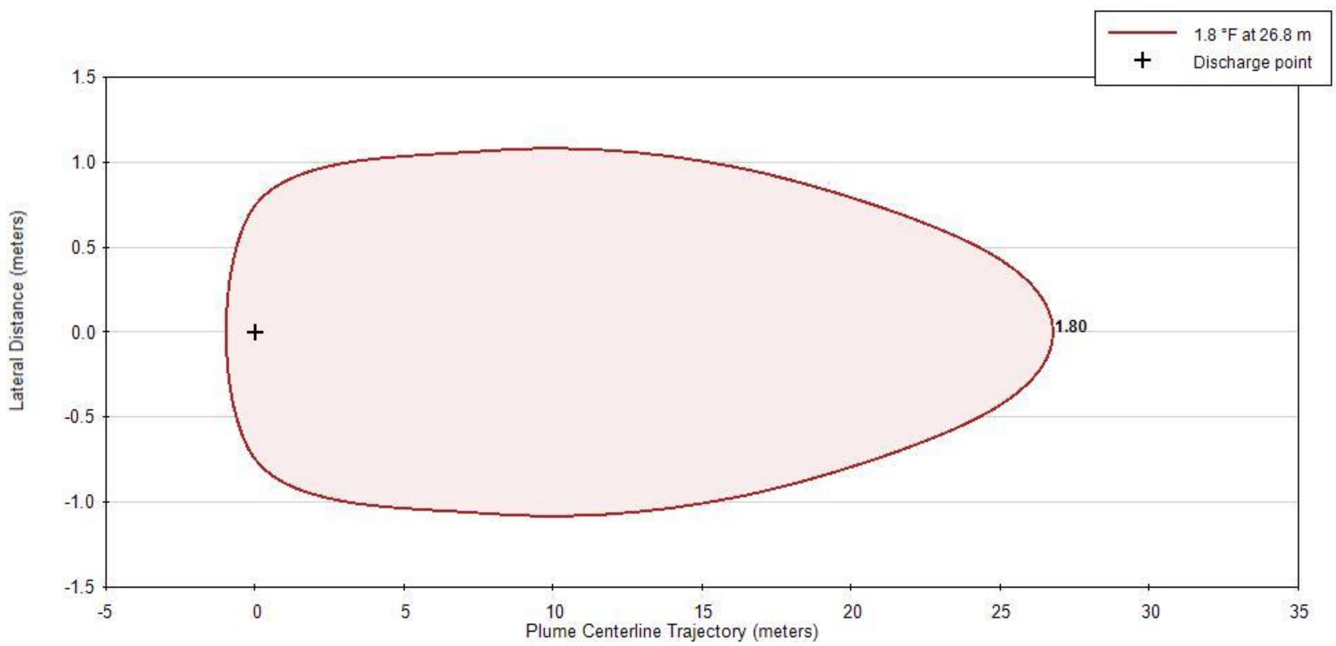


Figure 9: 1.8°F (1°C) temperature delta isoline for Scenario 7: Summer Max. Current Speed

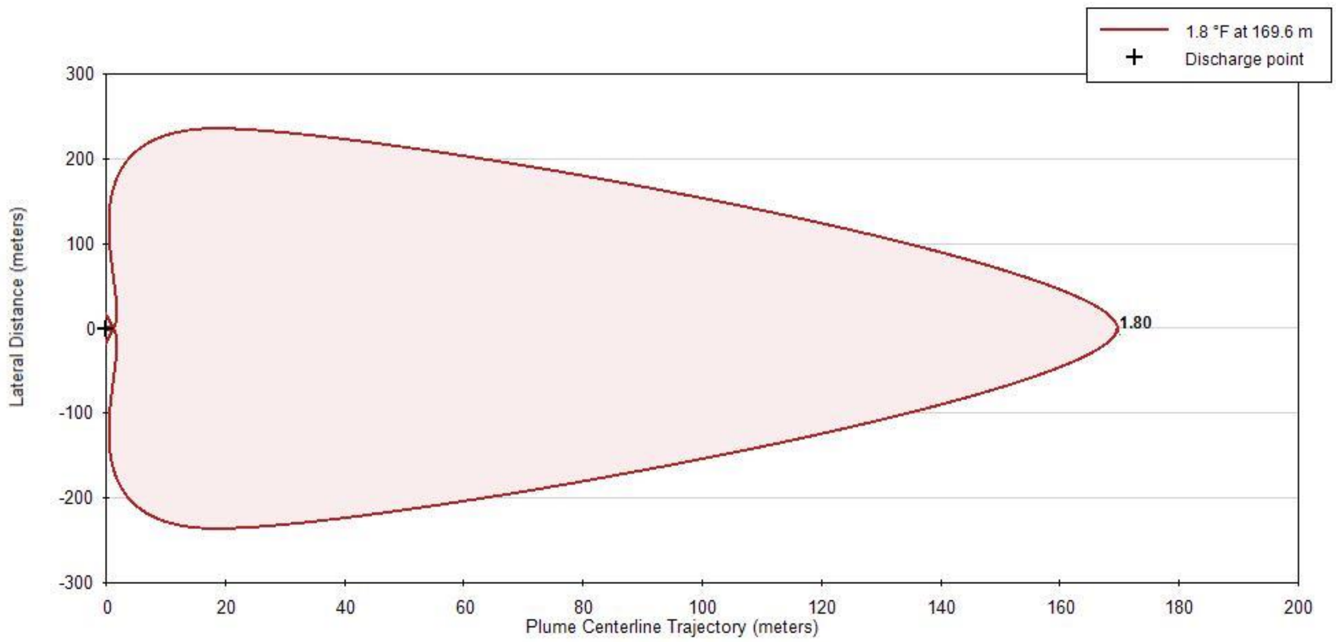


Figure 10: 1.8°F (1°C) temperature delta isoline for Scenario 8: Summer Min. Current Speed

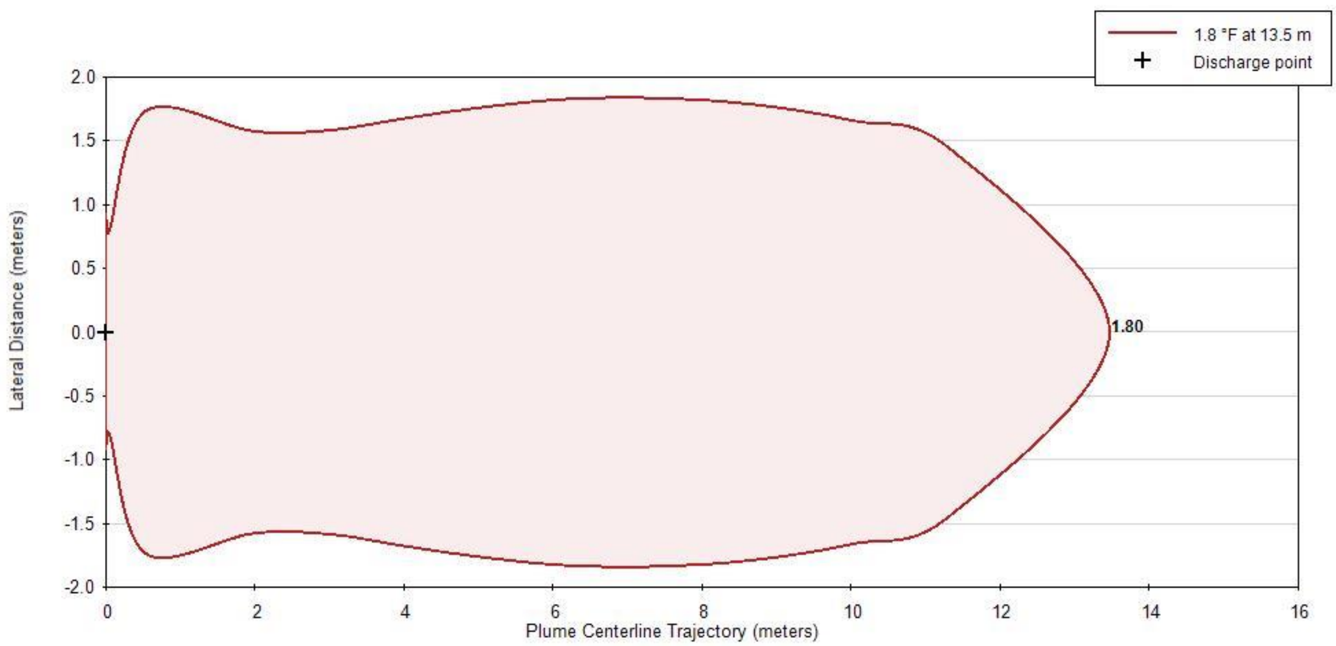


Figure 11: 1.8°F (1°C) temperature delta isoline for Scenario 9: Fall Max. Temp. Delta

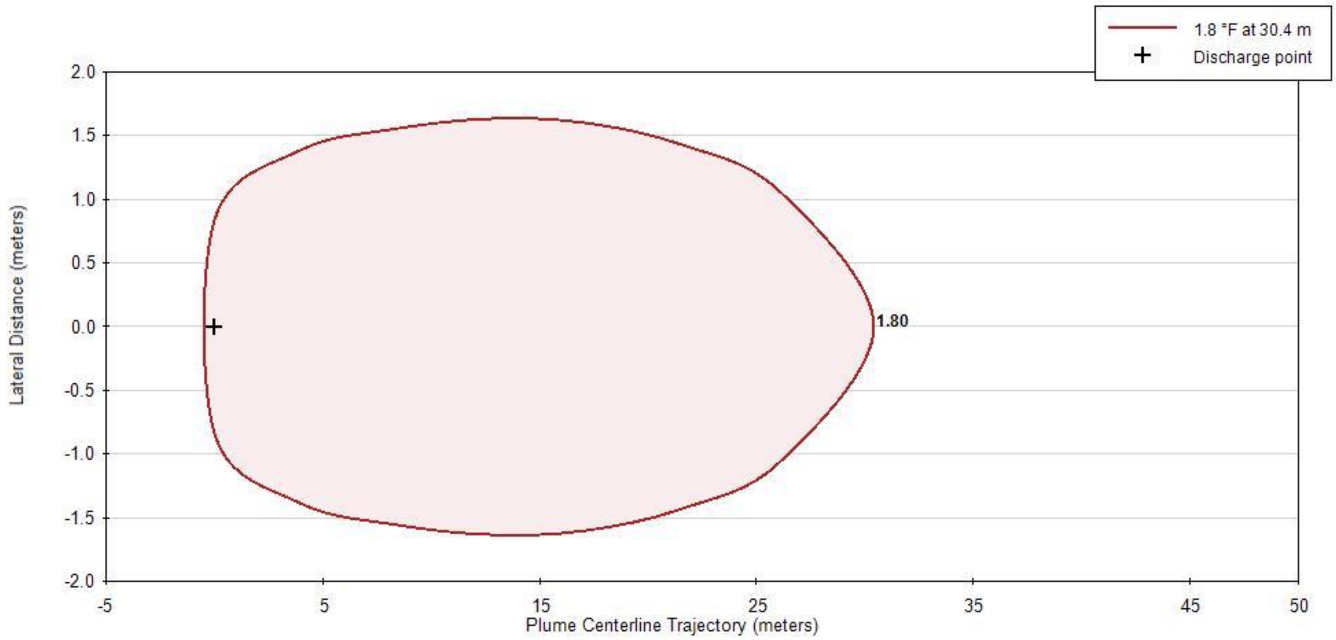


Figure 12: 1.8°F (1°C) temperature delta isoline for Scenario 10: Winter Max. Temp. Delta

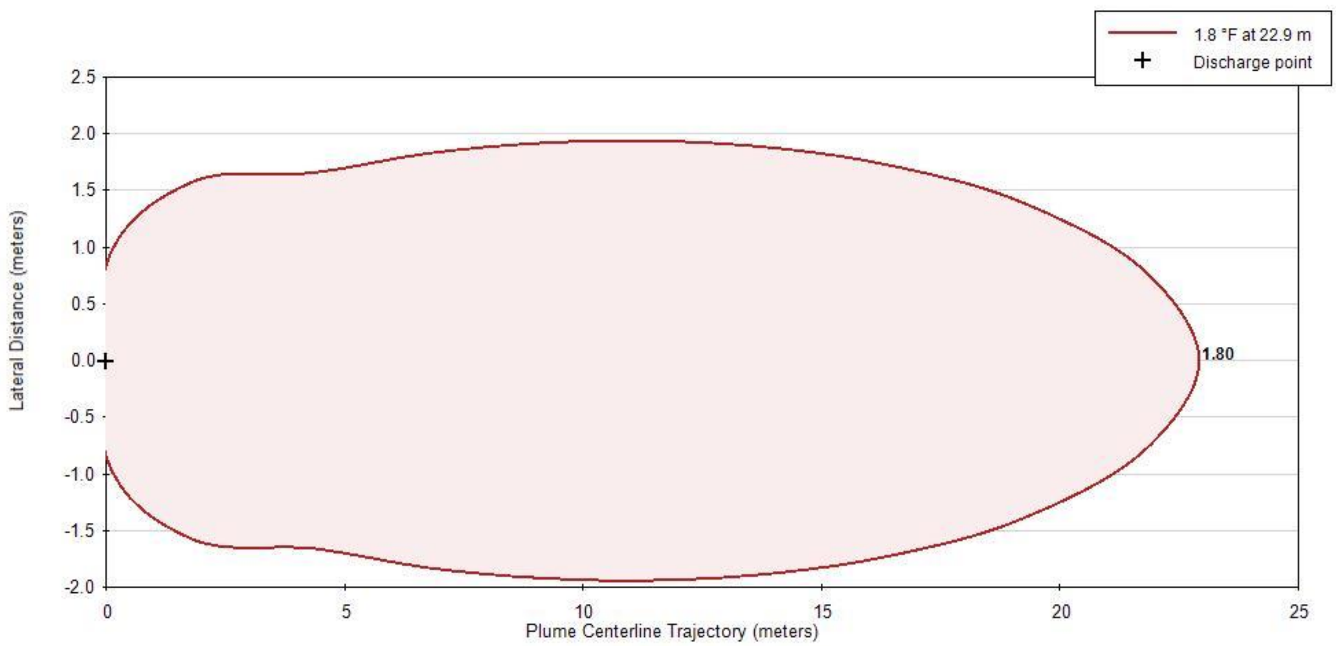


Figure 13: 1.8°F (1°C) temperature delta isoline for Scenario 11:Spring Max. Temp. Delta

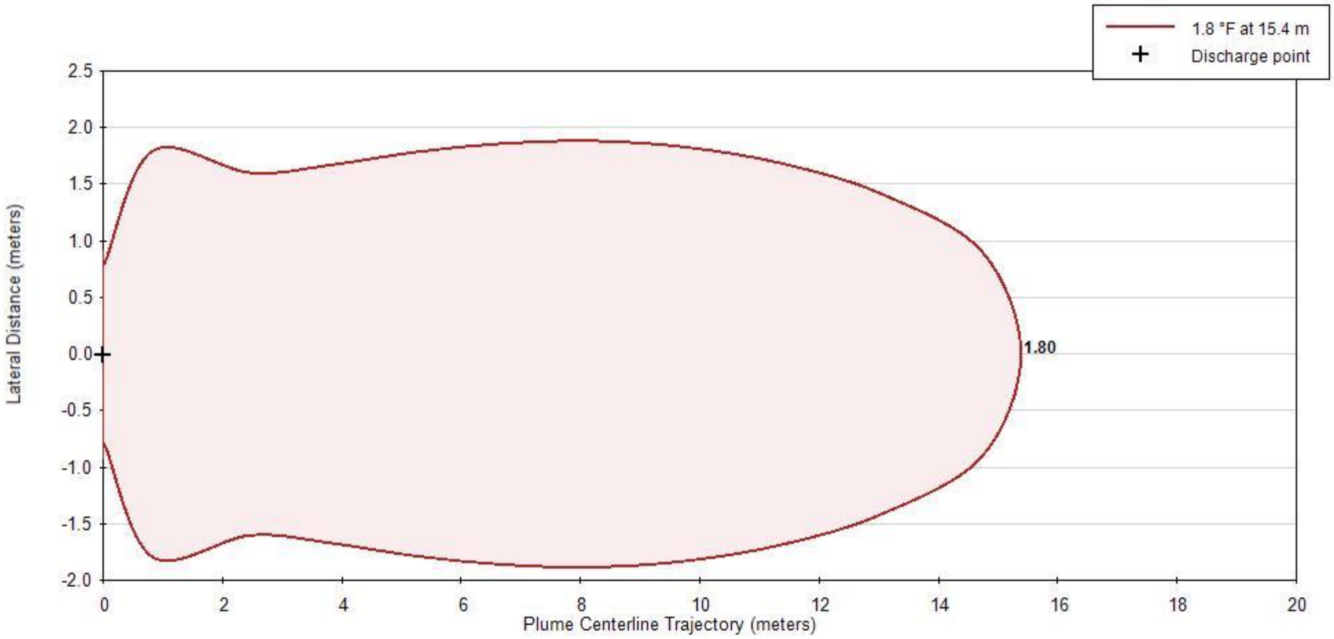


Figure 14: 1.8°F (1°C) temperature delta isoline for Scenario 12: Summer Max. Temp. Delta

CORMIX RESULTS SUMMARY

Critical Tidal Conditions

For the maximum current speed scenarios (Scenarios 1, 3, 5, and 7), the temperature delta at the edge of the NFR was less than 0.5°F. The NFR occurred between 265 ft and 309 feet away from the outfall (Table 3). The 1.8°F delta was met between 86 ft and 124 feet from the outfall. The plume widths were narrow, less than 8 feet.

For the minimum current speed scenarios (Scenarios 2, 4, 6, and 8), the temperature details were 1.6 – 1.7°F in the fall and summer months and 2.4 – 2.5°F in the winter and spring months (Table 3). The edge of the NFR occurred around 1,300 feet away from the outfall except for the summer scenario, which occurred 628 feet away from the outfall. For the fall and summer periods, the 1.8°F delta was met 1,133 ft and 557 feet away from the outfall pipe, respectively. For the winter and spring scenarios, the 1.8°F delta was met 13,796 feet and 11,991 ft away from the outfall pipe, respectively. The plumes in the minimum current speed winter and spring scenario have a strong upstream intrusion against ambient current (Figure 6 and Figure 8). The upstream intrusion is likely caused by the small ambient current speed (0.03 miles/hr [0.015 m/sec]) combined with the strong buoyancy of the effluent and higher effluent discharge velocity. According to the metocean depth averaged hourly current speed from January 1, 2000, through December 31, 2017, an ambient speed of 0.03 miles/hr [0.015 m/sec] occurred for 4 hours (0.0025%) in the fall, spring and winter months, so the occurrence of these scenarios is rare. The temperature delta in the upstream intrusion zones ranges was 4.7°F for the winter scenario to 4.6°F for the spring scenario.

Maximum Temperature Delta

The edge of the NFR ranged between 56 feet and 155 feet for the maximum temperature delta scenarios (Table 4). The temperature delta was 1.4°F or less at the edge of the NFR, and the 1.8°F delta was met less than 100 feet from the outfall for all four seasonal scenarios. The plume widths were narrow and ranged between 9 and 30 feet. These results indicate that impacts to the ocean temperature are minimal when the maximum temperature deltas occur.

REFERENCES

Doneker L. Robert and Jirka, H. Gerhard. 2021. CORMIX User's Manual. A Hydrodynamic Mixing Zone Model and Decision Support System for Pollutant Discharges into Surface Waters. EPA-823-K-07-001 December 2007 (Updated July 2021).

HYCOM 2022. Hybrid Coordinate Ocean Model (HYCOM) User's Manual, Code Version 2.0.01, Manual Version 2.0.01, March 4, 2002.

Mayflower 2022. Email exchange between Mayflower Wind and Tetra Tech on June 24, 2022 (Re Additional Data Needs.msg).

PLUME FIGURES

Please note that CCC stands for Criterion Continuous Concentration and is set at 1.8°F (1°C). The water surface is at 46.2 meters and the outfall is at 33.7 meters, 12.5 meters below the water surface.

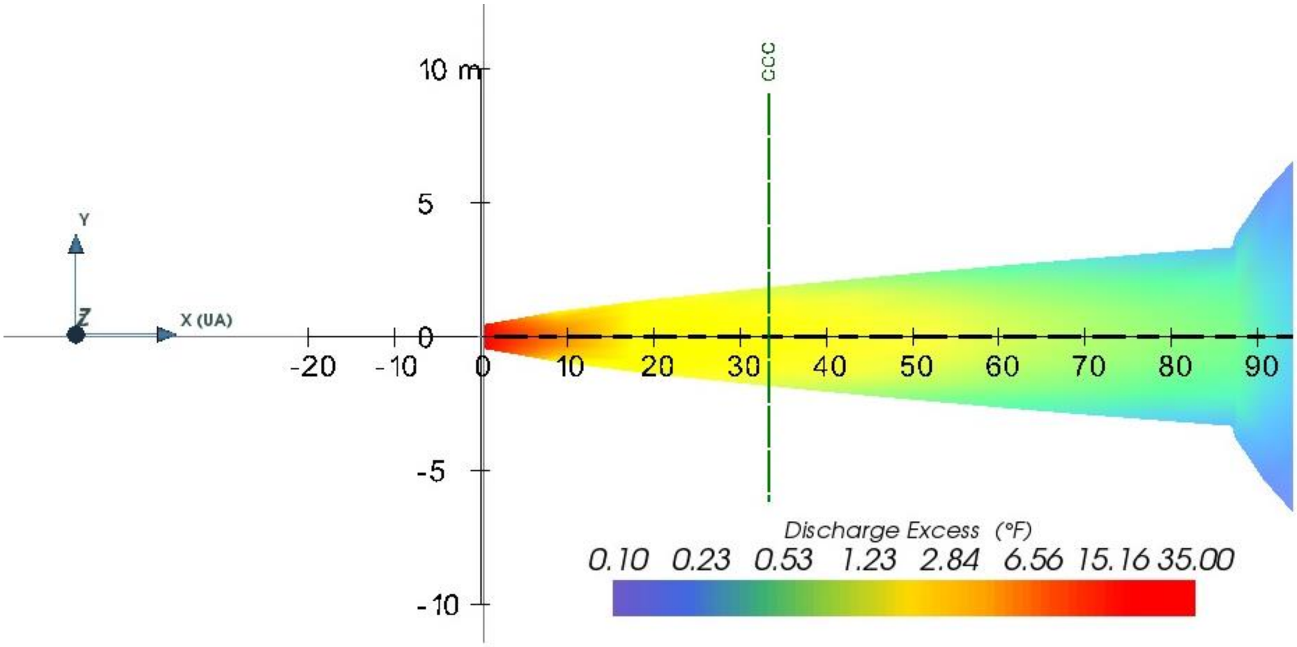


Figure 15: Plan view of the plume for Scenario 1: Fall Max. Current Speed

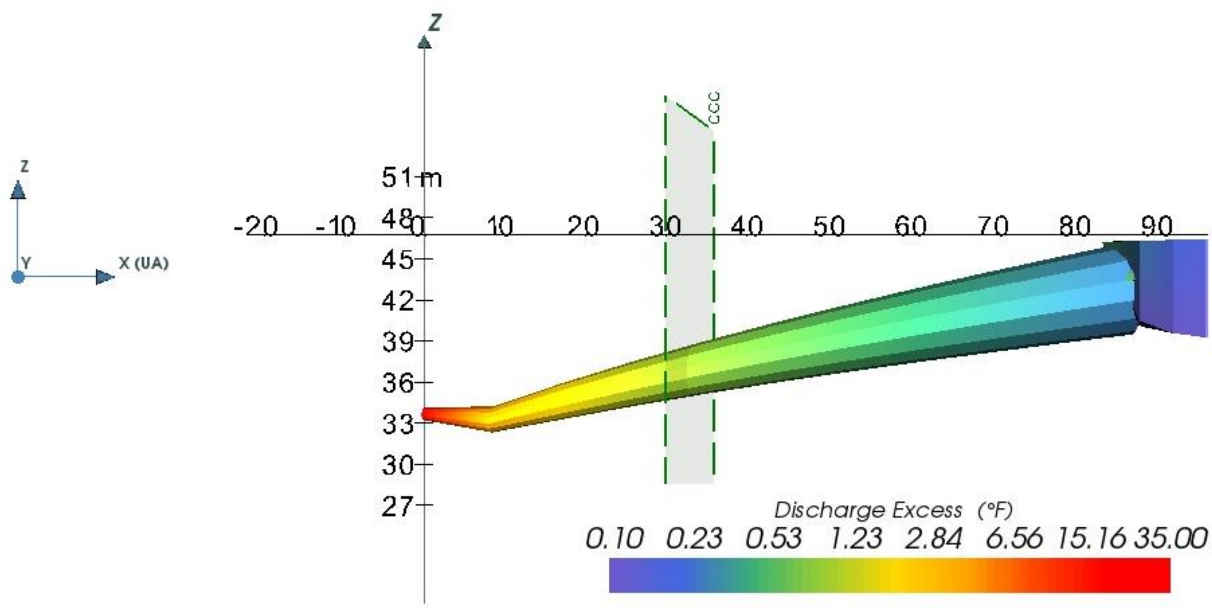


Figure 16: Profile view of the plume for Scenario 1: Fall Max. Current Speed

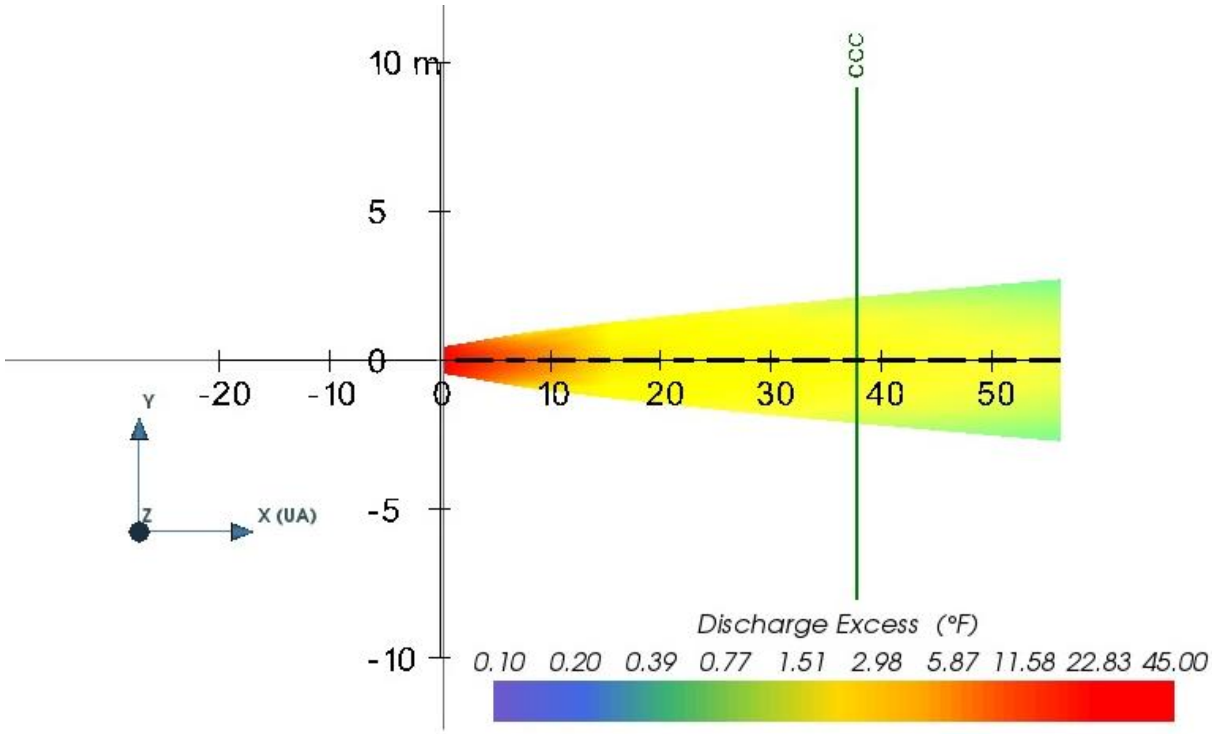


Figure 17: Plan view of the plume for Scenario 3: Winter Max. Current Speed

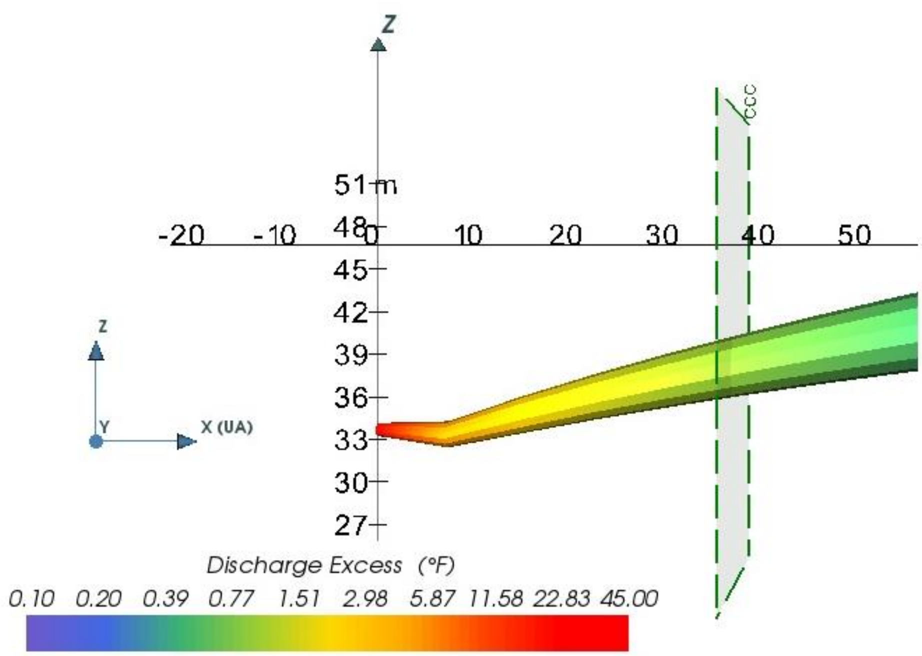


Figure 18: Profile view of the plume for Scenario 3: Winter Max. Current Speed

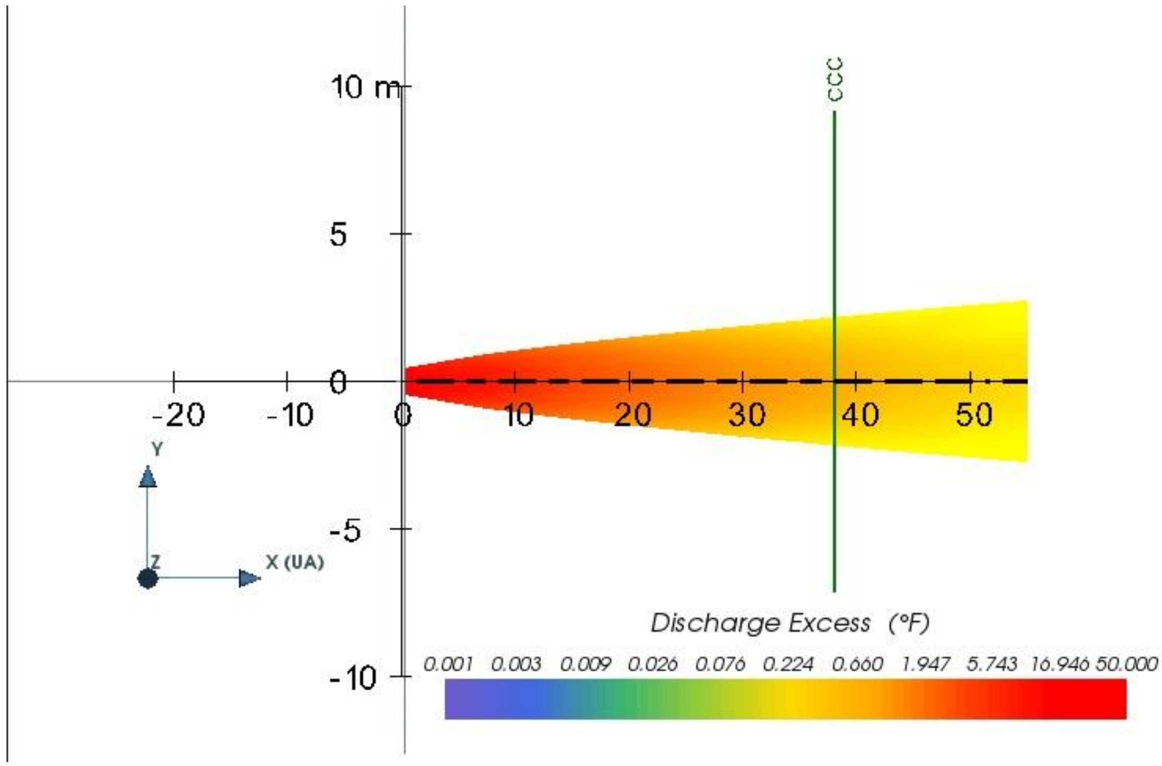


Figure 19: Plan view of the plume for Scenario 5: Spring Max. Current Speed

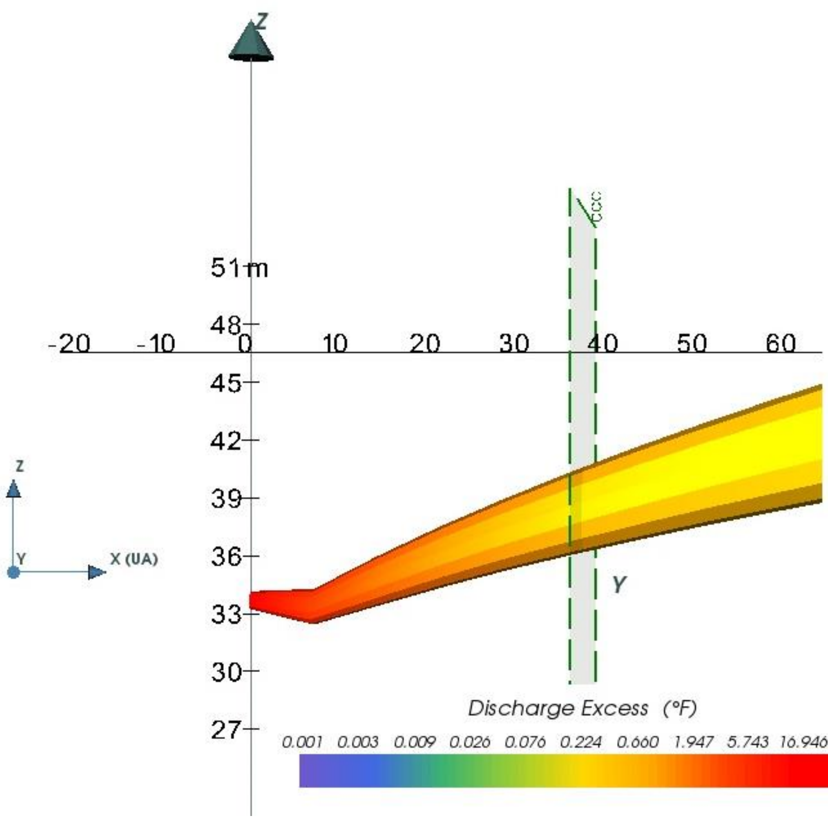


Figure 20: Profile view of the plume for Scenario 5: Spring Max. Current Speed

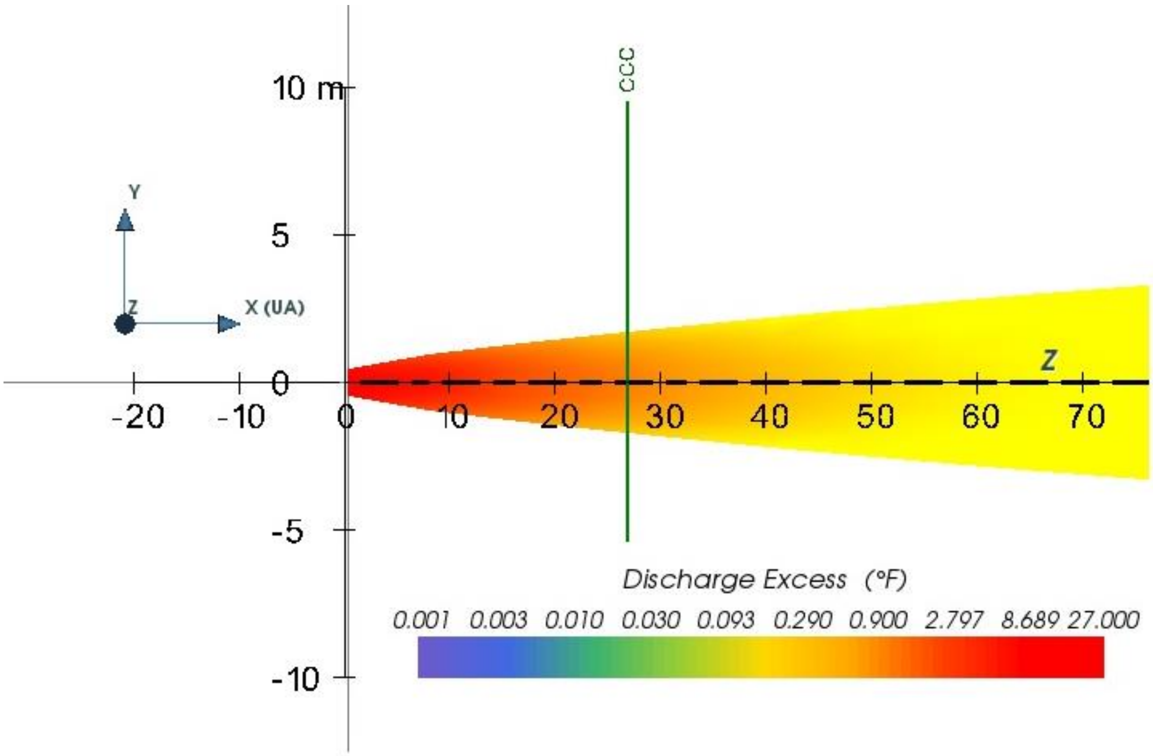


Figure 21: Plan view of the plume for Scenario 7: Summer Max. Current Speed

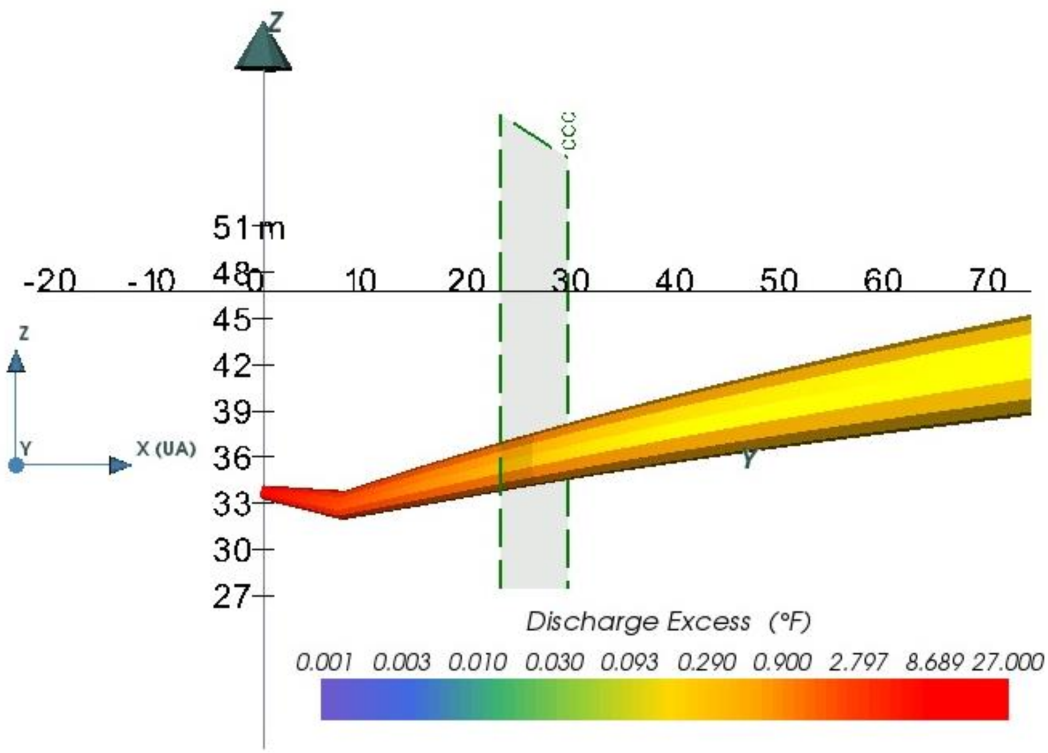


Figure 22: Profile view of the plume for Scenario 7: Summer Max. Current Speed

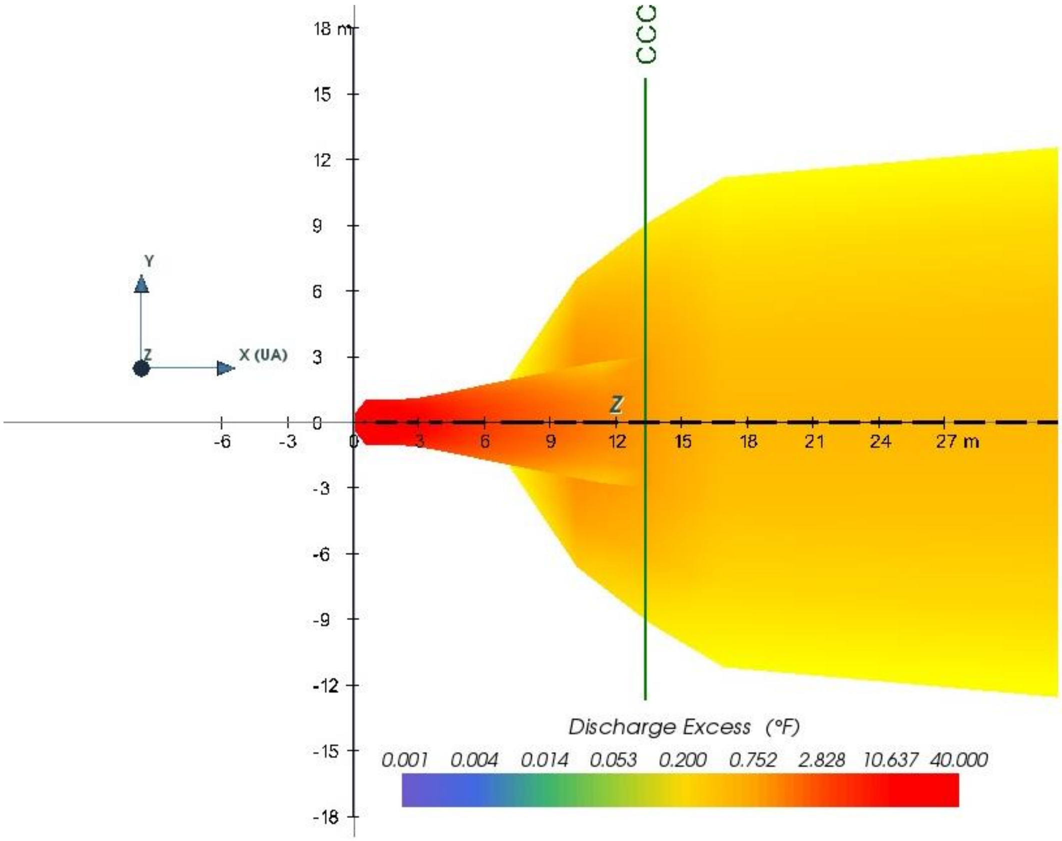


Figure 23: Plan view of the plume for Scenario 9: Fall Max. Temp. Delta

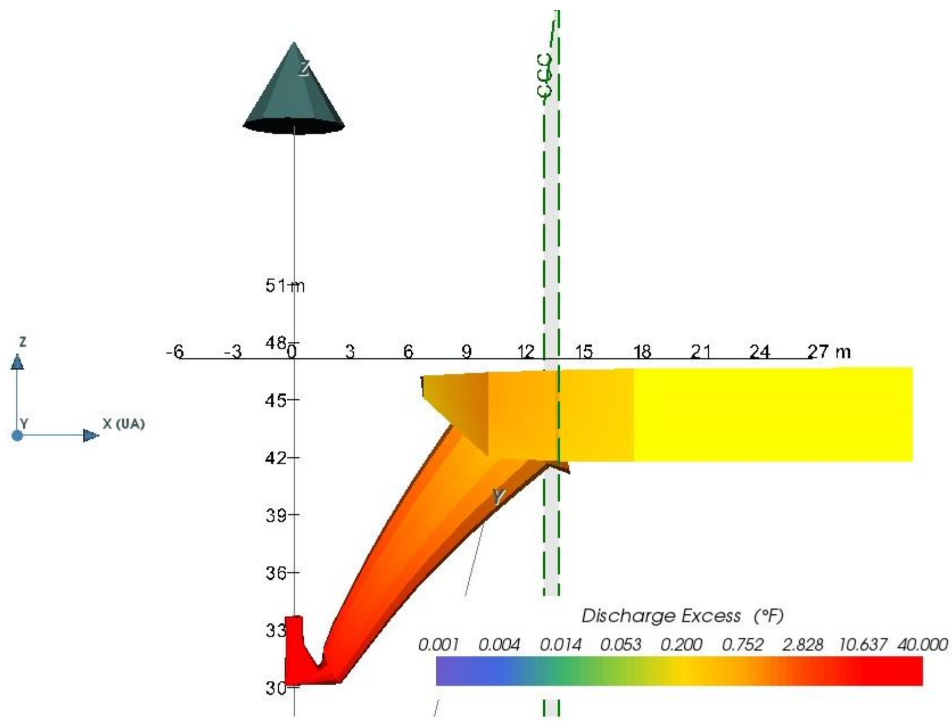


Figure 24: Profile view of the plume for Scenario 9: Fall Max. Temp. Delta

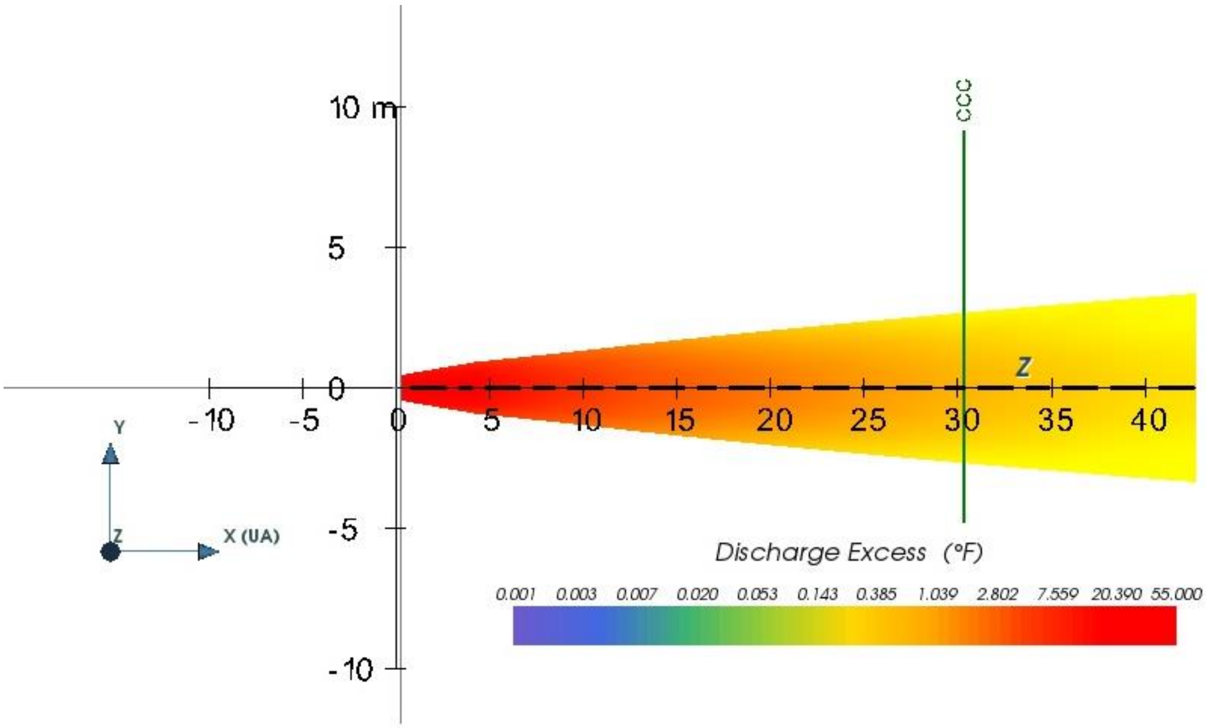


Figure 25: Plan view of the plume for Scenario 10: Winter Max. Temp. Delta

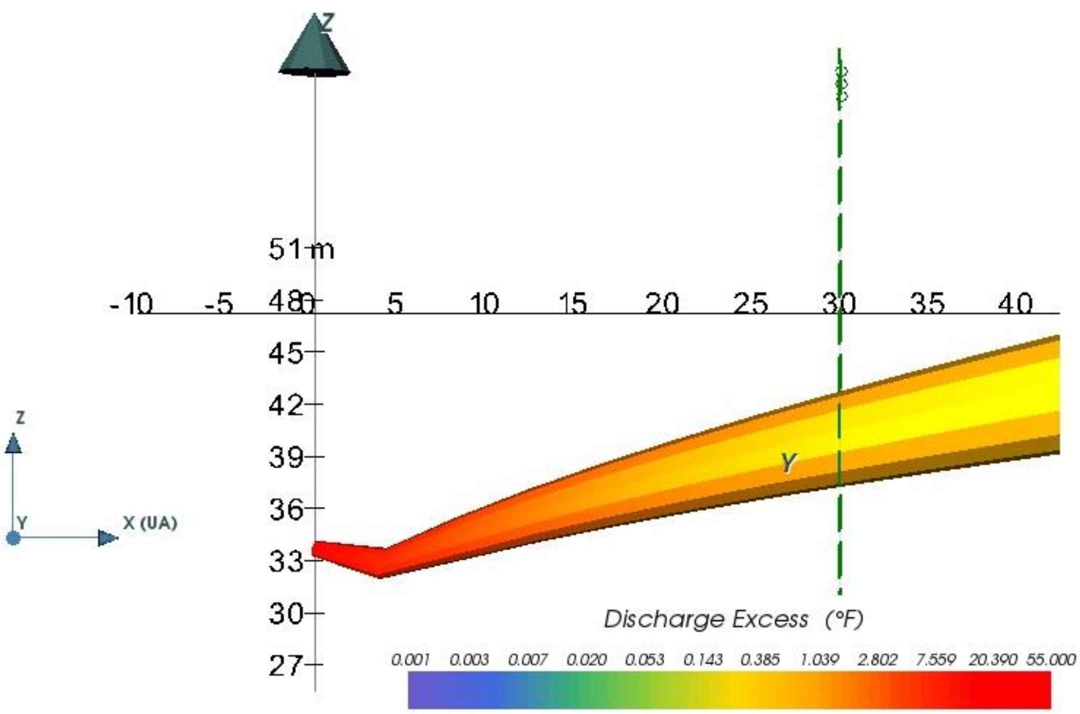


Figure 26: Profile view of the plume for Scenario 10: Winter Max. Temp. Delta

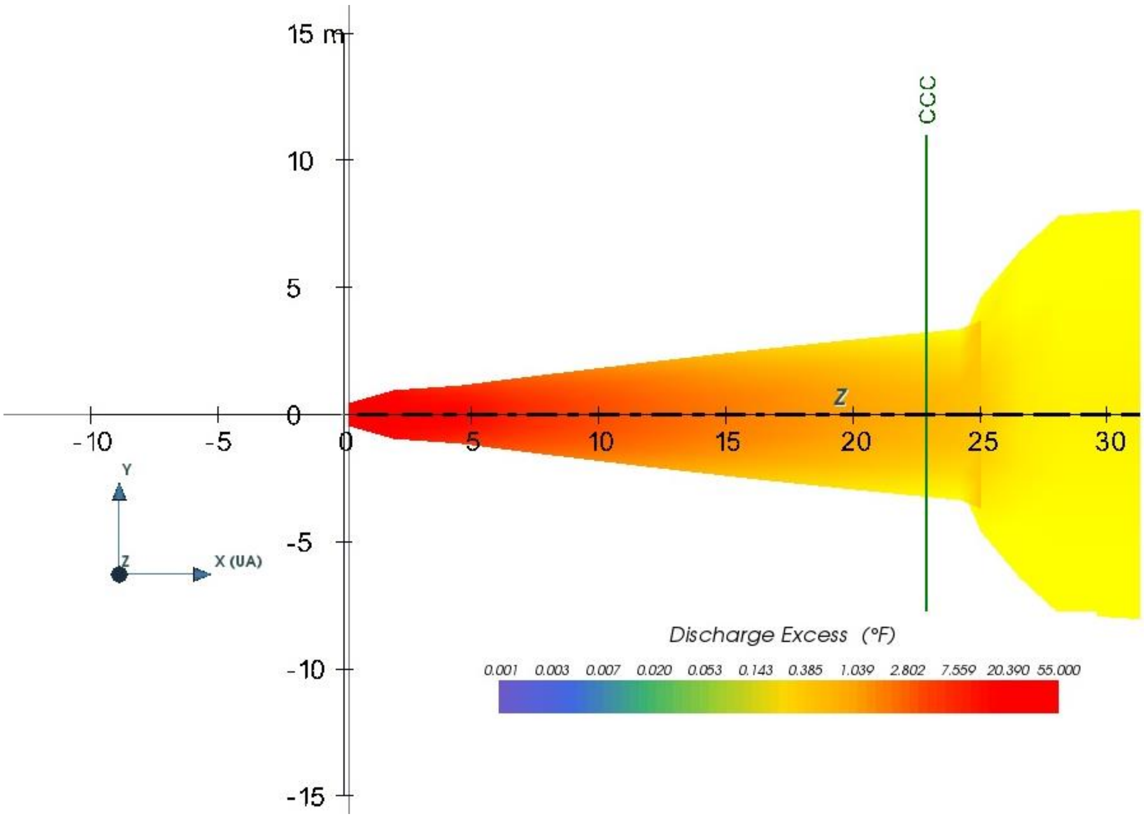


Figure 27: Plan view of the plume for Scenario 11:Spring Max. Temp. Delta

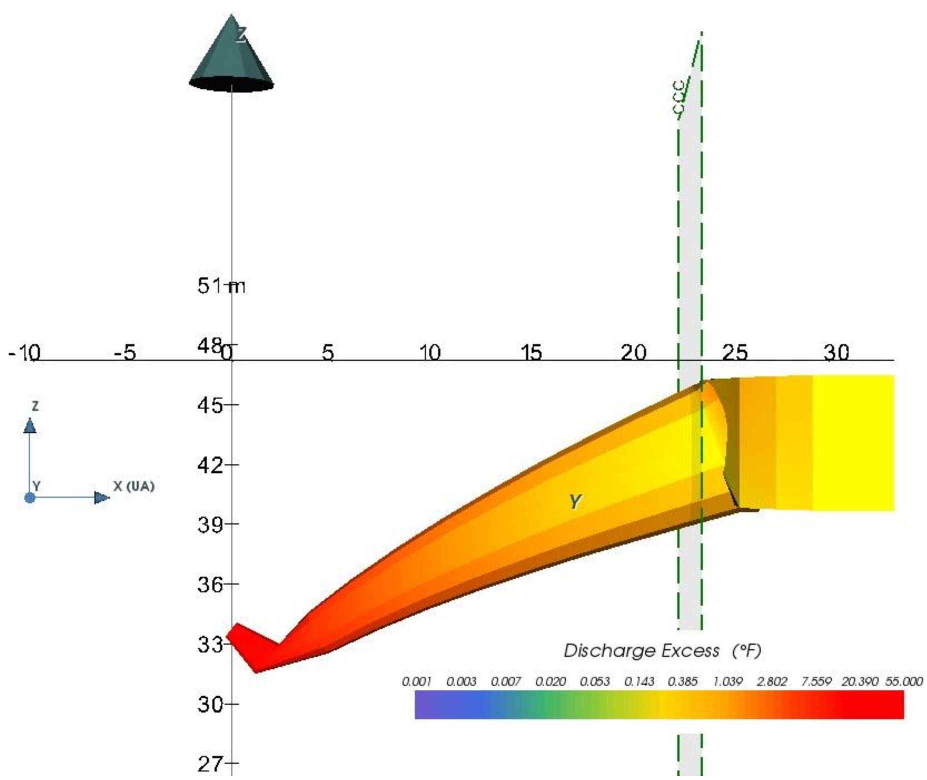


Figure 28: Profile view of the plume for Scenario 11:Spring Max. Temp. Delta

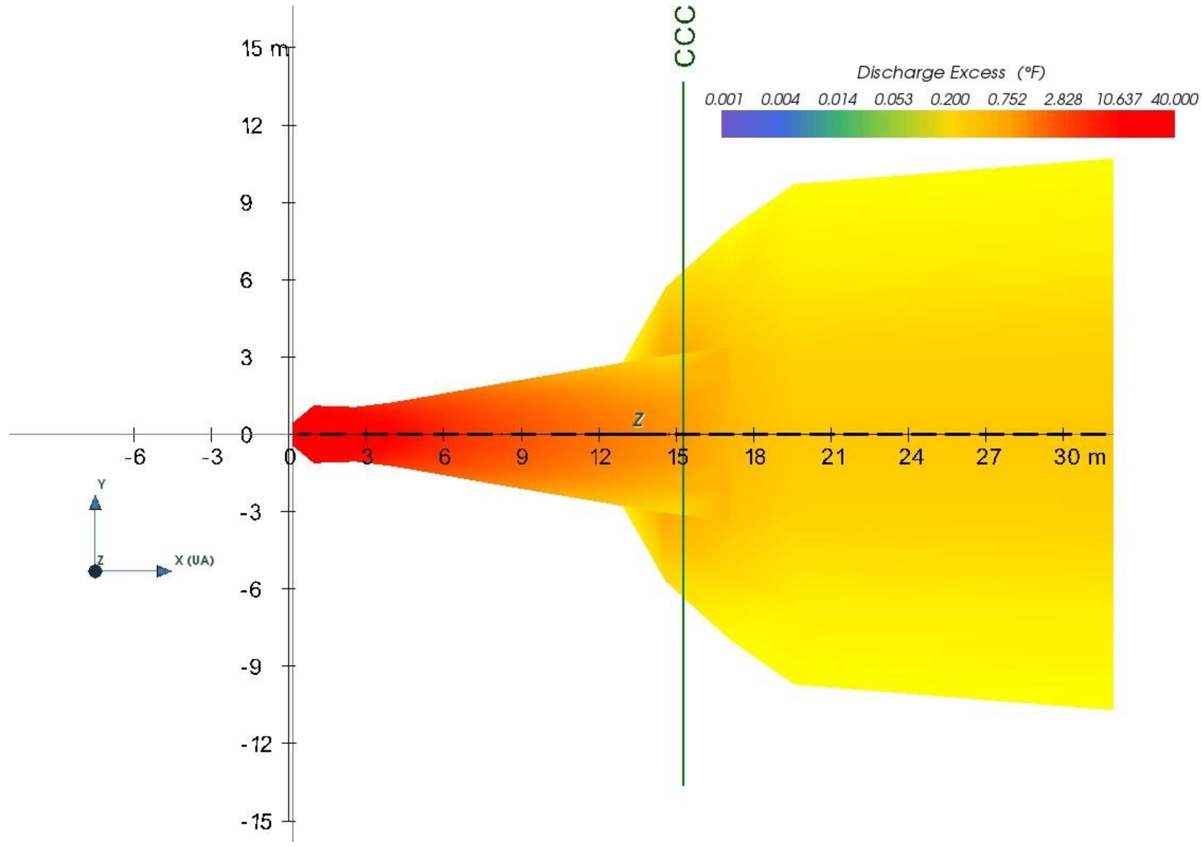


Figure 29: Plan view of the plume for Scenario 12: Summer Max. Temp. Delta

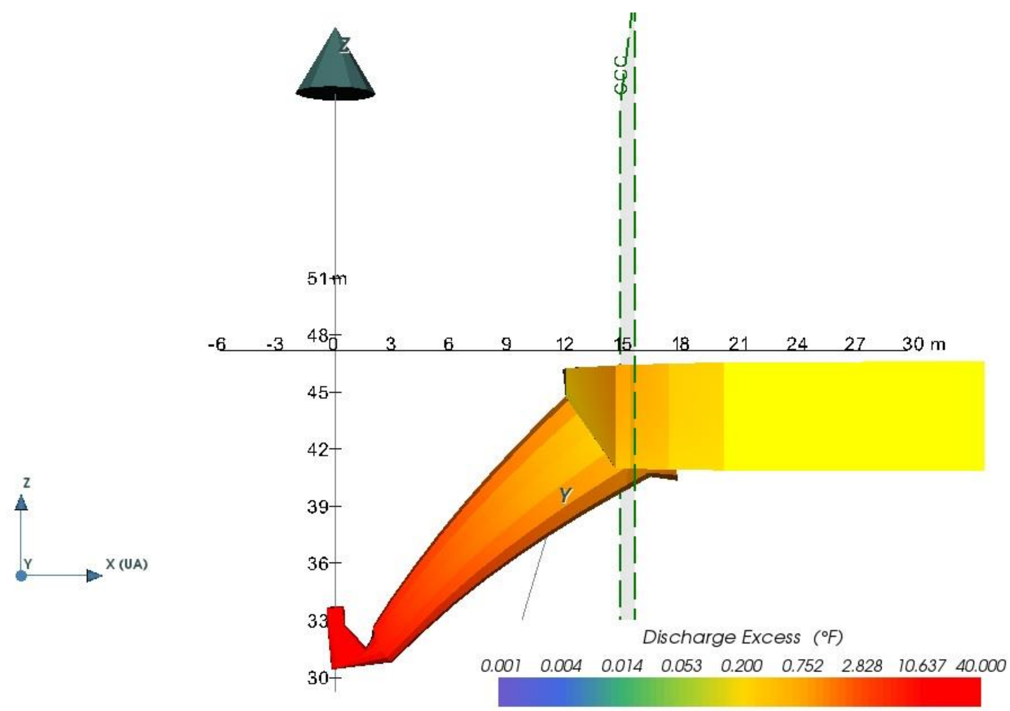


Figure 30: Profile view of the plume for Scenario 12: Summer Max. Temp. Delta

APPENDIX B: CONSTRUCTION AND OPERATIONS PLAN (COP) REFERENCES

The following COP Sections and Appendices are incorporated by reference, using verbatim text where appropriate in this document, and are available at the following links:

- SouthCoast Wind COP Volume I
  - Section 1: Introduction
  - Section 2: Project Siting and Design Development
  - Section 3: Description of Proposed Activities
- SouthCoast Wind COP Volume II
  - Section 4.1: Site Geology
  - Section 4.3: Physical Oceanography and Meteorology
  - Section 5.2: Water Quality
  - Section 6.6: Benthic and Shellfish
  - Section 6.7: Finfish and Invertebrates
  - Section 6.8: Marine Mammals
  - Section 6.9: Sea Turtles
  - Section 11: Commercial and Recreational Fisheries and Fishing Activity
- SouthCoast Wind COP Appendix A – Agency Correspondence
- SouthCoast Wind COP Appendix E – Marine Site Investigation Report (Confidential)
- SouthCoast Wind COP Appendix H – Water Quality Report
- SouthCoast Wind COP Appendix M – Benthic and Shellfish Resources Characterization Report
- SouthCoast Wind COP Appendix N – Essential Fish Habitat and Protected Fish Species Assessment
- SouthCoast Wind COP Appendix V – Commercial and Recreational Fisheries and Fishing Activity Technical Report

APPENDIX C: SOUTHCOAST WIND NPDES APPLICATION FORM 1 AND FORM 2D

NPDES Application Form 1 and Form 2d are provided on the EPA website (https://www.epa.gov/npdes/npdes-application-forms) for use in jurisdictions, such as Massachusetts, in which an EPA regional office administers the NPDES permit program. Form 2 and Form 2d were completed for the Project and are included as Appendix C to this NPDES Permit Application.

Print All Pages

Print Form Only

United States
Environmental Protection Agency

Office of Water
Washington, D.C.

EPA Form 3510-1
Revised March 2019

Water Permits Division

EPA

Application Form 1

General Information

NPDES Permitting Program

Note: All applicants to the National Pollutant Discharge Elimination System (NPDES) permits program, with the exception of publicly owned treatment works and other treatment works treating domestic sewage, must complete Form 1. Additionally, all applicants must complete one or more of the following forms: 2B, 2C, 2D, 2E, or 2F. To determine the specific forms you must complete, consult the "General Instructions" for this form.

EPA Identification Number	NPDES Permit Number	Facility Name	Form Approved 03/05/19 OMB No. 2040-0004
N/A - New Facility	N/A	SouthCoast Wind	

Form 1 NPDES

U.S. Environmental Protection Agency
Application for NPDES Permit to Discharge Wastewater

GENERAL INFORMATION

SECTION 1. ACTIVITIES REQUIRING AN NPDES PERMIT (40 CFR 122.21(f) and (f)(1))

Activities Requiring an NPDES Permit

1.1 Applicants *Not Required* to Submit Form 1

1.1.1 Is the facility a new or existing **publicly owned treatment works**? If yes, STOP. Do NOT complete Form 1. Complete Form 2A. ☐ No

1.1.2 Is the facility a new or existing **treatment works treating domestic sewage**? If yes, STOP. Do NOT complete Form 1. Complete Form 2S. ☐ No

1.2 Applicants *Required* to Submit Form 1

1.2.1 Is the facility a **concentrated animal feeding operation** or a **concentrated aquatic animal production facility?** ☐ Yes ➔ Complete Form 1 ***and*** Form 2B. ☐ No

1.2.2 Is the facility an **existing** manufacturing, commercial, mining, or silvicultural **facility** that **is currently discharging process wastewater**? ☐ Yes ➔ Complete Form 1 ***and*** Form 2C. ☐ No

1.2.3 Is the facility a **new** manufacturing, commercial, mining, or silvicultural **facility** that has **not yet commenced to discharge**? ☐ Yes ➔ Complete Form 1 ***and*** Form 2D. ☐ No

1.2.4 Is the facility a **new or existing** manufacturing, commercial, mining, or silvicultural **facility** that **discharges only nonprocess wastewater**? ☐ Yes ➔ Complete Form 1 ***and*** Form 2E. ☐ No

1.2.5 Is the facility a **new or existing facility** whose discharge is composed entirely of **stormwater associated with industrial activity** or whose discharge is composed of **both stormwater and non-stormwater**? ☐ Yes ➔ Complete Form 1 ***and*** Form 2F unless exempted by 40 CFR 122.26(b)(14)(x) or (b)(15). ☐ No

SECTION 2. NAME, MAILING ADDRESS, AND LOCATION (40 CFR 122.21(f)(2))

Name, Mailing Address, and Location

2.1 Facility Name

SouthCoast Wind Energy Project

2.2 EPA Identification Number

N/A

2.3 Facility Contact

Name (first and last)	Title	Phone number
Enrique Alvarez Cordobes	Project Director	(617) 519-3122

Email address
enrique.alvarez@southcoastwind.com

2.4 Facility Mailing Address

Street or P.O. box
101 Federal St., Suite 1900

City or town	State	ZIP code
Boston	MA	02110

Name, Mailing Address, and Location Continued

2.5 Facility Location

Street, route number, or other specific identifier		
Atlantic Ocean; approximately 26 nm(48km) south of Martha's Vineyard and 20 nm (37 km) south of Nantucket		
County name	County code (if known)	
City or town	State	ZIP code

SECTION 3. SIC AND NAICS CODES (40 CFR 122.21(f)(3))

SIC and NAICS Codes

3.1

SIC Code(s)	Description (optional)
4911	Electric Power Generation & Transmission

3.2

NAICS Code(s)	Description (optional)
221115	Electric Power Generation, Wind

SECTION 4. OPERATOR INFORMATION (40 CFR 122.21(f)(4))

Operator Information

4.1 Name of Operator

SouthCoast Wind Energy LLC

4.2 Is the name you listed in Item 4.1 also the owner?

☐ Yes ☐ No

4.3 Operator Status

☐ Public—federal ☐ Public—state ☐ Other public (specify)_______________

☐ Private ☐ Other (specify) _______________

4.4 Phone Number of Operator

(617) 519-3122

Operator Information Continued

4.5 Operator Address

Street or P.O. Box		
101 Federal St., Suite 1900		
City or town	State	ZIP code
Boston	MA	02210

Email address of operator

enrique.alvarez@southcoastwind.com

SECTION 5. INDIAN LAND (40 CFR 122.21(f)(5))

Indian Land

5.1 Is the facility located on Indian Land?

☐ Yes ☐ No

EPA Identification Number	NPDES Permit Number	Facility Name	Form Approved 03/05/19 OMB No. 2040-0004
N/A - New Facility	N/A	SouthCoast Wind	

SECTION 6. EXISTING ENVIRONMENTAL PERMITS (40 CFR 122.21(f)(6))

Existing Environmental Permits

6.1 **Existing Environmental Permits** (check all that apply and print or type the corresponding permit number for each)

☐ NPDES (discharges to surface water) NPDES-permitted discharge planned during operations. No NPDES-permitted discharge planned during construction	☐ RCRA (hazardous wastes)	☐ UIC (underground injection of fluids)
☐ PSD (air emissions)	☐ Nonattainment program (CAA)	☐ NESHAPs (CAA)
☐ Ocean dumping (MPRSA)	☐ Dredge or fill (CWA Section 404) See COP for list of anticipated permits required, see also: www.permits.performance.gov/permitting-project/southcoast-wind-energy-llc-southcoast-wind	☐ Other (specify) See COP for list of anticipated permits required, see also: www.permits.performance.gov/permitting-project/southcoast-wind-energy-llc-southcoast-wind

SECTION 7. MAP (40 CFR 122.21(f)(7))

Map

7.1 Have you attached a topographic map containing all required information to this application? (See instructions for specific requirements.)

☐ Yes ☐ No ☐ CAFO—Not Applicable (See requirements in Form 2B.)

SECTION 8. NATURE OF BUSINESS (40 CFR 122.21(f)(8))

Nature of Business

8.1 Describe the nature of your business.

SouthCoast Wind draws from the deep experience and skills of its sponsor companies in successfully permitting, financing, constructing and operating offshore energy production facilities. SouthCoast Wind is developing an offshore lease area that has the potential to generate over 2,400 megawatts (MW) of low-cost clean energy, or enough to power over one million homes. The project will occupy the 199 square-mile (or 127,000 acre) lease area, which was awarded through a competitive auction by the US Bureau of Ocean Energy Management. We expect to deliver clean energy from the project by the end of the 2020s.

See the attached Project Narrative for more detailed information.

SECTION 9. COOLING WATER INTAKE STRUCTURES (40 CFR 122.21(f)(9))

Cooling Water Intake Structures

9.1 Does your facility use cooling water?

☐ Yes ☐ No ➔ SKIP to Item 10.1.

9.2 Identify the source of cooling water. (Note that facilities that use a cooling water intake structure as described at 40 CFR 125, Subparts I and J may have additional application requirements at 40 CFR 122.21(r). Consult with your NPDES permitting authority to determine what specific information needs to be submitted and when.)

Atlantic Ocean.

See Project Narrative for additional information related to the source water, intake structure, and thermal modeling associated with the discharge.

SECTION 10. VARIANCE REQUESTS (40 CFR 122.21(f)(10))

Variance Requests

10.1 Do you intend to request or renew one or more of the variances authorized at 40 CFR 122.21(m)? (Check all that apply. Consult with your NPDES permitting authority to determine what information needs to be submitted and when.)

☐ Fundamentally different factors (CWA Section 301(n))

☐ Water quality related effluent limitations (CWA Section 302(b)(2))

☐ Non-conventional pollutants (CWA Section 301(c) and (g))

☐ Thermal discharges (CWA Section 316(a))

☐ Not applicable

EPA Identification Number	NPDES Permit Number	Facility Name	Form Approved 03/05/19 OMB No. 2040-0004
N/A - New Facility	N/A	SouthCoast Wind	

SECTION 11. CHECKLIST AND CERTIFICATION STATEMENT (40 CFR 122.22(a) and (d))

Checklist and Certification Statement

11.1 In Column 1 below, mark the sections of Form 1 that you have completed and are submitting with your application. For each section, specify in Column 2 any attachments that you are enclosing to alert the permitting authority. Note that not all applicants are required to provide attachments.

Column 1	Column 2
☐ Section 1: Activities Requiring an NPDES Permit	☐ w/ attachments
☐ Section 2: Name, Mailing Address, and Location	☐ w/ attachments
☐ Section 3: SIC Codes	☐ w/ attachments
☐ Section 4: Operator Information	☐ w/ attachments
☐ Section 5: Indian Land	☐ w/ attachments
☐ Section 6: Existing Environmental Permits	☐ w/ attachments
☐ Section 7: Map	☐ w/ topographic map ☐ w/ additional attachments
☐ Section 8: Nature of Business	☐ w/ attachments
☐ Section 9: Cooling Water Intake Structures	☐ w/ attachments
☐ Section 10: Variance Requests	☐ w/ attachments
☐ Section 11: Checklist and Certification Statement	☐ w/ attachments

11.2 **Certification Statement**

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Name (print or type first and last name)	Official title
Enrique Alvarez	Project Director
Signature	Date signed

Click to go back to the beginning of Form

Print All Pages

Print Form Only

United States
Environmental Protection Agency

Office of Water
Washington, D.C.

EPA Form 3510-2D
Revised March 2019

Water Permits Division

Application Form 2D

New Manufacturing, Commercial, Mining, and Silvicultural Operations That Have Not Yet Commenced Discharge of Process Wastewater

NPDES Permitting Program

Note: Complete this form ***and*** Form 1 if your facility is a new manufacturing, commercial, mining, or silvicultural facility that has yet to commence discharge of process wastewater.

EPA Identification Number	NPDES Permit Number	Facility Name	Form Approved 03/05/19 OMB No. 2040-0004
N/A - New Facility	N/A	SouthCoast Wind	

Form 2D NPDES

U.S. Environmental Protection Agency
Application for NPDES Permit to Discharge Wastewater

NEW MANUFACTURING, COMMERCIAL, MINING, AND SILVICULTURAL OPERATIONS THAT HAVE NOT YET COMMENCED DISCHARGE OF PROCESS WASTEWATER

SECTION 1. EXPECTED OUTFALL LOCATION (40 CFR 122.21(k)(1))

Outfall Location

1.1 Provide information on each of the facility's outfalls in the table below.

Outfall Number	Receiving Water Name	Latitude	Longitude
001	Atlantic Ocean	40° 48′ 18.16″	-70° 19′ 29.41″
		° ′ ″	° ′ ″
		° ′ ″	° ′ ″

SECTION 2. EXPECTED DISCHARGE DATE (40 CFR 122.21(k)(2))

Expected Discharge Date

2.1

Month	Day	Year
06	30	2027

SECTION 3. AVERAGE FLOWS AND TREATMENT (40 CFR 122.21(k)(3)(i))

Average Flows and Treatment

3.1 For each outfall identified under Item 1.1, provide average flow and treatment information. Add additional sheets as necessary.

Outfall Number 001

Operations Contributing to Flow

Operation	Average Flow
Once-through, non-contact cooling for converter station operations	6 to 9 mgd
Process water (pump filter backwash, freshwater generation)	1.2 mgd
	mgd
	mgd
	mgd

Treatment Units

Description (include size, flow rate through each treatment unit, retention time, etc.)	Code from Exhibit 2D-1	Final Disposal of Solid or Liquid Wastes Other Than by Discharge
Once-through, non-contact cooling water	4-B	Ocean discharge through outfall
All treated grey water, black water, and		Onshore licensed disposal as applicable
containment will be collected and transported		
onshore for appropriate disposal		

EPA Identification Number	NPDES Permit Number	Facility Name	Form Approved 03/05/19 OMB No. 2040-0004
N/A - New Facility	N/A	SouthCoast Wind	

Average Flows and Treatment Continued

3.1 Cont.

Outfall Number N/A

Operations Contributing to Flow

Operation	Average Flow
	mgd
	mgd
	mgd
	mgd
	mgd

Treatment Units

Description (include size, flow rate through each treatment unit, retention time, etc.)	Code from Exhibit 2D-1	Final Disposal of Solid or Liquid Wastes Other Than by Discharge

Outfall Number N/A

Operations Contributing to Flow

Operation	Average Flow
	mgd
	mgd
	mgd
	mgd
	mgd

Treatment Units

Description (include size, flow rate through each treatment unit, retention time, etc.)	Code from Exhibit 2D-1	Final Disposal of Solid or Liquid Wastes Other Than by Discharge

SECTION 4. LINE DRAWING (40 CFR 122.21(k)(3)(ii))

Line Drawing

4.1 Have you attached a line drawing to this application that shows the water flow through your facility with a water balance? (See instructions for drawing requirements. See Exhibit 2D–2 at end of instructions for example.)

☑ Yes See Section 3.4, Figure 23 in the Project Narrative ☐ No

SECTION 5. INTERMITTENT OR SEASONAL FLOWS (40 CFR 122.21(k)(3)(iii))

Intermittent or Seasonal Flows

5.1 Except for stormwater runoff, leaks, or spills, are any expected discharges described in Sections 1 and 3 intermittent or seasonal?

☐ Yes ☑ No → SKIP to Section 6.

5.2 Provide information on intermittent or seasonal flows for each applicable outfall. Attach additional pages, if necessary.

Outfall Number	Operations (list)	Frequency		Rate and Volume		Duration
		Average Days/Week	Average Months/Year	Maximum Daily Discharge	Maximum Total Volume	
		days/week	months/year	mgd	gallons	days
		days/week	months/year	mgd	gallons	days
		days/week	months/year	mgd	gallons	days

Outfall Number	Operations (list)	Frequency		Rate and Volume		Duration
		Average Days/Week	Average Months/Year	Maximum Daily Discharge	Maximum Total Volume	
		days/week	months/year	mgd	gallons	days
		days/week	months/year	mgd	gallons	days
		days/week	months/year	mgd	gallons	days

Outfall Number	Operations (list)	Frequency		Rate and Volume		Duration
		Average Days/Week	Average Months/Year	Maximum Daily Discharge	Maximum Total Volume	
		days/week	months/year	mgd	gallons	days
		days/week	months/year	mgd	gallons	days
		days/week	months/year	mgd	gallons	days

SECTION 6. PRODUCTION (40 CFR 122.21(k)(4))

Production

6.1 Do any effluent limitation guidelines (ELGs) promulgated by EPA under CWA Section 304 apply to your facility?

☐ Yes ☑ No → SKIP to Section 7.

6.2 Provide the following information on applicable ELGs.

ELG Category	ELG Subcategory	Regulatory Citation

Production Continued

6.3 Are the limitations in the applicable ELGs expressed in terms of production (or other measure of operation)?

☐ Yes ☐ No ➔ SKIP to Section 7.

6.4 Provide an expected measure of average daily production expressed in terms and units of applicable ELGs.

Expected Actual Average Daily Production for First Three Years				
Outfall Number	Year	Operation, Product, or Material	Quantity per Day (note basis if applicable)	Unit of Measure
	Year 1			
	Year 2			
	Year 3			
	Year 1			
	Year 2			
	Year 3			
	Year 1			
	Year 2			
	Year 3			

SECTION 7. EFFLUENT CHARACTERISTICS (40 CFR 122.21(k)(5))

Effluent Characteristics

See the instructions to determine the parameters and pollutants you are required to monitor and, in turn, the tables you must complete. Note that not all applicants need to complete each table.

Table A. Conventional and Non-Conventional Parameters

7.1 Are you requesting a waiver from your NPDES permitting authority for one or more of the Table A parameters for any of your outfalls?

☐ Yes ☑ No ➔ SKIP to Item 7.3.

7.2 If yes, indicate the applicable outfalls below. Attach waiver request and other required information to the application.

Outfall number ________ Outfall number ________ Outfall number ________

7.3 Have you have provided estimates or actual data for all Table A parameters for each of your outfalls for which a waiver has not been requested and attached the results to this application package?

☑ Yes ☐ No; a waiver has been requested from my NPDES permitting authority for all parameters at all outfalls.

Table B. Certain Conventional and Non-Conventional Pollutants

7.4 Have you checked "Believed Present" for all pollutants listed in Table B that are limited directly or indirectly by an applicable ELG?

☐ Yes ☑ No

7.5 Have you checked "Believed Present" or "Believed Absent" for all remaining pollutants listed in Table B?

☑ Yes ☐ No

7.6 Have you provided estimated data for those Table B pollutants for which you have indicated are "Believed Present" in your discharge?

☑ Yes ☐ No

Effluent Characteristics Continued

Table C. Toxic Metals, Total Cyanide, and Total Phenols			
7.7	Have you indicated whether pollutants are "Believed Present" or "Believed Absent" for all pollutants listed on Table C for all outfalls?	☑ Yes	☐ No
7.8	Have you completed Table C by providing estimated data for pollutants you indicated are "Believed Present," including the source of the information, for each applicable outfall?	☑ Yes	☐ No
Table D. Organic Toxic Pollutants (GC/MS Fractions)			
7.9	Do you qualify for a small business exemption under the criteria specified in the Instructions?	☐ Yes ➔ Note that you qualify at the top of Table D, then SKIP to Item 7.12.	☑ No
7.10	Have you indicated whether pollutants are "Believed Present" or "Believed Absent" for all pollutants listed on Table D for all outfalls?	☑ Yes	☐ No
7.11	Have you completed Table D by providing estimated data for pollutants you indicated are "Believed Present," including the source of the information, for each applicable outfall?	☑ Yes	☐ No
2,3,7,8-Tetrachlorodibenzo-p-Dioxin (TCDD)			
7.12	Does the facility use or manufacture one or more of the 2,3,7,8-TCDD congeners listed in the Instructions, or do you know or have reason to believe that TCDD is or may be present in effluent from any of your outfalls?	☐ Yes	☑ No
Table E. Certain Hazardous Substances and Asbestos			
7.13	Have you indicated whether pollutants are "Believed Present" or "Believed Absent" for all pollutants listed in Table E for all outfalls?	☑ Yes	☐ No
7.14	Have you completed Table E by reporting the reason the pollutants are expected to be present and available quantitative data for pollutants you indicated are "Believed Present" for each applicable outfall?	☑ Yes	☐ No
Intake Credits, Tables A through E			
7.15	Are you applying for net credits for the presence of any of the pollutants on Tables A through E for any of your outfalls?	☐ Yes ➔ Consult with your NPDES permitting authority.	☑ No

SECTION 8. ENGINEERING REPORT (40 CFR 122.21(k)(6))

Engineering Report

8.1	Do you have any technical evaluations of your wastewater treatment, including engineering reports or pilot plant studies?	☐ Yes	☑ No ➔ SKIP to Item 8.3.
8.2	Have you provided the technical evaluation and all related documents to this application package?	☐ Yes	☐ No
8.3	Are you aware of any existing plant(s) that resemble production processes, wastewater constituents, or wastewater treatment at your facility?	☑ Yes	☐ No ➔ SKIP to Section 9.

Engineering Report Continued

8.4 Provide the name and location of the similar plants.

Name of Similar Plants	Location of Similar Plants
DolWin Gamma	North Sea, Germany
Borwin Gamma	North Sea, Germany
Sunrise Wind (proposed)	Atlantic Ocean, United States

SECTION 9. OTHER INFORMATION (40 CFR 122.21(k)(7))

Other Information

9.1 Have you attached any optional information that you would like considered as part of the application review process (i.e., material beyond that which you have already noted in the application as being attached)?

☑ Yes ☐ No ➔ SKIP to Section 10.

9.2 List the additional items and briefly note why you have included them.

1. Project Narrative; source water, intake structure, and thermal modeling associated with the discharge
2.
3.
4.
5.

SECTION 10. CHECKLIST AND CERTIFICATION STATEMENT (40 CFR 122.22(a) and (d))

Checklist and Certification Statement

10.1 In Column 1 below, mark the sections of Form 2D that you have completed and are submitting with your application. For each section, specify in Column 2 any attachments that you are enclosing to alert the permitting authority. Note that not all applicants are required to complete all sections or tables, or provide attachments.

Column 1	Column 2
☑ Section 1: Expected Outfall Location	☑ w/ attachments (e.g., responses for additional outfalls)
☑ Section 2: Expected Discharge Date	☐ w/ attachments
☑ Section 3: Average Flows and Treatment	☐ w/ attachments
☑ Section 4: Line Drawing	☑ w/ line drawing ☐ w/ additional attachments
☐ Section 5: Intermittent or Seasonal Flows	☐ w/ attachments
☐ Section 6: Production	☐ w/ attachments
☑ Section 7: Effluent Characteristics	☐ w/ Table A waiver request or approval ☑ Table A ☑ Table B ☐ Table C ☐ Table D ☐ Table E ☑ w/ other attachments
☐ Section 8: Engineering Report	☐ w/ technical evaluations and related attachments
☑ Section 9: Other Information	☑ w/ optional information
☑ Section 10: Checklist and Certification Statement	☐ w/ attachments

Checklist and Certification Statement Continued			
	10.2	**Certification Statement** *I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.*	
		Name (print or type first and last name) Enrique Alvarez	Official title Project Director
		Signature	Date signed

This page intentionally left blank.

EPA Identification Number	Facility Name	Outfall Number
N/A - New Facility	SouthCoast Wind	001

Form Approved 03/05/19
OMB No. 2040-0004

TABLE A. CONVENTIONAL AND NON CONVENTIONAL PARAMETER ESTIMATES (40 CFR 122.21(k)(5)(i))[1]

	Pollutant	Waiver Requested (if applicable)	Units		Effluent Data: Maximum Daily Discharge (required)	Effluent Data: Average Daily Discharge (if available)	Effluent Data: Source of Information (use codes in instructions)	Intake Water: Believed Present? (check only one response per parameter)	
☐	Check here if you have applied to your NPDES authority for a waiver for *all* of the pollutants listed on this table for the noted outfall.								
1.	Biochemical oxygen demand (BOD_5)	☐	Concentration		*	*	*Assumed to be consistent with ambient source water parameters	☑ Yes	☐ No
			Mass		*	*	*Assumed to be consistent with ambient source water parameters		
2.	Chemical oxygen demand (COD)	☐	Concentration		*	*	*Assumed to be consistent with ambient source water parameters	☑ Yes	☐ No
			Mass		*	*	*Assumed to be consistent with ambient source water parameters		
3.	Total organic carbon (TOC)	☐	Concentration		*	*	*Assumed to be consistent with ambient source water parameters	☑ Yes	☐ No
			Mass		*	*	*Assumed to be consistent with ambient source water parameters		
4.	Total suspended solids (TSS)	☐	Concentration		*	*	*Assumed to be consistent with ambient source water parameters	☑ Yes	☐ No
			Mass		*	*	*Assumed to be consistent with ambient source water parameters		
5.	Ammonia (as N)	☐	Concentration		*	*	*Assumed to be consistent with ambient source water parameters	☑ Yes	☐ No
			Mass		*	*	*Assumed to be consistent with ambient source water parameters		
6.	Flow	☐	Rate	mgd	10.2 mgd	N/A	max. = 2 pumps, min = 1 pump	☑ Yes	☐ No
7.	Temperature (winter)	☐	°C	°C	32.2°C	N/A	best professional estimate	☑ Yes	☐ No
	Temperature (summer)	☐	°C	°C	32.2°C	N/A	best professional estimate		
8.	pH (minimum)	☐	Standard units	s.u.	*	*	*Assumed to be consistent with ambient source water parameters	☑ Yes	☐ No
	pH (maximum)	☐	Standard units	s.u.	*	*	*Assumed to be consistent with ambient source water parameters		

[1] Sampling shall be conducted according to sufficiently sensitive test procedures (i.e., methods) approved under 40 CFR 136 for the analysis of pollutants or pollutant parameters or required under 40 CFR chapter I, subchapter N or O. See instructions and 40 CFR 122.21(e)(3).

This page intentionally left blank.

EPA Identification Number	Facility Name	Outfall Number
N/A - New Facility	SouthCoast Wind	001

Form Approved 03/05/19
OMB No. 2040-0004

TABLE B. CERTAIN CONVENTIONAL AND NON CONVENTIONAL POLLUTANTS (40 CFR 122.21(k)(5)(ii))[1]

	Pollutant	Presence or Absence (check one)		Estimated Data for Pollutants Expected to be Present or Limited by an ELG (Provide both concentration and mass estimates for each pollutant.)					Intake Water
				Effluent					Intake Water
		Believed Present	Believed Absent	Units		Maximum Daily Discharge (required)	Average Daily Discharge (if available)	Source of Information (use codes in instructions)	Believed Present? (check only one response per item)
☐	Check (✓) here if you believe all pollutants listed to be absent from the discharge. You need not complete Table B for the noted outfall *unless* you have quantitative data available.								
1.	Bromide (24959-67-9)	☐	☑	Concentration		*	*	*Assumed consistent with ambient source water levels	☑ Yes ☐ No
				Mass		*	*		
2.	Chlorine, total residual	☑	☐	Concentration	ppm	2 ppm	N/A	Concentrations represent best professional estimate	☑ Yes ☐ No
				Mass	kg/day	95 kg/day	*		
3.	Color	☐	☑	Concentration		*	*	*Assumed consistent with ambient source water levels	☑ Yes ☐ No
				Mass		*	*		
4.	Fecal coliform	☐	☑	Concentration		*	*	*Assumed consistent with ambient source water levels	☑ Yes ☐ No
				Mass		*	*		
5.	Fluoride (16984-48-8)	☐	☑	Concentration		*	*	*Assumed consistent with ambient source water levels	☑ Yes ☐ No
				Mass		*	*		
6.	Nitrate-nitrite	☐	☑	Concentration		*	*	*Assumed consistent with ambient source water levels	☑ Yes ☐ No
				Mass		*	*		
7.	Nitrogen, total organic (as N)	☐	☑	Concentration		*	*	*Assumed consistent with ambient source water levels	☑ Yes ☐ No
				Mass		*	*		
8.	Oil and grease	☐	☑	Concentration		*	*	*Assumed consistent with ambient source water levels	☑ Yes ☐ No
				Mass		*	*		
9.	Phosphorus (as P), total (7723-14-0)	☐	☑	Concentration		*	*	*Assumed consistent with ambient source water levels	☑ Yes ☐ No
				Mass		*	*		
10.	Sulfate (as SO_4) (14808-79-8)	☐	☑	Concentration		*	*	*Assumed consistent with ambient source water levels	☑ Yes ☐ No
				Mass		*	*		
11.	Sulfide (as S)	☐	☑	Concentration		*	*	*Assumed consistent with ambient source water levels	☑ Yes ☐ No
				Mass		*	*		

TABLE B. CERTAIN CONVENTIONAL AND NON CONVENTIONAL POLLUTANTS (40 CFR 122.21(k)(5)(ii))[1]

	Pollutant	Presence or Absence (check one)		Estimated Data for Pollutants Expected to be Present or Limited by an ELG (Provide both concentration and mass estimates for each pollutant.)					Intake Water
				Effluent					
		Believed Present	Believed Absent	Units		Maximum Daily Discharge (required)	Average Daily Discharge (if available)	Source of Information (use codes in instructions)	Believed Present? (check only one response per item)
12.	Sulfite (as SO_3) (14265-45-3)	☐	☑	Concentration		*	*	*Assumed consistent with ambient source water levels	☑ Yes ☐ No
				Mass		*	*		
13.	Surfactants	☐	☑	Concentration		*	*	*Assumed consistent with ambient source water levels	☑ Yes ☐ No
				Mass		*	*		
14.	Aluminum, total (7429-90-5)	☐	☑	Concentration		*	*	*Assumed consistent with ambient source water levels	☑ Yes ☐ No
				Mass		*	*		
15.	Barium, total (7440-39-3)	☐	☑	Concentration		*	*	*Assumed consistent with ambient source water levels	☑ Yes ☐ No
				Mass		*	*		
16.	Boron, total (7440-42-8)	☐	☑	Concentration		*	*	*Assumed consistent with ambient source water levels	☑ Yes ☐ No
				Mass		*	*		
17.	Cobalt, total (7440-48-4)	☐	☑	Concentration		*	*	*Assumed consistent with ambient source water levels	☑ Yes ☐ No
				Mass		*	*		
18.	Iron, total (7439-89-6)	☐	☑	Concentration		*	*	*Assumed consistent with ambient source water levels	☑ Yes ☐ No
				Mass		*	*		
19.	Magnesium, total (7439-95-4)	☐	☑	Concentration		*	*	*Assumed consistent with ambient source water levels	☑ Yes ☐ No
				Mass		*	*		
20.	Molybdenum, total (7439-98-7)	☐	☑	Concentration		*	*	*Assumed consistent with ambient source water levels	☑ Yes ☐ No
				Mass		*	*		
21.	Manganese, total (7439-96-5)	☐	☑	Concentration		*	*	*Assumed consistent with ambient source water levels	☑ Yes ☐ No
				Mass		*	*		
22.	Tin, total (7440-31-5)	☐	☑	Concentration		*	*	*Assumed consistent with ambient source water levels	☑ Yes ☐ No
				Mass		*	*		

EPA Identification Number	Facility Name	Outfall Number
N/A - New Facility	SouthCoast Wind	001

Form Approved 03/05/19
OMB No. 2040-0004

TABLE B. CERTAIN CONVENTIONAL AND NON CONVENTIONAL POLLUTANTS (40 CFR 122.21(k)(5)(ii))[1]

Pollutant		Presence or Absence (check one)		Estimated Data for Pollutants Expected to be Present or Limited by an ELG (Provide both concentration and mass estimates for each pollutant.)					Intake Water
				Effluent					Intake Water
		Believed Present	Believed Absent	Units		Maximum Daily Discharge (required)	Average Daily Discharge (if available)	Source of Information (use codes in instructions)	Believed Present? (check only one response per item)
23.	Titanium, total (7440-32-6)	☐	☑	Concentration		*	*	*Assumed consistent with ambient source water levels	☑ Yes ☐ No
				Mass		*	*		
24.	Radioactivity								
24.1	Alpha, total	☐	☑	Concentration		*	*	*Assumed consistent with ambient source water levels	☐ Yes ☑ No
				Mass		*	*		
24.2	Beta, total	☐	☑	Concentration		*	*	*Assumed consistent with ambient source water levels	☐ Yes ☑ No
				Mass		*	*		
24.3.	Radium, total	☐	☑	Concentration		*	*	*Assumed consistent with ambient source water levels	☐ Yes ☑ No
				Mass		*	*		
24.4	Radium 226, total	☐	☑	Concentration		*	*	*Assumed consistent with ambient source water levels	☐ Yes ☑ No
				Mass		*	*		

[1] Sampling shall be conducted according to sufficiently sensitive test procedures (i.e., methods) approved under 40 CFR 136 for the analysis of pollutants or pollutant parameters or required under 40 CFR chapter I, subchapter N or O. See instructions and 40 CFR 122.21(e)(3).

This page intentionally left blank.

EPA Identification Number	Facility Name	Outfall Number
N/A - New Facility	SouthCoast Wind	001

Form Approved 03/05/19
OMB No. 2040-0004

TABLE C. TOXIC METALS, TOTAL CYANIDE, AND TOTAL PHENOLS (40 CFR 122.21(k)(5)(iii)(A))[1]

Pollutant (CAS Number, if available)		Presence or Absence (check one)		Estimated Data for Pollutants Expected to be Present in Discharge (Provide both concentration and mass estimates for each pollutant.)					Intake Water	
				Effluent					Believed Present? (Check only one response per pollutant.)	
		Believed Present	Believed Absent	Units		Maximum Daily Discharge (required)	Average Daily Discharge (if available)	Source of Information (Use codes in Instructions.)		
☑	Check (✓) here if you believe all pollutants listed to be absent from the discharge. You need not complete Table C for the noted outfall *unless* you have quantitative data available.									
1.	Antimony, Total (7440-36-0)	☐	☐	Concentration					☐ Yes	☐ No
				Mass						
2.	Arsenic, Total (7440-38-2)	☐	☐	Concentration					☐ Yes	☐ No
				Mass						
3.	Beryllium, Total (7440-41-7)	☐	☐	Concentration					☐ Yes	☐ No
				Mass						
4.	Cadmium, Total (7440-43-9)	☐	☐	Concentration					☐ Yes	☐ No
				Mass						
5.	Chromium, Total (7440-47-3)	☐	☐	Concentration					☐ Yes	☐ No
				Mass						
6.	Copper, Total (7440-50-8)	☐	☐	Concentration					☐ Yes	☐ No
				Mass						
7.	Lead, Total (7439-92-1)	☐	☐	Concentration					☐ Yes	☐ No
				Mass						
8.	Mercury, Total (7439-97-6)	☐	☐	Concentration					☐ Yes	☐ No
				Mass						
9.	Nickel, Total (7440-02-0)	☐	☐	Concentration					☐ Yes	☐ No
				Mass						
10.	Selenium, Total (7782-49-2)	☐	☐	Concentration					☐ Yes	☐ No
				Mass						
11.	Silver, Total (7440-22-4)	☐	☐	Concentration					☐ Yes	☐ No
				Mass						
12.	Thallium, Total (7440-28-0)	☐	☐	Concentration					☐ Yes	☐ No
				Mass						
13.	Zinc, Total (7440-66-6)	☐	☐	Concentration					☐ Yes	☐ No
				Mass						
14.	Cyanide, Total (57-12-5)	☐	☐	Concentration					☐ Yes	☐ No
				Mass						
15.	Phenols, Total	☐	☐	Concentration					☐ Yes	☐ No
				Mass						

[1] Sampling shall be conducted according to sufficiently sensitive test procedures (i.e., methods) approved under 40 CFR 136 for the analysis of pollutants or pollutant parameters or required under 40 CFR chapter I, subchapter N or O. See Instructions and 40 CFR 122.21(e)(3).

This page intentionally left blank.

TABLE D. ORGANIC TOXIC POLLUTANTS (Gas Chromatography/Mass Spectrometry or GC/MS Fractions) (40 CFR 122.21(k)(5)(iii)(B))[1]

	Pollutant (CAS Number, if available)	Presence or Absence (check one): Believed Present	Believed Absent	Estimated Data for Pollutants Expected to Be Present in Discharge (provide both concentration and mass estimates for each pollutant): Units		Effluent: Maximum Daily Discharge	Average Daily Discharge	Source of Information (use codes in instructions)	Intake Water: Believed Present? (check only one response per pollutant)
☑	Check here if all pollutants listed in Table D are expected to be absent from your facility's discharge.								
☐	Check here if the facility believes it is exempt from Table D reporting requirements because it is a qualified small business. See the instructions for exemption criteria and for a list of materials you must attach to the application.								
Note: If you check either of the above boxes, you do not need to complete Table D for the noted outfall *unless* you have quantitative data available.									
1. Organic Toxic Pollutants (GC/MS Fraction—Volatile Compounds)									
1.1	Acrolein (107-02-8)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
1.2	Acrylonitrile (107-13-1)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
1.3	Benzene (71-43-2)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
1.4	Bromoform (75-25-2)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
1.5	Carbon tetrachloride (56-23-5)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
1.6	Chlorobenzene (108-90-7)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
1.7	Chlorodibromomethane (124-48-1)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
1.8	Chloroethane (75-00-3)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
1.9	2-chloroethylvinyl ether (110-75-8)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
1.10	Chloroform (67-66-3)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
1.11	Dichlorobromomethane (75-27-4)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					

TABLE D. ORGANIC TOXIC POLLUTANTS (Gas Chromatography/Mass Spectrometry or GC/MS Fractions) (40 CFR 122.21(k)(5)(iii)(B))[1]

Pollutant (CAS Number, if available)		Presence or Absence (check one)		Estimated Data for Pollutants Expected to Be Present in Discharge (provide both concentration and mass estimates for each pollutant)					
						Effluent			Intake Water
		Believed Present	Believed Absent	Units		Maximum Daily Discharge	Average Daily Discharge	Source of Information (use codes in instructions)	Believed Present? (check only one response per pollutant)
1.12	1,1-dichloroethane (75-34-3)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
1.13	1,2-dichloroethane (107-06-2)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
1.14	1,1-dichloroethylene (75-35-4)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
1.15	1,2-dichloropropane (78-87-5)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
1.16	1,3-dichloropropylene (542-75-6)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
1.17	Ethylbenzene (100-41-4)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
1.18	Methyl bromide (74-83-9)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
1.19	Methyl chloride (74-87-3)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
1.20	Methylene chloride (75-09-2)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
1.21	1,1,2,2-tetrachloroethane (79-34-5)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
1.22	Tetrachloroethylene (127-18-4)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
1.23	Toluene (108-88-3)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
1.24	1,2-trans-dichloroethylene (156-60-5)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					

TABLE D. ORGANIC TOXIC POLLUTANTS (Gas Chromatography/Mass Spectrometry or GC/MS Fractions) (40 CFR 122.21(k)(5)(iii)(B))[1]

Pollutant (CAS Number, if available)		Presence or Absence (check one)		Estimated Data for Pollutants Expected to Be Present in Discharge (provide both concentration and mass estimates for each pollutant)					Intake Water
		Believed Present	Believed Absent	Units		Effluent: Maximum Daily Discharge	Effluent: Average Daily Discharge	Effluent: Source of Information (use codes in instructions)	Believed Present? (check only one response per pollutant)
1.25	1,1,1-trichloroethane (71-55-6)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
1.26	1,1,2-trichloroethane (79-00-5)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
1.27	Trichloroethylene (79-01-6)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
1.28	Vinyl chloride (75-01-4)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
2. Organic Toxic Pollutants (GC/MS Fraction—Acid Compounds)									
2.1	2-chlorophenol (95-57-8)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
2.2	2,4-dichlorophenol (120-83-2)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
2.3	2,4-dimethylphenol (105-67-9)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
2.4	4,6-dinitro-o-cresol (534-52-1)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
2.5	2,4-dinitrophenol (51-28-5)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
2.6	2-nitrophenol (88-75-5)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
2.7	4-nitrophenol (100-02-7)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
2.8	p-chloro-m-cresol (59-50-7)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
2.9	Pentachlorophenol (87-86-5)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					

EPA Identification Number	Facility Name	Outfall Number
N/A - New Facility	SouthCoast Wind	001

Form Approved 03/05/19
OMB No. 2040-0004

TABLE D. ORGANIC TOXIC POLLUTANTS (Gas Chromatography/Mass Spectrometry or GC/MS Fractions) (40 CFR 122.21(k)(5)(iii)(B))[1]

Pollutant (CAS Number, if available)		Presence or Absence (check one): Believed Present	Believed Absent	Estimated Data for Pollutants Expected to Be Present in Discharge (provide both concentration and mass estimates for each pollutant): Units		Effluent: Maximum Daily Discharge	Average Daily Discharge	Source of Information (use codes in instructions)	Intake Water: Believed Present? (check only one response per pollutant)
2.10	Phenol (108-95-2)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
2.11	2,4,6-trichlorophenol (88-05-2)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
3. Organic Toxic Pollutants (GC/MS Fraction—Base /Neutral Compounds)									
3.1	Acenaphthene (83-32-9)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
3.2	Acenaphthylene (208-96-8)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
3.3	Anthracene (120-12-7)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
3.4	Benzidine (92-87-5)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
3.5	Benzo (a) anthracene (56-55-3)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
3.6	Benzo (a) pyrene (50-32-8)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
3.7	3,4-benzofluoranthene (205-99-2)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
3.8	Benzo (ghi) perylene (191-24-2)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
3.9	Benzo (k) fluoranthene (207-08-9)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
3.10	Bis (2-chloroethoxy) methane (111-91-1)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
3.11	Bis (2-chloroethyl) ether (111-44-4)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					

EPA Identification Number	Facility Name	Outfall Number
N/A - New Facility	SouthCoast Wind	001

Form Approved 03/05/19
OMB No. 2040-0004

TABLE D. ORGANIC TOXIC POLLUTANTS (Gas Chromatography/Mass Spectrometry or GC/MS Fractions) (40 CFR 122.21(k)(5)(iii)(B))[1]

	Pollutant (CAS Number, if available)	Presence or Absence (check one)		Estimated Data for Pollutants Expected to Be Present in Discharge (provide both concentration and mass estimates for each pollutant)					Intake Water
		Believed Present	Believed Absent	Units		Effluent: Maximum Daily Discharge	Effluent: Average Daily Discharge	Source of Information (use codes in instructions)	Believed Present? (check only one response per pollutant)
3.12	Bis (2-chloroisopropyl) ether (102-80-1)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
3.13	Bis (2-ethylhexyl) phthalate (117-81-7)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
3.14	4-bromophenyl phenyl ether (101-55-3)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
3.15	Butyl benzyl phthalate (85-68-7)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
3.16	2-chloronaphthalene (91-58-7)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
3.17	4-chlorophenyl phenyl ether (7005-72-3)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
3.18	Chrysene (218-01-9)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
3.19	Dibenzo (a,h) anthracene (53-70-3)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
3.20	1,2-dichlorobenzene (95-50-1)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
3.21	1,3-dichlorobenzene (541-73-1)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
3.22	1,4-dichlorobenzene (106-46-7)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
3.23	3,3-dichlorobenzidine (91-94-1)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
3.24	Diethyl phthalate (84-66-2)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
3.25	Dimethyl phthalate (131-11-3)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					

TABLE D. ORGANIC TOXIC POLLUTANTS (Gas Chromatography/Mass Spectrometry or GC/MS Fractions) (40 CFR 122.21(k)(5)(iii)(B))[1]

Pollutant (CAS Number, if available)		Presence or Absence (check one)		Estimated Data for Pollutants Expected to Be Present in Discharge (provide both concentration and mass estimates for each pollutant)					
		Believed Present	Believed Absent	Units		Effluent: Maximum Daily Discharge	Effluent: Average Daily Discharge	Effluent: Source of Information (use codes in instructions)	Intake Water: Believed Present? (check only one response per pollutant)
3.26	Di-n-butyl phthalate (84-74-2)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
3.27	2,4-dinitrotoluene (121-14-2)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
3.28	2,6-dinitrotoluene (606-20-2)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
3.29	Di-n-octyl phthalate (117-84-0)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
3.30	1,2-diphenylhydrazine (as azobenzene) (122-66-7)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
3.31	Fluoranthene (206-44-0)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
3.32	Fluorene (86-73-7)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
3.33	Hexachlorobenzene (118-74-1)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
3.34	Hexachlorobutadiene (87-68-3)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
3.35	Hexachlorocyclopentadiene (77-47-4)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
3.36	Hexachloroethane (67-72-1)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
3.37.	Indeno (1,2,3-cd) pyrene (193-39-5)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
3.38	Isophorone (78-59-1)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
3.39	Naphthalene (91-20-3)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					

TABLE D. ORGANIC TOXIC POLLUTANTS (Gas Chromatography/Mass Spectrometry or GC/MS Fractions) (40 CFR 122.21(k)(5)(iii)(B))[1]

	Pollutant (CAS Number, if available)	Presence or Absence (check one)		Estimated Data for Pollutants Expected to Be Present in Discharge (provide both concentration and mass estimates for each pollutant)					Intake Water
		Believed Present	Believed Absent	Units		Effluent: Maximum Daily Discharge	Effluent: Average Daily Discharge	Effluent: Source of Information (use codes in instructions)	Believed Present? (check only one response per pollutant)
3.40	Nitrobenzene (98-95-3)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
3.41	N-nitrosodimethylamine (62-75-9)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
3.42	N-nitrosodi-n-propylamine (621-64-7)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
3.43	N-nitrosodiphenylamine (86-30-6)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
3.44	Phenanthrene (85-01-8)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
3.45	Pyrene (129-00-0)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
3.46	1,2,4-trichlorobenzene (120-82-1)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
4. Organic Toxic Pollutants (GC/MS Fraction—Pesticides)									
4.1.	Aldrin (309-00-2)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
4.2	α-BHC (319-84-6)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
4.3	β-BHC (319-85-7)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
4.4	γ-BHC (58-89-9)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
4.5	δ-BHC (319-86-8)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
4.6	Chlordane (57-74-9)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					

EPA Identification Number	Facility Name	Outfall Number
N/A - New Facility	SouthCoast Wind	001

Form Approved 03/05/19
OMB No. 2040-0004

TABLE D. ORGANIC TOXIC POLLUTANTS (Gas Chromatography/Mass Spectrometry or GC/MS Fractions) (40 CFR 122.21(k)(5)(iii)(B))[1]

	Pollutant (CAS Number, if available)	Presence or Absence (check one)		Estimated Data for Pollutants Expected to Be Present in Discharge (provide both concentration and mass estimates for each pollutant)					Intake Water
		Believed Present	Believed Absent	Units		Effluent: Maximum Daily Discharge	Effluent: Average Daily Discharge	Effluent: Source of Information (use codes in instructions)	Believed Present? (check only one response per pollutant)
4.7	4,4'-DDT (50-29-3)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
4.8	4,4'-DDE (72-55-9)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
4.9	4,4'-DDD (72-54-8)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
4.10	Dieldrin (60-57-1)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
4.11	α-endosulfan (115-29-7)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
4.12	β-endosulfan (115-29-7)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
4.13	Endosulfan sulfate (1031-07-8)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
4.14	Endrin (72-20-8)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
4.15	Endrin aldehyde (7421-93-4)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					

TABLE D. ORGANIC TOXIC POLLUTANTS (Gas Chromatography/Mass Spectrometry or GC/MS Fractions) (40 CFR 122.21(k)(5)(iii)(B))[1]

	Pollutant (CAS Number, if available)	Presence or Absence (check one)		Estimated Data for Pollutants Expected to Be Present in Discharge (provide both concentration and mass estimates for each pollutant)					Intake Water
		Believed Present	Believed Absent	Units		Effluent: Maximum Daily Discharge	Effluent: Average Daily Discharge	Effluent: Source of Information (use codes in instructions)	Believed Present? (check only one response per pollutant)
4.16	Heptachlor (76-44-8)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
4.17	Heptachlor epoxide (1024-57-3)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
4.18	PCB-1242 (53469-21-9)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
4.19	PCB-1254 (11097-69-1)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
4.20	PCB-1221 (11104-28-2)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
4.21	PCB-1232 (11141-16-5)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
4.22	PCB-1248 (12672-29-6)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
4.23	PCB-1260 (11096-82-5)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
4.24	PCB-1016 (12674-11-2)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					
4.25	Toxaphene (8001-35-2)	☐	☐	Concentration					☐ Yes ☐ No
				Mass					

[1] Sampling shall be conducted according to sufficiently sensitive test procedures (i.e., methods) approved under 40 CFR 136 for the analysis of pollutants or pollutant parameters or required under 40 CFR chapter I, subchapter N or O. See instructions and 40 CFR 122.21(e)(3).

This page intentionally left blank.

EPA Identification Number	Facility Name	Outfall Number
N/A - New Facility	SouthCoast Wind	001

Form Approved 03/05/19
OMB No. 2040-0004

TABLE E. CERTAIN HAZARDOUS SUBSTANCES AND ASBESTOS (40 CFR 122.21(k)(5)(v))[1]

	Pollutant	Presence or Absence (check one)		Reason Pollutant Believed Present in Discharge	Available Quantitative Data (specify units)
		Believed Present	Believed Absent		
☑	Check (✓) here if you believe all pollutants listed to be absent from the discharge. You need not complete Table E for the noted outfall *unless* you have quantitative data available.				
1.	Asbestos	☐	☐		
2.	Acetaldehyde	☐	☐		
3.	Allyl alcohol	☐	☐		
4.	Allyl chloride	☐	☐		
5.	Amyl acetate	☐	☐		
6.	Aniline	☐	☐		
7.	Benzonitrile	☐	☐		
8.	Benzyl chloride	☐	☐		
9.	Butyl acetate	☐	☐		
10.	Butylamine	☐	☐		
11.	Captan	☐	☐		
12.	Carbaryl	☐	☐		
13.	Carbofuran	☐	☐		
14.	Carbon disulfide	☐	☐		
15.	Chlorpyrifos	☐	☐		
16.	Coumaphos	☐	☐		
17.	Cresol	☐	☐		
18.	Crotonaldehyde	☐	☐		

EPA Identification Number	Facility Name	Outfall Number
N/A - New Facility	SouthCoast Wind	001

Form Approved 03/05/19
OMB No. 2040-0004

TABLE E. CERTAIN HAZARDOUS SUBSTANCES AND ASBESTOS (40 CFR 122.21(k)(5)(v))[1]

Pollutant		Presence or Absence (check one)		Reason Pollutant Believed Present in Discharge	Available Quantitative Data (specify units)
		Believed Present	Believed Absent		
19.	Cyclohexane	☐	☐		
20.	2,4-D (2,4-dichlorophenoxyacetic acid)	☐	☐		
21.	Diazinon	☐	☐		
22.	Dicamba	☐	☐		
23.	Dichlobenil	☐	☐		
24.	Dichlone	☐	☐		
25.	2,2-dichloropropionic acid	☐	☐		
26.	Dichlorvos	☐	☐		
27.	Diethyl amine	☐	☐		
28.	Dimethyl amine	☐	☐		
29.	Dintrobenzene	☐	☐		
30.	Diquat	☐	☐		
31.	Disulfoton	☐	☐		
32.	Diuron	☐	☐		
33.	Epichlorohydrin	☐	☐		
34.	Ethion	☐	☐		
35.	Ethylene diamine	☐	☐		
36.	Ethylene dibromide	☐	☐		
37.	Formaldehyde	☐	☐		

TABLE E. CERTAIN HAZARDOUS SUBSTANCES AND ASBESTOS (40 CFR 122.21(k)(5)(v))[1]					
Pollutant		Presence or Absence (check one)		Reason Pollutant Believed Present in Discharge	Available Quantitative Data (specify units)
		Believed Present	Believed Absent		
38.	Furfural	☐	☐		
39.	Guthion	☐	☐		
40.	Isoprene	☐	☐		
41.	Isopropanolamine	☐	☐		
42.	Kelthane	☐	☐		
43.	Kepone	☐	☐		
44.	Malathion	☐	☐		
45.	Mercaptodimethur	☐	☐		
46.	Methoxychlor	☐	☐		
47.	Methyl mercaptan	☐	☐		
48.	Methyl methacrylate	☐	☐		
49.	Methyl parathion	☐	☐		
50.	Mevinphos	☐	☐		
51.	Mexacarbate	☐	☐		
52.	Monoethyl amine	☐	☐		
53.	Monomethyl amine	☐	☐		
54.	Naled	☐	☐		
55.	Naphthenic acid	☐	☐		
56.	Nitrotoluene	☐	☐		

EPA Identification Number	Facility Name	Outfall Number
N/A - New Facility	SouthCoast Wind	001

Form Approved 03/05/19
OMB No. 2040-0004

TABLE E. CERTAIN HAZARDOUS SUBSTANCES AND ASBESTOS (40 CFR 122.21(k)(5)(v))[1]

	Pollutant	Presence or Absence (check one)		Reason Pollutant Believed Present in Discharge	Available Quantitative Data (specify units)
		Believed Present	Believed Absent		
57.	Parathion	☐	☐		
58.	Phenolsulfonate	☐	☐		
59.	Phosgene	☐	☐		
60.	Propargite	☐	☐		
61.	Propylene oxide	☐	☐		
62.	Pyrethrins	☐	☐		
63.	Quinoline	☐	☐		
64.	Resorcinol	☐	☐		
65.	Strontium	☐	☐		
66.	Strychnine	☐	☐		
67.	Styrene	☐	☐		
68.	2,4,5-T (2,4,5-trichlorophenoxyacetic acid)	☐	☐		
69.	TDE (tetrachlorodiphenyl ethane)	☐	☐		
70.	2,4,5-TP [2-(2,4,5-trichlorophenoxy) propanoic acid]	☐	☐		
71.	Trichlorofon	☐	☐		
72.	Triethanolamine	☐	☐		
73.	Triethylamine	☐	☐		
74.	Trimethylamine	☐	☐		
75.	Uranium	☐	☐		

EPA Identification Number	Facility Name	Outfall Number
N/A - New Facility	SouthCoast Wind	001

Form Approved 03/05/19
OMB No. 2040-0004

TABLE E. CERTAIN HAZARDOUS SUBSTANCES AND ASBESTOS (40 CFR 122.21(k)(5)(v))[1]

Pollutant		Presence or Absence (check one)		Reason Pollutant Believed Present in Discharge	Available Quantitative Data (specify units)
		Believed Present	Believed Absent		
76.	Vanadium	☐	☐		
77.	Vinyl acetate	☐	☐		
78.	Xylene	☐	☐		
79.	Xylenol	☐	☐		
80.	Zirconium	☐	☐		

[1] Sampling shall be conducted according to sufficiently sensitive test procedures (i.e., methods) approved under 40 CFR 136 for the analysis of pollutants or pollutant parameters or required under 40 CFR chapter I, subchapter N or O. See instructions and 40 CFR 122.21(e)(3).

Click to go back to the beginning of Form