South Fork Wind Farm and South Fork Export Cable Project

Biological Assessment

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For the National Marine Fisheries Service

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

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ABBREVIATIONS

μV/m	microvolts per meter
°C	degrees Celsius
°F	degrees Fahrenheit
AC	alternating current
AIS	automatic identification system
BA	biological assessment
BIA	biologically important area
BOEM	Bureau of Ocean Energy Management
CETAP	Cetacean and Turtle Assessment Program
CFR	Code of Federal Regulations
CMECS	Coastal and Marine Ecological Classification Standard
COP	construction and operations plan
dB	decibel
dB_{PEAK}	peak decibels
dB_{RMS}	root mean square decibels
dB_{SEL}	cumulative sound exposure level in decibels
DPS	distinct population segment
DWSF	Deepwater Wind South Fork, LLC
EMF	electromagnetic field
EPA	U.S. Environmental Protection Agency
EPM	environmental protection measure
ESA	Endangered Species Act
HRG	high-resolution geophysical
Hz	hertz
kg	kilograms
kHz	kilohertz
km	kilometer
km^2	square kilometer
kV	kilovolts
LFC	low-frequency cetacean
m	meter
MFC	mid-frequency cetacean
mG	milligauss
mg/L	milligrams per liter
MLLW	mean lower low water
m/s	meters per second
mV/m	millivolts per meter
MW	megawatt
NARW	North Atlantic right whale
nm	nautical mile
NMFS	National Marine Fisheries Service
NMS	noise mitigation system

NYS	New York State
O&M	operations and maintenance
OBIS-SEAMAP	Ocean Biogeographic Information System Spatial Ecological Analysis of Megavertebrate Populations
OCS	Outer Continental Shelf
OSS	offshore substation
PAM	passive acoustic monitoring
PDE	Project Design Envelope
PSO	Protected Species Observer
PTS	permanent threshold shift
RI/MA	Rhode Island-Massachusetts
SAP	site assessment plan
SFEC	South Fork Export Cable
SFWF	South Fork Wind Farm
SPL	sound pressure level
SPUE	sightings per unit effort
TSS	total suspended sediment
TTS	temporary threshold shift
USACE	U.S. Army Corps of Engineers
USC	United States Code
USCG	U.S. Coast Guard
USFWS	U.S. Fish and Wildlife Service
VMS	Vessel Monitoring System
WDA	Wind Development Area
WEA	Wind Energy Area
WTG	wind turbine generators

INTRODUCTION

The Energy Policy Act of 2005, Public Law No. 109-58, added Section 8(p)(1)(C) to the Outer Continental Shelf Lands Act, which grants the Secretary of the Interior the authority to issue leases, easements, or rights-of-way on the Outer Continental Shelf (OCS) for the purpose of renewable energy development (43 United States Code [USC] 1337(p)(1)(C)). The Secretary delegated this authority to the former Minerals Management Service, now the Bureau of Ocean Energy Management (BOEM). On April 22, 2009, BOEM (formerly the Bureau of Ocean Energy Management, Regulation, and Enforcement [BOEMRE]) promulgated final regulations implementing this authority at 30 Code of Federal Regulations (CFR) 585.

Additional agencies may coordinate with BOEM on issuance of permits related to the Proposed Action. These may include an air permit from the U.S. Environmental Protection Agency (EPA), and a Section 404 permit from the U.S. Army Corps of Engineers (USACE). Additional consultation may occur under Section 106 of the National Historic Preservation Act, as well as additional tribal consultation. In addition, the applicant is coordinating with the National Marine Fisheries Service (NMFS) and has applied for issuance of an Incidental Harassment Authorization (IHA) under the Marine Mammal Protection Act (MMPA).

This document is a biological assessment (BA) of impacts to endangered and threatened species listed under the Endangered Species Act (ESA) from the proposed construction, operation, and decommissioning of a commercial wind energy facility on the OCS offshore of New York and Rhode Island (the Project). This BA has been prepared in support of formal consultation with the NMFS pursuant to Section 7 of the ESA (50 CFR 402.14).

Deepwater Wind South Fork, LLC (DWSF or the Applicant), has submitted the draft construction and operations plan (COP) for the South Fork Wind Farm (SFWF) and South Fork Export Cable (SFEC) to BOEM for review and approval. Consistent with the requirements of 30 CFR 585.620 to 585.638, COP submittal occurs after BOEM grants a lease for the Proposed Action and the Applicant completes all studies and surveys defined in their site assessment plan (SAP). BOEM's renewable energy development process is described in the following section. The Applicant is working with BOEM to address additional information needs to finalize the COP. This BA is based on the best available information at the time of its preparation.

The SFWF includes up to 15 wind turbine generators (WTGs or turbines) with a nameplate capacity of 6 megawatts (MW) to 12 MW per turbine, an offshore substation (OSS), and a submarine transmission cable network connecting the WTGs (inter-array cables) to the OSS, all of which would be located in BOEM Renewable Energy Lease Area OCS-A 0517 (Lease Area), located within the Rhode Island-Massachusetts Wind Energy Area (RI/MA WEA). The Lease Area is located in federal waters of the OCS approximately 19 miles (30.6 kilometers [km], 16.6 nautical miles [nm]) southeast of Block Island, Rhode Island, and 35 miles (56.3 km, 30.4 nm) east of Montauk Point, New York. The SFWF also includes an operations and maintenance (O&M) facility that would be located onshore at a commercial port facility at Montauk in East Hampton, New York.

The SFEC is an alternating current (AC) electric cable that would connect the SFWF to the mainland electric grid in East Hampton, New York. The SFEC includes both offshore and onshore segments. Offshore, the SFEC would be located in federal waters (SFEC-OCS) and New York State territorial waters (SFEC-NYS) and would be buried to a target depth of 4 to 6 feet below the seabed. The onshore underground segment of the export cable (SFEC-Onshore) would be located in East Hampton, New York. The SFEC-NYS would be connected to the SFEC-Onshore via a sea-to-shore transition where the offshore and onshore cables would be spliced together. The SFEC includes a new interconnection facility to link the SFEC to the Long Island Power Authority electric transmission and distribution system. The interconnection facility would be located in the town of East Hampton, New York.

Action Area

The Proposed Action’s action area includes upland and coastal nearshore habitats on eastern Long Island and adjacent NYS waters, and ocean habitats in the RI/MA WEA on the OCS offshore of New York, Rhode Island, and Massachusetts. The SFWF and SFEC area and cable routes are shown in Figures 1 and 2. Although most activities would occur on the lease and along the proposed cable routes, vessels would travel locally between ports and the wind farm site. Some vessels used during construction may come from the Gulf of Mexico, Canada, or Europe. Currently most industry-specific vessels are located in Europe.

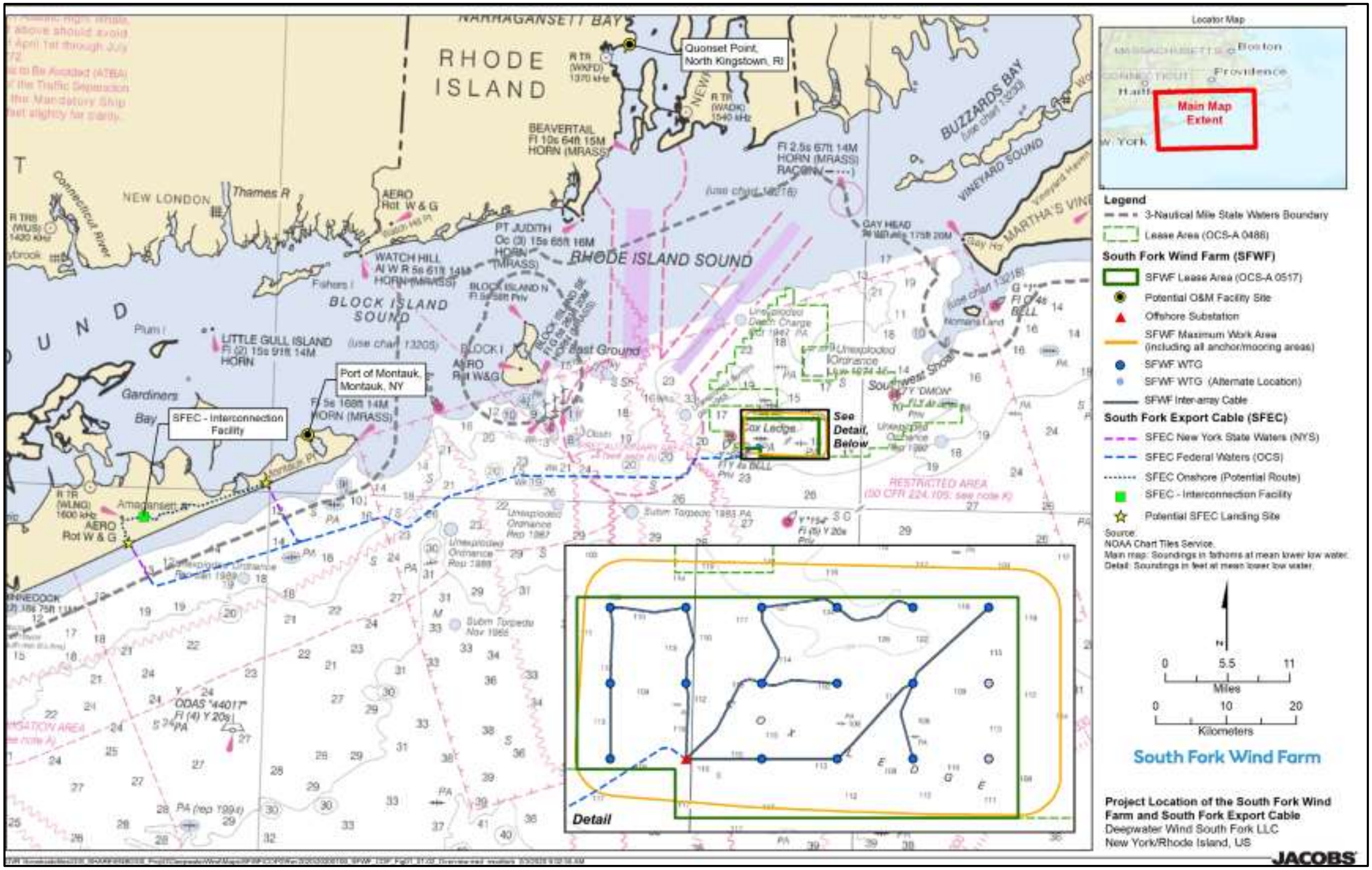

Figure 1. The South Fork Wind Farm proposed turbine locations, inter-array cables, and export cable route locations.

Under ESA Section 7 consultation regulations, the *action area* under the ESA refers to the area affected by the Proposed Action (50 CFR 402.02) and also includes all consequences to listed species or critical habitat that are caused by the Proposed Action, including actions that would occur outside the immediate area involved in the action (see 50 CFR 402.17). The immediate Project area includes the 5 × 4–nm wind farm footprint within the Lease Area and all inter-array cable routes and transmission cable right-of-way from the OSS to shore. In addition to the immediate Project footprint, the O&M facility, modifications at the Port of Montauk, and vessel transits are considered as part of the action area. Additionally, the size of the action area includes noise, electromagnetic field (EMF), water quality, benthic impacts, vessel and survey operations, and other impacts associated with the Proposed Action that have the potential for consequences that may affect listed species or critical habitat.

Underwater noise associated with construction-related pile driving is the most geographically extensive temporary noise effect resulting from the construction of the wind farm itself (see Tables 15–17 in the Effects of the Proposed Action section for details).

Potential vessel routes from port locations in the Gulf of Mexico, Canada, and Europe are part of the action area since these vessel routes would not occur but for the Proposed Action and are reasonably certain to occur. Although specific ports have not been identified where equipment and components may originate, vessel transits from ports in the regions may occur as a result of the Project. The following port towns may be used for fabrication, assembly, deployment, or decommissioning activities for the SFWF: Montauk, New York; Providence, Rhode Island: New Kingstown, Rhode Island; New Bedford, Massachusetts; New London, Connecticut; Paulsboro, New Jersey; Baltimore Maryland and/ or Norfolk, Virginia. In addition, the following port towns may be used as a base for crew transfers, cargo logistics or storage: New Bedford, Massachusetts; New London, Connecticut; Montauk, New York; Hamptons Bay, New York; Greenport, New York; New Kingstown, Rhode Island; New Shoreham, Rhode Island; and/ or Point Judith, Rhode Island. The action area would include any vessel routes between these port locations and the SFWF and cable route areas. The transport of some components and vessels purposed for the Project may possibly originate from the Gulf of Mexico, Europe, or other ports outside the immediate Project area (see Table 6 in the Proposed Action section for the total number of trips outside the RI/MA WEA). Whether ports in these regions would be used or not would not be known until additional details are available when contracts are in place. Until such a time additional details are available, potential routes from Europe, Canada, are the Gulf of Mexico are considered part of the Proposed Action to evaluate the potential effects should these ports be used. The number of ports under consideration does not increase the number of vessel trips that are likely to occur but may affect the location of the transits and the length of the transit.

Renewable Energy Process

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, defined below. Phases 1 through 3 have already been completed for the SFWF and SFEC; the Proposed Action addressed in this consultation represents phase 4 for the development:

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 state’s task forces; public information meetings; and input from the states, Native American tribes, and other stakeholders.
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. Approval of a 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 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. Approval of a COP (Proposed Action). 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 (30 CFR 585.620 to 585.638). BOEM approval of a COP is a precondition to the construction of any wind energy facility on the OCS (30 CFR 585.628). As with a SAP, BOEM may approve, approve with modification, or disapprove a lessee's COP (30 CFR 585.628). This phase is the focus of the Proposed Action including the SFWF and SFEC.

The regulations also require that a lessee provide the results of surveys with its SAP or COP, including a shallow hazards survey (30 CFR 585.626 (a)(1)), geological survey (30 CFR 585.616(a)(2)), geotechnical survey (30 CFR 585.626(a)(4)), and an archaeological resource survey (30 CFR 585.626(a)(5)). BOEM refers to these surveys as "site characterization" activities. Although BOEM does not issue permits or approvals for these site characterization activities, it will not consider approving a lessee's SAP or COP if the required survey information is not included. Guidelines for Providing Geological and Geophysical, Hazards, and Archaeological Information Pursuant to 30 CFR Part 585 (BOEM 2015).

The Proposed Action addresses phase 4 of the renewable energy process. The Applicant has completed site characterization activities and has developed a COP in accordance with BOEM regulations. BOEM is consulting on the proposed approval of the COP for the SFWF and SFEC as well as other permits and approvals from other agencies that are associated with the approval of the COP. BOEM is the lead federal agency for purposes of Section 7 consultation; the other action agencies include the Bureau of Safety and Environmental Enforcement (BSEE), the USACE, the EPA, the U.S. Coast Guard (USCG), and the NMFS Office of Protected Resources (OPR). This BA considers effects of the Proposed Action on ESA-listed whales, sea turtles, fish, and designated critical habitat that occur in the action area.

Regulatory Authorities

The Energy Policy Act of 2005 (Public Law 109-58) added Outer Continental Shelf Lands Act. The new section authorized the Secretary of Interior to issue leases, easements, and rights-of-way in the OCS for renewable energy development, including wind energy. The Secretary delegated this authority to the former Minerals Management Service, and later to BOEM. Final regulations implementing this authority (30 CFR 585) were promulgated on April 22, 2009. These regulations prescribe BOEM's responsibility for determining whether to approve, approve with modifications, or disapprove South Fork's COP. South Fork filed their COP with BOEM on June 29, 2018. An updated COP was submitted on May 24, 2019, and again on February 13, 2020.

BSEE's mission is to enforce safety, environmental, and conservation compliance with any associated legal and regulatory requirements during Project construction and future operations. BSEE will be in charge of the review of facility design and fabrication and installation reports, oversee inspections/enforcement actions as appropriate, oversee closeout verification efforts, oversee facility removal inspections/monitoring, and oversee bottom clearance confirmation.

USACE regulates work that is authorized or permitted through Section 10 of the Rivers and Harbors Act of 1899 and Section 404 of the Clean Water Act, which would include the construction of up to 15 offshore WTGs, scour protection around the base of the WTGs, one OSS, inter-array cables connecting the WTGS to the OSS, and one offshore export cables. The cable route(s) would originate from the OSS and would connect to the electric grid at East Hampton, New York.

The "OCS Air Regulations," found at 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; EPA issues OCS Air Permits. DWSF has submitted to EPA Region 1 an application requesting a Clean Air Act permit under Section 328 of the Clean Air Act for the construction and operation of an offshore windfarm, including export cables, on the OCS with the potential to generate up to 180 MW of electricity (the windfarm).

The EPA may also issue a National Pollutant Discharge Elimination System (NPDES) General Permit for construction activities under the Clean Water Act. The EPA uses general permits issued under Section 402 of the Clean Water Act (33 USC 1342 et seq.) to authorize routine discharges by multiple dischargers. Coverage for discharges under a general permit is granted to applicants after they submit a notice of intent (NOI) to discharge. Once the NOI is submitted and any review period specified under the construction general permit has closed, the Applicant is authorized to discharge under the terms of the general permit.

The USCG administers the permits for private aids to navigation (PATON) located on structures positioned in or near navigable waters of the United States. PATONS and federal aids to navigation (ATONS), including radar transponders, lights, sound signals, buoys, and lighthouses, are located throughout the Project area. USCG approval of additional PATONs during construction of the WTGs, OSS, and along the offshore export cable corridor may be required. These aids serve as a visual reference to support safe maritime navigation. South Fork would establish marine coordination to control vessel movements throughout the wind farm as required. Federal regulations governing PATON are found within 33 CFR 66 and address the basic requirements and responsibilities.

The Marine Mammal Protection Act of 1972 (MMPA) as amended and its implementing regulations (50 CFR 216) allow, upon request, the incidental take of small numbers of marine mammals by United States 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 OPR received a request from South Fork for an IHA to take marine mammals incidental to construction of an offshore wind energy project in the RI/MA WEA and adjacent NYS waters. The application was deemed adequate and complete on September 15, 2020. A notice of the proposed IHA is scheduled to be published in the Federal Register on February 8, 2021, according to the current schedule published on the FAST-41 Permitting Dashboard.

Design Envelope

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(C)). 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, to evaluate a design envelope approach for the environmental review of COPs (U.S. Department of Energy and U.S. Department of the Interior 2016:Action 2.1.3). A PDE approach is a permitting approach that allows a proponent the option to submit a reasonable range of design parameters within its permit application, allows a permitting agency to then analyze the maximum impacts that could occur from the range of design parameters, and may result in the approval of a Proposed Action that is constructed within that range. As the PDE relates to the National Environmental Policy Act, the PDE covers the range of alternatives being considered in the environmental impact statement in preparation for this Proposed Action. 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 and approval of the COP.

Endangered Species Act Section 7 Consultation History

BOEM completed an environmental assessment and biological assessment on the issuance of leases for wind resource data collection on the Outer Continental Shelf Offshore within the RI/MA WEA and the MA WEA in 2013 and on associated site characterization and site assessment activities that could occur on those leases, including the Lease Area. The RI/MA WEA comprises 13 whole and 29 partial lease blocks (see the Lease Area in Figure 1). On April 10, 2013, NMFS issued a programmatic biological opinion for commercial wind lease issuance and site assessment activities on the Atlantic OCS in Massachusetts, Rhode Island, New York and New Jersey WEAs. Proposed Action. Formal consultation was requested on concurrent with the transmittal of this BA to NMFS.

PROPOSED ACTION

The Proposed Action addressed in this BA covers the construction, O&M, and decommissioning of the SFWF and SFEC. The two major construction and operations components, the SFWF and the SFEC, are described in this section. Decommissioning and site clearance surveys are anticipated at the end of the Project life. There would be a maximum of 16 monopiles driven for SFWF. This would include up to 15 monopiles for the WTGs with a nameplate capacity of 6 to 12 MW per turbine and one monopile for an OSS. In addition to pile driving, submarine cables would be installed between the WTGs (inter-array cables) and to shore (export cable). The SFWF would be located within federal waters on the OCS specifically in the Lease Area. The Lease Area was previously part of BOEM OCS-A-0486, and in March 2020, the Lease Area was divided into two areas, one of which was assigned as OCS-A-0517 for SFWF. The lease is subject to all terms and conditions of the original lease. The Lease Area is approximately 30.6 km (19 miles, 16.6 nm) southeast of Block Island, Rhode Island, and 56.3 km (35 miles, 30.4 nm) east of Montauk Point, New York.

The SFEC is an AC electric cable that would connect the SFWF to the existing mainland electric grid in East Hampton, New York. The SFEC includes both offshore and onshore segments. Offshore, the SFEC would be located in federal waters (SFEC-OCS) and NYS territorial waters (SFEC-NYS), and would be buried to a target depth of 1.2 to 1.8 meters (m) (4 to 6 feet) below the seabed. Onshore, the terrestrial underground segment of the export cable (SFEC-Onshore) would be located in East Hampton, New York. The SFEC-NYS would be connected to the SFEC-Onshore via the sea-to-shore transition where the offshore and onshore cables would be spliced together. The SFEC would also include a new interconnection facility where the SFEC would interconnect with the Long Island Power Authority electric transmission and distribution system in the town of East Hampton, New York.

The Applicant has elected to use a PDE approach for describing the Proposed Action consistent with BOEM policy. For the purpose of ESA consultation, BOEM assumes that the Applicant will select the design alternative resulting in the greatest potential impact on the environment. For example, the Applicant has indicated they will select a 6- to 12-MW WTG design for the Proposed Action. BOEM is therefore presenting the effects of the larger 12-MW design in ESA consultation because those WTGs would affect a larger overall area.

PDE parameters for the SFWF and SFEC are summarized in Table 3. Construction, operation, and decommissioning methods, and proposed environmental protection measures (EPMs), are described in the following sections.

Construction

SFWF and SFEC construction PDE parameters pertinent to this consultation are summarized in Table 3 and described in the following sections. CH2M (2018) estimated the number of construction vessels used to build the SFWF and SFEC, vessel operational days in federal and state waters, and number of supply trips to port during construction for the COP air emissions analysis. The values used in that analysis provide a reasonable estimate of vessel use during construction. Vessel types and operational parameters are summarized in Table 4 and described further in the COP (Deepwater Wind, LLC 2020; CH2M 2018). The operational duration and miles traveled in Table 4 are estimates based on construction details provided in the COP and assumed supply trips to and from Providence Harbor (CH2M 2018). Additionally, Tables 2, 4, and 6 provide the total number of trips that could originate from outside the immediate Project area during construction, operations, and decommissioning, respectively. An approximate construction schedule for Proposed Action elements pertinent to this consultation is provided in Table 5. The timing, intensity, and duration of specific impact-producing activities, such as pile driving, are described below and addressed in detail in the effects analysis.

High-resolution geophysical (HRG) surveys are required throughout construction. Survey activities would include multibeam depth sounding, seafloor imaging, and shallow and medium penetration sub-bottom profiling within the wind farm area and export cable route. An estimated 1,000 line km plus in-fill and re-surveys are anticipated to perform construction surveys of the inter-array cable and the export cable. Although the final survey plans would not be completed until construction contracting commences, HRG surveys are anticipated to operate during any month of the year for a maximum of 60 vessel days surveying, on average, 70 line km per day at 4 knots. Additional geotechnical surveys may occur for further sediment testing at specific WTG locations. The geotechnical surveys would include in situ testing, boring, and sampling at foundation locations. Although South Fork has completed all biological surveys required with submission of the COP, South Fork has committed to working with BOEM and NMFS to conduct additional biological surveys during construction and/ or monitoring periods post-construction.

Construction of upland Proposed Action components would include the interconnection facility for the SFEC and an onshore O&M facility where staff can prepare and mobilize for offshore maintenance activities, monitor the wind farm, and/or access storage space for spare parts and other equipment to support maintenance activities. The facility would be located in a port in Montauk, New York, or at Quonset Point, Rhode Island, and would be used during the duration of the Project. The facility would include building(s) that provide office space (a maximum of up to approximately 1,000 square feet); equipment storage space (a maximum of up to approximately 6,600 square feet at Montauk and up to approximately 11,000 square feet at Quonset Point); a stationary crane for equipment transfer, up to three vessel berths for the crew transfer vessels (CTV); as well as accommodations for parking spaces, additional containers for equipment storage, and minor surface improvements.

Modifications at the Port of Montauk may also include reinforcement and/or rehabilitation of the quayside(s), as well as both initial and maintenance dredging to support the CTVs. These modifications are not anticipated to be required at Quonset Point.

South Fork Wind Farm

The SFWF would erect up to 15 WTGs within the action area (see Figure 1), separated by 1 nm spaced in a grid pattern. The selected WTGs would be at least 6 MW and could be as large as 12 MW. The WTGs would be mounted on 36-foot (11-m) monopile foundations driven up to 150 feet (46 m) into the seabed using an impact hammer deployed on a jack-up or heavy lift barge. The Applicant would employ a selection of sound attenuation technologies to achieve a minimum reduction of 10 decibels (dB) in peak noise levels. The SFWF OSS would be supported by a single 36-foot monopile similar to the WTG foundation design and installed using the same construction methods. The OSS would connect the SFWF inter-array cable network to the SFEC transmission line.

Construction of the SFWF would occur in 2023 and construction of the SFEC would occur between 2022 and 2023. During this period, activities would occur 24 hours a day to minimize the overall duration of activities and the associated period of potential impact on marine species. Although not anticipated, pile driving during nighttime hours could occur. Total number of construction days would depend on a number of factors, including environmental conditions, planning, construction and installation logistics. One pile would be installed without NMS, and 15 piles would be installed with NMS. DWSF would conduct sound field measurements for piles with and without NMS using the same methodologies for both. The general installation schedule is provided in Table 1; however, the installation schedule was approximated based on several factors, including the estimated timeframe in which permits are received, anticipated regulatory seasonal restrictions, environmental conditions, planning, and logistics. The installation schedule includes both pile driving and non-pile driving activities.

Table 1. Anticipated Installation Schedule for South Fork Wind Farm and South Fork Export Cable Containing Activities Addressed in the Application

Project Component	Milestone	Expected Duration
SFWF	Foundation installation	1 to 4 months
	HRG surveys	2 to 4 months
SFEC	Sea-to-shore installation (including horizontal directional drilling)	6 to 9 months
	HRG surveys	6 to 9 months

Impact pile-driving activities at SFWF would take place between May 1 and December 31. The current engineering design considers two pile driving scenarios. The standard scenario assumes that a pile is driven every other day such that 16 monopiles piles would be installed over a 30-day period. A more aggressive schedule is considered for the maximum design scenario in which six piles are driven in a week (7 days) such that the 16 piles are installed over a 20-day period.

Proposed mitigation includes no pile driving between January 1 and April 30 and enhanced mitigation measures during the month of May to minimize potential impacts to the North Atlantic right whale (NARW) (*Eubalaena glacialis*). This ultimately restricts the commencement of the wind farm installation process and sequence. To minimize time spent working offshore during hazardous weather conditions and to meet DWSF's contractual in-service obligation, all major components of the Project must be installed within a few months of monopile foundation installation.

It is necessary that the Proposed Action maintains the flexibility to install piles in May during which enhanced mitigation and monitoring measures are proposed to avoid and minimize potential effects to NARWs. The entire construction schedule comprises the installation of multiple Project components (e.g., onshore cable and interconnection, subsea export cable, inter-array cables, foundations, and wind turbine generators). Project component installation schedules can run concurrently, overlap, be sequential, and all have interdependencies. Monopile foundation installation is one of the first steps in the overall offshore construction sequence and is necessary prior to the installation of other components. The monopile foundations must be in place to provide connection points for the export cable and inter-array cables, as well as for the installation of the wind turbine generators and OSS. Therefore, it is crucial that monopile foundation installation occur early in the offshore work window to provide as much time as possible to complete the overall wind farm and export cable installation.

The WTGs would be linked to the SFEC by the inter-array cable, a 30-mile transmission cable connecting each of the WTGs to the OSS in sequence. The inter-array cables would have a transmission capacity of up to 66 kilovolts (kV). A deep-sea cable-laying vessel would be used to trench and bury the cable 4 to 6 feet below the seabed surface using standard marine construction techniques (Deepwater Wind, LLC 2020). This would involve the use of a jet plow, which is towed along the seabed and uses a water jet to liquify the substrate, thereby allowing burial of the cable without excavation. The jet plow methods for underwater cable installations are generally considered to be the most effective and least environmentally damaging when compared to traditional mechanical dredging and trenching operations. This method of laying and burying the cables simultaneously ensures the placement of the underwater cable system at the target burial depth with minimum bottom disturbance, with much of the fluidized sediment settling back into the trench. Jet plow equipment uses pressurized water (taken from existing waterbodies) from water pump systems onboard the cable vessel to fluidize sediment.

Cable burial produces a temporary disturbance footprint approximately 10 feet wide along the entire length of the buried cable segments. Where bed features like boulder fields or bedrock outcroppings prevent burial, the cable would be laid on the seabed surface and covered with a rock layer or concrete blanket.

Probable vessel classes used to construct the SFWF monopiles include heavy lift and derrick barge cranes, jack-up barges, material transport barges, a jack-up crane work vessel, and transport and anchor handling tugs (Table 4). A rock-dumping fallpipe vessel would be used to place scour protection, and a cable-laying vessel would be used to place the inter-array cable (see Table 4). A fuel-bunkering vessel would remain on station to refuel construction vessels and equipment. Transport vessels would be used to rotate construction crews to and from area ports. Small support vessels would be used for construction monitoring. Materials for construction may be transported from ports outside the Wind Development Area (WDA), including Europe, Canada, and the Gulf of Mexico. The number of trips from outside of the

United States, and which ports those trips could originate from, would not be fully known until contractors are selected and supply chains are established. However, this analysis assumes trips could originate from ports in Europe and/or Gulf of Mexico because many offshore wind components are currently manufactured there. Staging areas in Canada are also possible before transporting to the construction site. The values provided in Tables 2 and 4 are based on SFWF's current assumptions and are subject to change based on unforeseen circumstances. Currently, most industry-specific vessels are located in Europe but as the industry matures in the United States, fewer trips from Europe will be necessary. If WTG components are shipped to the WDA from one or more ports in Europe or other global suppliers, BOEM estimates this would consist of up to approximately eight vessel trips (see Table 4) based on the maximum design envelope installation of 15 WTGs.

The proposed onshore O&M facility would include office space for the operations center, warehouse and shop space for tools and replacement equipment, and a berthing area for maintenance vessels. The O&M facility would be constructed in Lake Montauk Harbor in Easthampton on Long Island, New York. The specific location has yet to be determined but it would likely be on a currently developed property on a dredged mooring area with appurtenant overwater facilities adjacent to the federally maintained navigation channel and boat basin.

Regular maintenance typically consists of routine inspections and preventative maintenance activities. These activities would require the use of crew transport vessels (CTVs) but would not require the use of other specialized vessels. Up to three CTVs would be used to service the wind farm during operations. The number of CTV trips to the WTGs and OSS during a typical year may vary but is estimated to be approximately 5 to 10 visits per year per WTG (225–500 trips per year) and approximately 20 to 30 visits per year to the OSS. Maintenance activities can occur year-round but would be more active during summer months when weather conditions are more favorable. Vessel usage would be limited to CTVs during routine O&M; however, if a major repair event occurs, the use of a specialized vessel may be required. SFWF plans that a major repair would require the use of one crane barge and two feeder barges. The exact type and number of any additional support vessels required would be dependent on the required repair and the contractor selected to perform the work. The use of specialized vessels (e.g., crane barge, feeder barge) would only be necessary for major repairs which are assumed to be a few times over the life of the wind farm.

Figure 2 depicts anticipated vessel routes to and from ports in the United States. The exact ship routes would ultimately depend on weather conditions and/or maritime traffic.

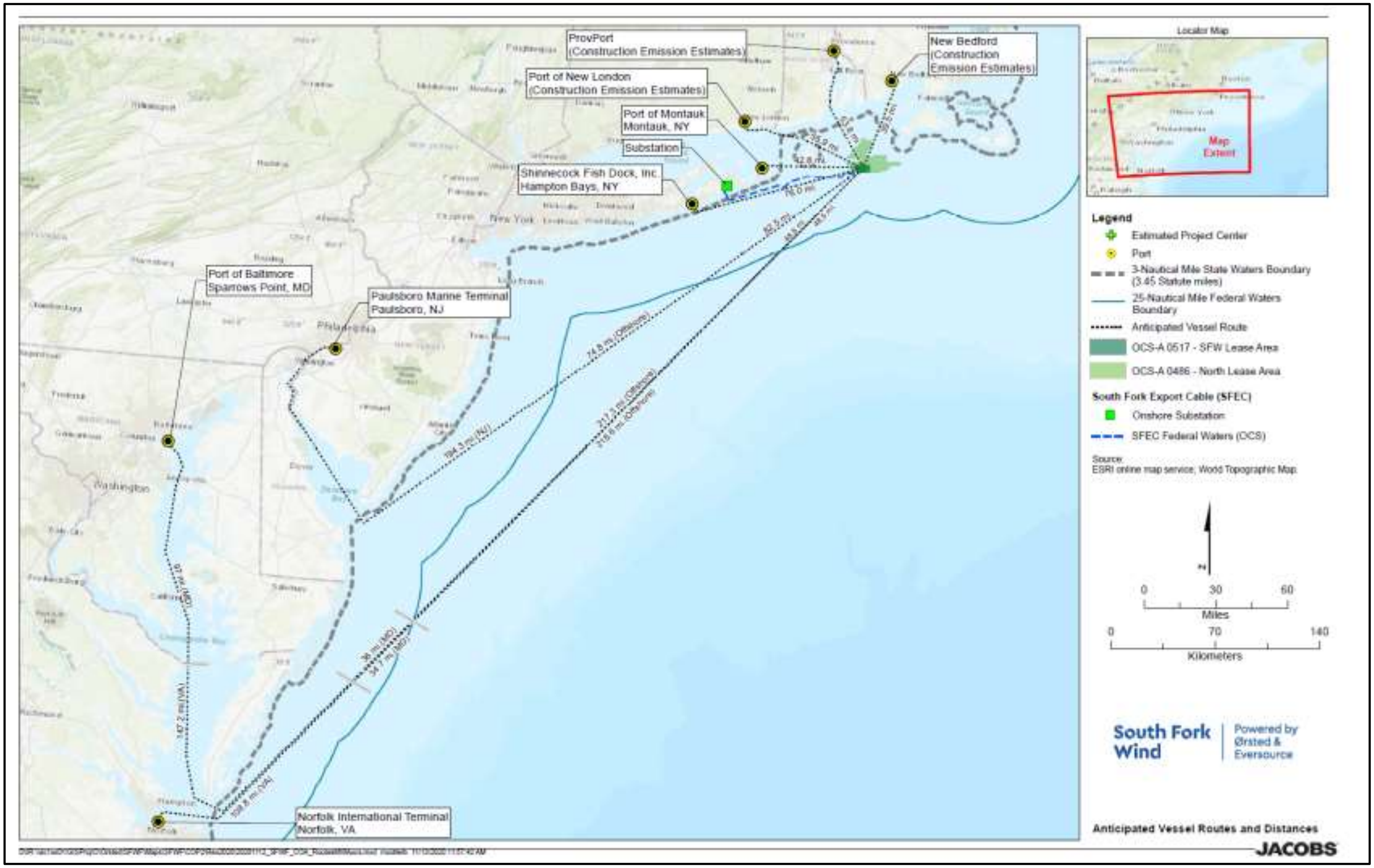

Figure 2. The anticipated vessel routes to and from ports in the United States (ports of origin for some components that may depart from foreign ports of Gulf of Mexico are not shown).

Table 2. Construction Phase Anticipated Number of Vessel Trips Outside of Rhode Island-Massachusetts

State/Origin	Potential Ports	Est. Max. Daily Trips	Est Max. Monthly Trips	Estimated Total	Likelihood of Use
New York	Montauk, Shinnecock Fish Dock	< 1	2	4	Unlikely
Connecticut	New London	< 1	6	50	Likely
Europe	Unknown at this time	N/A	2	6	Likely
Worldwide	Unknown at this time	N/A	1	2	Possible
Other United States ports	Paulsboro Marine Terminal (NJ), Port of Baltimore (MD), Sparrows Point (MD),Norfolk International Terminal (VA), Other Ports (Atlantic/Gulf of Mexico)	N/A	2	4	Unlikely
European ports	Unknown	N/A	Unknown	20	Possible

Table 3. Proposed Action Design Envelope Maximum Impacts

Proposed Action Element	Design Envelope Element	Effect Mechanism	Measurement Parameter	Maximum Impact
SFWF	Turbine selection/spacing	Installation disturbance area	WTG size	12 MW
			Number of turbines	15
			Rotor height above mean sea level	840 feet at peak 105 feet minimum
			Spacing	1 nm
			Array area	9 square miles
	Monopile foundation installation	Habitat alteration, physical disturbance	Number of monopiles	16
			Monopile diameter	36 feet/11 m
			Footprint area total (with scour protection)	15.6 acres
			Installation method	4,000 kilojoules impact hammer 2,500 strikes/day 80 days total for installation 2–4 hours per pile 30 days of pile driving
			Underwater noise (approximate)	227 peak sound pressure level in decibel (dB_{PEAK}) 216 root mean square decibel (dB_{RMS})
	Inter-array cable construction	Physical disturbance, turbidity	Total length	30 miles
			Installation method	Cable trenching/burial 4 to 6 feet depth
			Disturbance area	87 acres
			Long-term disturbance footprint	12.5 acres
			Activity duration	30 days
	Construction vessels	Physical disturbance, noise, and turbidity	Number of vessels	13
			Anchoring disturbance	821 acres
			Vessel noise	171 dB_{RMS} at 1 m

Proposed Action Element	**Design Envelope Element**	**Effect Mechanism**	**Measurement Parameter**	**Maximum Impact**
	Operation	Airborne disturbance area	Rotor swept area (per turbine/total)	424,173 square feet/turbine 6,362,595 square feet total
			Cut-in speed	Not available
		Operational EMF	Transmission voltage	34.5 kV
			Magnetic field	9.14 milligauss (mG) (buried cable) 65.13 mG (exposed cable)
			Induced electrical field	Buried cable: 1.4 millivolts/meter (mV/m) Exposed cable: 17 mV/m
		Vessel traffic	Number of vessels	2
			Anchoring disturbance	None
			Vessel noise	171 dB_{RMS} at 1 m
SFEC	Export cable construction	Installation disturbance area	Total length	OCS: 59.7 miles/93.2 km NYS: 3.5 miles/5.6 km
			Installation method	Cable trenching/burial 4 to 6 feet depth
			Disturbance area	OCS: 73 acres NYS: 4.4 acres
			Long-term disturbance footprint	21.1 acres (OCS) 1.3 acres (NYS)
			Activity duration	74 days
		Vessel traffic	Number of vessels	12
			Anchoring disturbance	None
			Vessel noise	171 dB_{RMS} at 1 m
	Sea-to-shore transition construction	Cofferdam installation	Cofferdam footprint	1,825 square feet
			Excavation/sidecast	825 cubic yards
			Sheet pile size	Z-Type typical
			Number of sheet piles	100
			Underwater noise	185 dB_{RMS} at 10 m
			Airborne noise	101 dBA at 50 feet
			Piles per day	100
			Total pile driving days	2
			Construction duration	12 weeks
			Substation disturbance footprint	18 acres
	Operation	Operational EMF	Transmission voltage	138 kV
			EMF generation – ocean	76.62
			Induced electrical field – ocean	17 mV/m
		Vessel traffic	Number of vessels	None

Source: Denes et al. (2020b).

Table 4. Estimated Proposed Action Vessel Use Parameters during South Fork Wind Farm and South Fork Export Cable Construction

Construction Element	Vessel Type	No. of Each Type of Vessel	Avg. Speed of Vessel (knots)	Estimated Work Duration (days)			Supply Trips to Port (1-way)	Estimated Number of Miles Traveled
				Federal Waters	New York State Waters	Other State Waters		
SFWF installation	Floating/jack-up crane barge	1	10	75	0	0	4	200
	Towing tug	2	11	45	0	0	15	750
	Material barge	2	4	30	0	50	5	250
	Anchor handling tug	1	11	45	0	0	30	1,500
	Rock dumping vessel	1	6.5	30	0	50	10	500
	Crew transport vessel	2	23	25	0	25	15	750
	Support vessel/inflatable	1	23	45	5	15	25	1,250
	Feeder barge: Monco 335	2	4	45	0	0	15	750
	Bunkering vessel	1	11	9	1	0	8	400
SFEC and inter-array cable	Transportation barge	1	4	0	0	60	0	0
	Fuel bunkering vessel	1	11	25	5	0	6	300
	Towing tug	2	11	20	0	0	8	400
	Material barge	1	4	20	0	60	8	400
	Anchor handling tug	1	11	20	0	0	8	400
	Cable-laying vessel	1	12.4	60	10	0	6	300
	Work vessel	1	10	45	0	0	30	1,500
	Work vessel support tug	1	11	45	0	0	30	1,500
	Crew transport vessel	2	23	60	0	60	30	1,500
	Support vessel/inflatable	1	23	30	15	15	20	1,000
Total		**25**	**N/A**	**674**	**36**	**335**	**273**	**13,650**

Source: CH2M (2018).

Table 5. Approximate South Fork Wind Farm and South Fork Export Cable Construction Schedule

Proposed Action Element	Construction Milestone	Activity Duration	Anticipated Timeframe
SFWF	Monopile foundation installation	4 months	May to December 2023 2023
	Inter-array cable installation	4 months	2023
	WTG installation	2 months	2023
	OSS installation	1 month	2023
	SFWF O&M facility	9 to 12 months	2021 to 2022
SFEC	Onshore interconnection facility	6 to 9 months	September 2021 to May 2022
	Sea-to-shore transition	6 to 9 months	September 2021 to May 2022
	Offshore cable installation	2 months	2023
	Onshore cable installation	9 to 12 months	September 2021 to May 2022

South Fork Export Cable

The SFEC would have portions in federal waters (SFEC-OCS), state waters (SFEC-NYS), and onshore (SFEC-onshore). The export cable would have a transmission capacity of up to 260 kV. The PDE lengths for the SFEC-OCS and SFEC-NYS segments total 57.9 and 3.5 miles, respectively, for a potential total length of 61.4 miles. The marine segments would be constructed using standard marine construction techniques (Deepwater Wind, LLC 2020) and buried to a target depth of 4 to 6 feet using the same trenching methods and construction vessels described above for the inter-array cable. Where burial is not possible, the cable would be laid on the bed surface and covered by a rock layer or concrete blanket placed by a rock-dumping fallpipe vessel. The effect analysis in this consultation considers the maximum potential length of each SFEC segment and a trench width of approximately 10 feet.

The SFEC-NYS and SFEC-Onshore components would be connected at a sea-to-shore transition point approximately 1,750 feet offshore from mean lower low water (MLLW). A horizontal directional drill would be used to tunnel approximately 65 feet below the beach and 20 to 35 feet below the seabed to the transition point. The horizontal directional drill may be installed with or without a temporary cofferdam, which would be either a sheet piled structure or a gravity cell structure placed on the sea floor using ballast weight. The cofferdam, if required, would be installed between October 1 and May 31. The sheet pile cofferdam would be placed around the transition point using a crane and vibratory hammer on a barge. Overall construction of the cofferdam is expected to take 1 to 3 days with vibratory pile driving of the sheet piles occurring for approximately 18 hours within the installation period window. Removal of the cofferdam would be done using a vibratory extractor and would be expected to also require 18 hours for sheet pile removal. No bubble curtain would be used for the cofferdam installation due to the short time period and operational considerations in shallow water. Removal of the cofferdam using a vibratory extractor is expected to be acoustically comparable to installation activities. No NMS would be used during vibratory pile driving. The cofferdam would be dewatered and the overlying substrates excavated and sidecast to expose the cable tunnel. The sea-to-shore transition cable would be threaded through the tunnel to the transition point and connected to the SFEC-NYS. The connected segments would then be sealed and reburied with native seabed sediments, and the cofferdam would be dismantled and removed (Deepwater Wind, LLC 2020).

SFEC-Onshore construction would include installation of buried utility vaults and monitoring equipment at the onshoring site, and excavation of an underground duct bank along the entire cable route. The duct bank would be constructed entirely within public rights-of-way and an existing rail corridor. The specific configuration of the duct bank is not yet determined; however, the ducts would be placed within a 4 × 8–foot trench along the onshore route. The duct bank would be constructed by clearing existing road or sidewalk surfaces where necessary, excavating a trench, laying the cable and concrete armoring, and then reburying. Road surfaces, sidewalks, or railroad prism would be replaced. Disturbed ground would be revegetated with suitable species where appropriate. SFEC-Onshore segment construction and operation would not result in effects on the marine environment and is therefore not considered further in this document.

Operation

SFWF and SFEC operational PDE parameters pertinent to this consultation are described below. The information presented in this section was obtained from the Volume I Section 3 of the COP (Deepwater Wind, LLC 2020).

South Fork Wind Farm Repair and Maintenance

The PDE for the SFWF includes up to 15 WTGs with a capacity of up to 12 MW. The number of turbines would not increase if the Applicant elects to use a lower capacity model. The 12-MW turbines would stand 472 feet above mean sea level at hub height, with three 358-foot rotors. The rotor-swept area would extend from 105 feet to a total height of 840 feet above mean sea level.

The SFWF would be remotely monitored and operated from an onshore facility. The Applicant does not expect the SFEC to require planned maintenance but would maintain a stockpile of transmission cable for emergency repairs as needed. SFWF WTGs would be regularly inspected and maintained by service technicians delivered by a dedicated crew transport vessel from a nearby port. Should unplanned maintenance (e.g., WTG replacement) be required, support vessels may travel directly to the SFWF from locations that would be determined based on the type of maintenance that is required and vessel availability. These vessels may originate from the Gulf of Mexico, Atlantic Coast, Europe, or other worldwide ports. Table 6 represents anticipated vessel traffic from outside of RI/MA during the O&M phase.

Table 6. Operations and Maintenance Phase Anticipated Trips Outside of Rhode Island-Massachusetts

State Origin	Potential Ports	Est. Max. Daily Trips	Est. Max. Monthly Trips	Estimated Total (30 years)	Likelihood of Use
New York	Montauk, Shinnecock Fish Dock	< 1	7	2,500	Likely
Connecticut	New London	N/A	< 1	50	Possible
Europe	Unknown at this time	N/A	< 1	30	Likely
Worldwide	Unknown at this time	N/A	< 1	1	Unlikely
Other United States ports	Paulsboro Marine Terminal (NJ), Port of Baltimore (MD), Sparrows Point (MD), Norfolk International Terminal (VA), other ports (Atlantic/Gulf of Mexico)	N/A	< 1	30	Unlikely

South Fork Export Cable

The SFEC would operate at a maximum transmission voltage of 132 kV. The SFEC would generate an induced EMF and heat while carrying current. These effects are addressed in the effects analysis. Like the

SFWF, the SFEC marine segments would be remotely monitored from an onshore facility. The Applicant does not expect the SFEC to require planned maintenance but would maintain a stockpile of equipment and materials for emergency repairs as needed in the unlikely event of mechanical damage to the transmission cable (e.g., by a ship anchor). Should unplanned maintenance or repairs be required, support vessels could travel directly to the site from any global port as determined by the availability of vessels with appropriate capabilities. These would likely be marine service vessels similar in size to those used for construction and crew transport vessels.

Decommissioning and Site Clearance

The SFWF and SFEC would be decommissioned and removed when these facilities reach the end of their designed service life; approximately 25 to 30 years. The Applicant's COP (Deepwater Wind, LCC 2020) describes the proposed scenario for decommissioning and removal of the SFWF and SFEC at the end of facility service life. The same types of vessels used during construction would be employed for decommissioning. This process would emphasize the recovery of valuable materials for recycling. The WTGs would be removed and the monopiles cut off below the seabed and recovered to a barge for transport. A cable-laying vessel would be used to remove as much of the inter-array and SFEC transmission cables from the seabed as practicable to recover and recycle valuable metals. Cable segments that cannot be easily recovered would be left buried below the seabed or rock armoring. Table 7 represents anticipated vessel traffic from outside of RI/MA during the decommissioning phase.

Table 7. Decommissioning Phase Anticipated Trips Outside of Rhode Island-Massachusetts

State Origin	Potential Ports	Est. Max. Daily Trips	Est. Max. Monthly Trips	Estimated Total	Likelihood of Use
New York	Montauk, Shinnecock Fish Dock	< 1	5	15	Possible
Connecticut	New London	< 1	6	50	Likely
Europe	Unknown at this time	N/A	1	4	Likely
Worldwide	Unknown at this time	N/A	1	2	Possible
Other United States ports	Paulsboro Marine Terminal (NJ), Port of Baltimore (MD), Sparrows Point (MD), Norfolk International Terminal (VA), Other Ports (Atlantic/Gulf of Mexico)	N/A	2	4	Possible

In accordance with 30 CFR 585.905 through 585.912, BOEM requires permitted operators to decommission offshore energy facilities at the end of their design life and restore environment to baseline conditions to the extent practicable. As detailed in 30 CFR Part 585.902, the lessee must submit an application and receive approval from BOEM before commencing with the decommissioning process. Final approval of this application is a separate process from approval of the conceptual decommissioning methodology in the COP.

Decommissioning is intended to recover valuable recyclable materials, including steel piles, turbines and related control equipment, and the copper 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. Monopile WTG foundations must be removed by cutting at least 15 feet (4.6 m) below mudline (see 30 CFR 585.910(a)). BOEM assumes the WTG towers and foundations can be removed using non-explosive severing methods. The inter-array and SFEC transmission cables would be extracted to recover valuable metals. Cable segments that cannot be recovered would be cut and left buried. BOEM anticipated that site clearance of the sea bottom would be required following removal of the structure. Site clearance procedures are expected to include site scan sonar and visual surveys using remotely operated vehicle surveys. All vessel strike avoidance measures would be required for vessel operations associated with decommissioning and site clearance. Site clearance using high-resolution side scan sonar equipment would operate at frequencies above the hearing ranges of all listed species (greater than 180 kilohertz [kHz]).

Proposed Mitigation, Monitoring, and Reporting Measures

This section outlines the proposed mitigation, monitoring, and reporting conditions that are intended to minimize or avoid potential impacts to ESA-listed species. Marine mammal requirements resulting from the IHA, which has been applied for under the MMPA by Orsted for this Project, would also be required through the ESA consultation. Notably, the scope of the ESA consultation is broader and covers the life of the Project where the IHA is only issued for a duration of 1 year for construction 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 IHA. Mitigation measures committed to by the Applicant through the MMPA process will be included as conditions of the final IHA and will be requirements. A requirement to follow final IHA conditions that apply to ESA-listed whales will also be included as a condition in the final record of decision.

A full description of all proposed measures under the Proposed Action is in Table 8.

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Table 8. Proposed Mitigation, Monitoring, and Reporting Measures for Consultation with National Marine Fisheries Service under the Endangered Species Act

No.	Measure	Description	Project Phase	Expected Effects
1	Adaptive refinement of exclusion zones and monitoring protocols	Reduce unanticipated impacts on marine trust resources through near-term refinement of exclusion zones by refining pile-driving monitoring protocols based on monthly and/or annual monitoring results, in coordination with BOEM and NMFS. The sizes of exclusion zones and any modifications may increase zones based on required reporting.	Construction	This mitigation measure would ensure that exclusion zones are the appropriate size during pile driving.
2	Passive acoustic monitoring (PAM)	Use PAM buoys or autonomous PAM devices to record ambient noise and marine mammal species vocalizations in the Lease Area before, during, and immediately after construction (at least 2 years of operation) to monitor Project noise including vessel noise, pile driving, and WTG operation, and large whale detections in the WDA. Monitoring would also occur during the decommissioning phase. The total number of PAM stations and array configuration will depend on the size of the zone to be monitored, the amount of noise expected in the area, and the characteristics of the signals being monitored to accomplish both monitoring during constructions, and also meet post-construction monitoring needs. Results must be provided within 90 days of construction completion and again within 90 days of the 1-year and 2-year anniversary of collection. The underwater acoustic monitoring must follow standardized measurement and processing methods and visualization metrics developed by the Atlantic Deepwater Ecosystem Observatory Network (ADEON) for the U.S. Mid- and South Atlantic OCS (see https://adeon.unh.edu/). At least two buoys must be independently deployed within or bordering the Lease Area or one or more buoys must be deployed in coordination with other acoustic monitoring efforts in the RI and MA Lease Areas.	Construction, O&M, and decommissioning	This monitoring measure would not reduce the expected adverse effects on listed species, but the data gathered could be used to evaluate impacts and potentially lead to additional mitigation measures, if required (30 CFR 585.633(b)).
3	Periodic underwater surveys, reporting, and monofilament and other fishing gear cleanup around WTG foundations	Monitor impacts associated with charter and recreational gear lost from expected increases in fishing around WTG foundations. Surveys by remotely operated vehicles, divers, or other means will inform frequency and locations of debris removal to decrease ingestion by and entanglement of marine species. The results of the surveys will be reported to BOEM (renewable_reporting@boem.gov) by April 30 for the preceding calendar year in which the survey is performed. Reports will 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 will include daily survey reports that include the 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.	O&M	The removal of fishing gear would reduce the expected adverse effects on sea turtles by reducing the potential for habitat modification as well as hooking, entrapment, injury, and death from lost fishing gear, and decrease the potential for ingestion by marine species.
4	Noise mitigation systems during pile driving	Noise mitigation systems (NMS) are required during impact pile driving activities to reduce the sound pressure levels (SPLs) that are transmitted through the water by at least 10 dB below predicted levels. A primary NMS is required, and a secondary NMS is required as a backup or be deployed in addition to the primary NMS to achieve a noise reduction target of -10 dB.	Construction	The reduction in SPLs will reduce the area of effects to ESA-listed whales, sea turtles, Atlantic sturgeon, and the prey they feed upon.
5	Soft start for pile driving	SFWF must implement soft-start techniques for impact pile driving. The soft start must include an initial set of three strikes from the impact hammer at reduced energy, followed by a 1-minute waiting period. This process must be repeated a total of three times prior to initiation of pile driving. Soft start is required for any impact driving, including at the beginning of the day, and at any time following a cessation of impact pile driving of 30 minutes or longer.	Construction	The establishment of soft-start protocols would minimize the potential for adverse effects and warn animals of the pending pile driving activity in the area and allow them to leave before full hammer power is reached.
6	Pile-driving sound source verification plan	To ensure that the required -10 dB re 1 µPa noise attenuation is met, field verification during pile driving will be conducted. A Sound Source Verification Plan will be submitted to the USACE, BOEM at renewable_reporting@boem.gov, and NMFS at incidental.take@noaa.gov for review 90 days prior to the commencement of field activities for pile driving. Sound source verification must be carried out for the first monopile and first jacket foundation to be installed. Should larger diameter piles be installed, or greater hammer size or energy used, additional field measurements must be conducted. The plan must describe how SFWF will ensure that the location selected is representative of the rest of the piles of that type to be installed and, in the case that it is not, how additional sites will be selected for sound source verification or how the results from the first pile can be used to predict actual installation noise propagation for subsequent piles. The plan must describe how the effectiveness of the sound attenuation methodology will be evaluated based on the results. The plan must be sufficient to document sound propagation from the pile and distances to isopleths for potential injury and harassment. The measurements must be compared to the Level A and Level B harassment zones for marine mammals (and the injury and behavioral disturbance zones for sea turtles and Atlantic sturgeon).	Construction	This monitoring measure would not reduce effects but would ensure that the deployed noise reduction technologies are effective.
7	Pile-driving time-of-year restriction	No impact or vibratory pile-driving activities will occur from January 1 to April 30.	Construction	Time of year restrictions for pile-driving activities would minimize and avoid potentially adverse effects to ESA-listed species that are more likely to occur in the area during that time period.
8	Pile-driving weather and time restrictions	To minimize the effects of sun glare on visibility, no impact or vibratory pile driving may begin until at least 1 hour after (civil) sunrise to ensure effective visual monitoring can be accomplished in all directions. To minimize the potential for pile driving to continue after sunset when visibility will be impaired, no pile driving may begin within 1.5 hours of (civil) sunset. Pile driving must only commence when all exclusion zones are fully visible (i.e., are not obscured by darkness, rain, fog, etc.) for at least 30 minutes. If conditions (e.g., darkness, rain, fog, etc.) prevent the visual detection of marine mammals in the exclusion zones, construction activities must not be initiated until the full extent of all exclusion zones are fully visible. The lead Protected Species Observer (PSO) will determine when there is sufficient light to ensure effective visual monitoring in all directions. SFWF must develop and implement measures for enhanced monitoring in the event that poor visibility conditions unexpectedly arise and pile driving cannot be stopped due to safety or operational feasibility. SFWF must prepare and submit an Alternative Monitoring Plan to NMFS and BOEM for NMFS' review and approval at least 90 days prior to the planned start of pile driving. This plan may include deploying additional observers, alternative monitoring technologies (i.e., night vision, thermal, infrared), and/or PAM with the goal of ensuring the ability to effectively monitor all exclusion zones for all ESA-listed species in the event of unexpected poor visibility conditions.	Construction	Time of day, visibility and weather restrictions would ensure that exclusion zones are effectively monitored to minimize and avoid potentially adverse effects to ESA-listed species.
9	Pile-driving monitoring plan and PSO requirements	A final pile-driving monitoring plan must be submitted to BOEM and NMFS for review and approval a minimum of 90 days prior to the commencement of pile-driving activities. The plan must: Contain information on the visual and PAM components of the monitoring plan; Ensure that the full extent of the harassment distances from piles are monitored for marine mammals and sea turtles to ensure that all potential take is documented; Include the number of PSOs (and Native American[1] monitors, if on board), the platforms and/or vessels upon which they will be deployed, and contact information for the PSO provider(s); and Include measures for enhanced monitoring capabilities in the event that poor visibility conditions unexpectedly arise, and pile driving cannot be stopped. The plan may also include deploying additional PSOs, use of night vision goggles, or use of PAM with the goal of ensuring the ability to maintain all exclusion zones in the event of unexpected poor visibility conditions. A communication plan detailing the chain of command, mode of communication, and decision authority must be described. PSOs must be previously approved by NMFS to conduct mitigation and monitoring duties for pile-driving activity. An adequate number of PSOs must be used to adequately monitor the area of the exclusion zone. The size of the exclusion zone may vary with specific time-of-year requirements for NARWs and should be described in the plan.	Construction	This monitoring measure would not minimize adverse effects but would ensure the effectiveness of the required mitigation and monitoring measures for pile driving.

[1] BOEM is not requiring Native American monitors but BOEM encourages engagement and information sharing with Native American Tribes and participation in marine mammal monitoring programs.

No.	Measure	Description	Project Phase	Expected Effects
10	Pile-driving monitoring plan and PSO reporting requirements for sea turtles	A pile-driving monitoring plan must be submitted to BOEM and NMFS for review and approval a minimum of 90 days prior to the commencement of pile-driving activities. The plan must: Ensure that the full extent of the harassment distances (175 dB RMS) from piles are monitored for sea turtles to ensure that all potential take is documented; Include (1,640 feet [500 m]) exclusion zones and exclusion zone modification protocols and approvals required for modification; Include number of PSOs that will be used, the platforms and/or vessels upon which they will be deployed, and contact information for the PSO provider(s); and Include measures for enhanced monitoring capabilities in the event that poor visibility conditions unexpectedly arise, and pile driving cannot be stopped. The plan may also include deploying additional observers, use of night vision goggles with the goal of ensuring the ability to maintain all exclusion zones in the event of unexpected poor visibility conditions. A communication plan detailing the chain of command, mode of communication, and decision authority must be described. PSOs must be previously approved by NMFS to conduct mitigation and monitoring duties for pile-driving activity. A sufficient number of PSOs must be used to fully monitor the exclusion zone. Daily PSO forms including effort, survey, and sightings forms, must be submitted to BOEM at renewable_reporting@boem.gov monthly on the 15th day of each month for the previous calendar month of activities. Required data and reports may be archived, analyzed, published, and disseminated by BOEM.	Construction	The use of visual surveys prior to the initiation of daily pile-driving activities minimizes the potential for temporary adverse effects on sea turtles during pile driving. Monitoring and reporting can be used to evaluate impacts and potentially lead to additional mitigation measures, if required.
11	Pile-driving noise reporting and clearance zone adjustment	Before driving any additional piles following underwater noise measurements, SFWF must review the initial field measurement results and make any necessary adjustments to the sound attenuation system and/or the exclusion or monitoring zones as detailed below. If the initial field measurements indicate that the isopleths of concern are larger than those considered, in coordination with BOEM, NMFS, and USACE, SFWF must ensure that additional sound attenuation measures are put in place before additional piles are installed. Additionally, the exclusion and monitoring zones must be expanded to match the actual distances to the isopleths of concern. If the exclusion zones are expanded beyond 4,921.3 feet (1,500 m) for marine mammals, additional observers must be deployed on additional platforms, with each observer responsible for maintaining watch in no more than 180 degrees with a radius no greater than 0.93 miles (1.5 km). The exclusion zones established in the Proposed Action must be considered minimum exclusion zones and may not be reduced based on sound source verification results. SFWF must provide the initial results of the field measurements to NMFS, USACE, and BOEM as soon as they are available; NMFS, USACE, and BOEM will discuss these as soon as feasible with a target for that discussion of within two business days of receiving the results. BOEM and NMFS will provide direction to SFWF on whether any additional modifications to the sound attenuation system or changes to the exclusion or monitoring zones are required. BOEM must also discuss with NMFS the potential need for re-initiation of consultation if appropriate.	Construction	This monitoring measure would ensure that the deployed sound mitigation systems are effective.
12	Impact pile-driving exclusion zones (no-go zones) for sea turtles	To ensure that 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 1,640.4-foot (500-m) sea turtle exclusion zone for all impact pile-driving activities.	Construction	The use of PSO visual monitoring will reduce adverse effects to sea turtles by establishing exclusion zones that must be free of sea turtles before pile-driving activities commence.
13	Impact pile driving exclusion zones (no-go zones) for ESA-listed whales	To ensure that pile-driving operations are carried out in a way that minimizes the exposure of listed whales to noise that may result in injury or behavioral disturbance, PSOs will establish a 2,200-m exclusion zone for all impact pile-driving activities for all large whales, except NARWs. For NARWs or any unidentified large cetacean, PSOs will establish a 4,686-m exclusion zone.	Construction	The establishment and maintenance of marine mammal exclusion zones will reduce the potential for temporary adverse effects to ESA-listed whales.
14	Vibratory pile driving exclusion zone for ESA-listed whales	PSOs will establish a 1,500-m monitoring zone around all vibratory pile driving activities.	Construction	The establishment and maintenance of exclusion zones reduce the potential for temporary adverse effects to ESA-listed whales.
15	Protocol when ESA-listed whales or sea turtles are sighted during pre-pile driving exclusion	If a ESA-listed whale or sea turtle is observed entering or within the relevant exclusion zones prior to the initiation of pile-driving activity, pile-driving activity must be delayed (unless activities must proceed for human safety or installation feasibility) until: The animal is verified to have voluntarily left and is heading away from the exclusion area; or 30 minutes have elapsed without re-detection of the animal	Construction	The establishment and maintenance of exclusion zones will reduce adverse effects by limiting exposure to pile driving.
16	Enhanced time-of-year pile-driving shutdown and restart procedures for NARWs (May 1 to May 14 and November 1 to December 31)	Should a NARW be observed/detected within the exclusion zone, pile-driving activities must stop (unless activities must proceed for human safety or installation feasibility concerns) and may not resume until: The following day, or until a follow-up aerial or vessel-based survey is able to confirm all NARW(s) have departed a 6.2-mile (10-km) extended exclusion zone, as determined by the lead PSO after a full day of monitoring to confirm NARW(s) have left the 6.21-mile (10-km) exclusion zone (May 1 to 14); Confirmation that all NARW(s) have left the 6.21-mile (10-km) exclusion zone (November 1 to December 31); or Confirmation that all of NARW(s) have left the 0.62-mile (1-km) exclusion zone after 60 minutes of monitoring (May 15 to October 31).	Construction	The establishment of enhanced time-of-year requirements for NARWs will reduce impacts by limiting marine mammal exposure to pile driving.
17	Submittal of raw field data collection of observations of ESA listed species in the pile-driving exclusion zone	If an ESA-listed whale or sea turtle in the exclusion zone results in a shutdown or a power-down, it should be reported to BOEM within 24 hours at renewable_reporting@boem.gov. In addition, the raw data collected in the field, must be submitted by the PSO provider and include the daily form, 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 exclusion zone, time the pile driver was restarted or powered back up, and any photographs that may have been taken. This data report must be submitted to BOEM at renewable_reporting@boem.gov monthly on the 15th day of each month for the previous calendar month of activities.	Construction	The data gathered during these observations could be used to evaluate impacts and potentially lead to additional mitigation measures, if required (30 CFR 585.633(b)).

No.	Measure	Description	Project Phase	Expected Effects
18	PSO and reporting requirements for pile driving	PSOs must be previously approved by NMFS to conduct mitigation and monitoring duties for pile-driving activity. An sufficient number of PSOs must be used to fully monitor the exclusion zone. Daily PSO forms including electronic effort, survey, and sightings forms, must be submitted to BOEM at renewable_reporting@boem.gov monthly on the 15th day of each month for the previous calendar month of activities. Required data and reports may be archived, analyzed, published, and disseminated by BOEM. **Detection Information for Protected Species During Vessel Operations** Date (YYYY-MM-DD) Sighting ID (01, 02 or sequential sighting number for that day) (multiple sightings of same animal or group should use the same ID) Date and Time at first detection in UTC (YY-MM-DDT HH:MM) Time at last detection in UTC (YY-MM-DDT HH:MM) PSO Name(s) (Last, First) Effort (On=source on; Off = source off) Latitude (decimal degrees dd.ddddd), Longitude (decimal degrees dd.ddddd) Compass heading of vessel (degrees) Water depth (meters) Swell height (meters) Beaufort scale Precipitation Visibility (km) Cloud coverage (%) Glare Sightings including common name, scientific name, or family Certainty of identification Number of adults Number of juveniles Total number of animals Bearing to animal(s) when first detected (ship heading + clock face) Range from vessel (reticle distance in meters) Description (include features such as overall size; shape of head; color and pattern; size, shape, and position of dorsal fin; height, direction, and shape of blow, etc.) Detection narrative (note behavior, especially changes in relation to survey activity and distance from source vessel) Direction of travel / first approach (relative to vessel) Behaviors observed: Indicate behaviors and behavioral changes observed in sequential order (use behavioral codes) If any bow-riding behavior is observed, record total duration during detection (HH:MM) Initial heading of animal(s) (degrees) Final heading of animal(s) (degrees) Source activity at initial detection Source activity at final detection (on or off) Exclusion zone size during detection (meters) Was the animal inside the exclusion zone? Closest distance to vessel (reticle distance in meters) Time at closest approach (UTC HH:MM) Time animal entered exclusion zone (UTC HH:MM) Time animal left exclusion zone (UTC HH:MM) If observed/detected during ramp up / power up: First distance (reticle distance in meters). Closest distance (reticle distance in meters), Last distance (reticle distance in meters), Behavior at final detection Shut-down or power-down occurrences Detections with PAM **Monitoring Effort Information During Pile Driving Operations** Date Effort (ON=source on; OFF= source off) If visual, how many PSOs on watch at one time? PSOs (Last, First) Start time of observations End time of observations Duration of visual observation Wind Speed (knots), from direction Beaufort scale Swell (meters) Water depth (meters) Visibility (km) Glare severity Block name and number Location: Latitude and Longitude	Construction and O&M	This mitigation measure would be used to evaluate impacts and potentially lead to additional mitigation measures, if required (30 CFR 585.633(b)).
19	Injured/protected species reporting	Any potential takes, strikes, or dead/injured protected species regardless of the cause, should be reported immediately, but no later than 24 hours of the take, to NMFS Protected Resources Division, incidental.take@noaa.gov; NOAA Fisheries 24-hour Stranding Hotline number (866-755-6622); and BOEM at renewable_reporting@boem.gov. In the event that an injured or dead marine mammal or sea turtle is sighted, SFWF must report the incident to NMFS Protected Resources Division, incidental.take@noaa.gov; NOAA Fisheries 24-hour Stranding Hotline number (866-755-6622); and BOEM at renewable_reporting@boem.gov as soon as feasible, but no later than 24 hours from the sighting. The report must include the following information: (1) time, date, and location (latitude/longitude) of the first discovery (and updated location information if known and applicable); (2) species identification (if known) or description of the animal(s) involved; (3) condition of the animal(s) (including carcass condition if the animal is dead); (4) observed behaviors of the animal(s), if alive; (5) if available, photographs or video footage of the animal(s); and (6) general circumstances under which the animal was discovered. Staff responding to the hotline call will provide any instructions for handling or disposing of any injured or dead animals by individuals authorized to collect, possess, and transport sea turtles. In the event of a suspected or confirmed vessel strike of a sea turtle by any Project vessel, SFWF must report the incident to NMFS Protected Resources Division, incidental.take@noaa.gov; NOAA Fisheries 24-hour Stranding Hotline (866-755-6622); and BOEM at renewable_reporting@boem.gov as soon as feasible. The report must include the following information: (1) time, date, and location (latitude/longitude) of the incident; (2) species identification (if known) or description of the animal(s) involved; (c) vessel's speed during and leading up to the incident; (4) vessel's course/heading and what operations were being conducted (if applicable); (5) status of all sound sources in use; (6) description of avoidance measures/ requirements that were in place at the time of the strike and what additional measures were taken, if any, to avoid strike; (7) environmental conditions (e.g., wind speed and direction, Beaufort scale, cloud cover, visibility) immediately preceding the strike; (8) estimated size and length of animal that was struck; (9) description of the behavior of the animal immediately preceding and following the strike; (11) estimated fate of the animal (e.g., dead, injured but alive, injured and moving, blood or tissue observed in the water, status unknown, disappeared); and (12) to the extent practicable, photographs or video footage of the animal(s). In addition, any occurrence of dead non-ESA-listed fish of 10 or more individual fish within established exclusion and/or monitoring zones must also be reported to BOEM at renewable_reporting@boem.gov as soon as feasible.	Construction, O&M, and decommissioning	This monitoring measure would ensure monitoring of mitigation effectiveness and compliance. The data gathered could be used to evaluate impacts and potentially lead to additional mitigation measures, if required (30 CFR § 585.633(b)).
20	Automatic identification system (AIS) on Project construction and operations vessels, turbines, and ESPs	The USCG may require the installation of operational AIS on vessels associated with the construction and operation of the Project. AIS may also be required to mark the location of WTGs and the ESP. AIS may be required to monitor the number of vessels and traffic patterns for analysis and compliance with vessel speed requirements, and to make identification of infrastructure easier for non-Project vessels.	Construction, O&M, and decommissioning	The use of AIS would monitor the number of vessels and traffic patterns during the course of Project construction, O&M, and decommissioning as well as make the identification and avoidance of proposed-Project infrastructure easier; and ensure that proposed-Project vessels comply with speed restrictions.

No.	Measure	Description	Project Phase	Expected Effects
21	Marine debris awareness and elimination	Marine debris is defined by BSEE as any object or fragment of wood, metal, glass, rubber, plastic, cloth, paper, or any other manmade item or material that is lost or discarded in the marine environment. SFWF must ensure that vessel operators, employees, and contractors engaged in offshore activities pursuant to the COP are briefed on marine debris prevention. BOEM must ensure that SFWF employees and contractors receive training to understand and implement best practices to ensure that debris is not intentionally or accidentally discharged into coastal or marine environments. Training must occur for all employees and contract personnel on the proper storage and disposal practices at-sea to reduce the likelihood of accidental discharge of marine debris at all at-sea and dockside operations that can impact protected species through entanglement or incidental ingestion. Training must include the environmental and socioeconomic impacts associated with marine trash and debris, as well as their responsibilities for ensuring that trash and debris are not intentionally or accidentally discharged into coastal and marine environments. In the event that any materials unexpectedly enter the water, personnel must follow best practices to recover it if conditions are safe to do so, or notify the appropriate officials if conditions are unsafe. Briefing materials on marine debris awareness, prevention, and protected species are available at https://www.bsee.gov/debris	Construction and O&M	Training of crew and personnel would decrease the incidences of marine debris, which could decrease the potential for entanglement or ingestion of debris by listed species.
22	Exclusion zones (no-go zones) for NARWs	Reduce the potential for impacts to NARWs through the use of continuous PAM, and visual monitoring by PSOs during pile-driving activities following standard protocols and data collection requirements specified by BOEM. PSOs will establish the following exclusion zones for NARWs 60 minutes prior to pile-driving activities through 30 minutes post-completion of pile-driving activity: At all times of year that pile driving takes place, for purposes of monitoring the exclusion zone, any large whale sighted by a PSO within 3,281 feet (1,000 m [a NARW exclusion zone]) that cannot be identified to species must be treated as if it were a NARW. Additionally, a NARW observation at any distance from the pile must be treated as an observation within the exclusion zone and trigger any required delays or shutdowns in pile installation. From November 1 to December 31 and May 1 to May 14, establish a 6.21-mile (10-km) exclusion zone for NARWs (SFWF may have the option to use aerial or vessel-based surveys to clear the area from May 1 to May 14 at NMFS discretion). For any piles driven May 15 to May 31, the exclusion zone must be extended from 3,281 feet (1,000 m) to 6,562 feet (2 km) for monopiles and 5,249 feet (1,600 m) for jacket (i.e., half distance to Level B threshold) to minimize the extent of any take of NARWs. For any pile driving June 1 to October 31, establish a 5,249-foot (1-km) clearance zone for NARW with the exception as follows. Where the predicted Level B harassment zone will overlap with a DMA or Right Whale Slow Zone, the exclusion zone must be extended from 3,281 feet to 6,562 feet (1 to 2 km) for monopiles and 5,249 feet (1,600 m) for jacket piles (i.e., half distance to Level B threshold) to minimize the extent of any take of NARWs. For all pile-driving activity, SFWF must designate clearance zones with radial distances as follows: All other mysticete whales (including humpback, fin, sei, and minke whale): 1,649-foot (500-m) exclusion zone at all times; Monitoring must occur over the entire Level B distance to document impacts and any potential take.	Construction	The use of PAM and PSO visual monitoring to ensure that exclusion zones are free of NARWs before r pile-driving activities can commence, and to record any observations of NARW prior to commencement of pile-driving through 30 minutes post pile-driving.
23	NARW PAM monitoring	A PAM plan describing all equipment, procedures, and protocols will be prepared and submitted to BOEM and NMFS at least 90 days prior to initiation of pile-driving activities. The PAM system must be designed such that detection capability extends to 6.21 miles (10 km) from the pile-driving location. If the PAM operator has at least 75% confidence that a vocalization originated from a NARW within 6.21 miles (10 km) of the pile-driving location, the PAM operator must determine that a NARW has been detected. SFWF must continue to deploy the PAM system that is in place May 1- through May 31 and implement an extended PAM monitoring zone of 6.21 miles (10 km) around any pile to be driven with all detections of NARWs provided to the visual PSO to increase situational awareness and to be considered as pile driving is planned. At all times of year that pile driving takes place, any PAM detection of a NARW within the clearance/exclusion zone (May 1–May 14: radius 10,000 m; May 15—December 31: radius 6,000 m) surrounding a pile must be treated the same as a visual observation and trigger any required delays in pile installation. Between June 1 and October 31, if a DMA or Right Whale Slow Zone is designated that overlaps with a predicted Level B harassment zone from a pile to be installed, the PAM system in place during this period must be extended to the largest practicable detection zone to increase situational awareness of the visual PSOs and for purposes of planning pile installation. At all times of year any visual or PAM detection in the seasonal exclusion zones must trigger any required delays or shutdowns in pile installation.	Construction	The use of PAM and PSOs better ensures that exclusion zones are free of NARWs before pile-driving activities commence, and monitors any NARWs in the area during and after pile driving.
24	Protocols for shutdown and power-down when ESA-listed species are sighted during pile driving	If an ESA-listed species is observed entering or within the relevant exclusion zone during pile driving, the hammer must be shut down (unless activities must proceed for human safety or installation feasibility) until: The animal is verified to have voluntarily left and is heading away from the exclusion area; or 30 minutes have elapsed without re-detection for ESA-listed whales; or 60 minutes have elapsed without re-detection for sea turtles; or Enhanced time-of-year NARW protocols are followed. If shutdown is called for but SFWF 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.	Construction	The establishment of shutdown and power-down protocols may decrease the potential for impacts to ESA-listed species.

No.	Measure	Description	Project Phase	Expected Effects
25	Weekly and monthly pile-driving reports	During the pile driving/construction period, SFWF must compile and submit weekly reports that document start and stop of all pile driving daily, the start and stop of associated observation periods by the PSOs, details on the deployment of PSOs, and a record of all observations of marine mammals and sea turtles. These weekly reports must be submitted by the POS providers to BOEM at renewable_reporting@boem.gov and NMFS at incidental.take@noaa.gov and can consist of raw data. Weekly reports are due on Wednesday for the previous week (Sunday–Saturday). Required data and reports 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 effort during construction activities, and every week thereafter until the final reporting period. Weekly reports are due on Wednesday for the previous week. Any editing, review, and quality assurance checks must only be completed by the PSO provider prior to submission. Monthly summary reports must be submitted by the SFWF in coordination with PSO providers as needed. Qualified PSOs must monitor watch and exclusion zones when using geological and geophysical equipment that may adversely affect protected species. **<u>Reporting Instructions</u>** SFWF must submit a monthly summary report of construction activities on the 15th of each month including summaries of pile driving, vessel operations (including port departures, number, type of vessel, and route), protected species sightings, vessel strike-avoidance measures taken, and any shutdowns or potential takes that may have occurred. SFWF must require PSO providers to submit PSO data in Excel format every 7 days. Data must be collected in accordance with standard reporting forms, software tools, or electronic data forms approved by BOEM for the particular activity. Forms must be filled out for each vessel with PSOs aboard. Do not use NA for unfilled cells; leave them empty. Submit report in Word and Excel formats (do not submit a pdf). All dates must be entered as YYYY-MM-DD. All times must be entered in 24 Hour UTC as HH:MM. Please note that new entries should be made on the Effort form each time a pile segment or weather conditions change, and at least once an hour as a minimum. Both weekly and monthly reports must be submitted to BOEM at renewable_reporting@boem.gov. Always check forms for completeness and resolve any problems before submittal. Name the file: Lease#_ ProjectName_PSOData_YearMonthDay to YearMonthDay.xls The following Project, Operations, Detection, and Effort data fields are required to be reported in Excel format as weekly reports during construction. These data may be generated through software applications or otherwise recorded electronically by PSOs. Applications developed to record PSO data are encouraged as long as the data fields listed below can be recorded and exported to Excel. Alternatively, BOEM has developed an Excel spreadsheet with all the necessary data fields that is available upon request. **<u>Project Information for Pile Driving</u>** Project Name Lease Number State Coastal Zones PSO Contractor(s) Vessel Name(s) Reporting dates Sound sources including hammer type(s) and power levels used Visual monitoring equipment used (e.g., bionics, magnification, IR cameras, etc.) Distance finding method used PSO names and training Observation height above sea surface **<u>Operations Information for Pile Driving</u>** Date Hammer type (make and model) Greatest hammer power used for each pile Pile identifier and pile number for the day (e.g., pile 2 of 3 for the day) Pile diameters Pile length Pile locations (latitude and longitude) Time pre-exclusion visual monitoring began in UTC (HH:MM) Time pre-exclusion monitoring ended in UTC (HH:MM) Time pre-exclusion PAM monitoring began in UTC (HH:MM) Time PAM monitoring ended in UTC (HH:MM) Duration of pre-exclusion and PAM visual monitoring Time power up/ramp up began Time equipment full power was reached Duration of power up/ramp up Time pile driving began (hammer on) Time pile-driving activity ended (hammer off) Duration of activity Did a shutdown/powerdown occur? Time shutdown was called for (UTC) Time equipment was shutdown (UTC) Record any habitat or prey observations Record any marine debris sighted **<u>Detection Information for Protected Species</u>** Date (YYYY-MM-DD) Sighting ID (V01, V02, or sequential sighting number for that day) (multiple sightings of same animal or group should use the same ID) Date and time at first detection in UTC (YY-MM-DDT HH:MM) Time at last detection in UTC (YY-MM-DDT HH:MM) PSO name(s) (Last, First) Effort (On=source on; Off = source off) Latitude (decimal degrees dd.ddddd), longitude (decimal degrees dd.ddddd) Compass heading of vessel (degrees) Water depth (meters) Swell height (meters) Beaufort scale Precipitation Visibility (km) Cloud coverage (%) Glare Sightings including common name, scientific name, or family Certainty of identification Number of adults Number of juveniles Total number of animals Bearing to animal(s) when first detected (ship heading + clock face) Range from vessel (reticle distance in meters) Description (include features such as overall size; shape of head; color and pattern; size, shape, and position of dorsal fin; height, direction, and shape of blow, etc.) Detection narrative (note behavior, especially changes in relation to survey activity and distance from source vessel) Direction of travel/first approach (relative to vessel) Behaviors observed: indicate behaviors and behavioral changes observed in sequential order (use behavioral codes) If any bow-riding behavior observed, record total duration during detection (HH:MM) Initial heading of animal(s) (degrees) Final heading of animal(s) (degrees) Source activity at initial detection Source activity at final detection (on or off) Exclusion zone size during detection (meters) Was the animal inside the exclusion zone? Closest distance to vessel (reticle distance in meters) Time at closest approach (UTC HH:MM) Time animal entered exclusion zone (UTC HH:MM) Time animal left exclusion zone (UTC HH:MM) If observed/detected during ramp up/power up: first distance (reticle distance in meters), closest distance (reticle distance in meters), last distance (reticle distance in meters), behavior at final detection Shut-down or power-down occurrences Detections with PAM	Construction	This monitoring measure would gather data that could be used to evaluate impacts and potentially lead to additional mitigation measures, if required (30 CFR § 585.633(b)).

No.	Measure	Description	Project Phase	Expected Effects
		Monitoring Effort Information for Pile Driving Date Effort (ON=source on; OFF= source off) If visual, how many PSOs on watch at one time? PSOs (Last, First) Start time of observations End time of observations Duration of visual observation Wind speed (knots), from direction Swell (meters) Water depth (meters) Visibility (km) Glare severity Block name and number Location: Latitude and Longitude		
26	PSO/PAM training requirements	PSOs must be provided by a third-party provider. PSOs must have no tasks other than to conduct observational effort, collect and report data, and communicate with and instruct relevant vessel crew with regard to the presence of ESA-listed species and mitigation requirements (including brief alerts regarding maritime hazards). PSOs and/or PAM operators must have completed a commercial PSO training program for the Atlantic with an overall examination score of 80% or greater (Baker et. al 2013). Training certificates for individual PSOs must be provided to BOEM upon request. PSOs and PAM operators must be approved by NMFS prior to the start of a survey. Application requirements to become a NMFS-approved PSO for construction activities can be found at https://www.fisheries.noaa.gov/new-england-mid-atlantic/careers-and-opportunities/protected-species-observers or for geological and geophysical surveys by sending an inquiry to nmfs.psoreview@noaa.gov. SFWF must provide to BOEM upon request, documentation of NMFS approval for individual PSOs. For the following activities, lead PSOs must be deployed as part of the minimum number of PSOs as follows: at least one lead PSO must be on duty at any given time as the lead PSO or PSO monitoring coordinator during pile driving; at least one lead PSO must be present on each HRG survey vessel; PSOs on transit vessels must be trained, but do not need to be authorized as a lead PSO. Any required lead PSOs must have prior approval from NMFS to be a lead or unconditionally approved PSO. PSOs on duty must be clearly listed on daily data logs for each shift. A sufficient number of PSOs, consistent a with the final IHA, must be deployed to: record data in real time, effectively monitor the affected area for the Project with visual surveys in all directions around a pile, PAM, and continuous monitoring of sighted NARWs in the area during enhanced seasonal monitoring requirements. PSOs must not be on watch for more than 4 consecutive hours, with at least a 2-hour break after a 4-hour watch. PSOs must not work for more than 12 hours in any 24-hour period unless an alternative schedule is approved by BOEM. Visual monitoring must occur from the most appropriate vantage point on the associated operational platforms that allows for 360-degree visual coverage around a vessel. SFWF must ensure that suitable equipment is available to PSOs including binoculars, range-finding equipment, a digital camera, and electronic data recording devices (e.g., a tablet) to adequately monitor the distance of the watch and exclusion zones, to determine the distance to protected species during surveys, to record sightings and verify species identification, and to record data. Observations must be conducted while free from distractions and in a consistent, systematic, and diligent manner.	Construction, O&M, and decommissioning	The mitigation measure would ensure that PSOs have appropriate training for monitoring ESA-listed species during vessel operations and pile driving.
27	Vessel crew training requirements	Project-specific training must be conducted for all vessel crew prior to the start of in-water construction activities. Confirmation of the training and understanding of the requirements must be documented on a training course log sheet. The log sheets must be provided to BOEM upon request. All vessel crewmembers must be briefed in the identification of sea turtles and marine mammals and in regulations and best practices for avoiding vessel collisions. Reference materials must be available aboard all Project vessels for identification of sea turtles and marine mammals. The expectation and process for reporting of sea turtles and marine mammals (including live, entangled, and dead individuals) must be clearly communicated and posted in highly visible locations aboard all Project vessels, so that there is an expectation for reporting to the designated vessel contact (such as the lookout or the vessel captain), as well as a communication channel and process for crew members to do so.	Construction, O&M, and decommissioning	Training of crew and personnel would minimize the potential for adverse effects to ESA-listed species by increasing the effectiveness of mitigation and monitoring measures through educational and training materials and avoid vessel interactions with ESA-listed species.
28	Daily pre-construction surveys	PAM and visual surveys must be conducted each day before pile driving begins to establish the numbers, surface presence, behavior, and travel directions of protected species in the area. These surveys will follow standard protocols and data collection specified by BOEM. In addition to standard daily surveys, SFWF must include an enhanced survey plan for November–December and May 1–May 31 to minimize risk of exposure of NARWs to pile-driving noise that includes daily pre-construction surveys.	Construction	The use of PAM and visual surveys prior to the initiation of daily pile-driving activities would minimize the potential for adverse effects on marine mammals and sea turtles by identifying individuals that may be adversely affected by acoustic impacts from pile driving.
29	Vessel strike avoidance of ESA-listed whales (non-geophysical survey vessels)	Vessel operators and crews must maintain a vigilant watch for all marine mammals and slow down, stop their vessel, or alter course, as appropriate and regardless of vessel size, to avoid striking any marine mammal as long as it is safe to do so. Vessel speeds must be reduced to 10 knots or less when mother/calf pairs, pods, or large assemblages of cetaceans are observed within the path of the vessel. Large whales: Avoidance measures must occur for listed whales or any other unidentified whale sighted within a 180-degree direction of the forward path of the vessel (90 degrees port to 90 degrees starboard) at a distance of 1,640 feet (500 m) or less from a survey vessel. Trained crew or PSOs must notify the vessel captain of any whale within 1,640 feet (500 m) of vessel within this area. The vessel captain must immediately implement strike-avoidance procedures to maintain a separation distance of 1,640 feet (500 m) from all ESA-listed whales, changing vessel direction or reducing vessel speed to allow the animal to travel away from the vessel. Any time a listed whale is within 656 feet (200 m) of an underway vessel, a full stop is required if safety permits. 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 take appropriate action to avoid the animal.	Construction, O&M, and decommissioning	The mitigation and monitoring measure would minimize the potential for adverse effects on marine mammals resulting from vessel interactions.
30	Vessel strike avoidance of sea turtles (non-geophysical survey vessels)	During all phases of the Project, vessel operators and crews must maintain a vigilant watch for sea turtles and slow down, stop their vessel, or alter course, as appropriate and regardless of vessel size, to avoid striking any sea turtles as long as it is safe to do so. All vessels must maintain a minimum separation distance of 328 feet (100 m) from sea turtles whenever possible. Trained crew lookouts must monitor seaturtlesightings.org daily and prior to each trip to note and report any observations of sea turtles in the vicinity of the planned transit to all vessel operators/captains and lookouts on duty that day. If a sea turtle is sighted within 328 feet (100 m) of the operating vessels' forward path, the vessel operator must slow down to 4 knots (unless unsafe to do so) and may resume normal vessel operations once the vessel has passed the sea turtle. If a sea turtle is sighted within 164 feet (50 m) of the forward path of the operating vessel, the vessel operator must shift to neutral when safe to do so and then proceed away from the turtle at a speed of 4 knots or less until there is a separation distance of at least 328 feet (100 m) at which time normal vessel operations may be resumed. Between June 1 and November 30, vessels must avoid transiting through areas of visible jellyfish aggregations or floating vegetation 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.	Construction, O&M, and decommissioning	This mitigation measure would minimize the potential for ship strikes of sea turtles.
31	Vessel observer requirements	SFWF must ensure that vessel operators and crew maintain a vigilant watch for marine mammals, giant manta rays or sea turtles by slowing down, altering course, or stopping the vessel to avoid striking marine mammals or sea turtles. Vessel personnel must be provided an Atlantic reference guide that includes and helps identify marine mammals and sea turtles that may be encountered in the Project area and material regarding NARW SMAs, sightings information, and reporting. When not on active watch duty, members of the monitoring team must consult NMFS' NARW reporting systems for the presence of NARWs in the Project area. A visual observer aboard the vessel must monitor a vessel strike-avoidance zone around the vessel. All vessels transiting to and from the WDA and traveling over 10 knots must have a visual observer on duty at all times. SFWF must also have a trained lookout on all vessels during all phases of the Project between June 1 and November 30 to observe for sea turtles and communicate with the captain to take required avoidance measures as soon as possible if one is sighted. If a vessel is carrying a visual observer for the purposes of maintaining watch for NARWs, an additional lookout is not required and this visual observer must maintain watch for whales, giant manta rays and sea turtles. If the trained lookout is a vessel crewmember, this must be their designated role and primary responsibility while the vessel is transiting. Any designated crew observers should be trained in the identification of sea turtles and in regulations and best practices for avoiding vessel strikes. The trained lookout must monitor seaturtlesightings.org prior to each trip and report any observations of sea turtles in the vicinity of the planned transit to all vessel operators/captains and lookouts on duty that day.	Construction, O&M, and decommissioning	The mitigation and monitoring measure would minimize the potential for adverse effects on ESA-listed species.

No.	Measure	Description	Project Phase	Expected Effects
32	Vessel speed requirements November 1 through May 14	From November 1 through May 14, all vessels must travel at 10 knots or less when transiting to/from or within the WDA, except within Nantucket Sound (unless an active DMA is in place) and except crew transfer vessels as described below. From November 1 through May 14, crew transfer vessels may travel at more than 10 knots if there is at least one visual observer on duty at all times aboard the vessel to visually monitor for large whales, and real-time PAM is conducted. If a NARW is detected via visual observation or PAM within or approaching the transit route, all crew transfer vessels must travel at 10 knots or less for the remainder of that day.	Construction, O&M, and decommissioning	The mitigation and monitoring measure would minimize the potential for ship strikes.
33	Vessel speed requirements in DMAs	All vessels, regardless of length, must travel at 10 knots or less within any NMFS-designated DMA, with the exception of crew transfer vessels as described above. Crew transfer vessels traveling within any designated DMA must travel at 10 knots or less, unless NARWs are confirmed to be clear of the transit route and WDA for two consecutive days, as confirmed by either vessel-based surveys conducted during daylight hours and PAM, or by an aerial survey conducted once the lead aerial observer determines adequate visibility. If confirmed clear by one of these measures, vessels transiting within a DMA must employ at least two visual observers on duty to monitor for NARWs. If a NARW is observed within or approaching the transit route, vessels must operate at 10 knots or less until clearance of the transit route for two consecutive days is confirmed by the procedures described above.	Construction, O&M, and decommissioning	The mitigation and monitoring measure would minimize the potential for ship strikes.
34	Vessel speed requirements in SMAs	All vessels greater than or equal to 65 feet (19.8 m) in overall length must comply with the 10-knot speed restriction in any SMA (see https://www.fisheries.noaa.gov/national/endangered-species-conservation/reducing-ship-strikes-north-atlantic-right-whales).	Construction, O&M, and decommissioning	This mitigation and monitoring measure minimizes the potential for impacts to NARWs from vessel interactions.
35	Reporting of all NARW sightings	If a NARW is observed at any time by PSOs or personnel on any Project vessels, during any Project-related activity or during vessel transit, SFWF must immediately report the sighting information to NMFS and BOEM (the time, location, and number of animals) to the NOAA Fisheries 24-hour Stranding Hotline number (866-755-6622), the USCG via channel 16, and through the WhaleAlert app (http://www.whalealert.org/).	Construction, O&M, and decommissioning	This monitoring measure would ensure that NMFS, BOEM, and other vessels in the area are aware of the NARW's presence.
36	Vessel communication of threatened and endangered species sightings	Whenever multiple Project vessels are operating, any visual observations of listed species (marine mammals and sea turtles) must be communicated to a PSO and/or vessel captains associated with other Project vessels.	Construction, O&M, and decommissioning	Communication between Project vessels would further reduce potentially adverse effects by alerting vessels to the presence of marine mammals in the area, potentially minimizing the vessel interactions.
37	Marine mammal and sea turtle geophysical survey exclusion zones	Measures will be required under the Data Collection Programmatic Consultation upon completion of the ongoing consultation with NMFS	Construction, O&M, and decommissioning	The use of PSO visual monitoring for establishing that exclusion zones are free of marine mammals or sea turtles before geophysical surveys commence decreases the potential for behavioral take.
38	Geophysical survey off-effort PSO monitoring	Measures will be required under the Data Collection Programmatic Consultation upon completion of the ongoing consultation with NMFS	Construction, O&M, and decommissioning	This monitoring measure would be used to evaluate impacts and potentially lead to additional mitigation measures, if required.
39	Geophysical survey vessel whale strike-avoidance and equipment shutdown protocols	Measures will be required under the Data Collection Programmatic Consultation upon completion of the ongoing consultation with NMFS	Construction, O&M, and decommissioning	The mitigation and monitoring measure would minimize or avoid potentially adverse effects on ESA-listed species. The shutdown and power-down protocols would avoid impacts by ensuring that no listed species are adversely affected.
40	Geophysical survey clearance of exclusion zone and restart protocols following shutdowns	Measures will be required under the Data Collection Programmatic Consultation upon completion of the ongoing consultation with NMFS	Construction, O&M, and decommissioning	The use of PSO visual monitoring and exclusion zones would avoid adverse effects to ESA-listed whales.
41	Sea turtle avoidance and exclusion zones during geophysical surveys	Measures will be required under the Data Collection Programmatic Consultation upon completion of the ongoing consultation with NMFS	Construction, O&M, and decommissioning	The use of PSO visual monitoring would further reduce the expected temporary impacts on sea turtles by establishing exclusion zones that must be free of sea turtles for HRG survey activities to commence.
42	Geophysical survey exclusion zone, power-up, and re-start procedures	Measures will be required under the Data Collection Programmatic Consultation upon completion of the ongoing consultation with NMFS.	Construction, O&M, and decommissioning	The use of PSO visual monitoring would further reduce the expected temporary impacts on sea turtles by establishing exclusion zones that must be free of sea turtles for HRG survey activities to commence or resume.

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SPECIES AND CRITICAL HABITAT CONSIDERED, BUT DISCOUNTED FROM FURTHER ANALYSIS

Several species and critical habitats have the potential to only be affected by interactions with vessels outside of the SFWF, SFEC, and supporting ports in the WDA. Primarily, these interactions may be associated with transits of vessels and the transport of components during construction of the Project. In other cases, the occurrence of the species is so unlikely or rare that the potential for adverse effects to occur is discountable. As described in the Proposed Action section above, the action area includes potential transits from the Gulf of Mexico, Canada, or Europe. Potential interactions with blue whale, giant manta ray, hawksbill sea turtle, Northeast Atlantic DPS of loggerhead sea turtle, Atlantic salmon, and ocean whitetip shark are not expected in the SFWF and SFEC footprint, but may be affected by transits during construction of the Proposed Action from these distant port locations. Likewise, transits may occur through critical habitat designated for NARWs, but are not expected to adversely affect the essential features of that critical habitat.

Blue Whale – Endangered

In the North Atlantic Ocean, the range of blue whales (*Balaenoptera musculus*) extends from the subtropics to the Greenland Sea. As described in Hayes et al. 2020 (the most recent stock assessment report), blue whales have been detected and tracked acoustically in much of the North Atlantic with most of the acoustic detections around the Grand Banks area of Newfoundland and west of the British Isles. Photo-identification in eastern Canadian waters indicates that blue whales from the St. Lawrence, Newfoundland; Nova Scotia; New England; and Greenland all belong to the same stock, whereas blue whales photographed off Iceland and the Azores appear to be part of a separate population (Cetacean and Turtle Assessment Program [CETAP] 1982; Sears and Calambokidis 2002; Sears and Larsen 2002; Wenzel et al. 1988). In the action area, blue whales are most frequently sighted in the waters off eastern Canada, with most of the recent records in the Gulf of St. Lawrence (Hayes et al. 2020), which is outside the action area. The largest concentrations of blue whales are found in the lower St. Lawrence Estuary (Comtois et al. 2010; LeSage et al. 2007), which is outside of the action area. Blue whales do not regularly occur within the United States Exclusive Economic Zone and typically occur further offshore in areas with depths of 100 m or more (Waring et al. 2010).

Migration patterns for blue whales in the eastern North Atlantic Ocean are poorly understood. However, blue whales have been documented in winter months off Mauritania in northwest Africa (Baines and Reichelt 2014); in the Azores, where their arrival is linked to secondary production generated by the North Atlantic spring phytoplankton bloom (Visser et al. 2011); and traveling through deepwater areas near the shelf break west of the British Isles (Charif and Clark 2009). Blue whale calls have been detected in winter on hydrophones along the mid-Atlantic ridge south of the Azores (Nieukirk et al. 2004).

Blue whales have not been documented in the WEA. The rarity of observations in this area is consistent with the conclusion in Hayes et al. (2020) that the blue whale is best considered as an occasional visitor in United States Atlantic Exclusive Economic Zone waters and would be rare along the vessel transit route from East Coast vessel transit routes. Given the rarity of blue whales in this area, it is extremely unlikely that any blue whales would co-occur in the area with these vessel trips. Similarly, given the rarity of blue whales along any transit routes from Europe, co-occurrence with any of those trips is not reasonably expected. However, even if co-occurrence did occur, any effects are extremely unlikely. This is because the slow transit speed (not exceeding 10 knots) and the use of a dedicated lookout would allow vessel operators to avoid interactions with any whales along the vessel transit route. Traveling at speeds not exceeding 10 knots provides a significant reduction in risk of vessel strike because it provides for greater opportunity for a whale to evade the vessel and also ensures that vessels are operating at such a speed that they can make evasive maneuvers in time to avoid a collision (Jensen and Silber 2004; Laist et al. 2001; Vanderlaan and Taggart 2007). Therefore, based on the unexpected co-occurrence of blue whales and Project vessels as well as the speed reductions and use of a lookout, any effects to blue whales are extremely unlikely to occur.

Available sightings data are available at: http://seamap.env.duke.edu/species/180528.

Shortnose Sturgeon – Endangered

The shortnose sturgeon (*Acipenser brevirostrum*) is anadromous, spawning and growing in freshwater and foraging in both the estuary of its natal river and shallow marine habitats close to the estuary (Bain 1997; Fernandes et al. 2010). Although the Hudson and Connecticut Rivers support known populations of shortnose sturgeon, the estuarine habitats associated with these systems are separated from the WDA by a minimum of 30 miles of marine habitat. This open water creates an effective movement barrier. Within the Gulf of Maine, some portion of the shortnose sturgeon population natal to the Kennebec River make nearshore coastal migrations north to at least the Penobscot River and south to the Merrimack River. Despite intense study of shortnose sturgeon in New England, there is only one recorded occurrence of a shortnose sturgeon making a coastal migration outside of the Gulf of Maine. In autumn 2014, a shortnose sturgeon was caught in the Merrimack River (Massachusetts) carrying a tag that was implanted in the Connecticut River in 2001 (personal communication Kieffer and Savoy 2014, as cited in NMFS 2020a). The genetic differentiation between the Connecticut and Merrimack River sturgeon populations is a reflection of the rarity of these types of movements. Based on this information, shortnose sturgeon are not likely to occur in the action area, and effects of the Proposed Action on the shortnose sturgeon are not anticipated.

Giant Manta Ray – Threatened

The giant manta ray (*Manta birostris*) inhabits temperate, tropical, and subtropical waters worldwide, between 35°N and 35°S latitudes. In the western Atlantic Ocean, this includes South Carolina south to Brazil and Bermuda. Sighting records of giant manta rays in the Mid-Atlantic and New England are rare, but individuals have been observed as far north as New Jersey (Miller and Klimovich 2017) and Block Island (Gudger 1922). Giant manta rays travel long distances during seasonal migrations and may be found in upwelling waters at the shelf break south of the Project area. There is a small chance that the Project vessels traveling between the WDA and Europe could traverse some upwelling areas. The species could also be encountered in the action area associated with Project vessels moving between the WDA and ports in the Gulf of Mexico or the Southeast United States Based on the low potential for occurrence in the WDA and the probable low encounter rate by vessels in the action area, effects of the Proposed Action on the giant manta ray are not anticipated. Additionally, the general mitigation and monitoring measures proposed for all Project vessels to watch out for and avoid all giant manta rays would further reduce the chance of any adverse effects to the species from the Proposed Action.

Hawksbill Sea Turtle – Endangered

The hawksbill sea turtle (*Eretmochelys imbricata*) is found in tropical and subtropical regions of the Atlantic, Pacific, and Indian Oceans and is uncommon in the waters of the continental United States. Hawksbills are typically associated with coral reefs, such as those found in the Caribbean and Central America. Occurrence north of Florida is rare (NMFS and USFWS 1993). Hawksbill sea turtles are a circumtropical species that in the Atlantic Ocean is most commonly observed between 30°N and 30°S latitude. In the western Atlantic, hawksbills are typically found in the Caribbean Sea and the Gulf of Mexico off the coasts of Florida and Texas. No nesting beaches exist in the action area. United States records of species occurrence near the proposed wind farm area are rare. The Ocean Biogeographic Information System Spatial Ecological Analysis of Megavertebrate Populations (OBIS-SEAMAP) database (Halpin et al. 2009) contains only six hawksbill turtle observation records for the region. These include two verified stranding records, both from Martha's Vineyard in 1911, and four shipboard survey records at and seaward of the shelf break to the east and south of the action area. The species was not observed in recent, multi-year aerial and shipboard surveys of the RI/MA WEA (Kraus et al. 2016). These historical observations are considered extralimital because the action area and surroundings are outside the normal range of hawksbill turtles. The small number of individuals observed were most likely stunned by exposure to unusual cold-water events and transported northward into the region by the Gulf Stream. These occurrences are not representative of normal behaviors or distribution, and the affected individuals would likely die without human intervention. Extralimital occurrence is not representative of even occasional individual or population behavior, meaning effectively that this species does not occur in the action area and would not be affected by the construction, O&M, and decommissioning of the Proposed Action. However, hawksbills could be present in vessel transit area originating or returning to ports in the Gulf of Mexico. Despite their potential presence, their densities are expected to be low in the deeper water transit routes expected to be taken by vessels. In addition to encounters between vessels and hawksbills is expected to be discountable due to the mitigation and monitoring measures proposed for all Project vessels to watch out for and avoid all sea turtles. The Proposed Action is not expected to result in any adverse effects to hawksbill sea turtles.

Gulf of Maine Distinct Population Segment of Atlantic Salmon – Endangered

The only remaining populations of the Gulf of Maine DPS of the Atlantic salmon (*Salmo salar*) are in Maine. Smolts migrate from their natal river to foraging grounds in the North Atlantic, and after one or more winters at sea, adults return to their natal river to spawn. Atlantic salmon are not known to occur in the WEA; the only potion of the action area that may overlap with their distribution is their migration route in the GOM, which may be transited by vessels from Canada. There is no evidence of interactions between vessels and Atlantic salmon. Vessel strikes are not identified as a threat in the listing determination (74 *Federal Register* 29344) or the recent recovery plan (NMFS and USFWS 2019a), and there is no information to suggest that vessels in the ocean have any effects on migrating Atlantic salmon. Therefore, effects to Atlantic salmon are not expected even if migrating individuals co-occur with Project vessels moving between the Project site and ports in Canada.

Oceanic Whitetip Shark – Threatened

The oceanic whitetip shark (*Carcharhinus longimanus*) is typically found offshore in the open ocean, on the OCS, or around oceanic islands in water deeper than 184 m. As noted in Young et al. 2017, the species has a clear preference for open ocean waters between 10°N and 10°S but can be found in decreasing numbers out to latitudes of 30°N and 35°S, with abundance decreasing with greater proximity to continental shelves. In the western Atlantic 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. Oceanic whitetip sharks are not known to occur in the WDA; the only portion of the action area that overlaps with their distribution is the open ocean waters that may be transited by vessels from Europe. Vessel strikes are not identified as a threat in the status review (Young et al. 2017), listing determination (83 *Federal Register* 4153), or the recovery outline (NMFS 2018d). There is no information to suggest that vessels in the ocean have any effects on oceanic whitetip sharks. Therefore, effects to this species are not expected even if migrating individuals co-occur with Project vessels.

Northeast Atlantic Distinct Population Segment of Loggerhead Sea Turtle

The Northeast Atlantic DPS of loggerhead sea turtle (*Caretta caretta*) occurs in the northeast Atlantic Ocean north of the equator, south of 60°N Latitude, and east of 40°W Longitude except in the vicinity of the Strait of Gibraltar where the eastern boundary is 5°36′ W Longitude. The only portion of the action area where Northeast Atlantic DPS loggerheads occur is along the portion of any vessel transit routes from Europe that are east of 40°W Longitude. In this portion of the action area, co-occurrence of Project vessels and individual sea turtles is expected to be extremely unlikely; this is because of the dispersed nature of sea turtles in the open ocean and because of the only intermittent presence of Project vessels. Together, these make it extremely unlikely that any Northeast Atlantic DPS loggerheads would be struck by a Project vessel. No other effects to sea turtles from this DPS are anticipated.

Critical Habitat Designated for the North Atlantic Right Whale

On January 27, 2016, NMFS issued a final rule designating critical habitat for NARWs (81 *Federal Register* 4837). Critical habitat includes two areas (units) located in the Gulf of Maine and Georges Bank Region (Unit 1) and off the coast of North Carolina, South Carolina, Georgia and Florida (Unit 2). The proposed vessel transit routes to be used for some Project vessels may originate from Canada, the Gulf of Mexico, or Europe.

As identified in the final rule (81 *Federal Register* 4837), the physical and biological features essential to the conservation of the NARW that provide foraging area functions in Unit 1 are as followings:

- The physical oceanographic conditions and structures of the Gulf of Maine and Georges Bank region that combine to distribute and aggregate *Calanus finmarchicus* (a copepod species abundant in the Atlantic Ocean) for right whale foraging, namely prevailing currents and circulation patterns, bathymetric features (basins, banks, and channels), oceanic fronts, density gradients, and temperature regimes
- Low flow velocities in Jordan, Wilkinson, and Georges Basins that allow diapausing *Calanus finmarchicus* to aggregate passively below the convective layer so that the copepods are retained in the basins
- Late stage *Calanus finmarchicus* in dense aggregations in the Gulf of Maine and Georges Bank region
- Diapausing *Calanus finmarchicus* in aggregations in the Gulf of Maine and Georges Bank region

This BA considers whether the Proposed Action would have any effects to NARW critical habitat Unit 1. Copepods in critical habitat originate from Jordan, Wilkinson, and Georges Basin. The effects of the Proposed Action, including those of vessels going to/from Canada, do not extend to these areas, and effects to the generation of copepods in these areas that could be attributable to the Proposed Action are not expected. The Proposed Action would also not affect any of the physical or oceanographic conditions that serve to aggregate copepods in critical habitat. Offshore wind farms can reduce wind speed and wind stress, which can lead to less mixing, lower current speeds, and higher surface water temperature (Afsharian et al. 2020); can cause wakes that will result in detectable changes in vertical motion and/or structure in the water column (e.g., Broström 2008; Christiansen and Hasager 2005); and can cause detectable wakes downstream from a wind farm by increased turbidity (Vanhellemont and Ruddick 2014). However, these effects would not extend more than a few hundred meters from each foundation. The Vineyard Wind project is a significant distance from NARW critical habitat and, thus, this project is not anticipated to affect the oceanographic features of critical habitat. Further, the Vineyard Wind project is not anticipated to cause changes to the physical or biological features of critical habitat by worsening climate change, given the energy generated by the project is anticipated to displace electricity generated by existing fossil-fuel fired plants and to only support existing uses. Therefore, the Proposed Action would have no effect on NARW critical habitat Unit 1.

In regard to Unit 2, BOEM did not identify any potential effects of the Proposed Action that would affect calm sea surface conditions of Force 4 or less on the Beaufort Wind Scale, nor affect sea surface temperatures. No potential effects to water depths were identified that would increase or decrease water depths between 6 to 28 m and no essential features would be affected by the Proposed Action. Because these features are not affected, the Proposed Action would not affect the simultaneous co-occurrence of these features over contiguous areas of at least 231 nm^2 of ocean waters from November through April.

BOEM did not identify any potential effects of the Proposed Action that would affect the ability of NARW cows and calves to select an area with these features, when they co-occur, within the ranges specified. The presence of vessels and small acoustic footprint of surveys are not expected to affect the selection of these critically important features by right whales. As a precaution, and required by federal regulations, all vessels must maintain a distance of 500 m or greater from any sighted right whale. Adherence to this requirement would further ensure no adverse effects on the ability of whales to select an area where these features co-occur.

Following the analysis of the potential effects to NARW northern and southern critical habitat, BOEM concludes that the Proposed Action would not affect any of the essential features. The Proposed Action would not affect any critical habitat for NARWs that has been designated under the ESA.

Critical Habitat Designated for the Northwest Atlantic Distinct Population Segment of Loggerhead Sea Turtle

BOEM analyzed the primary constituent elements of loggerhead nearshore reproductive habitat, foraging habitat, winter habitat, breeding habitat, migratory habitat, and *Sargassum* (floating species of algae) habitat. There is no critical habitat designated for the Northwest Atlantic DPS of loggerhead sea turtle in the North Atlantic Renewable Energy Region. Primarily, winter, breeding, and migratory habitat for this species occurs in Mid-Atlantic and South Atlantic regions where some vessel transits may occur. Offshore transits may possibly overlap with *Sargassum* critical habitat. However, BOEM did not identify any adverse effects on *Sargassum* critical habitat resulting from vessel transits.

BOEM did not identify any potential effects of the Proposed Action that would affect nearshore waters 1.6 km (1 mile) offshore the highest density nesting beaches and their adjacent beaches, as identified in 50 CFR 17.95I. BOEM did not identify any potential effects of the Proposed Action that would affect the elements of foraging habitat. Vessel transits would not affect the seafloor or prey items. No effects to sufficient prey availability and prey quality would occur. As a result of the Proposed Action. The proposed vessel transits would not impact water temperatures that support loggerhead inhabitance (i.e., generally above 10 degrees Celsius [°C]). BOEM did not identify any potential effects of the Proposed Action that would affect or raise water temperatures to above 10°C from November through April, affect habitat in continental shelf waters near the western boundary of the Gulf Stream, or change water depths between 20 and 100 m. Although the Proposed Action may occur in these areas where these features occur, the temperature and depth features of the habitat would not be affected in any manner that adversely impacts the critical habitat.

BOEM did not identify any potential effects of the Proposed Action that would affect high densities of reproductive male and female loggerheads near the primary Florida migratory corridor and Florida nesting grounds. Vessel transits would not constrict or concentrate migratory pathways. Vessel transits would not impede, change, or otherwise alter passage conditions to allow for migration to and from nesting, breeding, and/or foraging areas.

Following the above analysis of potential impacts of the Proposed Action on loggerhead critical habitat, BOEM has determined that the Proposed Action would not affect any loggerhead critical habitat designated under the ESA.

Critical Habitat for All Listed Distinct Population Segments of Atlantic Sturgeon

Five separate DPSs of Atlantic sturgeon were listed under the ESA in 2012 (77 *Federal Register* 5880, 77 *Federal Register* 5914): Chesapeake Bay (endangered), Carolina (endangered), New York Bight (endangered), South Atlantic (endangered), and Gulf of Maine (threatened). The final rule for Atlantic sturgeon critical habitat (all listed DPSs) was issued on August 17, 2017 (82 *Federal Register* 39160). Included in this rule are 31 units, all rivers, occurring from Maine to Florida. No marine habitats were identified as critical habitat because the physical and biological features in these habitats essential for the conservation of Atlantic sturgeon could not be identified. Critical habitat designations for the New York Bight include the Hudson, Connecticut, and Housatonic Rivers to where the mainstem discharges into either New York Harbor or Long Island Sound. There is no designated critical habitat for Atlantic sturgeon in marine waters. No critical habitat has been designated for Atlantic sturgeon within drainages where potential ports are located (Deepwater Wind, LLC. 2020: Table 3.0-1). Therefore, no critical habitat for Atlantic sturgeon would be affected by the Proposed Action.

Because effects of the Proposed Action would not extend into critical habitat for Atlantic sturgeon, BOEM concludes that the Proposed Action would not affect any critical habitat for Atlantic sturgeon that has been designated under the ESA.

THREATENED AND ENDANGERED SPECIES CONSIDERED FOR FURTHER ANALYSIS

Nine ESA-listed species under NMFS jurisdiction are considered for further analysis; these include four large whale species, four sea turtle species, and one fish species. These species and their potential occurrence in the action area are summarized in Table 9. General information about these species, current status and threats, use of the action area, and additional information about habitat use that is pertinent to this consultation are described in the following sections.

Table 9. Endangered Species Act–Listed Species Considered for Further Analysis

Species	Listing Status	Critical Habitat Status	Known or Likely Occurrence in Action Area	
			Species	Critical Habitat
Marine Mammals				
Fin whale (*Balaenoptera physalus*)	Endangered – 6/2/1970 35 *Federal Register* 8491	Not designated	Yes	Not applicable (N/A)
Sei whale (*Balaenoptera borealis*)	Endangered – 6/2/1970 35 *Federal Register* 8491	Not designated	Yes	N/A
NARW (*Eubalaena glacialis*)	Endangered – 6/2/1970 35 *Federal Register* 8491	Designated – 1/27/2016 81 *Federal Register* 4838	Yes	No
Sperm whale (*Physeter macrocephalus*)	Endangered – 6/2/1970 35 *Federal Register* 8491	Not designated	Yes	N/A
Sea Turtles				
Green sea turtle (North Atlantic DPS) (*Chelonia mydas*)	Threatened – 5/6/2016 81 *Federal Register* 20057	Not designated	Yes	N/A
Kemp's ridley sea turtle (*Lepidochelys kempii*)	Endangered – 12/2/1970 35 *Federal Register* 18319	Proposed – 11/29/1978 43 *Federal Register* 45905	Yes	No
Leatherback sea turtle (*Dermochelys coriacea*)	Endangered – 6/2/1970 35 *Federal Register* 8491	Designated – 3/23/1999 64 *Federal Register* 14052	Yes	No
Loggerhead sea turtle (Northwest Atlantic DPS) (*Caretta caretta*)	Threatened – 9/22/2011 76 *Federal Register* 58868	Designated – 7/10/2014 79 *Federal Register* 39755	Yes	No
Fish				
Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*)	Endangered – 2/6/2012 77 *Federal Register* 5913	Designated – 9/18/2017 82 *Federal Register* 39160 for five DPSs	Yes	No

Information about species occurrence was drawn from several available sources. These include a directed survey that characterized large whale and marine reptile occurrence in the RI/MA WEA sponsored by BOEM (Kraus et al. 2016); a regional survey of marine species known or likely to occur in Rhode Island coastal and offshore waters (Kenney and Vigness-Raposa 2010); predictive seasonal models of marine mammal density by species along the Atlantic Coast developed by the Marine-Life Data and Analysis Team (Curtice et al. 2018); aerial and shipboard species observation data collected by the Atlantic Marine Assessment Program for Protected Species (NEFSC and SEFSC 2018); the most current marine mammal stock assessments (Hayes et al. 2020); and other specific research (e.g., Davis et al. 2020). Additional species-specific sources of information are cited below where appropriate.

Marine Mammals

Four marine mammal species listed under the ESA are known to occur in the action area, all of which are large whales. These are the fin whale (*Balaenoptera physalus*), NARW (*Eubalaena glacialis*), sei whale (*Balaenoptera borealis*), and sperm whale (*Physeter macrocephalus*). Blue whale (*Balaenoptera musculus*) has been documented in the vicinity but is unlikely to occur in the action area based on available data. Estimated densities in the action area in winter (defined as January to March by Denes et al. [2020b]) and by month from May through December are shown in Table 10. Species descriptions, status, likelihood, and timing of occurrence in the action area, and information about feeding habits and hearing ability relevant to this effect analysis are provided in the following sections.

Table 10. Estimated Density of Endangered Species Act–Listed Whale Species in the Action Area by Month and Season (peak occurrence periods in bold)

Species	Estimated Density (animals/km²)*								
	Winter	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
Fin whale	0	**0.00201**	**0.00219**	**0.00264**	**0.00251**	**0.00217**	0.00145	0.00102	0.00105
NARW	**0.0008–0.0027**	**0.00236**	0.00185	< 0.0001	< 0.0001	0.00024	< 0.0001	< 0.0001	0.00082
Sei whale	0	**0.00020**	**0.00013**	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Sperm whale	0	< 0.0001	< 0.0001	**0.00031**	**0.00024**	0.00010	< 0.0001	< 0.0001	< 0.0001

* Winter (January to March) density based on average of annual estimates from Kraus et al. (2016). Monthly density estimates for May to December from Denes et al. (2020a), as derived from Roberts et al. (2018). Blue whale monthly and seasonal density estimates derived from Denes et al. (2020a) and timing of acoustic detections summarized by Kraus et al. (2016) and Davis et al. (2020).

The Mid-Atlantic OCS provides important habitats for several marine mammals, including the ESA-listed species considered in this consultation. LaBrecque et al. (2015) delineated biologically important areas (BIAs) for multiple marine mammal species, including fin whale, NARW, and sei whale in and near the action area. Although these areas remain important, their significance may change over time as a result of emerging ecological trends resulting from climate change. For example, NARW appears to be shifting northward in response to changes in marine ecosystem productivity caused by climate change and increasing anthropogenic disturbance (Meyer-Guthbrod et al. 2015, 2018). Sei whales are likely to demonstrate similar shifts in abundance based on their similar diet and close association with NARW in the region. Numerous fish and invertebrate species are undergoing or likely to undergo changes in abundance and distribution shifts in response to climate change impacts (Hare et al. 2016; Rogers et al. 2019). Fin whales and sperm whales are likely to shift their behavior and habitat preferences in response to these changes in prey availability. Areas that are currently biologically important may become less so overtime, whereas currently unused areas may become more important. These changes are difficult to predict with certainty, requiring flexible and adaptive management to ensure species protection into the future.

Fin Whale

Fin whales are a globally distributed baleen whale species found in the Atlantic, Pacific, and Southern Hemisphere (NMFS 2010a). Fin whales are listed at the species level under the ESA (35 *Federal Register* 8491). Critical habitat has not been designated for this species. The International Whaling Commission has divided this species into discrete stocks by ocean basin, but the biological evidence for these stock definitions is mixed (Hayes et al. 2020). The western North Atlantic stock is concentrated in the United States and Canadian Atlantic Exclusive Economic Zones from Cape Hatteras to Nova Scotia (Hayes et al. 2020) and is therefore the most likely source of individuals occurring in the action area. Fin whales are the most commonly sighted large whale species in this region, accounting for 46% of all sightings in aerial surveys conducted from 1978 to 1982 (CETAP 1982; Hayes et al. 2018), and make up the majority of large whale sightings in recent aerial and shipboard surveys (NEFSC and SWFSC 2018; Kraus et al. 2016). They are present throughout this region year-round, but abundance in specific locations varies by season (Hayes et al. 2017).

SPECIES STATUS

Fin whales have been listed as endangered under the ESA since the Act's passage in 1973 (35 *Federal Register* 8491). Critical habitat has not been designated. The species is also on the International Union for Conservation of Nature Red List (Kenney and Vigness-Raposa 2010). The best available abundance estimate for the western North Atlantic stock is 1,618 with a minimum population estimate of 1,234 based on shipboard and aerial surveys conducted in 2011 (Hayes et al. 2017, 2018). These estimates are uncertain and likely low given the limitations of the survey. NMFS has not conducted a population trend analysis due to insufficient data (Hayes et al. 2018). The best available information indicates the gross annual reproduction rate is 8%, with a mean calving interval of 2.7 years (Hayes et al. 2017, 2018).

OCCURRENCE IN THE ACTION AREA

Fin whales commonly occur in the action area. A portion of a well-known feeding area partially overlaps the action area. This feeding area extends in a zone east from Montauk, Long Island, New York, to south of Nantucket (Kenney and Vigness-Raposa 2010; NMFS 2010a) and is a well-known location where fin whales congregate in dense aggregations and sightings frequently occur (Kenney and Vigness-Raposa 2010). Aerial survey observations collected by Kraus et al. (2016) from 2011 through 2015 and Quintana et al. (2018) in 2017 and 2018 indicate peak fin whale occurrence in the RI/MA WEA from May to August; however, the species may be present at varying densities during any month of the year. The

Marine-Life Data and Analysis Team (Curtice et al. 2018) has assembled available data on fin whale occurrence to assemble a model of monthly occurrence density off the Atlantic Coast. LaBrecque et al. (2015) delineated a BIA for fin whale feeding in an area extending from Montauk Point, New York, to the open ocean south of Martha's Vineyard between the 49-foot (15-m) and 164-foot (50-m) depth contours. This BIA encompasses the SFWF footprint. It is used extensively by feeding fin whales from March to October.

Denes et al. (2020a) compiled these and other data to develop monthly density estimates in the action area, which are summarized in Table 10. The collective findings of these efforts indicate that fin whales could occur in the action area during every month of the year. Estimated densities during this period range from 0.0020 to 0.0026 animals per square kilometer (km^2) (Denes et al. 2020a; Roberts et al. 2018). Kraus et al. (2016) observed fewer individuals from September through March. Fin whale sightings per unit effort (SPUE) in the RI/MA WEA and larger action area in 2017 and 2018 are displayed by season in Figure 3 (from Quintana et al. 2018). Seasons are defined as Winter = December, January, and February; Spring = March, April, and May; Summer = June, July, and August; and Autumn = September, October, and November. SPUE is symbolized as the extrapolated number of individuals per 1,000 km of aerial survey observations, assigned to 5 × 5–minute latitude and longitude grid cells (Kraus et al. 2016; Quintana et al. 2018). As shown, fin whales are most likely to be present in the action area during spring and summer, but this and prior surveys (Kraus et al. 2016) have documented occurrence in autumn and winter months. This is consistent with regional occurrence timing derived from regional PAM data, which indicate that this species is present in the region throughout the year with the lowest likelihood of occurrence in May and June (Davis et al. 2020).[2]

FEEDING BEHAVIOR AND HEARING

Fin whales are fast swimmers typically found in social groups of two to seven, often congregating with other whales in large feeding groups (Hayes et al. 2017). The species returns annually to established feeding areas and fasts during migration between feeding and calving grounds. The OCS adjacent to New England supports established summer feeding areas for this species (LaBrecque et al. 2015). Fin whales in the North Atlantic feed on krill (*Meganyctiphanes norvegica* and *Thysanoessa inermis*) and schooling fish such as capelin (*Mallotus villosus*), herring (*Clupea harengus*), and sand lance (*Ammodytes* spp.), captured by skimming or lunge feeding (Borobia et al. 1995). Several studies suggest that distribution and movements of fin whales along the east coast of the United States is influenced by the availability of sand lance (Kenney and Winn 1986; Payne et al. 1990).

Fin whales and other baleen whales belong to the low-frequency cetacean (LFC) marine mammal hearing group, which have a generalized hearing range of 7 hertz (Hz) to 35 kHz (NMFS 2018a). Peak hearing sensitivity of fin whales ranges from 20 to 150 Hz (Erbe 2002).

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

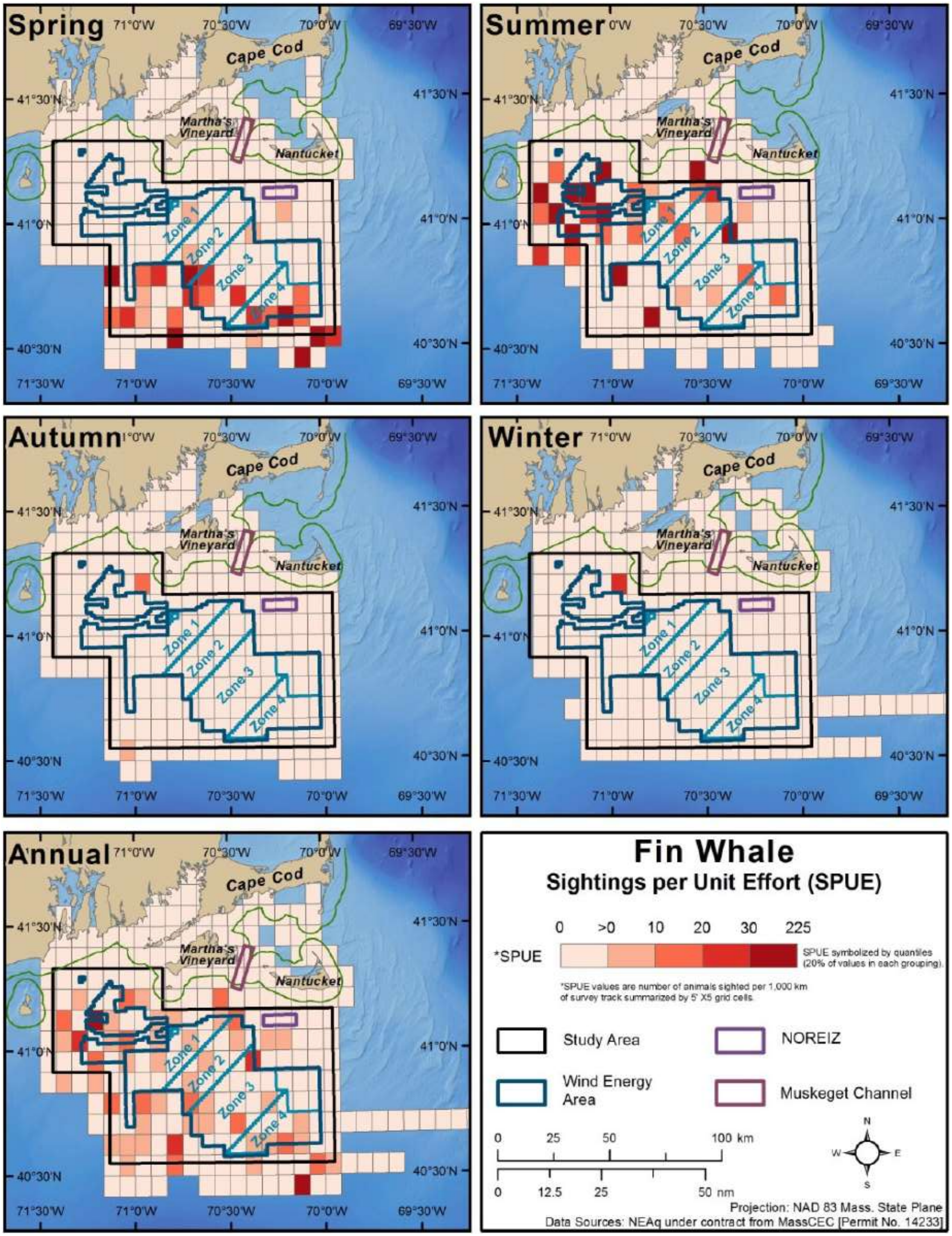

Figure 3. Fin whale seasonal sightings per unit effort in the Rhode Island-Massachusetts Wind Energy Area in 2017 and 2018 (Quintana et al. 2018).

North Atlantic Right Whale

The NARW is a large baleen whale, ranging from 45 to 55 feet in length and weighing up to 70 tons at maturity, with females being larger than males. The NARW is recognized as a separate species from the Southern right whale (*Eubalaena australis*). These two species are separated into distinct populations in the northern Atlantic and Pacific Oceans. The North Atlantic population, referred to as the NARW, ranges from calving grounds in coastal waters of the southeastern United States 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, right whales migrate north to the productive waters of the northeast region to feed and nurse their young. Within the northeast region, feeding habitats have been observed off the coast of Massachusetts, at Georges Bank, the Great South Channel, in the Gulf of Maine, over the Scotian Shelf, and in the Bay of Fundy (Brilliant et al. 2015; Hayes et al. 2020). These feeding and calving habitats are considered high-use areas for the species. Although high-use areas have been established for the right whale, frequent travel along the east coast of the United States is common. Satellite tags have shown NARW making round-trip migrations to an area off the southeastern United States and back to Cape Cod Bay at least twice during the winter (Hayes et al. 2020). Although these historical high-use areas are well known, NARW distribution during winter is uncertain and may include the Mid-Atlantic OCS to a greater extent than previously understood (Davis et al. 2017; Hayes et al. 2020).

SPECIES STATUS AND CRITICAL HABITAT

NARWs have been listed as endangered under the ESA since the Act’s passage in 1973 (35 *Federal Register* 8491). The species was nearly driven to extinction by commercial whaling efforts over more than three centuries. The historical size of the western Atlantic population is uncertain but likely numbered in the tens of thousands (Monsarrat et al. 2016; Reeves et al. 2007). The population has modestly rebounded after the cessation of commercial whaling, increasing from an estimated low of approximately 270 individuals in 1990 to a recent peak of approximately 483 in 2010 (Pace et al. 2017). The population has since exhibited a significant downward trend in abundance as well as changes in distribution that have increased exposure to vessel strikes, fishing gear entanglement, and other anthropogenic stressors (Corkeron et al. 2018; Kenney 2018). By 2015, total abundance declined to an estimated 458 individuals when the rate of unusual mortalities began to accelerate. By 2017, the population had declined to the most recent estimate of just 428 individuals, which does not include several additional mortalities recorded during and after that year (Hayes et al. 2020; Pace et al. 2017). This is a concerning trend given the low reproductive productivity demonstrated by this population (Hayes et al. 2020).

OCCURRENCE IN THE ACTION AREA

The Mid-Atlantic Bight is an important migratory corridor for NARW traveling between summer feeding and winter calving grounds on the northern and southern Atlantic coasts. LaBreque et al. (2015) defined five BIAs in Atlantic waters of New England, all of which were located outside of the action area. The LaBrecque et al. (2015) delineations reflect NARW observations prior to 2010 that are not representative of recent shifts in species distribution. NARW occurrence on the Mid-Atlantic OCS is far more prevalent since 2011 (Davis et al. 2017), indicating an increasingly likelihood of species occurrence in the action area.

Kraus et al. (2016) observed that NARWs were most commonly present in and near the RI/MA WEA in the winter and spring and absent in the summer and fall. In contrast, Quintana et al. (2018) observed similar occurrence patterns in the winter and spring but an increase in observations in the summer and fall. The change in seasonal occurrence between the 2011 to 2015 (Kraus et al. 2016) and 2017 and 2018 (Quintana et al. 2018) aerial surveys is consistent with an increase trend in acoustic detections on the

Mid-Atlantic OCS in the summer and autumn (Davis et al. 2017).[3] These data suggest an increasing likelihood of species presence from September through June. NARW SPUE in and near the RI/MA WEA by season in 2017 and 2018 is summarized in Figure 4. Seasons are defined as Winter = December, January, and February; Spring = March, April, and May; Summer = June, July, and August; and Autumn = September, October, and November.

The Marine-Life Data and Analysis Team (Curtice et al. 2018; Roberts et al. 2018) has developed updated monthly density models of NARW distribution off the Atlantic Coast. Denes et al. (2020a) compiled data from these and other sources to develop monthly NARW density estimates from May through December. Collectively, these results indicate this species could occur in the marine component of the action area from December through June, with the highest probability of occurrence extending from January through April (see Table 10). NARW density estimates in the RI/MA WEA during this period range from 0.0008 to 0.0027/km^2 (Kraus et al. 2016).

FEEDING BEHAVIOR AND HEARING

The NARW is primarily planktivorous, preferentially targeting certain calanoid copepod species, primarily the late juvenile developmental stage of *Calanus finmarchicus*. This species occurs in dense patches and demonstrates both diel and seasonal vertical migration patterns (Baumgartner et al. 2011). Baumgartner et al. (2017) investigated NARW foraging ecology in the Gulf of Maine and southwestern Scotian Shelf Right using archival tags. Diving behavior was variable but followed distinct patterns correlated with the vertical distribution of forage species in the water column. Importantly, Baumgartner et al. found that NARWs spent 72% of their time within 33 feet (10 m) of the surface. Although NARWs are always at risk of ship strike when breathing, the tendency to forage near to but below the surface for extended periods substantially increases this risk (Baumgartner et al. 2017). NARW feeding behavior varies by region in response to different seasonal and prey availability conditions. For example, NARW 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).

NARW and other baleen whales belong to the LFC marine mammal hearing group, which has a generalized hearing range of 7 Hz to 35 kHz (NMFS 2018a). Peak hearing sensitivity of NARW is most likely between 100 to 400 Hz based on recorded vocalization patterns (Erbe 2002).

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

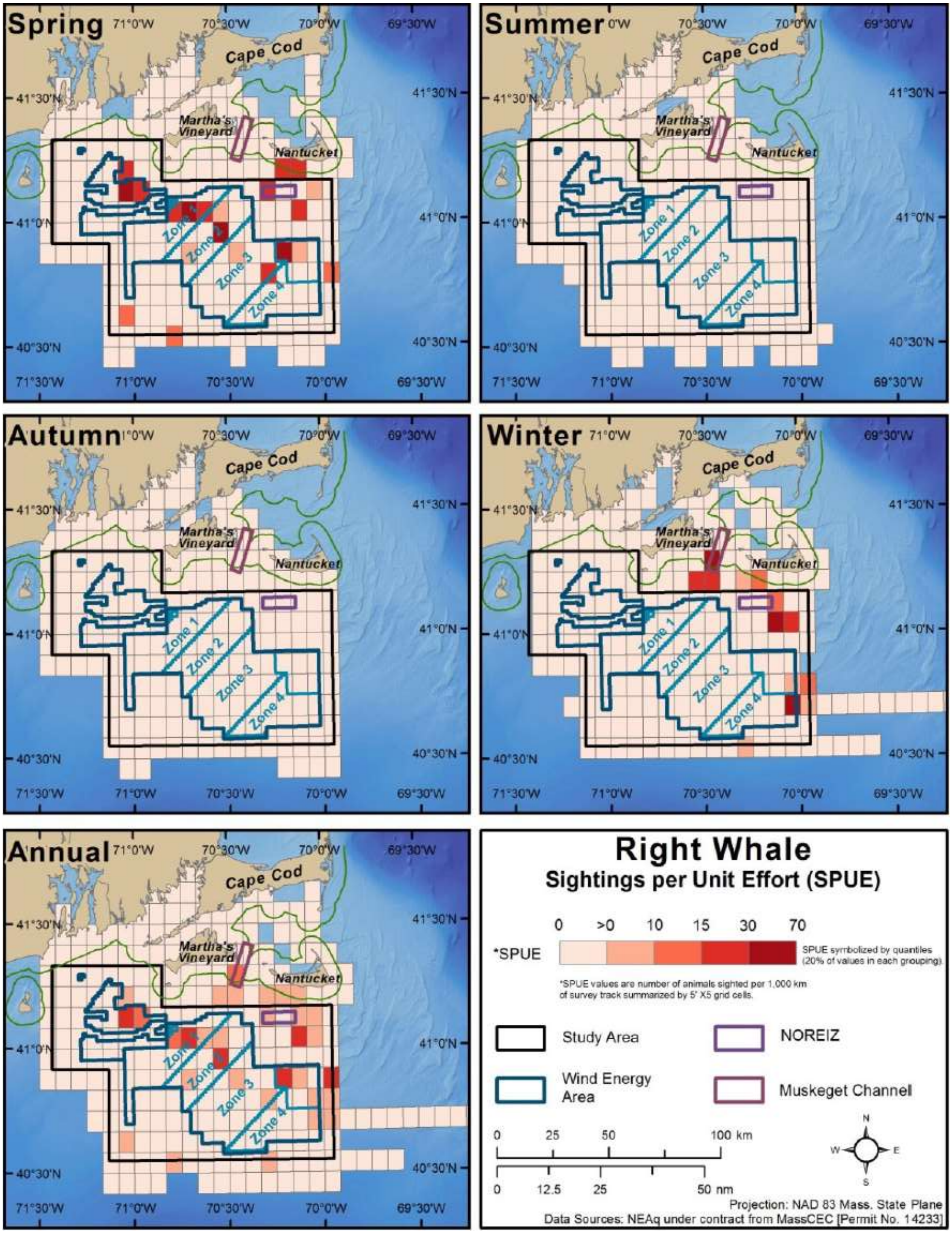

Figure 4. North Atlantic right whale seasonal sightings per unit effort in the Rhode Island-Massachusetts Wind Energy Area in 2017 and 2018 (Quintana et al. 2018).

Sei Whale

The sei whale is a large baleen whale species found in subtropical, temperate, and subpolar waters around the globe, most commonly observed in temperate waters at mid-latitudes. The movement patterns of sei whales are not well known, but they are typically observed in deeper waters far from the coastline. The species is notable for its unpredictable distribution, concentrating in specific areas in large numbers for a period and then abandoning those habitats for years or even decades. The breeding and calving areas used by this species are unknown (Hayes et al. 2020).

SPECIES STATUS

Sei whales have been ESA-listed as endangered at the species level since the passage of the act in 1973 (35 *Federal Register* 8491). Critical habitat has not been designated. This species was subjected to intense commercial whaling pressure in the nineteenth and twentieth centuries, with an estimated 300,000 animals killed for their meat and oil. Commercial whaling ended for this species in 1980, but limited scientific whaling continues today in Iceland and Japan. Vessel strikes and fishing gear entanglement pose the greatest risk to the species today (Hayes et al. 2020). The most recent abundance estimate for the Nova Scotia stock of sei whales is 6,292 adults, based on aerial surveys conducted from 2010 through 2013 (Hayes et al. 2020). The majority of sightings were concentrated in offshore waters between 328 and 3,280 feet (100 and 1,000 m) deep.

OCCURRENCE IN THE ACTION Area

Sei whales are somewhat regularly observed in the Gulf of Maine, and on Georges Bank and Stellwagen Bank in the summer. These areas appear to be core feeding areas at the southern end of the species range in the North Atlantic. Baumgartner et al. (2011) reported multiple sei whale observations in the spring in the Great South Channel from 2004 to 2010, suggesting that these whales are relatively common in the region. LaBrecque et al. (2015) defined a May to November feeding BIA for sei whales that extends from the 82-foot (25-m) contour off coastal Maine and Massachusetts east to the 656-foot (200-m) contour in the central Gulf of Maine, including the northern shelf break area of Georges Bank, the Great South Channel, and the southern shelf break area of Georges Bank from 328 to 6,562 feet (100–2,000 m). This feeding BIA does not overlap the action area.

Although most commonly observed in deep waters at the edge of the continental shelf, sei whales periodically move onto the shelf or even into inshore waters when zooplankton blooms are abundant (Hayes et al. 2020). The species is most likely to occur in the action area during one of these periods. Sei whales may be present in the general vicinity year-round but are most commonly present in the spring and early summer (Davis et al. 2020).[4] Kraus et al. (2016) and Quintana et al. (2018) observed sei whales in and near the RI/MA WEA from March through June from 2011 through 2015 and in 2017, respectively, with the timing of peak occurrence varying by year. Sei whales were absent from the area from August through February. Sei whale SPUE in the RI/MA WEA in 2017 is displayed by season in Figure 5. As shown, sightings were generally concentrated to the south and east of the SFWF. This distribution suggests that sei whales are likely to occur in and near the action area between March and June if recent patterns of habitat use continue. However, no sei whales were observed in the same study area in 2018 (Quintana et al. 2018).

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

Denes et al. (2020a) compiled cetacean density data for the action area from Roberts et al. (2018) and other available data sources to develop composite monthly density values. As shown in Table 10, the assembled data indicate that sei whale density in the action area is generally low, peaking in May and June at densities ranging from 0.00013 to 0.00020 individuals/km^2. Sei whale SPUE in and near the RI/MA WEA from 2011 to 2015 are displayed by season in Figure 5. As shown, sightings were generally concentrated to the south and east of the SFWF. This distribution suggests that sei whales are likely to occur in and near the action area between March and June if recent patterns of habitat use continue.

FEEDING BEHAVIOR AND HEARING

Sei whales are a fast-swimming, highly mobile species that ranges widely on an annual basis (Hayes et al. 2020). The species is notable for its unpredictable distribution, concentrating in specific areas in large numbers for a period and then abandoning those habitats for years or even decades (Hayes et al. 2020). The species is typically associated with deeper water, and sightings in United States Atlantic waters are typically centered on mid-shelf and the shelf edge and slope (Olsen et al. 2009). Sei whales usually travel alone or in small groups of 2 to 5 animals, occasionally in groups as large as 10 (Hayes et al. 2020).

Potential species occurrence in the action area is likely to be closely tied to feeding behavior and seasonal availability of preferred prey resources. Sei whales in the North Atlantic preferentially prey on calanoid copepods, particularly *Calanus finmarchicus*, over all other zooplankton species (NMFS 2011; Prieto et al. 2014), demonstrating a clear preference for copepods between June and October, with euphausiids constituting a larger part of the diet in May and November (NMFS 2011; Prieto et al. 2014). The prey preferences of sei whales closely resemble those of NARW (Hayes et al. 2020), particularly where the two species overlap.

Sei whales and other baleen whales belong to the LFC hearing group of marine mammals, which has a generalized hearing range of 7 Hz to 35 kHz (NMFS 2018a). Peak hearing sensitivity of sei whales ranges from 1.5 to 3.5 kHz based on recorded vocalization patterns (Erbe 2002).

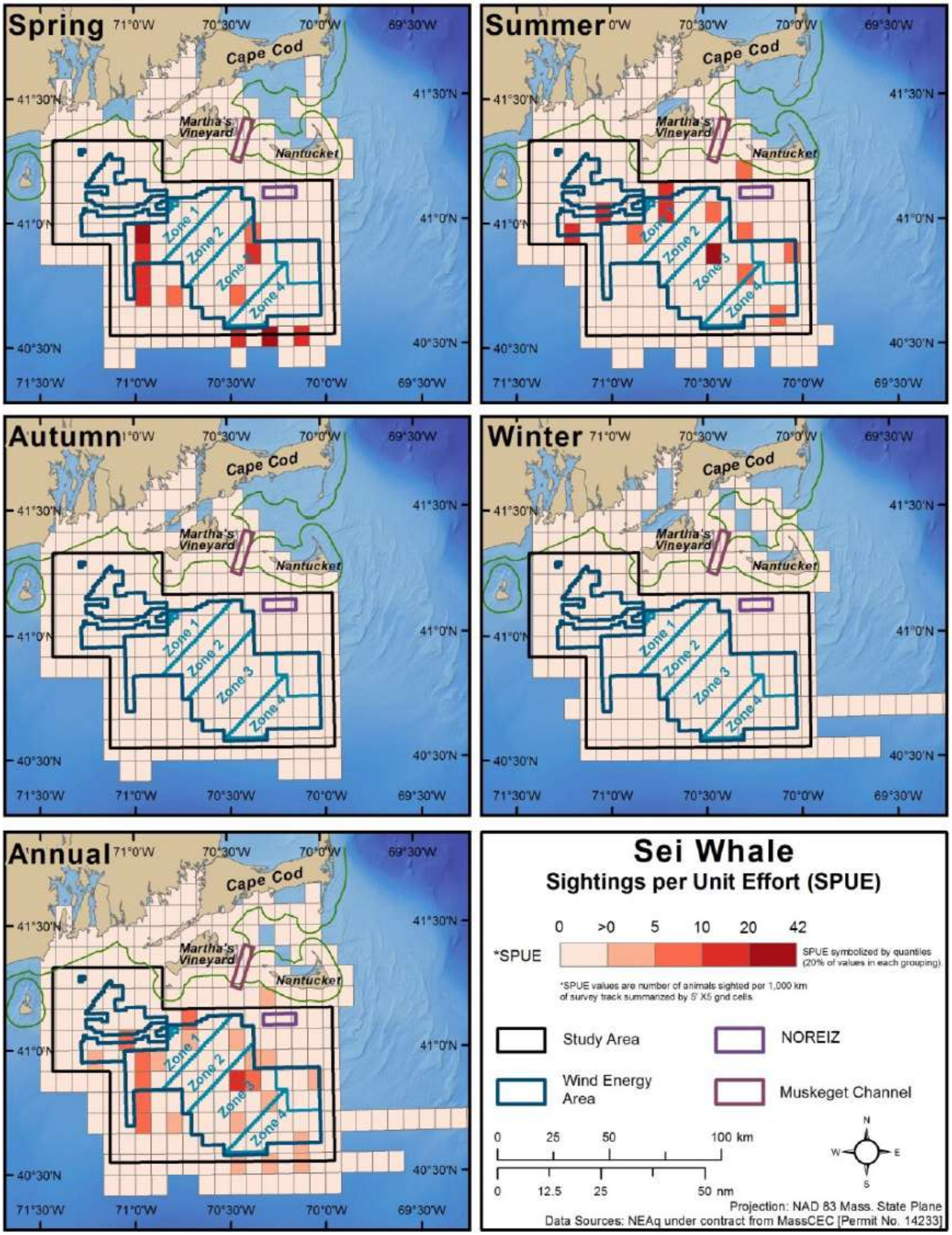

Figure 5. Sei whale seasonal sightings per unit effort in the Rhode Island-Massachusetts Wind Energy Area in 2017 and 2018 (Quintana et al. 2018).

Sperm Whale

The sperm whale is the largest member of the order Odontocetes, or toothed whales, and the largest predator on earth. The species is found in tropical, subtropical, and ice-free temperate ocean regions around the globe. They are most commonly observed in association with continental shelf margins and marine canyons with depths greater than 2,000 feet and are rarely observed in waters less than 1,000 feet deep (NMFS 2010b). Geographic distribution appears to be linked to social structure. Females and juveniles tend to congregate in matrilineal social groups in subtropical waters, whereas males range widely from the tropics to high latitudes and breed across social groups (Hayes et al. 2020). Sperm whales in the North Atlantic display sufficient genetic isolation from other Atlantic groupings to justify their identification as a breeding stock, but insufficient data are available to determine a definitive population structure (Waring et al. 2015). Sperm whales in and near the action area are most likely members of this stock or transient males.

SPECIES STATUS

Sperm whales have been listed as endangered under the ESA since the initial passage of the act (35 *Federal Register* 8491). Critical habitat has not been designated. The species was subjected to intense commercial whaling pressure in the eighteenth, nineteenth, and early twentieth centuries, resulting in a prolonged and severe decline in abundance. Sperm whale populations are rebuilding after the cessation of commercial whaling on the species; the primary threats today are ship collisions and fishing gear entanglement (Hayes et al. 2020). The most recent abundance estimate for the North Atlantic stock is 4,349; between 1,000 to 3,400 of these individuals occur in United States waters (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 discrete from the eastern North Atlantic population (Hayes et al. 2020).

OCCURRENCE IN THE ACTION AREA

North Atlantic sperm whales display a distinct seasonal distribution. In the winter, females and juveniles congregate in large groups east and northeast of Cape Hatteras. In the spring, the center of distribution shifts northward throughout the central portion of the Mid-Atlantic Bight and the southern portion of Georges Bank. In the summer, this distribution expands to include areas east and north of Georges Bank and into the Northeast Channel region. They remain in this broad area through the fall, concentrating in greatest abundance along the continental shelf south of New England (NMFS 2010b; Scott and Sadove 1997). Notably, this summer and autumn distribution extends into relatively shallow waters on the continental shelf including the action area (Hayes et al. 2020; Scott and Sadove 1997).

Historical sightings data from 1979 to 2018 indicate that sperm whales may occur in and near the RI/MA WEA in the summer and autumn in relatively low to moderate numbers (North Atlantic Right Whale Consortium 2018). Kraus et al. (2016) recorded four sperm whale sightings in and near the RI/MA WEA between 2011 and 2015. Three of the four sightings occurred in August and September 2012, and one occurred in June 2015. Because of the limited sample size, Kraus et al. (2016) were not able to calculate SPUE or estimate abundance in the action area, and specific sighting locations were not provided. Sperm whale sightings in the region during AMAPPS aerial surveys conducted from 2010 to 2013 are shown in Figure 6.

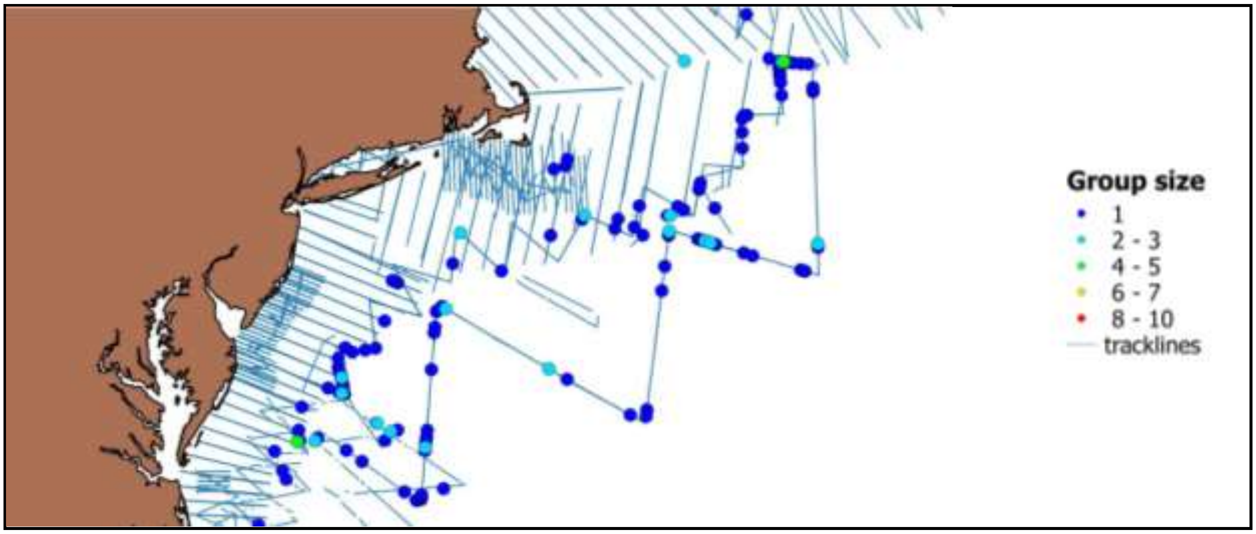

Figure 6. Sperm whale sightings in the Mid-Atlantic Outer Continental Shelf during 2010 to 2013 AMAPPS aerial surveys (NEFSC and SEFSC 2018).

Denes et al. (2020a) compiled cetacean density data for the action area from available data sources and developed composite monthly density values. As shown in Table 10, the assembled data indicate that sperm whale density in and near the action area is generally low but with a distinct peak in July and August at densities ranging from 0.00024 to 0.00031/ km^2. Density models developed by Curtice et al. (2018) indicate this species is likely to occur in the marine component of the action area at low densities between June and November, with the highest probability of occurrence in July and August. The species is unlikely to be present from December through April.

FEEDING BEHAVIOR AND HEARING

Sperm whales are predatory specialists known for hunting prey in deep water. The species is amongst the deepest diving of all marine mammals. Males have been known to dive 3,936 feet (1,200 m), whereas females dive to at least 3,280 feet (1,000 m); both can continuously dive for more than 1 hour. Sperm whales are also relatively fast swimmers, capable of swimming at speeds of up to 9 m per second or 20 miles per hour (Aoki et al. 2007). The species preferentially target squid, which make up at least 70% of the whale's typical diet (Kawakami 1980; Pauly et al. 1998). Sperm whale are also known to prey on bottom-oriented organisms such as octopus, fish, shrimp, crab, and sharks (Leatherwood et al. 1988; Pauly et al. 1998). Sperm whales occurring in and near the action area are likely targeting smaller squid, crustaceans, and fish common to the shallow waters of the OCS.

Sperm whales belong to the mid-frequency cetacean (MFC) marine mammal hearing group, which has a generalized hearing range of 150 Hz to 160 kHz (NMFS 2018a). Peak hearing sensitivity of sperm whales ranges from 5 to 20 kHz based on auditory brainstem response to recorded stimuli (Ridgway and Carder 2001). Sperm whales communicate and search for prey using broadband transient signals between 500 Hz and 24 kHz, with most sound energy focused in the 2- and 9-kHz range (Lohrasbipeydeh et al. 2012).

Sea Turtles

Five species of sea turtles listed under the ESA are known to occur in the western North Atlantic and in the action area. However, hawksbill sea turtle are rare in the WDA and may only occur within potential vessel transit routes originating from the Gulf of Mexico. As previously mentioned, potential effects to hawksbills from the Proposed Action would be discountable due to the low number of vessels transits and low likelihood of co-occurrence of hawksbills and vessels in the transit routes. Therefore, this section further analyzes the potential effects to the Northwest Atlantic DPS of loggerhead sea turtle, Kemp's ridley sea turtle (*Lepidochelys kempii*), leatherback sea turtle (*Dermochelys coriacea*), and North Atlantic DPS of green sea turtle (*Chelonia mydas*). In general, the available data suggest that the relative abundance in the WDA is greatest for loggerhead, followed by Kemp's ridley, leatherback, and green sea turtle. A notably higher density of leatherback sea turtles is present during autumn. However, Kraus et al. (2016) sighted three species of sea turtles in the waters around the Massachusetts Lease Area from October 2011 through June 2015: leatherback sea turtle (161 sightings), loggerhead sea turtle (87 sightings), and Kemp's ridley sea turtles (six sightings), suggesting that leatherbacks may be more abundant in the offshore Lease Area, but Kemp's ridleys may be more abundant in nearshore areas, which would correspond with known habitat preferences for these species. Information about species occurrence in the action area was obtained from aerial surveys (Kraus et al. 2016; NEFSC and SEFSC 2018; North Atlantic Right Whale Consortium 2018), regional historical data (Kenney and Vigness-Raposa 2010), bycatch data (NMFS 2018c), and sea turtle stranding records from the OBIS-SEAMAP database (Halpin et al. 2009).

Denes et al. (2020a) compiled estimated seasonal densities for Kemp's ridley, leatherback, and loggerhead sea turtles in the action area using data obtained from the U.S. Navy Operating Area Density Estimate and OBIS-SEAMAP databases (DoN 2007, 2012; Halpin et al. 2009). These estimates, provided in Table 11, are approximate and reflect the limitations of current survey methods, which include variable adult detection rates under different weather conditions, poor juvenile detection ability, and incomplete coverage of nearshore habitats used by juveniles and subadults. Denes et al. (2019a) did not attempt to estimate green sea turtle densities because suitable data for the region are limited. The action area is at the extreme end of the species range and occurrence in the action area is rare at best, usually individual temperature-shocked turtles that are outside of their typical habitat range. No green sea turtles were positively identified in the Kraus et al. (2016) aerial surveys.

Aerial surveys of sea turtle occurrence in the RI/MA WEA were conducted from 2011 through 2020. Sea turtle sightings and number of individuals sighted by season in aerial surveys of the RI/MA WEA are summarized in Table 12. SPUE for all sea turtle species in the action area are displayed graphically in Figure 7. Species descriptions, status, likelihood of occurrence in the action area, and information about feeding habits and hearing ability relevant to this effect analysis are provided in the following sections.

Table 11. Estimated Seasonal Densities of Endangered Species Act–Listed Turtles in the Wind Development Area

Species	Density (animals/km^2)			
	Winter (December–February)	Spring (March–May)	Summer (June– August)	Fall (September– November)
Kemp's ridley sea turtle	0.009	0.009	0.009	0.009
Leatherback sea turtle	0.000	0.000	0.0063	0.0087
Loggerhead sea turtle*	0.035	0.035	0.038	0.035

Note: Seasonal density estimates of Kemp's ridley and loggerhead sea turtles are compiled from various sources summarized and incorporated by reference from Denes et al. (2020a).

* Leatherback densities are average densities derived from aerial surveys in the MA/RI WEAs between 2011 and 2015 (Krause et al. 2016)

Table 12. Summary of Endangered Species Act–Listed Sea Turtle Sightings and Estimated Number of Individuals Observed by Season in Aerial Surveys of the Rhode Island-Massachusetts Wind Energy Area from 2011 to 2015

Species	Winter	Spring	Summer	Fall
	Sightings Rate (animals/1,000 km)			
All turtles	0	0.19	8.66	10.46
Kemp's ridley sea turtle	0	0	0	0
Leatherback sea turtle	0	0.08	4.65	4.59
Loggerhead sea turtle	0	0.07	1.52	3.97

Source: Kraus et al. (2016).

The Wellfleet Bay Wildlife Sanctuary strandings data are shown in Figure 8. The Northeast Fisheries Observer Program statistical area 537 encompasses the waters from the southern shores of Martha's Vineyard and Nantucket south to the OCS waters off New York (NMFS 2018c). NMFS bycatch data in this area indicate that a total of 31 turtles (four leatherback, two green, 20 loggerhead, and five unidentified hard-shelled turtles) were incidentally caught in monkfish, squid, and skate fishery gear from 2008 through 2017 (NMFS 2018c). These data under-represent the actual number of bycaught turtles due to the limited observer coverage for each fishery. The turtles were caught from June through December, with the majority in July (18 of 31) and August (five of 31). In area 538, which includes the waters from the south shore of Cape Cod to the southern shores of Martha's Vineyard and Nantucket, one loggerhead sea turtle was incidentally caught in August of 2014 (NMFS 2018c).

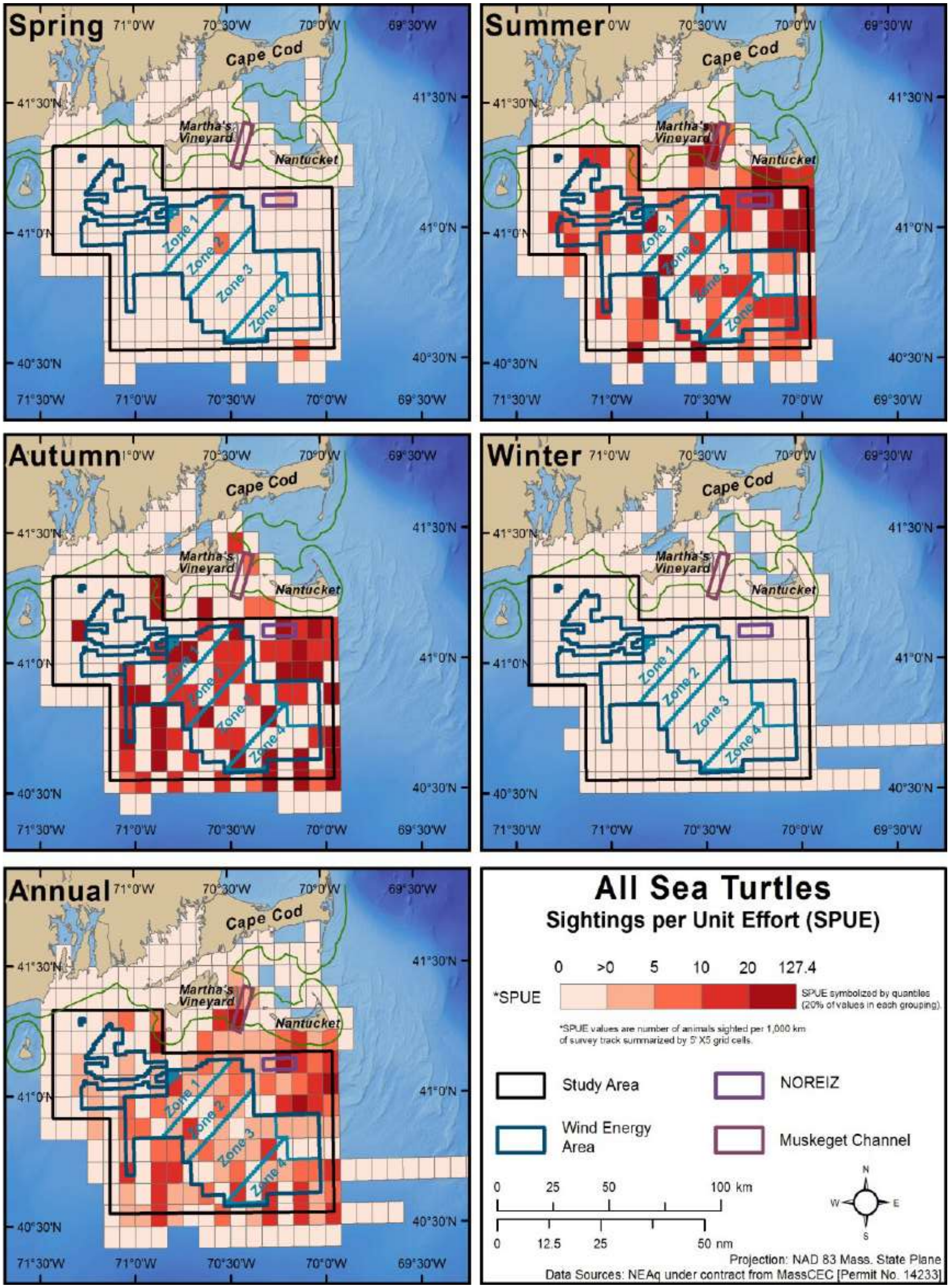

Figure 7. Seasonal sightings per unit effort for all sea turtle species in the Rhode Island-Massachusetts Wind Energy Area (Kraus et al. 2016).

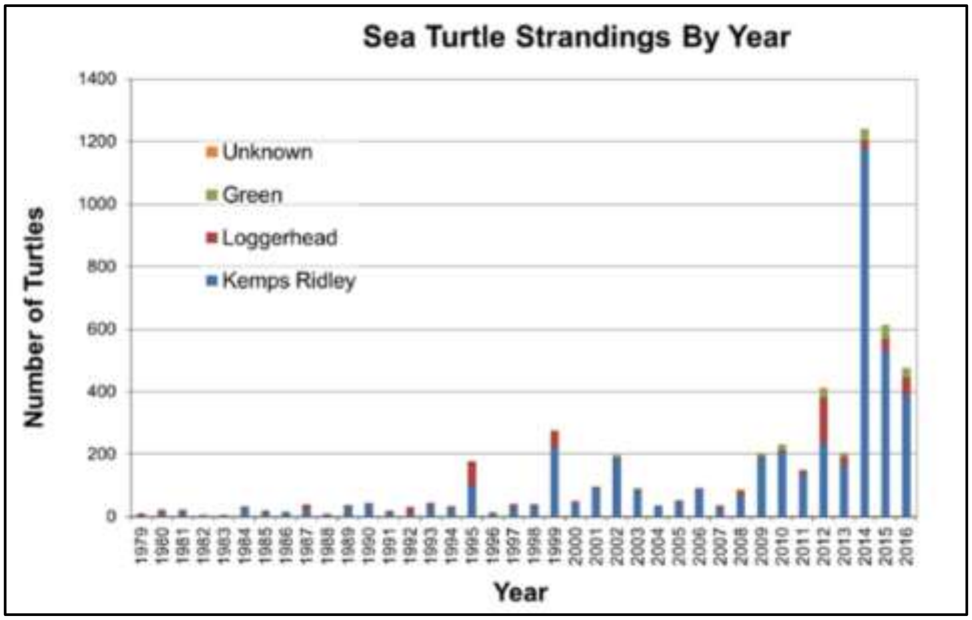

Figure 8. Sea turtle stranding in the geographic region of the Project from 1979 to 2016.

The suitability of Mid-Atlantic OCS sea turtle foraging habitats is shifting as a result of current climate change trends. For example, pelagic foraging habitats for leatherback sea turtles in the North Atlantic are strongly associated with the 59 degrees Fahrenheit (°F) (15°C) isotherm, which is shifting northward at a rate of approximately 124 miles (200 km) per decade (McMahon and Hays 2006). Other sea turtle species are likely to shift their range in response to changing temperature conditions and changes in the distribution of preferred prey (Hawkes et al. 2009). Numerous fish and invertebrate species on the Mid-Atlantic OCS are currently undergoing or likely to undergo changes in abundance and distribution in response to climate change impacts (Hare et al. 2016; Rogers et al. 2019). The implications of these range shifts are difficult to predict and will likely vary by species. For example, loggerhead sea turtles exhibit a high degree of dietary flexibility (Plotkin et al. 1993; Ruckdeschel and Shoop 1988; Seney and Musick 2007) and may more readily adapt to changes in ecosystem structure than dietary specialists like leatherbacks. Rare species like green sea turtles that are currently at the northern limit of their range could become more common in the action area as summer temperature conditions become more favorable. Resource managers will need to consider these trends and adapt management to meet evolving species requirements to ensure their long-term conservation.

North Atlantic Distinct Population Segment of Green Sea Turtle

The green sea turtle is the largest of the hard-shelled sea turtles, growing to a maximum length of approximately 4 feet (1.2 m) and weighing up to 440 pounds (200 kilograms [kg]) (NMFS and USFWS 1991). The species inhabits tropical and subtropical waters around the globe. They are most commonly observed feeding in shallow waters of reefs, bays, inlets, lagoons, and shoals that are abundant in algae or marine grass, such as eelgrass (*Zostera marina*) (NMFS and USFWS 2007a). Individuals display fidelity for specific nesting habitats, which are concentrated in lower latitudes well south of the action area. The primary breeding areas in the United States are located in southeast Florida (NMFS and USFWS 1991). In summer, the distribution of foraging subadults and adults can expand to include subtropical waters at higher latitudes. Juveniles and subadults are occasionally observed in Atlantic coastal waters as far north as Massachusetts (NMFS and USFWS 1991), including Cape Cod Bay (CETAP 1982), and may be present in the action area.

SPECIES STATUS

The green sea turtle was originally listed under the ESA in 1978 as threatened across its range. The listing was subsequently updated in 2016 (81 *Federal Register* 20057), confirming threatened status across the range, with specific breeding populations in Florida and the Pacific Coast of Mexico listed as endangered (NMFS 2011). The primary nesting beaches are Costa Rica, Mexico, United States (Florida), and Cuba. According to Seminoff et al. (2014), nesting trends are generally increasing for this DPS. Critical habitat has not been designated. The species was listed on the basis of significant population declines resulting from egg harvesting, incidental mortality in commercial fisheries, and nesting habitat loss. Current threats to the species include nesting habitat degradation and artificial lighting effects resulting from coastal development, and degradation and loss of seagrass and marine algae foraging resources. Illegal harvest of eggs and mature adults and incidental fisheries mortality remain significant threats, particularly outside the United States. Predation on depleted population groups and diseases (e.g., fibropapillomatosis) are also emerging risks (NMFS and USFWS 2007a).

OCCURRENCE IN THE ACTION AREA

Kenney and Vigness-Raposa (2010) recorded one confirmed sighting within the RI/MA WEA in 2005. Five green turtle sightings were recorded off the Long Island shoreline 10 to 30 miles southwest of the WEA in aerial surveys conducted from 2010 to 2013 (NEFSC and SEFSC 2018), but none were positively identified in multi-season aerial surveys of the RI/MA WEAs from October 2011 to June 2015 (Kraus et al. 2016). However, the aerial survey methods used in the region to date are unable to reliably detect juvenile turtles and do not cover the shallow nearshore habitats most commonly used by this species. Although green turtles are expected to be relatively uncommon, their occurrence is likely underestimated in the WDA. Although green sea turtles are relatively uncommon compared to other species in the WDA portion of the action area, they may still be present. Denes et al. (2019a) did not attempt to estimate green sea turtle density in the action area to support modeling of hydroacoustic impacts because no accurate estimate is available.

Juvenile green sea turtles represented 6% of 293 cold-stunned turtle stranding records collected in inshore waters of Long Island Sound from 1981 to 1997 (Gerle et al. 1998) and represent the lowest number of overall stranding between 1979 and 2016 (Figure 8). These and other sources of information indicate that juvenile green turtles occur periodically in shallow nearshore waters of Long Island Sound and the coastal bays of New England (Morreale et al. 1992; Massachusetts Audubon 2012), but their presence offshore in the Lease Area is also possible.

Based on the available information, green sea turtle occurrence in the action area appears to be low but cannot be ruled out. They would most likely occur as juveniles or subadults in the shallow coastal waters adjacent to the Long Island shoreline and, potentially, in Lake Montauk. The species could occur in the offshore portion of the WDA, but their expected occurrence is low.

FEEDING BEHAVIOR AND HEARING

Green turtles spend most of their lives in coastal foraging grounds including open coastline waters (NMFS and USFWS 2007a). Green turtles often return to the same foraging grounds following periodic nesting migrations (Godley et al. 2002). However, some green sea turtles remain in the open ocean habitat for extended periods, and possibly never recruit to coastal foraging sites (Pelletier et al. 2003). Once thought to be strictly herbivorous, more recent research indicates that this species also forages on invertebrates including jellyfish, sponges, sea pens, and pelagic prey while offshore, and sometimes in coastal habitats (Heithaus et al. 2002).

Piniak et al. (2016) studied hearing sensitivity in green sea turtles and determined species hearing range extends from 50 Hz to 1.6 kHz, with the greatest sound sensitivity from 200 to 400 Hz. The scientific understanding of how green turtles use sound and hearing is not well developed.

Kemp's Ridley Sea Turtle

The Kemp's ridley sea turtle is one of the smallest of sea turtle species. Adults can weigh between 70.5 and 108 pounds (32 and 49 kg) and reach up to 24 to 28 inches (60 to 70 centimeters) in length (NMFS and USFWS 2007b). The population was severely decimated in 1985 because of intensive egg collection and fishery bycatch, with only 702 nests counted during the entire year (Bevan et al. 2016; NMFS and USFWS 2015). Recent models indicate a persistent reduction in survival and/or recruitment to the nesting population suggesting that the population is not recovering (NMFS and USFWS 2015). Evaluations of hypothesized causes of the nesting setback, including the Deepwater Horizon oil spill in 2010, have been inconclusive, and experts suggest that various natural and anthropogenic causes could have contributed to the nesting setback either separately or synergistically (Caillouet et al. 2018). The preferred diet of the Kemp's ridley sea turtle is crabs, although they may also prey on fish, jellyfish, and mollusks (NMFS and USFWS 2007b). Kemp's ridley sea turtles are most commonly found in the Gulf of Mexico and along the United States Atlantic Coast. The species is coastally oriented, rarely venturing into waters deeper than 160 feet (50 m). They are primarily associated with mud and sand-bottomed habitats where primary prey species are found (NMFS and USFWS 2007b). Most nesting areas are in the western Gulf of Mexico, primarily Tamaulipas and Veracruz, Mexico. Some nesting occurs periodically in Texas and few other United States, occasionally extending up the Atlantic Coast to North Carolina.

SPECIES STATUS

The Kemp's ridley sea turtle was listed as endangered at the species level with the passage of the ESA in 1970 (35 *Federal Register* 18319). The species has experienced large population declines due to egg harvesting, loss of nesting habitat to coastal development and related human activity, bycatch in commercial fisheries, vessel strikes, and other anthropogenic and natural threats. The species began to recover in abundance and nesting productivity since conservation measures were initiated following listing. However, since 2009, the number of successful nests has declined markedly (NMFS and USFWS 2015). Potential explanations for this trend, including the Deepwater Horizon oil spill in 2010, have proven inconclusive, suggesting that the decline in nesting may be due to a combination of natural and anthropogenic stressors (Caillouet et al. 2018). Population models indicate a persistent reduction in survival and/or nesting adult recruitment, suggesting that the species is not recovering. Current threats include incidental fisheries mortality, ingestion, and entanglement in marine debris, and vessel strikes (NMFS and USFWS 2015).

OCCURRENCE IN THE ACTION AREA

Juvenile and subadult Kemp's ridley sea turtles are known to travel as far north as Long Island Sound and Cape Cod Bay during summer and autumn foraging (NMFS, USFWS and SEAMARNAT 2011). Visual sighting data are limited because this small species is difficult to observe using aerial survey methods (Kraus et al. 2016), and most surveys do not cover its preferred shallow bay and estuary habitats. However, Kraus et al. (2016) recorded six observations in the RI/MA WEA over 4 years, all in August and September 2012. The sighting data were insufficient for calculating SPUE for this species (Kraus et al. 2016). Other aerial surveys efforts conducted in the region between 1998 and 2017 have observational records of species occurrence in the waters surrounding the RI/ME WEA during the autumn (September to November) at densities ranging from 10 to 40 individuals per 1,000 km (North Atlantic Right Whale Consortium 2018; NEFSC and SEFSC 2018). Juvenile Kemp's ridley sea turtles represented 66% of 293 cold-stunned turtle stranding records collected in inshore waters of Long Island Sound from 1981 to 1997 (Gerle et al. 1998) and represent the greatest number of sea turtle strandings in most years (see Figure 8).

During spring and summer, juvenile Kemp's ridleys generally occur in the shallow coastal waters of the northern Gulf of Mexico from south Texas to north Florida and along the United States Atlantic coast from southern Florida to the Mid-Atlantic and New England. In addition, the NEFSC caught a juvenile Kemp's ridley during a recent research project in deep water south of Georges Bank (NEFSC unpublished data, as cited in NMFS [2020a]). In the fall, most Kemp's ridleys migrate to deeper or more southern, warmer waters and remain there through the winter (Schmid 1998). As adults, many turtles remain in the Gulf of Mexico, with only occasional occurrence in the Atlantic Ocean (NMFS, USFWS and SEAMARNAT 2011). Adult habitat largely consists of sandy and muddy areas in shallow, nearshore waters less than 120 feet (37 m) deep (Landry and Seney 2008; Shaver et al. 2005; Shaver and Rubio 2008), although they can also be found in deeper offshore waters.

Based on this information, juvenile and subadult Kemp's ridley sea turtle could occur in the action area from July through September and perhaps as late as October. The highest likelihood of occurrence is in coastal nearshore areas adjacent to Long Island and, potentially, Lake Montauk Harbor. Occurrence in the offshore portion of the action area is also possible but unlikely with increasing distance from shore. Denes et al. (2020a) estimated that Kemp's ridley sea turtles occur in the action area at a low density of 0.009 individuals/km^2 across all months for the purpose of hydroacoustic impact modeling (see Table 11).

FEEDING BEHAVIOR AND HEARING

When present in and near the action area, juvenile Kemp's ridley sea turtles are foraging primarily in inshore waters. Kemp's ridley sea turtles are generalist feeders that prey on a variety of species, including crustaceans, mollusks, fish, jellyfish, and tunicates, and forage on aquatic vegetation. The species is also known to ingest natural and anthropogenic debris (Burke et al. 1993, 1994; Witzell and Schmid 2005). Crabs compose most of the diet of juveniles foraging in NYS waters (Burke et al. 1993, 1994; Morreale et al. 1992; Morreale and Standora 1998).

Dow Piniak et al. (2012) concluded that sea turtle hearing is generally confined to lower frequency ranges below 1.6 kHz, with the greatest hearing sensitivity between 100 and 700 Hz, varying by species. Bartol and Ketten (2006) determined that Kemp's ridley hearing is more limited, ranging from 100 to 500 Hz, with greatest sensitivity between 100 and 200 Hz. The scientific understanding of how Kemp's ridley sea turtles use sound and hearing is not well developed.

Leatherback Sea Turtle

The leatherback sea turtle is the largest sea turtle in the world and one of the largest living reptiles (NMFS 2012). Adults can reach up to 2,000 pounds (900 kg) and can be more than 6 feet (2 m) long (NMFS 2012; NMFS and USFWS 2007c). The species has unique characteristics that distinguish it from other sea turtles. Instead of bony plates, it has a carapace consisting of a leather-like outer layer of oil-saturated connective tissue covering a nearly continuous layer of small dermal bones (NMFS and USFWS 1992). Unlike other predatory sea turtles with crushing jaws, the leatherback has evolved a sharp-edged jaw for consuming soft-bodied oceanic prey such as jellyfish and salps (NMFS 2012).

The leatherback is the most globally distributed sea turtle species, ranging broadly from tropical and subtropical to temperate regions of the world's oceans (NMFS and USFWS 1992). The species nests on tropical and subtropical beaches. Nesting beaches in the United States is concentrated in southeastern Florida from Brevard County south to Broward County (NMFS and USFWS 1992; USFWS 2015). Leatherbacks are a pelagically oriented species, but they are often observed in coastal waters along the United States continental shelf (NMFS and USFWS 1992). Leatherbacks have been sighted along the entire coast of the eastern United States from the Gulf of Maine in the north and south to Puerto Rico, the Gulf of Mexico, and the U.S. Virgin Islands (NMFS and USFWS 1992).

SPECIES STATUS

The leatherback sea turtle was listed as endangered at the species level with the passage of the ESA in 1970 (35 *Federal Register* 18319). Critical habitat was designated in 1999 and covers core nesting and breeding areas, migratory habitat, and offshore foraging and overwintering areas along the Atlantic and Gulf Coasts of the United States (64 *Federal Register* 14052). The population estimate (total number of adults) in the Atlantic is 34,000 to 94,000 (NMFS and USFWS 2013; TEWG 2007). Aside from the western Caribbean, nesting trends at all other Atlantic nesting sites are generally stable or increasing (NMFS and USFWS 2013; TEWG 2007). Critical habitat does not occur in the action area. Primary threats to the species include illegal harvesting of eggs, nesting habitat loss, and shoreline development. In-water threats include incidental catch and mortality from commercial fisheries, vessel strikes, anthropogenic noise, marine debris, oil pollution, and predation by native and exotic species (NMFS and USFWS 1992).

OCCURRENCE IN THE ACTION AREA

Leatherback sea turtles are commonly observed in and near the action area. The high observation frequency compared to other turtle species is a function of both distribution and large body size. Leatherbacks are a predominantly pelagic species that ranges into cooler waters at higher latitudes than other sea turtles, and their large body size makes the species easier to observe in aerial and shipboard surveys. The CETAP regularly documented leatherback sea turtles on the OCS between Cape Hatteras and Nova Scotia during summer months in aerial and shipboard surveys conducted from 1978 through 1988. The greatest concentrations were observed between Long Island and the Gulf of Maine (Shoop and Kenney 1992). AMAPPS surveys conducted from 2010 through 2013 routinely documented leatherbacks in the action area and surrounding areas during summer months (NEFSC and SEFSC 2018). Leatherbacks were the most frequently sighted sea turtle species in monthly aerial surveys of the RI/MA WEA from October 2011 through June 2015. Kraus et al. (2016) recorded 153 observations (161 animals) in monthly aerial surveys, all between May and November, with a strong peak in August (see Table 12). Leatherback SPUE in the RI/MA WEA from 2011 to 2015 are displayed by season in Figure 9. As shown, most of the observations were clustered to the east of the action area south of Nantucket Island; however, several summer observations were recorded in immediate proximity to the SFWF. Leatherbacks tagged off Massachusetts showed a strong affinity to the northeast United States continental shelf before dispersing widely throughout the northwest Atlantic (Dodge et al. 2014). From the tagged turtles in this study, there was a strong seasonal component to habitat selection, with most leatherbacks remaining in temperate latitudes in the summer and early autumn and moving into subtropical and tropical habitat in the late autumn, winter, and spring. Leatherback turtles might initiate migration when the abundance of their prey declines (Sherrill-Mix et al. 2008).

Based on this information, leatherback sea turtles are likely to occur in the action area between May and November, with the highest probability of occurrence from July through September.

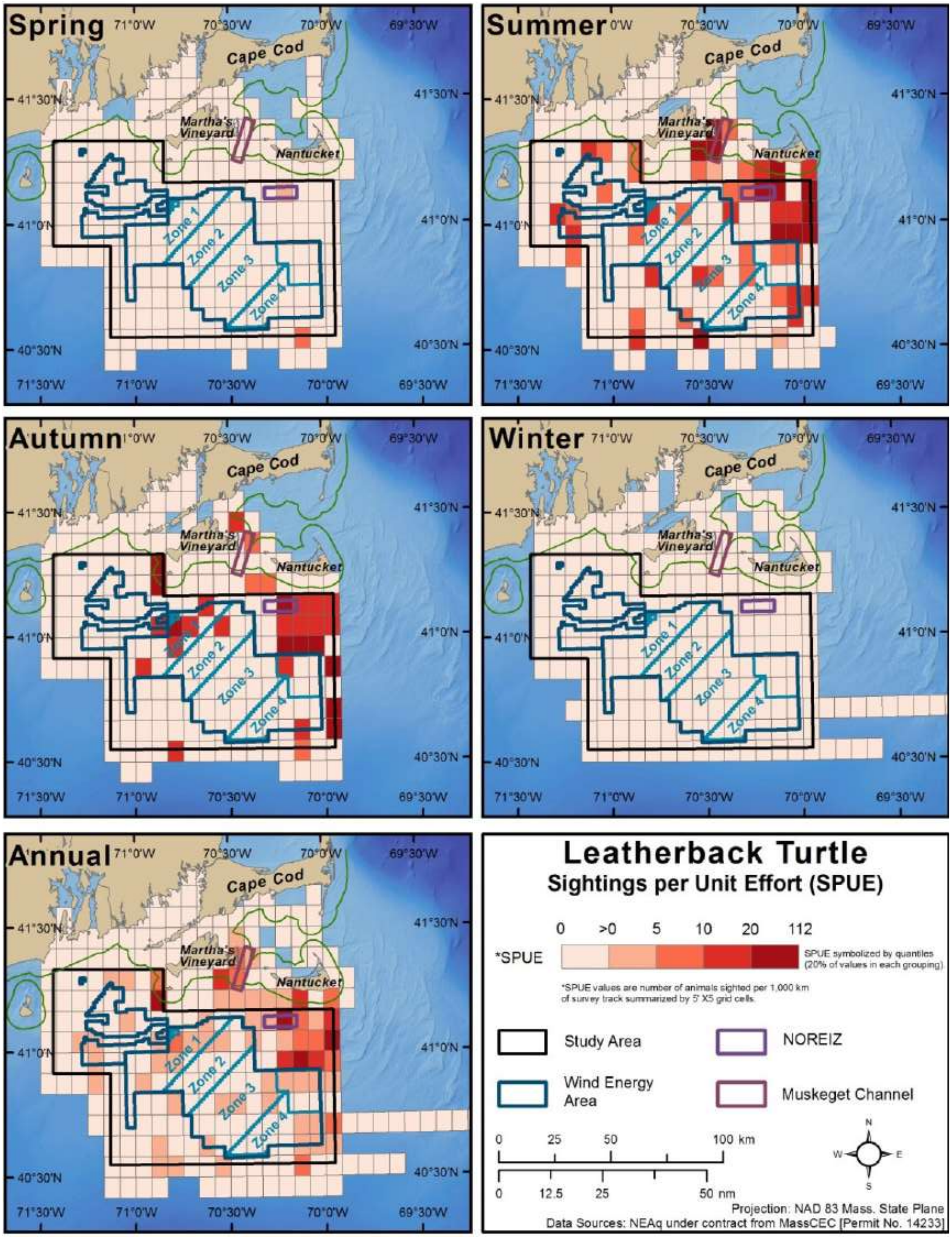

Figure 9. Leatherback sea turtle seasonal sightings per unit effort in the Rhode Island-Massachusetts Wind Energy Area (Kraus et al. 2016).

FEEDING BEHAVIOR AND HEARING

Leatherback sea turtles from nesting areas in the southern United States, Central and South America, and the Caribbean migrate to the open ocean waters of the North Atlantic OCS in spring and early summer to feed, spending up to 4 months in the region before returning south in autumn. Leatherbacks are dietary specialists, feeding almost exclusively on jellyfish, siphonophores, and salps, and migratory behavior is closely tied to the availability of pelagic prey resources (Eckert et al. 2012; NMFS and USFWS 1992). James et al. (2005) studied migratory behavior using satellite tags and observed that the timing of southerly migration ranges widely, extending from mid-August to mid-December, but with a distinct peak in October. The continental slope to the east and south of Cape Cod and the OCS south of Nantucket appear to be hotspots, where several tagged turtles congregated to feed for extended periods. The latter comports with Kraus et al. (2016), who recorded most of their leatherback sightings in the same area (Figure 9). The migratory corridors between breeding and northerly feeding areas appear to vary widely, with some individuals traveling through the OCS and others using the open ocean far from shore (James et al. 2005).

Dow Piniak et al. (2012) determined that the hearing range of leatherback sea turtles extends from approximately 50 to 1,200 Hz, which is comparable to the general hearing range of turtles across species groups. Leatherbacks greatest hearing sensitivity is between 100 and 400 Hz. The scientific understanding of how leatherback turtles use sound and hearing is not well developed.

Northwest Atlantic Distinct Population Segment of Loggerhead Sea Turtle

The loggerhead sea turtle is a globally distributed species found in temperate and tropical regions of the Atlantic, Pacific, and Indian Oceans (NMFS and USFWS 2008). Loggerheads are the most common sea turtle species observed in offshore and nearshore waters along the United States East Coast, and virtually all of these individuals belong to the Northwest Atlantic DPS. Most of the loggerhead sea turtles nesting in the eastern United States occur from North Carolina through southwest Florida. Some nesting also occurs in southern Virginia and along the Gulf of Mexico coast westward into Texas (NMFS and USFWS 2008). Foraging loggerhead sea turtles range widely—they have been observed along the entire Atlantic Coast of the United States as far north as the Gulf of Maine (Shoop and Kenney 1992) and northward into Canadian waters. The loggerhead is distinguished from other sea turtle species by a relatively large head with powerful jaws evolved for capturing and crushing hard-shelled organisms (NMFS 2012). It preys on crustaceans, mollusks, jellyfish, small finfish, and other marine organisms (NMFS and USFWS 2008).

SPECIES STATUS

The Northwest Atlantic DPS of loggerhead sea turtle was listed as federally threatened under the ESA effective on October 24, 2011 (76 *Federal Register* 58868). The regional abundance estimate in the Northwest Atlantic Continental Shelf in 2010 was approximately 588,000 adults and juveniles of sufficient size to be identified during aerial surveys (interquartile range of 382,000 to 817,000; NEFSC and SEFSC 2011). Although some progress has been made since publication of the 2008 loggerhead sea turtle recovery plan (NMFS and USFWS 2008), the recovery units have not met most of the critical benchmark recovery criterion (NMFS and USFWS 2019b). Critical habitat has not been designated. Factors affecting the conservation and recovery of this species include beach development, related human activities that damage nesting habitat, and light pollution (NMFS and USFWS 2008). In-water threats include bycatch in commercial fisheries, vessel strikes, anthropogenic noise, marine debris, legal and illegal harvest, oil pollution, and predation by native and exotic species (NMFS and USFWS 2008).

OCCURRENCE IN THE ACTION AREA

In southern New England loggerhead sea turtles can be found seasonally, primarily in the summer and autumn months when surface temperatures range from 44.6ºF to 86ºF (7ºC to 30ºC) (Kenney and Vigness-Raposa 2010; Shoop and Kenney 1992). Loggerheads are absent from southern New England during winter months (Kenney and Vigness-Raposa 2010; Shoop and Kenney 1992). During the CETAP surveys, one of the largest observed aggregations of loggerheads was documented in shallow shelf waters northeast of Long Island (Shoop and Kenney 1992). Loggerheads were most frequently observed in areas ranging from 72 to 160 feet (22 and 49 m) deep. Over 80% of all sightings were in waters less than 262 feet (80 m), suggesting a preference for relatively shallow OCS habitats (Shoop and Kenney 1992). Juvenile loggerheads are prevalent in the nearshore waters of Long Island from July through mid-October (Morreale et al. 1992; Morreale and Standora 1998), accounting for more than 50% of live strandings and incidental captures (Morreale and Standora 1998). Extensive tagging results suggest that tagged loggerheads occur on the continental shelf along the United States Atlantic from Florida to North Carolina year-round but also highlight the importance of summer foraging areas on the Mid-Atlantic shelf, northerly which includes the Action Area (Winton et al. 2018).

The loggerhead was the most frequently observed sea turtle species in 2010 to 2013 AMAPPS aerial surveys of the Atlantic continental shelf. Large concentrations were regularly observed in proximity to the RI/MA WEA (NEFSC and SEFSC 2018). Kraus et al. (2016) observed loggerhead sea turtles within the RI/MA WEA in the spring, summer, and autumn, with the greatest density of observations in August and September. Loggerhead SPUE in the RI/MA WEA from 2011 to 2015 are displayed by season in Figure 10. Denes et al. (2019a) estimated a species density ranging from 0.35 individuals/km^2 in the spring and autumn and a peak density of 0.38 individuals/km^2 in the summer (Table 11).
Collectively, the available information indicates that loggerhead sea turtles are likely to occur in the action area as adults, subadults, and juveniles from the late spring through early autumn. The highest probability of occurrence is in August and September.

FEEDING BEHAVIOR AND HEARING

The loggerhead sea turtle has a powerful beak and crushing jaws specially adapted to feed on hard-bodied benthic invertebrates, including crustaceans and mollusks. Mollusks and crabs are primary food items for juvenile loggerheads (Burke et al. 1993). Although loggerheads are dietary specialists, the species demonstrates the ability to adjust their diet in response to changes in prey availability in different geographies (Plotkin et al. 1993; Ruckdeschel and Shoop 1988). For example, loggerheads in the Gulf of Mexico feed primarily on crabs, but sea pens are also a major part of the diet. Loggerheads in Chesapeake Bay, Virginia, primarily targeted horseshoe crabs (*Limulus polyphemus*) in the early to mid-1980s but subsequently shifted their diet to blue crabs in the late 1980s, and then to finfish from discarded fishery bycatch in the mid-1990s (Seney and Musick 2007).

Martin et al. (2012) and Lavender et al. (2014) used behavioral and auditory brainstem response methods to identify the hearing range of loggerhead sea turtles. Both teams identified a generalized hearing range from 50 Hz to 1.1 kHz, with greatest hearing sensitivity between 100 and 400 Hz. The scientific understanding of how loggerhead sea turtles use sound and hearing is not well developed.

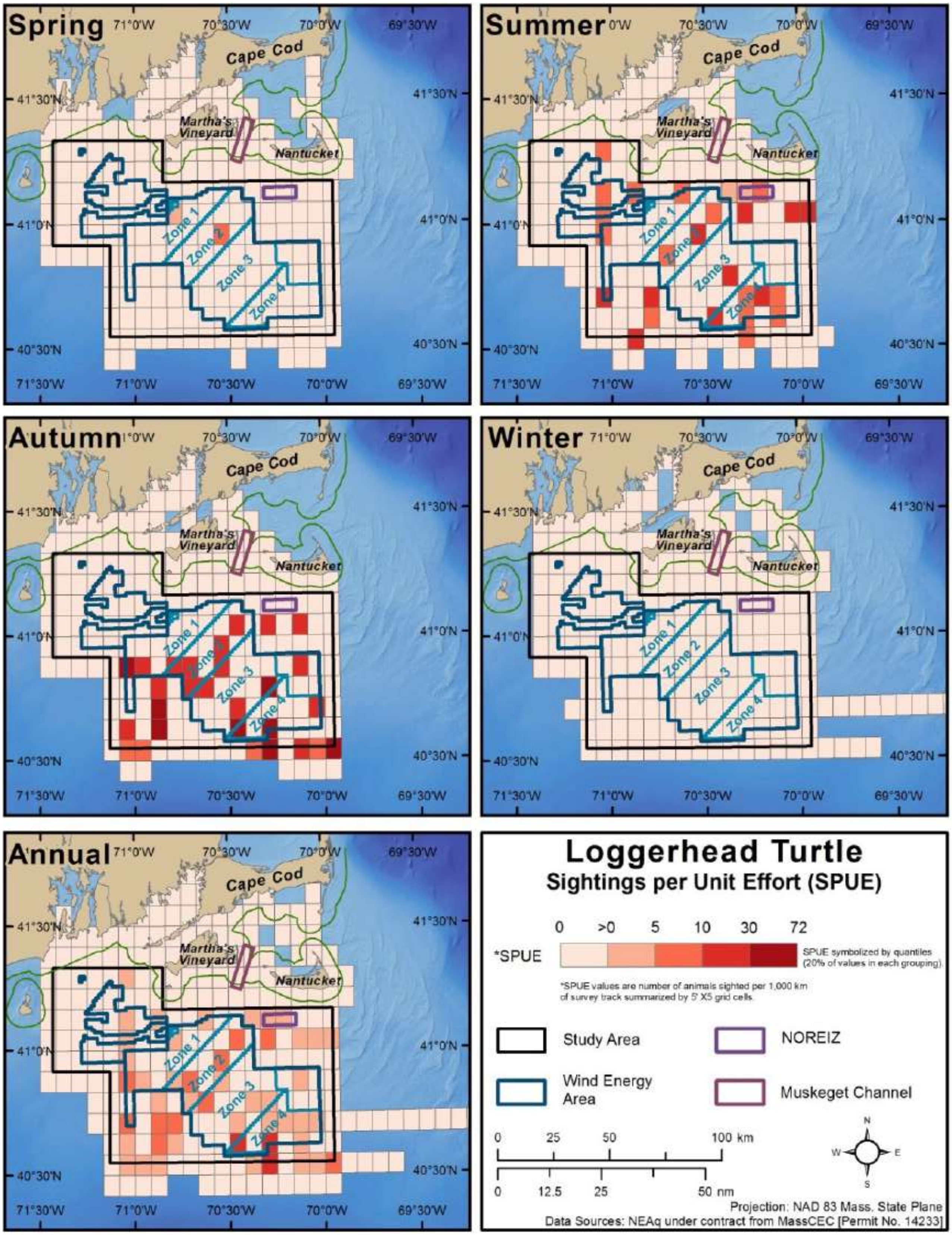

Figure 10. Loggerhead sea turtle seasonal sightings per unit effort in the Rhode Island-Massachusetts Wind Energy Area (Kraus et al. 2016).

Marine Fish

The only ESA-listed fish species considered for analysis in this BA is the Atlantic sturgeon. There are five DPSs of Atlantic sturgeon present or likely to be present in the action area.

Atlantic Sturgeon

The Atlantic sturgeon is a large bottom-feeding fish that grows up to 14 feet (4.2 m), reaches weights up to 600 pounds (270 kg), and lives up to 60 years. The species is anadromous and spawns in medium to large rivers on the United States Atlantic Coast. It is known to inhabit 38 major estuarine and associated riverine systems in the eastern United States and Canada (ASSRT 2007) from Labrador Inlet, Labrador, Canada, to Cape Canaveral, Florida (77 *Federal Register* 5879).

Adult and subadult Atlantic sturgeon range widely across the Atlantic OCS, feeding primarily on benthic invertebrates and small fish on or near the seabed. They appear to congregate in areas providing favorable foraging conditions (Stein et al. 2004a, 2004b), exhibit dietary flexibility, and can adapt to changing prey availability (Guilbard et al. 2007; Johnson et al. 1997).

Male Atlantic sturgeon generally do not reach maturity until at least 12 years and females as late as 19 years (Dovel and Berggren 1983). Their interannual spawning period can range from 3 to 5 years, and adults inhabit marine waters either all year during non-spawning years or seasonally during spawning years (Bain 1997). Tagging data show that while at sea, adults intermix with populations from other rivers (Collins et al. 2000, as cited in ASSRT 2007). Despite their ability to range widely along the Atlantic coast, tagging and genetic studies indicate high site fidelity in natal rivers and very low gene flow among populations (Dovel and Berggren 1983; Grunwald et al. 2008; Savoy and Pacileo 2003).

SPECIES STATUS

Five separate DPSs of Atlantic sturgeon were listed under the ESA in 2012 (77 *Federal Register* 5880, 77 *Federal Register* 5914): Chesapeake Bay (endangered), Carolina (endangered), New York Bight (endangered), South Atlantic (endangered), and Gulf of Maine (threatened). Final determinations listing the Atlantic sturgeon New York Bight and Chesapeake Bay DPSs as endangered, Gulf of Maine DPS as threatened (77 *Federal Register* 5880), and Carolina and South Atlantic DPSs as endangered (77 *Federal Register* 5914) were issued in February 2012, and the rulings became effective on April 6, 2012. Atlantic sturgeon originating from rivers in Canada are not currently listed.

As part of the final rule listing, factors leading to the five statutory ESA listing factors were identified: 1) present or threatened destruction, modification, or curtailment of its habitat or range; 2) overutilization for commercial, recreational, scientific, or educational purposes; 3) predation or disease; 4) inadequacy of existing regulatory mechanisms; or 5) other natural or manmade factors affecting their continued existence. The listing rule from 2012 included the following threats to recovery of Atlantic sturgeon: destruction of habitat or range, dams and tidal turbines, dredging and blasting, and degradation of water quality (77 *Federal Register* 5880).

The species has suffered significant population declines across its range as a result of historical overfishing and degradation of freshwater and estuarine habitats by human development (ASSRT 2007). Bycatch mortality, water quality degradation, and dredging activities remain persistent threats. Some populations are impacted by unique stressors, such as habitat impediments and apparent ship strikes (ASSRT 2007).

OCCURRENCE IN THE ACTION AREA

The Atlantic sturgeon demonstrates strong spawning habitat fidelity and extensive migratory behavior (Savoy et al. 2017). Adults and subadults migrate extensively along the Atlantic coastal shelf (Erickson et al. 2011; Savoy et al. 2017), and all life stages use the coastal nearshore zone as a migratory corridor between river systems (ASSRT 2007; Eyler et al. 2004). Erickson et al. (2011) found that adults remain in nearshore and shelf habitats ranging from 6 to 125 feet (2 to 38 m) in depth, preferring shallower waters in the summer and autumn and deeper waters in the winter and spring. Data from capture records, tagging studies, and other research efforts (Damon-Randall et al. 2013; Dunton et al. 2010; Stein et al. 2004a, 2004b; Zollett 2009) indicate the potential for occurrence in the action area during all months of the year. Individuals from every Atlantic sturgeon DPS have been captured in the Virginian marine ecoregion (Cook and Auster 2007; Wirgin et al. 2015a, 2015b), which extends from Cape Cod, Massachusetts, to Cape Lookout, North Carolina.

Adult and subadult endangered Atlantic sturgeon are expected to occur in offshore waters within the action area throughout the year but appear to be present in lower numbers in the summer (Stein et al. 2004b). Dunton et al. (2015) caught sturgeon as bycatch in waters less than 50 feet deep during the New York summer flounder fishery, and Atlantic sturgeon occurred along eastern Long Island in all seasons except for the winter, with the highest frequency in the spring and fall. The species migrates along coastal New York from April to June and from October to November (Dunton et al. 2015). Ingram et al. (2019) studied Atlantic sturgeon distribution using acoustic tags and determined peak seasonal occurrence in the offshore waters of the OCS from November through January, whereas tagged individuals were uncommon or absent from July to September. The authors reported that the transition from coastal to offshore areas, predictably associated with photoperiod and river temperature, typically occurred in the autumn and winter months.

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

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

Collectively, this information indicates that Atlantic sturgeon are likely to occur in the action area as subadults and adults,[5] and that individuals from every extant DPS could be present in the action area during any month of the year.

FEEDING BEHAVIOR AND HEARING

Atlantic sturgeon are opportunistic predators that feed primarily on benthic invertebrates but will adjust their diet to exploit other types of prey resources when available. For example, Johnson et al. (1997) found that polychaetes composed approximately 86% of the diet of adult Atlantic sturgeon captured in the New York Bight. Isopods, amphipods, clams, and fish larvae composed the remainder of the diet, with the latter accounting for up to 3.6% of diet in some years. In contrast, Guilbard et al. (2007) observed that small fish

[5] Subadults are defined as sexually immature individuals between 30 and 59 inches (760 to 1,500 mm) total length; adults are defined as sexually mature individuals greater than 59 inches (1,500 mm) (NOAA 2018a).

accounted for up to 38% of subadult Atlantic sturgeon diet in the St. Lawrence River estuarine transition zone during summer, but less than 1% in fall. The remainder of the diet consisted primarily of amphipods, oligochaetes, chironomids, and nematodes with the relative importance of each varying by season.

Meyer et al. (2010) and Lovell et al. (2005) studied the auditory system morphology and hearing ability of lake sturgeon (*Acipenser fulvescens*), a closely related species. The Acipenseridae (sturgeon family) have a well-developed inner ear that is independent of the swim bladder. The results of these studies indicate a generalized hearing range from 50 to approximately 700 Hz, with greatest sensitivity between 100 and 300 Hz.

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
- The impact of state or private actions that are contemporaneous with the consultation in process (50 CFR 402.02)

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

Seabed and Water Column Habitat Conditions

The marine component of the action area extends from the SFWF portion of the action area located near Cox Ledge in Rhode Island Sound on the OCS of southern New England westward to the coastal nearshore of Long Island associated with the SFEC landing (see Figure 1). This portion of the OCS is located in the Virginian subprovince of the Northeast Atlantic Temperate Marine bioregion (Cook and Auster 2007). The marine component of the action area is divided into three subareas for the purpose of describing the environmental baseline: the SFWF, the section of the SFEC located in federal waters on the OCS (i.e., the SFEC-OCS), and the section of the SFEC located in NYS waters (i.e., SFEC-NYS) (see Figure 1).

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 CMECS aquatic setting, substrate, and biotic components for the three Proposed Action subareas are described in Table 13.

The biotic component of the CMECS classifies living organisms of the seabed and water column based on physical habitat associations across a range of spatial scales. This component is organized into a five-level branched hierarchy: biotic setting, biotic class, biotic subclass, biotic group, and biotic community. The biotic subclass is a useful classification category for characterizing the aquatic ecosystem in the action area. Biotic component classifications in the SFWF and SFEC footprints are defined by the dominance of life forms, taxa, or other classifiers observed in surveys of the site. Biotic component classification in the O&M facility footprint is based on available literature for Lake Montauk. In the case of photographs, dominance is assigned to the taxa with the greatest percentage cover in the photograph (FGDC 2012).

Table 13. Coastal and Marine Ecological Classification Standard Aquatic Setting, Substrate Group, and Biotic Subclasses in the Action Area

Proposed Action Element	CMECS Component				
	Aquatic Setting			Substrate Group	Biotic Subclass
	System	Subsystem	Tidal Zone		
SFWF and SFEC offshore	Marine	Offshore	Subtidal	Gravel Gravelly	Soft Sediment Fauna Attached Fauna Inferred Fauna
SFEC nearshore	Marine	Nearshore	Subtidal	Gravelly	Soft Sediment Fauna Inferred Fauna
SFWF O&M facility	Estuarine	Coastal	Intertidal Subtidal	Sand Muddy Sand	Soft Sediment Fauna Inferred Fauna Aquatic Vascular Vegetation Benthic Macroalgae Emergent Tidal Marsh

Seabed Conditions

The Applicant conducted surveys of substrate conditions and associated benthic fauna in the SFWF and SFEC Proposed Action footprint (Fugro 2018a, 2018b; Inspire Environmental 2018). Three benthic habitat types were documented in the three subareas within the action area. Sand sheets were the dominant habitat type throughout the marine component of the action area, with sand and mobile gravel present in portions of the SFWF and the SFEC, particularly along the SFEC-OCS. Patchy cobbles and boulders on sand were only observed within and directly around the SFWF, concentrated predominantly on the western side of the SFWF footprint. Ripples and low-relief mounds and hummocks were the dominant bedforms associated with these habitat types, indicating a dynamic and mobile bed environment (Fugro 2018a, 2018b; Inspire Environmental 2018).

The O&M facility would be located in Lake Montauk Harbor, a shallow coastal embayment surrounded by natural and developed shorelines. The facility would be sited in developed harbor areas adjacent to the federally maintained navigation channel and boat basin at the northern end of the bay. Subtidal depths in this area range from -2 to -20 feet MLLW (USACE 2018). The surrounding shorelines are mostly bulkhead, armored, or otherwise modified and intertidal habitats been dredged to provide vessel access. Some limited areas of undredged shoreline supporting eelgrass are present on the eastern side of the navigation channel (NYSDS 2014). Substrates within and adjacent to the navigation channel are primarily sand, transitioning to sand and silt within the boat basin and the southern end of the lake.

The dominant CMECS biotic subclass across the SFWF was Soft Sediment Fauna (see COP Appendix N [Inspire Environmental 2018]). The Soft Sediment Fauna subclass includes any invertebrate that creates a permanent or semi-permanent home in the substrate. Invertebrates that move slowly over the sediment surface but are not capable of moving outside of the boundaries of the subclass within 1 day are also included. Most of the invertebrates associated with the Soft Sediment Fauna possess specialized organs for burrowing, digging, embedding, tube-building, anchoring, or locomotion in soft substrates. Invertebrates associated with the Soft Sediment Fauna subclass include worm-like invertebrates (e.g., oligochetes, polychaetes, flatworms [Platyhelminthes], and nematodes [Nematoda]); burrowing amphipods, mysids, and copepods; crabs (Brachyura); sand dollars (Clypeasteroida); starfish (Asteroidea); and sea urchins (Echinoidea) (FGDC 2012; see COP Appendix N). Economically important species, including sea scallops, horseshoe crabs (Limulidae), surf clams, and the ocean quahog, are also associated with the Soft Sediment Fauna subclass.

The second dominant CMECS biotic subclass (i.e., co-dominant subclass) across the SFWF and offshore SFEC identified during surveys was Attached Fauna. The Attached Fauna subclass often co-occurs with the Soft Sediment Fauna subclass. Invertebrates classified as Attached Fauna maintain contact with hard substrate surfaces, including firmly attached, crawling, resting, interstitial, or clinging invertebrates. Attached invertebrates may be found on, between, or under rocks or other hard substrates or substrate mixes. These invertebrates use pedal discs, cement, byssal threads, feet, claws, appendages, spines, suction, negative buoyancy, or other means to stay in contact with the hard substrate, and may or may not be capable of slow movement over the substrate. Invertebrates typically associated with the Attached Fauna subclass include sea anemones, barnacles, corals, mussels, oysters, some crabs, small shrimp, amphipods, starfish, and sea urchins (FGDC 2012; see COP Appendix N). Economically important species, notably lobster and squid, are also associated with the Attached Fauna subclass. These hard substrate areas serve as important nursery habitat for juvenile lobster and substrate upon which squid lay their eggs.

Dominant CMECS biotic subclasses in Lake Montauk included Benthic Macroalgae, Aquatic Vascular Vegetation, and Emergent Tidal Marsh, as well as Soft Sediment Fauna. Macroalgae is associated primarily with artificial hard surfaces (e.g., the jetty at the harbor mouth), eelgrass occurs in shallow nearshore areas throughout the inner harbor, and emergent tidal marsh vegetation is most prevalent along undeveloped shorelines at the southern end of the lake. Lake Montauk supports commercial harvest of scallops and oysters, including oyster aquaculture. Scallops, crabs, shrimp, periwinkles, clams, oysters, and slipper shells periodically occur within the lake. Grass shrimp are the most abundant species encountered in ongoing biological surveys (NYSDS 2014).

Benthic habitats in the SFWF and SFEC are subjected to regular disturbance by commercial fishing activity. Bottom-disturbing methods like bottom trawls, scallop and clam dredges, and lobster pots are the dominant gear types used in the area (Deepwater Wind, LLC 2018). Chronic disturbance of benthic habitat communities by commercial fishing activities can negatively impact community structure and diversity and limit recovery, potentially for long time periods (Nilsson and Rosenberg 2003; Rosenberg et al. 2003). In contrast, benthic communities that are adapted to naturally dynamic environments like those present in the action area tend to recover from disturbance relatively quickly (Dernie et al. 2003). Montauk Harbor is routinely dredged to maintain navigation and desired berthing depths. Regular dredging-related disturbance has similar effects on benthic community structure.

Water Column Conditions

The marine component of the action area is located in coastal and open waters of the Atlantic OCS. Water depths in the three Proposed Action subareas range from 108 to 125 feet (33–38 m) below MLLW in the SFWF, 85 to 154 feet (26–47 m) in the SFEC-OCS, and 30 to 85 feet (9–26 m) in the SFEC-NYS. Water depths in the surrounding area are similar. The regional waters off the coast of Rhode Island, Massachusetts, and Long Island, New York, are a transitional zone separating Narragansett Bay and Long Island Sound from the OCS (BOEM 2013). These waters straddle the Mid-Atlantic and New England ecoregions and support a diverse and abundant community of marine organisms in the region.

The Mid-Atlantic cold pool is a seasonal oceanographic feature that provides important ecological functions for marine species through its influence on regional biological oceanography (Chen 2018; Lentz 2017). Changes in the size and seasonal duration of the cold pool over the past five decades have been associated with shifts in the fish community composition of the Mid-Atlantic Bight (Chen 2018; Saba and Munroe 2019). The WDA and neighboring WEAs are located on the approximate northern boundary of the cold pool.

Water quality conditions in the action area are described below.

Underwater Noise

Kraus et al. (2016) surveyed the ambient underwater noise environment in the RI/MA WEA as part of a broader study of large whale and sea turtle use of marine habitats in this wind energy development area. The SFWF lies within a dynamic ambient noise environment, with natural background noise contributed by natural wind and wave action, a diverse community of vocalizing cetaceans, and other organisms. Anthropogenic noise sources, including commercial shipping traffic in high-use shipping lanes in proximity to the action area, also contributed ambient sound.

Acoustic monitoring sensor locations in and around the RI/MA WEA are depicted in Figure 11. As shown, sensors RI-1, RI-2, and RI-3 effectively surround the SFWF, whereas the remaining sensor locations are in the more seaward portion of the WEA. Figure 12 displays 50th percentile power spectral density and cumulative percentile distribution of peak ambient sound levels measured between November 2011 and March 2015. Depending on location, ambient underwater sound levels within the RI/MA WEA varied from 96 to 103 dB in the 70.8- to 224-Hz frequency band at least 50% of the recording time, with peak ambient noise levels reaching as high as 125 dB on the western side of the SFWF in proximity to the Narraganset Bay and Buzzards Bay shipping lanes (Kraus et al. 2016). Low-frequency sound from large marine vessel traffic in these and other major shipping lanes to the east (Boston Harbor) and south (New York) are the dominant sources of underwater noise in the action area.

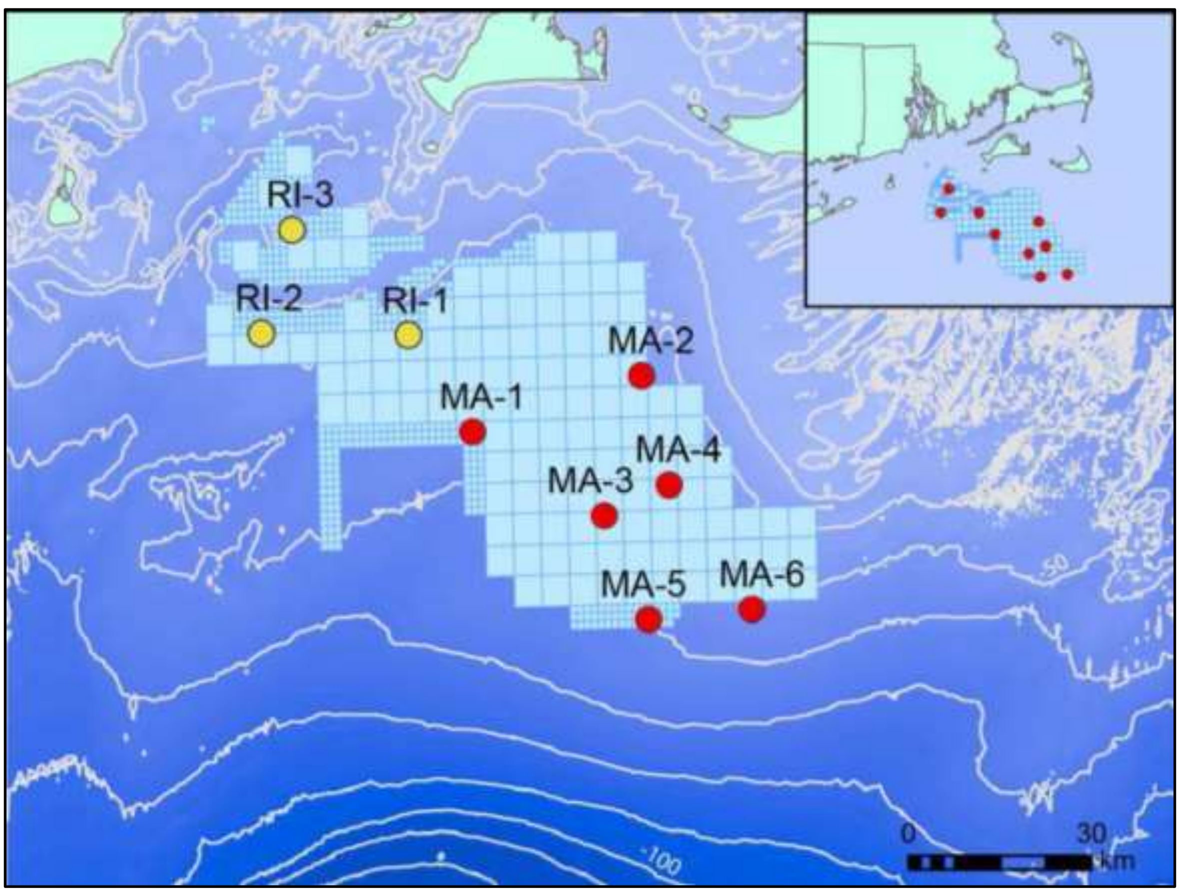

Figure 11. Acoustic monitoring locations near the action area (Kraus et al. 2016).

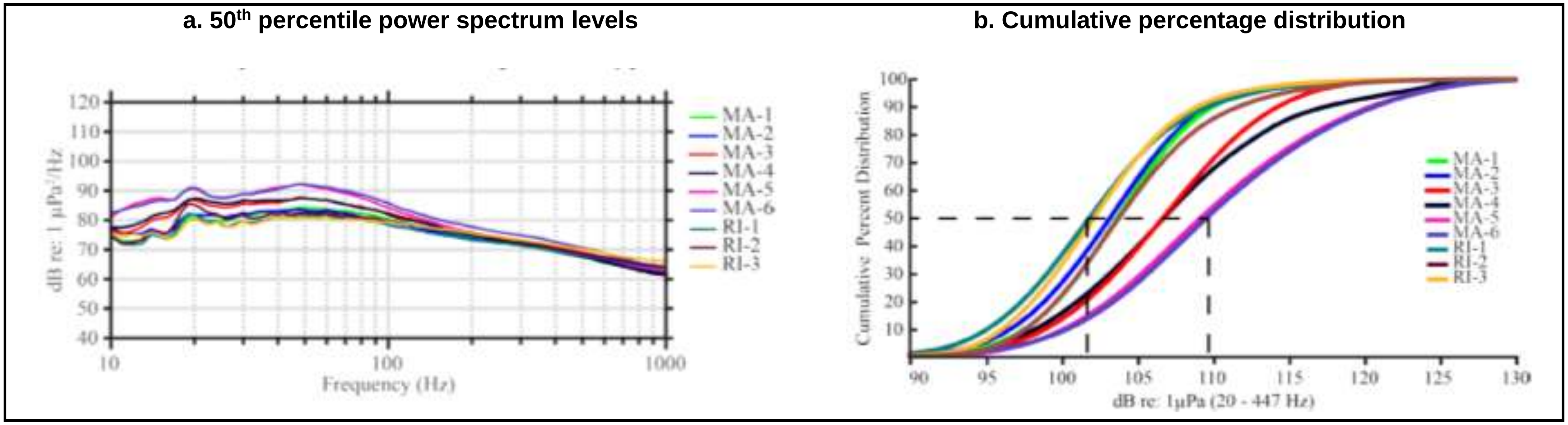

Figure 12. Power spectral density plot and cumulative percentage distribution of sound levels within a 20- to 477-Hz frequency band at ambient underwater noise monitoring locations in the action area (Kraus et al. 2016).

Water Quality

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

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

Water quality conditions in Lake Montauk generally meet state and federal requirements for contact recreation and shellfishing, although portions of the waterbody are closed to shellfish harvest based on proximity to commercial and recreational moorage facilities. Water clarity, nutrient concentration, chlorophyll *a*, and fecal coliform metrics met NYS standards in at least 93% of samples collected in the center of the lake from 1994 through 2011 (NYSDS 2014). Dissolved oxygen met state standards in all samples collected during this period. Fecal coliform levels exceed state standards at specific locations around the lake, associated predominantly with domestic pets and wildlife, with septic systems being a minor source (NYSDS 2014).

For the purpose of Section 7 consultation, total suspended sediment (TSS) is the pertinent water quality parameter likely to be measurably affected by the Proposed Action. Ocean waters beyond 3 miles (4.8 km) offshore typically have low concentrations of suspended particles and low turbidity. TSS in Rhode Island Sound from five studies cited in ACE (2004) ranged from 0.1 to 7.4 milligrams/liter (mg/L) TSS. Bottom currents may re-suspend silt and fine-grained sands, causing higher suspended particle levels in benthic waters. Storm events, particularly frequent intense wintertime storms, may also cause a short-term increase in suspended sediment loads (BOEM 2013). Vinhateiro et al. (2018) assumed that ambient TSS levels in the marine component of the action area were generally low, less than 10 mg/L. However, Inspire Environmental (2018) periodically encountered water column turbidity levels high enough to prevent observation of the benthos during benthic surveys of the Proposed Action area. This occurred throughout the action area, but most commonly in the shallower waters associated with the SFEC-NYS. Based on camera distance to the bed (Inspire Environmental 2018) and observed relationships between TSS and visibility (West and Scott 2016), this suggests that baseline TSS and turbidity in the action area are generally low but could periodically exceed 100 mg/L near the channel bed.

Electromagnetic Fields

The natural magnetic field in the action area has a total intensity of approximately 512 to 517 milligauss (mG) at the seabed, based on modeled magnetic field strength from 2014 through 2019 (NOAA 2018a). The marine environment continuously generates additional ambient EMF effects. 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 field effects. Their magnitude at a given time and location are 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 generate variable EMF effects.

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). Modeled current speeds in the action area are on the order of 0.1 to 0.35 m/s at the seabed (Vinhateiro et al. 2018), indicating baseline current-induced electrical field strength on the order of 5 to 15 µV/m at any given time. Wave action would also induce electrical and magnetic fields at the water surface on the order of 10 to 100 uV/m and 1 to 10 mG, respectively, depending on wave height, period, and other factors. Although these effects dissipate with depth, wave action would likely produce detectable EMF effects up to 185 feet (56 m) below the surface (Slater et al. 2010).

At least seven submarine power and communications cables cross the marine component of the action area in the SFEC-OCS and SFEC-NYS (NOAA 2011) (Figure 13). The type and power capacity of those cables is not specified in available information. 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 1 m 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.

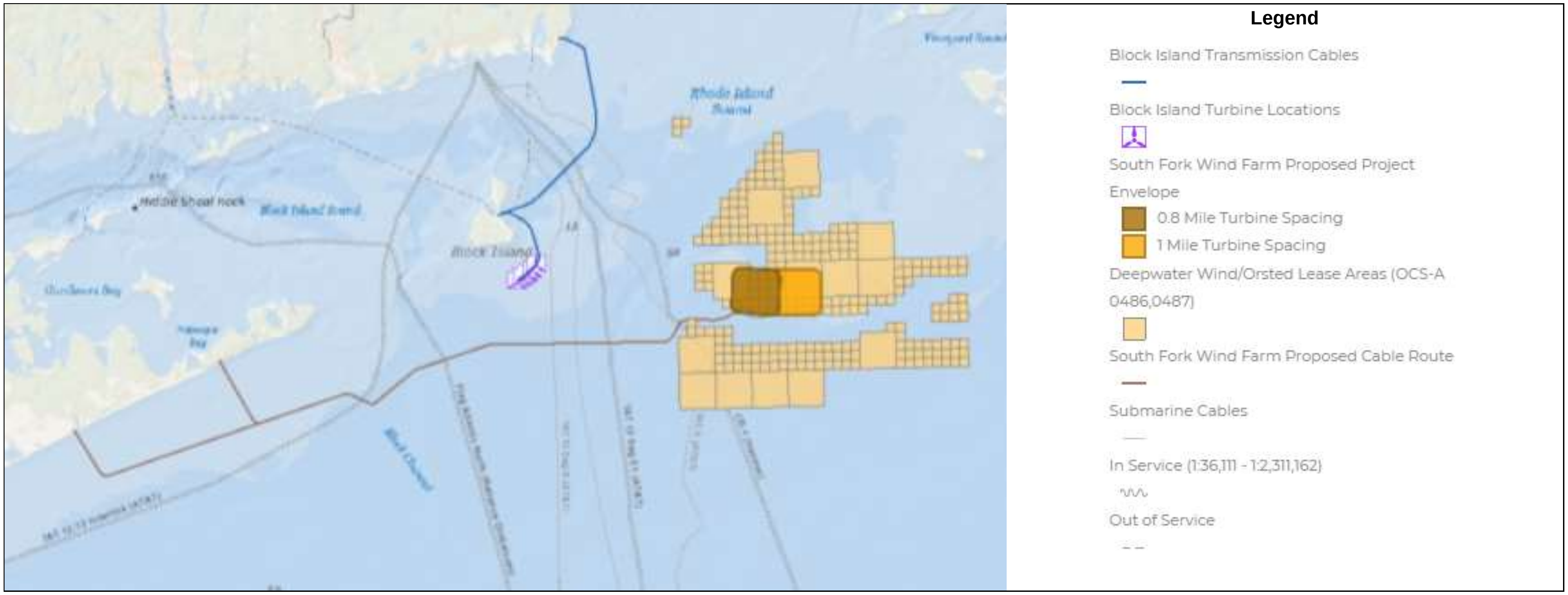

Figure 13. Existing submarine transmission and telecommunications cables in the action area.

Artificial Light

Vessel traffic and navigational safety lights on buoys and meteorological towers are the only artificial lighting sources in the open-water portion of analysis area. Land-based artificial light sources become more predominant approaching the Long Island shoreline.

Vessel Traffic

General vessel traffic in the action area varies, ranging from thousands of large and small vessel trips in and around major shipping lanes to dozens of vessel trips in the low-traffic areas in the SFWF footprint (DNV GL 2018). DNV GL 2018 summarized vessel traffic in the WDA based on automatic identification system (AIS) data from July 18, 2016, through July 18, 2017. The data include eight vessel classes: cargo/carrier, fishing, other and unidentified, passenger, pleasure, tanker, tanker – oil, and tug and service. Most vessels sail between 8 and 12 knots. A 5-mile buffer around the WDA was used to determine the vessel types transiting in the area; AIS data suggest that only fishing, other and unidentified, and pleasure vessels currently transit within the SFWF. No military vessels operated in this area during this period. In 2016, there were 19,164 vessel crossings of a measurement line between Montauk and Sconticut Neck, located south of New Bedford in Buzzards Bay. Approximately 75% of these crossings were fishing or pleasure vessels. Tug and service vessels accounted for 74% of the 7,209 transits originating from Brooklyn and Staten Island. Fishing and pleasure vessels account for approximately 83% of the vessels that went into the WDA.

DNV GL (2018) analyzed vessel traffic patterns in the WDA to assess navigation safety risks using a two-step analysis. The first step relied on quantification of vessel transits through designated cross sections in proximity to the action area using AIS data for all vessel classes. The second step relied on Vessel Monitoring System (VMS) data for fishing vessels. Fishing vessels commonly deactivate their AIS transponders when actively fishing to avoid revealing proprietary fishing areas. The VMS system provides location data used by NMFS to monitor fishing activity while maintaining confidentiality.

Figure 14 displays AIS vessel tracks and the 20 analysis cross sections in proximity to the Proposed Action footprint, regional traffic corridors, and port entrances, excluding foreign ports and the Gulf of Mexico. Vessel transits through each cross section during the study period are displayed in Figure 15. Vessel classes represented by these results include deep-draft commercial vessels (e.g., cargo/carriers and tankers), tugs/barges, service, fishing, passenger and recreational vessels, and other or unspecified vessel types. Annual vessel transits through each analysis cross section are summarized in Figure 15.

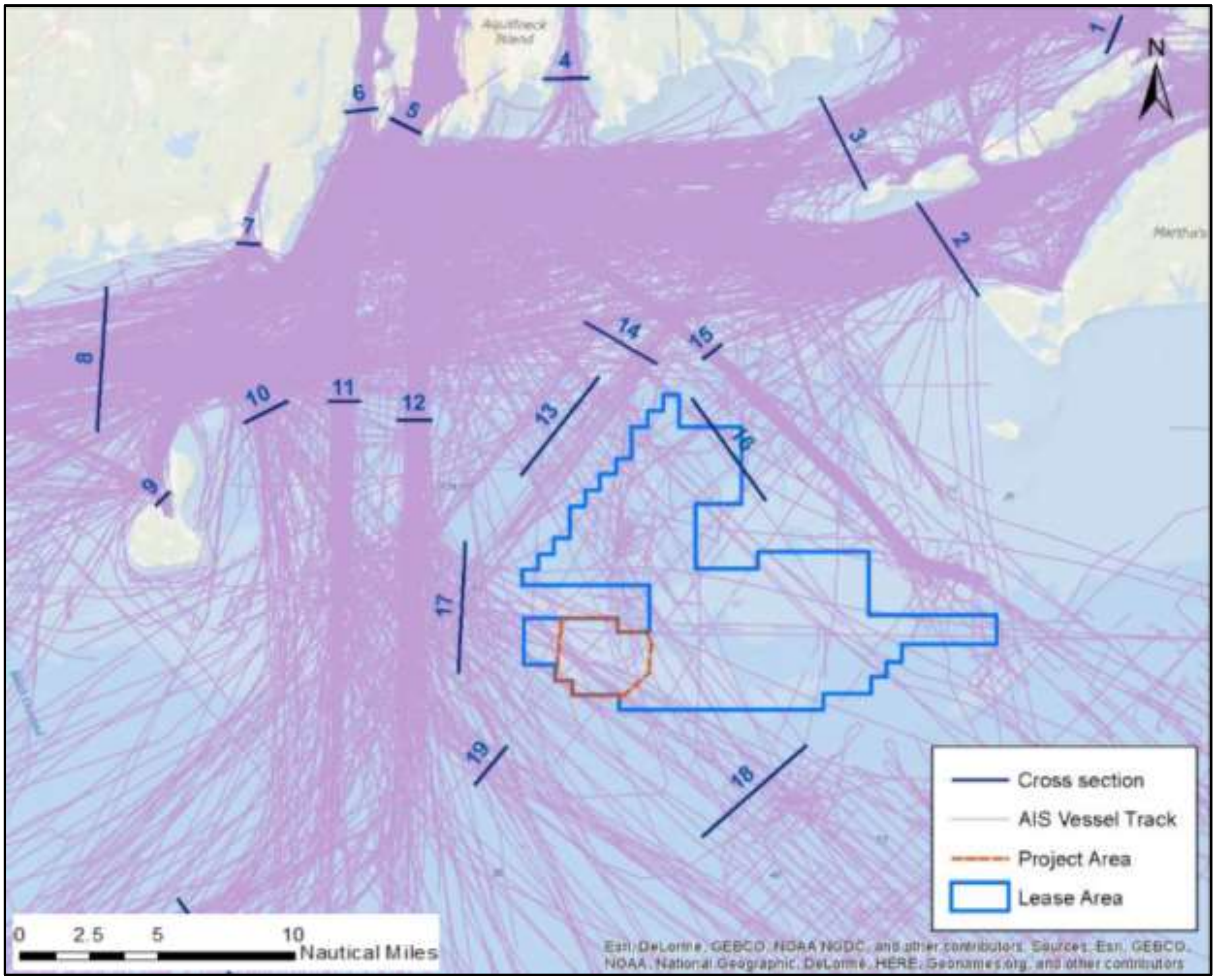

Figure 14. Automatic identification system vessel traffic tracks for June 2016 to July 2017 and analysis cross sections used for traffic pattern analysis (DNV GL 2018).

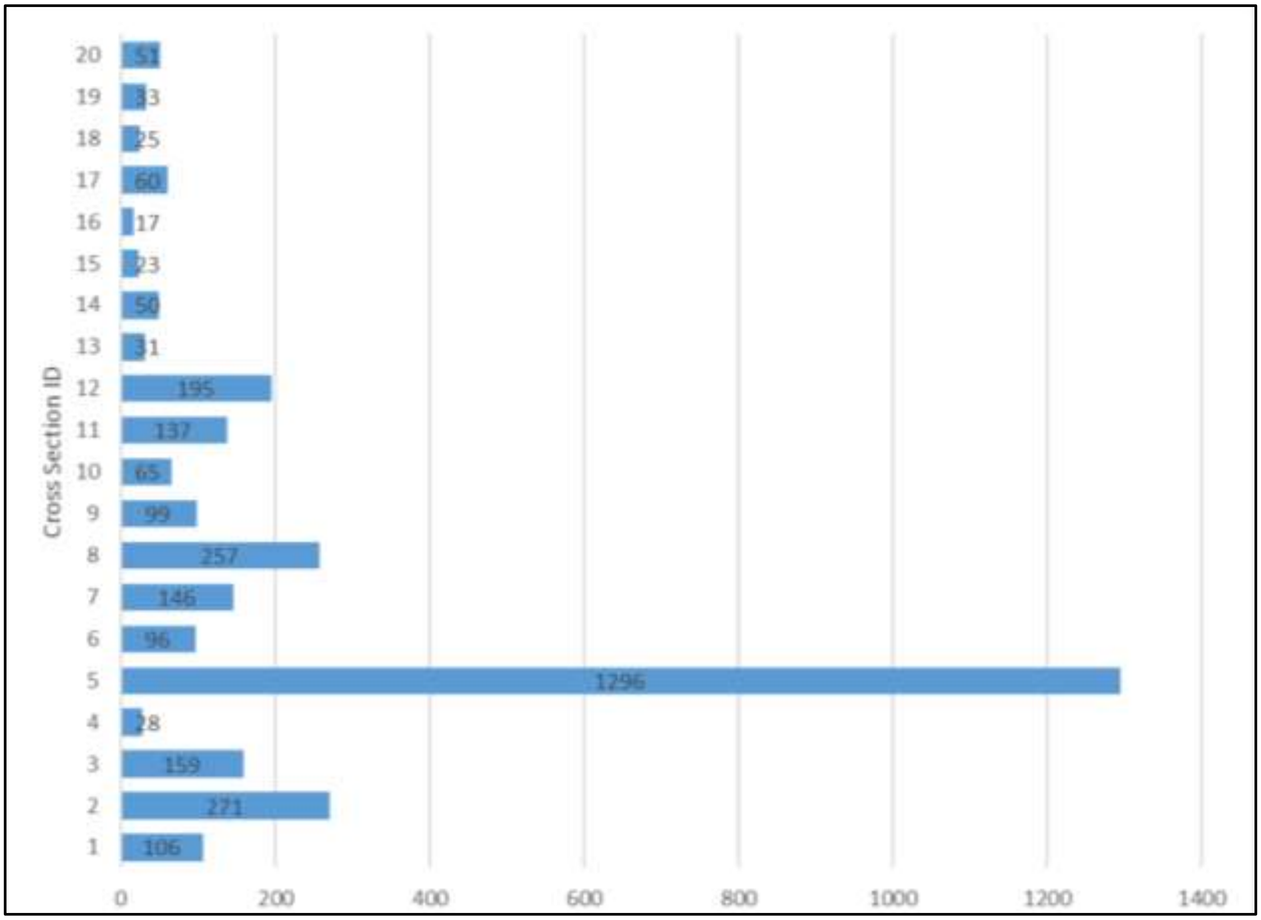

Figure 15. Vessel transits from June 2016 to July 2017 by analysis cross section, all vessel classes (DNV GL 2018).

As shown, the cross sections surrounding the Lease Area (13, 16, and 18) have relatively low annual traffic counts with less than 30 transits per year. Cross-section 17 has a slightly higher annual traffic count with 60 transits per year. From cross-section 17, many of the tracks are merging into/out of the Buzzards Bay inbound traffic lane and do not cross through the Lease Area. In contrast, the approach to Narraganset Bay (cross-section 5) has a high level of vessel traffic consistent with the presence of several commercial and recreational port facilities and a major naval and coast guard facility. These results do not include commercial fishing traffic, which is underrepresented in the AIS data.

DNV GL (2018) analyzed the proportional distribution of vessel types crossing each cross section. Half of the traffic transiting cross-sections 13 and 16 is from pleasure/recreation vessels with "other" vessels being the next largest contributor. Cross-section 17, which captures vessels merging in and out of regional traffic separation zones, shows 55% of the tracks captured

are from deep draft vessels (cargo/carrier and tankers). Approximately 76% of transits through cross-section 18 are in other, passenger, or recreational vessel categories. Recreational fishing vessels are likely included in this category or underrepresented in the AIS dataset.

Analysis of VMS data for the action area indicates a high level of commercial fishing activity in and near the WDA. Fishing vessels typically do not follow the prescribed routes used by other commercial vessel types and route density patterns are more erratic (DNV GL 2018). VMS vessel activity data are summarized by fishery type in Figure 16. Note that these heat maps only display low-speed operations during actual fishing and not typical vessel speeds when traveling to and from fishing areas. As shown, the SFWF has been sited in a relatively low-intensity fishing area but is surrounded by areas of high-intensity activity. The number of fishing vessels represented in these data is unclear, but likely number in the hundreds based on the 420 fishing vessels active in federal catch share fishery programs in the Mid-Atlantic and New England as of 2016 (NMFS 2018b). Most of these vessels originate from regional ports in Rhode Island, Massachusetts, and Long Island (DNV GL 2018).

Routine and accidental releases of small amounts of petroleum during normal vessel operations accounts for a significant percentage of chronic oil pollution in the world's oceans (International Fund for Animal Welfare n.d.; Hampton et al. 2003; Laws 1993; OSPAR 2010; Weise 2002). Small oil releases from tankers and cargo vessels commonly occur during bilge water discharge and normal engine operations. Illicit discharges from shipping traffic are also a global concern. Based on the proximity of the action area to major shipping lanes and high vessel traffic, chronic low-level oil pollution is likely to be present throughout the action area.

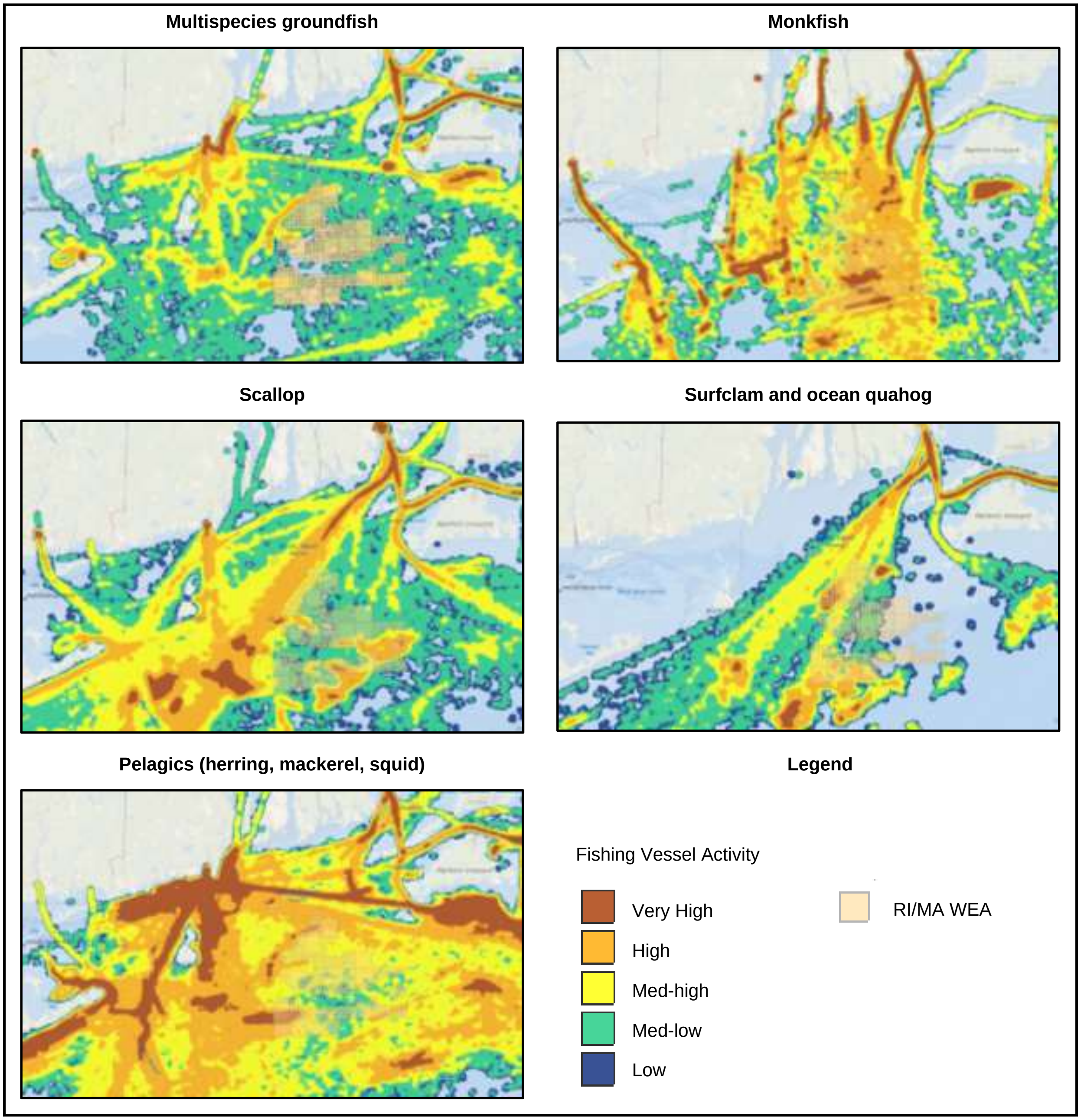

Figure 16. Commercial fishing vessel activity in proximity to the Proposed Action area by fishery type.

EFFECTS OF THE PROPOSED ACTION

The effects of the Proposed Action on the environment were analyzed using the Proposed Action PDE maximum impact scenario described above in the Proposed Action section. Effects of the action are all consequences to listed species or critical habitat that are caused by the Proposed Action. This includes the consequences of other activities that would not occur but for the Proposed Action that are reasonably certain to occur. Effects were considered relative to the likelihood of species exposure to those effects 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 where specific thresholds are lacking the extent and variability of environmental effects relative to baseline conditions described in this BA and associated documents referenced.

Seabed and Water Column Disturbance

Proposed Action construction would result in direct disturbance to the seabed within the SFWF and along the SFEC corridor, including temporary construction-related disturbance and long-term alteration of the seabed by Proposed Action features. These Proposed Action effects are summarized by area and Proposed Action component in Table 14 and are described in detail below.

Temporary construction-related disturbance in the SFWF would total 858 acres of seabed, comprising 821 acres from construction vessel anchoring and 37 acres for site preparation, trenching, and burial of the inter-array cable. The vessel anchoring disturbance area estimate is based on the conservative assumption that three construction vessels would use anchors, three vessels would use spud cans, and all six construction vessels would visit each of the 16 foundations. SFEC cable placement would temporarily disturb 73 acres of seabed in the SFEC-OCS and 4.4 acres in the SFEC-NYS during trenching and burial. Temporary cofferdam placement and sediment sidecast during sea-to-shore transition construction would temporarily disturb approximately 0.15 acre of seabed. The affected seabed is composed primarily of unconsolidated sand and gravel deposits that are regularly reworked by current action (Fugro 2018a, 2018b). Benthic communities that inhabit dynamic bed environments typically recover rapidly from construction-related disturbance, usually within 1 year (Dernie et al. 2003; Department for Business, Enterprise and Regulatory Reform 2008).

The footprint of the SFWF WTGs and OSS foundations and associated scour protection in the form of boulders and concrete mats would modify approximately 28.1 acres of seabed. Approximately 12.5 acres of scour protection would be required where boulder substrates prevent burial of the inter-array cable. An estimated 24.4 acres of scour protection would be required for portions of the SFEC cable route where cable burial is not possible (21.1 and 1.3 acres in the SFEC-OCS and SFEC-NYS, respectively). This would only occur in areas where boulders or other hard substrates are present on or immediately below the bed surface. Although these effects would be long term, the placement of additional rock on existing mixed-boulder substrate would not substantially alter the character of the current habitat.

Table 14. Summary of Temporary Disturbance and Long-Term, Alteration of the Seabed from Construction of the South Fork Wind Farm and South Fork Export Cable

Proposed Action Component	Feature	Temporary Disturbance (acres)	Long-Term Alteration (acres)
SFWF	Monopile foundation and scour protection	–	15.6
	Foundation cable protection	–	5.2
	Inter-array cable track preparation, trenching and burial	37.0	--
	Inter-array cable scour protection	–	12.5
	Construction vessel anchoring	821	–
	Total	**858**	**33.3**
SFEC-OCS	Cable track preparation, trenching and burial	73	–
	SFEC cable scour protection	–	3.4
	Total	**73**	**3.4**
SFEC-NYS	Cable track preparation, trenching and burial	4.4	–
	Scour protection	–	0.2
	Cofferdam	0.15	–
	Total	**4.55**	**0.2**

In general, effects from temporary disturbance and alteration of the seabed would be limited to the potential for some short-term displacement of some ESA-listed marine mammal species in the action area due to temporary turbidity or displacement of prey species. The baleen whale species addressed in this consultation are pelagic filter feeders that do not forage in or rely on benthic habitats. Sperm whale are known to prey on bottom-oriented organisms including octopus, fish, shrimp, crab, and sharks. However, given the limited area affected, temporary seabed disturbance is unlikely to affect the prey base for this species. Therefore, the effects of the Proposed Action on ESA-listed whales resulting from benthic habitat alteration are likely to be insignificant.

Leatherback sea turtles are dietary specialists, feeding almost exclusively on pelagic jellyfish, salps, and siphonophores, rather than prey species affected by benthic habitat alteration. Green, Kemp’s ridley, and loggerhead sea turtles all feed on benthic organisms; however, benthic habitat disturbances are anticipated to be temporary and localized and unlikely to affect the availability of prey resources for these species. The Proposed Action would avoid impacting submerged aquatic vegetation and would therefore avoid adversely affecting forage resources for green and Kemp’s ridley sea turtles. Although the Proposed Action would temporarily impact benthic prey resources, those effects would be temporary and limited to less than 0.0001% of the action area and an even smaller percentage of suitable foraging habitat in nearshore and offshore areas of the Atlantic OCS. Given that the action area is naturally dynamic and exposed to anthropogenic disturbance, the species that occur in this region already adjust their 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 disturbance, the temporary and localized nature of these effects, and the ability of these species to adjust their diet in response to resource availability, the resulting effects of benthic disturbance on these species would be insignificant.

A similar rationale applies to Atlantic sturgeon. Although Proposed Action construction would kill or displace preferential prey organisms within the footprint defined by placement of the monopiles, scour protection, the inter-array cable and SFEC corridors, and the sea-to-shore transition cofferdam and sidecast, these effects would be temporary in duration and limited to an insignificant (less than 0.0001%) percentage of available foraging habitat in the action area. Given the limited extent of effects and the likelihood of rapid recovery to baseline benthic community conditions, the effects of Proposed Action construction on seabed and water column habitat conditions are likely to be insignificant.

The WTG and SFEC OSS foundations constitute obstacles in the water column that could alter the normal behavior of aquatic organisms in the SFWF. Although operational noise is recognized as a potential effect mechanism, insufficient information is available to characterize how the presence of WTG foundations in the water column would affect the behavior of whales, fish, and other organisms (Long 2017; Thompson et al. 2015). Long (2017) compiled several years of observer data for marine mammal and bird interactions with tidal and wave energy testing facilities in Scotland. He was unable to identify any changes in behavior or distribution associated with the presence of ocean energy structures once construction was complete, concluding that the available data were insufficient to determine the presence or absence of significant effects.

Other research on the behavioral and displacement effects of offshore structures is equivocal. Delefosse et al. (2017) reviewed marine mammal sighting data around oil and gas structures in the North Sea and found no clear evidence of species attraction or displacement. In contrast, Russel et al. (2014) found clear evidence that seals were attracted to a European wind farm, apparently exploiting the abundant concentrations of prey produced by artificial reef effects, while Teilmann and Carstensen (2012) documented the apparent long-term displacement of harbor porpoises from previously occupied habitats within and around a windfarm in the Baltic Sea.

The NMFS (2020a) biological opinion for the Vineyard Wind project considered the effects of WTG foundation presence on ESA-listed marine mammals and concluded the following:

> The WTGs are proposed to be laid out in a grid-like pattern with spacing of 0.76-1.0 nautical mile between turbines. The minimum distance between nearest turbines is no less than 0.65 nautical mile and the maximum distance between nearest turbines is no more than 1.1 nm. The average spacing between turbines is 0.86 nm. The upper range of whale lengths are as follows: North Atlantic right whale (59 feet [18 meters]), fin whale (79 feet [24 meters]), sei whale (59 feet [18 meters]), and sperm whales (59 feet [18 meters]). As noted in the BA, for reference, about 103, 59-ft long North Atlantic right whales (large females) would fit end-to-end between two foundations spaced at 1 nm. Based on a simple assessment of spacing, it does not appear that the WTGs would be a barrier to the movement of any listed species through the area. (NMFS 2020a:249–250)

Given that the Proposed Action involves a smaller number of turbines sited in a similar configuration, it is reasonable to conclude that the presence of the SFWF would not pose a barrier to the movement of ESA-listed marine mammals.

The SFWF monopiles, scour protection, and cable armoring would introduce new, stable hard surfaces to the marine environment, producing an artificial reef effect (Langhamer 2012; Wilson and Elliot 2009). These surfaces would be available for colonization by algae and sessile organisms, and would concentrate fish and other species, potentially altering predator-prey dynamics near the structures. The resulting effects on ESA-listed species could be neutral or beneficial, depending on how those species interact with structures in the environment. Overall, these effects are likely be insignificant based on the size of the affected area relative to the habitat available across the range of each species.

Underwater Noise Effects

NMFS recognizes high underwater sound pressure levels (SPLs) as a possible source of take for ESA-listed aquatic species, including large whales, sea turtles, and fish occurring in the action area. The Proposed Action would produce temporary construction-related and long-term operational underwater noise above levels that may impact listed species. Potential sources include impact and vibratory pile driving during construction, construction and operational vessel noise, and operational noise from the WTGs.

For the purpose of this consultation, the action area is defined by the greatest distance from the source required to attenuate underwater noise below the lowest biologically significant effects threshold for each listed species group, and/or for their prey and forage species. Potential behavioral and injury-level take of listed species from pile driving would be restricted to this effect area, with the extent and severity of effects dependent on the timing of pile driving relative to species occurrence, the type of noise impact, and species-specific sensitivity. The Applicant conducted Project-specific modeling to characterize the area affected by underwater noise from impact and vibratory pile driving and from construction vessel operation, and to estimate the number of each ESA-listed species likely to be exposed to injury and behavioral level effects from these noise sources. The results of this modeling effort were used to develop the effects analysis presented in this BA and are described below.

Denes et al. (2020b) modeled maximum underwater noise levels likely to be produced by impact and vibratory pile-driving activities and Proposed Action construction vessels. They used a refined noise attenuation model that factors in multiple parameters affecting noise propagation in the marine environment, producing an accurate estimate of potential effects. The PDE assumptions used in this analysis are as follows:

- 11-m monopile foundation installation:
  - Assumes 1 “difficult” installation scenario requiring 8,000 pile strikes over a 4-hour period for each pile, and 15 “normal” installations requiring 4,000 pile strikes over a 2-hour period, using an impact hammer operating at 4,500 kilojoules.
  - Assumes use of a noise attenuation system achieving a 10-dB reduction in peak noise levels.
  - Monopile installation would occur between May 1 and December 31.
  - Aggressive installation scenario: Six piles are driven over 7 days, such that the 16 piles are installed over a 20-day period. Each installation would be separated by a minimum of 12 hours.
- Sheet pile cofferdam installation and removal:
  - Vibratory hammer installation of Z-type steel sheet piles 9 m (30 feet) into the sediment.
  - Installation would require 18 hours of hammer operation over a 1- to 3-day period.
  - Sheet pile removal using a vibratory extractor, requiring approximately 18 hours of hammer operation over 1 to 3 days.
  - Cofferdam installation and removal would occur as separate events at the beginning and end of a 6- to 8-month construction period extending from October 1 to May 31.
  - Sheet pile removal using a vibratory extractor, requiring approximately 18 hours of hammer operation over 1 to 3 days.
- Construction vessels: Peak noise levels produced by typical cable-laying and construction support vessels using dynamic positioning thrusters; model vessels range from 325 to 351 feet (99–107 m) in total length and 4,000 to 6,772 horsepower.

- HRG surveys: Up to 60 days of HRG survey operations, averaging 70 line km per day at a speed of 4 knots. Analysis assumes the loudest potential type of HRG survey equipment.

Denes et al. (2020b) used these assumptions to estimate source noise levels and calculate the distance required to attenuate Proposed Action noise to established injury and behavioral-level effects thresholds for different species groups based on site-specific substrate and oceanographic conditions in and near the action area. The biological effects thresholds reflect the current guidance and best available science. Sound exposure thresholds levels to assess potential effects to ESA-listed species are summarized in Table 15. Noise-related effects on each listed-species group are discussed in the following sections.

Table 15. Threshold Levels Modeled to Assess Potential Effects to Threatened and Endangered Species from Impulsive and Non-Impulsive Noise Sources

Faunal Group	Physiological Thresholds		Behavioral Threshold
	SEL_{cum} $L_{E,24}$ (dB re 1 μPa²·s)	Lpk (unweighted, dB re 1 μPa)	RMS (unweighted, dB re 1 μPa)
Impulsive Noise			
LFC*	183	219	160
MFC*	185	230	160
Sea turtles†	210	207	175
Atlantic sturgeon†	210	207	150
Atlantic sturgeon‡	187	206	150
Non-Impulsive Noise			
LFC*	199	N/A**	120
MFC*	198	N/A**	120
Sea turtles	180§	N/A**	175
Atlantic sturgeon	N/A	N/A**	150

* Data from NMFS (2018a).

† Data from Popper et al. (2014).

‡ NMFS recommended criteria for SEL_{cum} (for fish ≥ 2g) and Lpk (for all sizes of fish) (Fisheries Hydroacoustic Working Group 2008); Lp (Andersson et al. 2007; Purser and Radford 2011; Wysocki et al. 2007, as cited in in NMFS 2020a.

§ NMFS recommended threshold at time COP was submitted.

** Threshold not applicable to this source type.

Marine Mammal Noise Exposure

Cetaceans have well-adapted acoustical and hearing abilities that they rely on for communication, foraging, mating, predator avoidance, and navigation (Madsen et al. 2006; Weilgart 2007). The Proposed Action includes several elements (e.g., pile driving, vessel operation, and WTG operation) that produce underwater noise that could affect marine mammals. These potential effects range in severity from temporary auditory masking, to increased stress, to permanent injury depending on the nature and intensity of the noise source, and proximity and duration of exposure (NMFS 2018a; Rolland et al. 2012; Southall et al. 2007; Williams et al. 2015). Underwater noise can have adverse effects on marine mammals even in the absence of overt injury or observable behavioral effects. Auditory masking due to anthropogenic noise can substantially shrink the “communication space” available to marine mammals, interfering with their ability to identify and locate cohort members, other populations, and other species (Cholewiak et al. 2018). This has important implications for both individual animals and populations. For example, noise-related communication disruptions have been associated with increased stress hormone levels in individual NARW, potentially contributing to immune suppression and depressed reproductive success (Hatch et al. 2012; Rolland et al. 2012). Davis et al. (2017) documented an evident shift in NARW distribution over the past decade and identified anthropogenic noise as a probable contributing factor. The reduced ability to communicate normally across distance may contribute to population dispersal and fragmentation (Brakes and Dall 2016), which can have important implications for the conservation of imperiled populations like NARW.

NMFS has released updated technical guidance for assessing the effects of underwater noise on marine mammals (NMFS 2018a). This guidance considers noise exposure capable of causing a permanent loss of hearing sensitivity, referred to as a permanent threshold shift (PTS), to be the onset of physical injury and relies on the current state of the science to define sound exposure thresholds sufficient to cause PTS in different marine mammal species. NMFS (2018a) provides thresholds for evaluating potential behavioral disturbance effects on marine mammals from both impulsive and non-impulsive noise sources. Different taxa are sensitive to different frequencies of sound, and therefore may be more or less prone to injury-level noise effects depending on the nature and intensity of the noise source. The ESA-listed baleen whales (*Mysticetes*) considered in this assessment belong to the LFC hearing group, which is most sensitive to sound in the 10- to 30-Hz range. The ESA-listed sperm whale belongs to the MFC hearing group, which is most sensitive to sound in the 150-Hz to 160-kHz range (Southall et al. 2007). Species-specific hearing and communication frequencies are discussed in the species descriptions above.

Denes et al. (2020a; 2020b) used these thresholds to evaluate the potential effects of Project construction on marine mammals based on the PDE and the timing and density of species occurrence in the WDA. These results were in turn used to develop an application for an IHA under the MMPA (CSA 2020). The IHA represents the best current understanding of potential noise effects on marine mammals resulting from Project construction. The NMFS (2018a) effect thresholds are also used to evaluate the potential effects of operational noise based on sound intensity and probability of exposure. Underwater noise effects from Project construction and operation are addressed below.

PROPOSED ACTION CONSTRUCTION

Denes et al. (2020b) modeled attenuation distances for impact pile driving, vibratory pile driving, HRG surveys, and construction vessel noise to a selection of marine mammal effect thresholds for different aspects of Project construction using the PDE. The predicted distances to the threshold distances for each proposed activity are summarized in Table 16.

As shown, the effect threshold distances vary by marine mammal hearing group and threshold category. The area of potential PTS injury effects around impact pile driving is largest for the LFC marine mammal group, extending up to 7,846 m, followed by 32 m for MFC. For both LFC and MFC, the distance for potential behavioral disturbance extends up to 4,685 m from a pile.

Table 16. Mean Acoustic Range to Physiological and Behavioral Thresholds by Activity and Species Group

Construction Activity	Species Group	Exposure Distance to Peak Pressure (meters)	Exposure Distance to SEL_{cum} (meters)	Exposure Distance to Behavioral Effects (meters)
Monopile foundation installation‡	LFC	8	7,846	4,684
	MFC	2	32	4,684
Temporary cofferdam installation**, ‡	LFC	N/A	1,470	36,690
	MFC	N/A	0	20,890
Construction vessel operation†, ‡	LFC	N/A	112	14,654
	MFC	N/A	35	13,483
HRG surveys§	LFC	0	1.5	141
	MFC	0	< 1	141
O&M facility improvements††, ‡‡	LFC	N/A	52	N/A
	MFC	N/A	4.5	N/A

‡ Values are maximum modeled effect distance estimates for difficult installation of an 11-m monopile using an IHC S-4000 impact hammer with 10-dB attenuation. A difficult installation would require double the number of hammer strikes anticipated for a typical pile installation. This represents the worst-case scenario for a single difficult pile; the cumulative injury threshold distances for typical pile installation and specific-specific mean 95% exposure ranges would be smaller (Denes et al. 2020b).

** Sheet pile cofferdam installed using a vibratory hammer (Denes et al. 2020b).

§ Maximum threshold distances generated by available HRG equipment types, based on 70 line km/day at a speed of 4 kts (CSA 2020). Project design criteria for certain types of HRG surveys are being developed through consultation with NMFS and the PDCs are expected to be incorporated into this consultation.

† Analysis considered use of dynamic positioning thrusters by construction vessels. This analysis did not consider the timing, frequency, and duration of noise from background vessel traffic in and near the Lease Area. Noise levels produced by construction vessels are expected to be similar to these background sources.

†† Distance to threshold estimated assuming the use of AZ-type sheet piles, with a maximum of 33 piles driven within a 24-hour period.

‡‡ Calculated using the methods and associated analysis tools described in NOAA (2018a).

The areas exposed to behavioral and injury-level noise effects from impact pile driving vary depending on the type of exposure (i.e., single strike, cumulative) and marine mammal hearing group. For example, when the planned noise attenuation system is operating at a 10-dB effectiveness, an individual NARW would have to be within 9 m of active impact pile driving to be injured by peak noise from a single pile strike. In contrast, a right whale that remains within 6,344 m over the 4-hour pile driving session for a difficult foundation installation could experience permanent cumulative hearing injury. Sperm whales, which belong to the MFC hearing group, are relatively insensitive to pile-driving noise in comparison to the other ESA-listed species. Individuals would have to remain within 60 m of pile driving over an entire 4-hour pile-driving session in a given construction day to experience PTS injury.

The PTS threshold distances for vibratory pile driving, HRG surveys, and construction vessel operation are considerably smaller than those for impact pile driving. NARW and the other LFC marine mammals would have to remain within 1,470 m of vibratory pile driving for 18 hours to experience potential PTS effects. PTS distances for the other species and activity types are considerably smaller, less than 112 m (see Table 16).

Underwater noise from Project construction is likely to cause behavioral effects at greater distances, with exceptions depending on the noise source and species sensitivity. The threshold distance for potential behavioral effects on LFCs, specifically NARWs, sei, and fin whales, extends 4,684 m from the source. The cumulative SEL injury threshold distance is greater than the behavioral threshold distance for this group, extending 7,846 m from the source (see Table 16). In contrast, the behavioral effect threshold distance for sperm whales is far larger than the cumulative SEL injury threshold distance (4,684 m versus 32 m, respectively). Non-impulsive intermittent noise sources like vibratory pile driving and construction vessels produce less intense peak sound but are capable of causing auditory masking and behavioral effects at greater distances. Vibratory pile driving and construction vessel noise could cause behavioral effects on NARW, sei, and fin whales up to 36,690 m and 14,654 m from the source, respectively, and on sperm whales up to 20,890 and 13,483 m from the source, respectively (see Table 16).

ESA-listed marine mammal species in this region are not expected to remain near the cofferdam location for an extended amount of time. Additionally, documented aversion responses in many marine mammal species indicate they are likely to avoid the area while vibratory pile-driving activities occur (Ellison et al. 2011). LFCs within approximately 59 km (36.7 miles) of the SFEC sea-to-shore transition could experience behavioral effects from vibratory pile-driving noise during temporary cofferdam installation, excluding areas sheltered by Long Island and other land masses (see Table 16). Although vibratory pile-driving noise can cause behavioral effects at greater distances compared to impact pile-driving noise, the overall sound levels are less intense and less likely to cause injury. LFCs would have to remain within 1.47 km (0.91 mile) over an entire 18-hour vibratory pile-driving event to experience permanent hearing injury. MFCs are less sensitive to the intense, low-frequency sounds produced by vibratory pile driving and would not be expected to experience hearing injury (see Table 16). CSA (2020) evaluated potential marine mammal exposure to two 18-hour periods of vibratory pile driving occurring between October 1 and May 31 and concluded that cofferdam installation would not result in PTS effects on any of the ESA-listed marine mammal species likely to occur in this component of the action area.

The PTS and behavioral threshold distances shown for each species group are useful for characterizing the size of the potential exposure area. Quantifying the potential number of individual marine mammal exposures requires consideration of the timing and duration of the activity relative to species occurrence, occurrence density, and the effectiveness of applicant proposed EPMs and additional mitigation measures required as a condition of Project approval.

The Proposed Action includes a range of measures to avoid and minimize marine mammal exposure to injurious pile-driving noise. The Project would adhere to timing restrictions to avoid periods of peak NARW occurrence to the greatest extent practicable. The Project would implement clearance zones of 4,500 m for NARW and 2,000 m for other ESA-listed whale species around impact pile driving. Clearance zones must be clear of target species for at least 60 minutes before impact pile driving can begin. The Project would maintain exclusion zones of 2,000 m around impact pile driving, the area in which shutdown or other mitigation measures must be implemented if a whale enters that zone while a noise source is active. The Project would similarly implement clearance and exclusion zones of 500 m for NARW and 100 m for other ESA-listed whales around HRG activities, and clearance and exclusion zones of 1,500 m around vibratory pile driving for all ESA-listed species.

The clearance zones would be monitored by Protected Species Observers (PSOs) using PAM, thermal cameras, and visual observations in real time to ensure that they are clear of respective marine mammal species for at least 60 minutes prior to implementing impact pile driving. Pile-driving activities would only commence under visibility and acoustic background conditions suitable to ensure proper site clearance. Although these measures are likely to be effective, they cannot completely eliminate all risk of exposure to potentially harmful noise effects.

Denes et al. (2020a) used a proprietary exposure model to estimate the number of individuals of each ESA-listed species that could be exposed to injury and behavioral-level noise effects under the PDE. The model uses monthly species-specific marine mammal density information for the Mid-Atlantic OCS (Roberts et al. 2016, 2017, 2018). CSA (2020) used the results generated by Denes et al. (2020a, 2020b) and species density developed by Roberts et al. (2016) and Roberts (2018, 2020) to estimate the maximum number of individuals that could be exposed to PTS-level noise effects (i.e. Level A harassment) and temporary threshold shift (TTS) or behavioral disturbance (Level B harassment) when timing restrictions, PSO monitoring, and other planned EPMs and mitigation measures are considered. CSA (2020) developed separate estimates for Project noise from impact pile driving, vibratory pile driving, and HRG surveys. These results are summarized in Table 17.

Table 17. Estimated Number of Individual Endangered Species Act–Listed Marine Mammals Exposed to Permanent and Temporary Threshold Shifts or Behavioral-Level Noise Effects from Project Construction

Species	Individuals Exposed to PTS*			Individuals Exposed to Behavioral Effects		
	Impact Pile Driving	Vibratory Pile Driving	HRG Surveys	Impact Pile Driving	Vibratory Pile Driving†	HRG Surveys
Fin whale	1	< 1	< 1	7	2	3
NARW	< 1	< 1	< 1	4	3	3
Sei whale	< 1	< 1	< 1	1	1	< 1
Sperm whale	< 1	0	0	< 1	0	< 1

Source: CSA (2020).

* Considers both LE (cumulative SEL re: 1 μPa²s) and Lpk (flat peak SPL re: 1 μPa) exposure. LE = cumulative SEL re: 1 μPa²s.

† Cofferdam installation may occur from October through May. Values shown are the range of estimated monthly individual exposures with the peak exposure months in parentheses.

As shown in Table 17, CSA (2020) estimates that, with the exception of fin whales, fewer than one of each ESA-listed marine mammal species would be exposed to PTS injury when planned construction EPMs and mitigation measures are implemented. Values of < 1 or n/a indicate a discountable risk of PTS exposure for NARW and blue, sei, and sperm whales. CSA (2020) estimated that up to one individual fin whale could be exposed to PTS injury from exposure to impact pile driving noise. The likelihood of PTS effects from exposure to vibratory pile driving and HRG survey noise is discountable for all ESA-listed marine mammal species.

CSA (2020) estimates that up to six fin whales and four NARW could be exposed to TTS or behavioral effects from impact pile driving. The number of individuals exposed to TTS and behavioral-level effects from vibratory pile driving varies depending on the timing of cofferdam installation and removal. Depending on the month, between one to four individual fin whales, zero to 12 NARW, and zero to one sei whales could experience TTS or behavioral effects from exposure to vibratory pile driving noise. The likelihood of blue whale and sperm whale exposure to vibratory pile driving noise sufficient to cause TTS or behavioral effects is discountable. In addition, up to three fin whales and three NARW could be exposed to TTS or behavioral effects from HRG survey activities. The likelihood of blue, sei, and sperm whale exposure to TTS or behavioral effects from HRG surveys is discountable.

PROPOSED ACTION OPERATION

Once operational, transmission of vibrations from the WTG drivetrain and power generator into the steel monopile foundation would generate underwater noise. WTGs typically produce audible underwater noise in lower frequency bands that overlap communication frequencies used by some marine mammal species, presenting the potential for auditory masking and behavioral effects. Concern about the extent and significance of these potential effects has motivated several research studies and is a topic of ongoing monitoring and evaluation.

Much of the currently available information on operational noise is based on monitoring of existing windfarms in Europe. Although useful for characterizing the general range of WTG operational noise effects, this information is drawn from studies of older generation WTGs and is not necessarily representative of current generation direct drive systems (Elliot et al. 2019; Tougaard et al. 2020).

These studies indicate that the typical noise levels produced by older-generation geared WTGs range from 110 to 130 root mean square decibel (dB_{RMS}) with 1/3-octave bands in the 12.5- to 500-Hz range, sometimes louder under extreme operating conditions (Betke et al. 2004; Jansen and de Jong 2016; Madsen et al. 2006; Marmo et al. 2013; Nedwell and Howell 2004; Tougaard et al. 2009). Operational noise increases concurrently with ambient wind and wave noise, meaning that noise levels usually remain indistinguishable from background within a short distance from the source under typical operating conditions.

Madsen et al. (2006) concluded that the noise levels observed at operating wind farms would be unlikely to impair marine mammal hearing but could disrupt the behavior of individuals in proximity (i.e., within tens of meters) under low ambient noise conditions. Jansen and de Jong (2016) and Tougaard et al. (2009) concluded that marine mammals would be able to detect operational noise from WTGs within a few hundred meters, but the effects would be insignificant. In contrast, Teilmann and Carstensen (2012) documented apparent long-term behavioral avoidance of historically used habitats by harbor porpoises following offshore windfarm installation. Although the specific causal factors were unclear, these findings suggest at least some potential for WTG-related noise to influence the behavior of this particular species.

More recently, Tougaard et al. (2020) concluded that operational noise from multiple WTGs could elevate noise levels within a few kilometers of large windfarm operations under low ambient noise conditions and recommended further consideration of cumulative noise effects in Project planning and assessment. Specifically, although the combined source level of a large wind farm is smaller or comparable to background noise produced by large cargo ships, the cumulative noise effects of multiple large wind farms constructed in coastal and shelf waters should not be ignored. This is particularly applicable to development in areas having low background noise levels where a change in the noise environment could result in negative effects on marine mammals and other species. Tougaard et al. (2020) caution that their analysis is based on monitoring data for older generation WTG designs that are not necessarily representative of the noise levels produced by modern direct drive systems.

More recently, Elliot et al. (2019) summarized findings from hydroacoustic monitoring of operational noise from the Block Island Windfarm (BIWF). The BIWF is composed of five Haliade 150 6-MW direct-drive WTGs on jacketed foundations located approximately 30 km west of the proposed SFWF. Operational noise from the direct-drive WTGs at the Block Island Windfarm were generally lower than those observed for older generation WTGs, particularly when weighted by the hearing sensitivity of different marine mammal species. Elliot et al. (2019) presented a representative high operational noise scenario at an observed wind speed of 15 m/s (approximately 33 miles per hour), which is summarized in Table 18. As shown, the BIWF WTGs produced frequency weighted instantaneous noise levels of 103 and 79 dB SEL for the LFC and MFC marine mammal hearing groups in the 10-Hz to 8-kHz frequency band, respectively. Frequency weighted noise levels for the LFC and MFC hearing groups were higher for the 10-Hz to 20-kHz frequency band at 122.5- and 123.3-dB SEL, respectively.

Table 18. Frequency Weighted Underwater Noise Levels at 50 Meters from an Operational 6-megawatt Wind Turbine Generator at the Block Island Windfarm

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

Source: Elliot et al. (2019).

* 1-second SEL re 1 $\mu Pa S^2$ at 15 m/s (33 mph) wind speed.

† Cumulative SEL re 1 $\mu Pa S^2$ assuming continuous 24 exposure at 50 m from WTG foundation operating at 15 m/s.

The observed range of operational BIWF WTG noise overlaps the lower and upper limits of the 1/3 octave bands regularly used by several members of the LFC hearing group for communication. For example, NARW and fin whale communication is concentrated in the 36- to 891-Hz and 15- to 22-Hz frequency bands, respectively (Cholewiak et al. 2018). This suggests that WTG noise could theoretically mask or interfere with communication, but this is unlikely because the noise levels produced are low in intensity and likely difficult to distinguish from background within a short distance of the source. For example, the weighted operational noise level of 103-dB SEL in the 10-Hz to 8-kHz frequency band would attenuate to the 50th percentile of ambient noise levels in the RI/MA WEA observed by Kraus et al. (2016) within a few hundred meters. The operational case summarized in Table 18 occurred under high wind speed conditions when ambient wind and wave noise levels are higher. Normal operational noise levels are lower, meaning that the distance required to attenuate WTG noise to background levels is likely less than estimated here.

Sperm whales communicate and search for prey using broadband transient signals between 500 Hz and 24 kHz, with most sound energy focused in the 2- and 9-kHz range (Lohrasbipeydeh et al. 2012). This suggests that weighted operational noise of 79 dB in the 10-Hz to 8-kHz range would be below the 50th percentile of ambient noise levels in the WDA. Again, the noise levels presented in Table 18 represent a worse case and likely overrepresent typical conditions.

Elliot et al. (2019) also estimated cumulative SEL for the BIWF WTGs assuming continuous 24-hour exposure for a stationary receptor located 50 m from the source (see Table 18). The frequency weighted cumulative SEL is below established PTS effect thresholds for the LFC and MFC marine mammal hearing groups (199- and 183-dB SEL, respectively). Therefore, even this unlikely exposure scenario would not result in permanent hearing injury to the ESA-listed marine mammal species likely to occur in the action area.

Based on this information, operational noise effects of the Proposed Action on ESA-listed marine mammals would be insignificant. This determination is consistent with the findings reached by NMFS (2020a) in the biological opinion for the Vineyard Wind project. NMFS determined that underwater noise effects on ESA-listed marine mammals from this project, which is comparable to but larger in scale than the Proposed Action, would be insignificant. They based this determination on the conclusion that operational noise would drop below ambient noise levels within 50 m from each WTG, and ESA-listed whales are unlikely to approach WTG foundations within that distance and would therefore not experience meaningful noise effects.

EFFECTS ON PREY ORGANISMS

Effects on marine mammals from underwater noise impacts on prey organisms are likely to be insignificant based on the sensitivity of preferred forage species to underwater noise. Broadly speaking, the ESA-listed marine mammals occurring in the action area feed primarily on zooplankton and invertebrates, with fish a variable but relatively minor component of the diet. Additional detail on primary prey species that are likely to occur in the action area are described in the species descriptions section of this BA.

The susceptibility of invertebrates to human-made sounds is unclear, and there is currently insufficient scientific basis to establish biological effects thresholds (NOAA 2016). The available research on the topic is limited and relatively recent (Carroll et al. 2016; Edmonds et al. 2016; Hawkins and Popper 2014; Pine et al. 2012; Weilgart 2018). This research indicates that invertebrate sound sensitivity is restricted to particle motion, the effect of which dissipates rapidly such that any effects are highly localized to the immediate proximity (i.e., less than 1 m) from the noise source (Edmonds et al. 2016). This indicates that the invertebrate forage base for marine mammals is unlikely to be measurably affected by underwater noise resulting from the Proposed Action. For this reason, the effects of underwater noise on the prey base for NARW and sei whales are likely to be insignificant because these species are dietary specialists that feed primarily on invertebrate zooplankton.

Fin whales and sperm whales periodically feed on fish, with fin whales preferentially targeting schooling forage fish like sand lance and capelin when available in abundance. Denes et al. (2020b) modeled underwater noise attenuation distances from SFWF and SFEC construction for a range of fish thresholds (Table 15). Effect distances vary depending on fish size. Applying the FHWA (2008) cumulative injury criteria for impulsive sounds, small fish (< 2 grams) and large fish (> 2 grams) within 16,277 m and 12,746 m of the source, respectively, could be exposed to non-lethal and lethal injuries within these ranges (see Table 23).

These results suggest some potential for temporary effects on the availability of fish prey for fin whales and sperm whales. This potential would be mitigated to some extent by EPMs and mitigation measures protecting marine mammals when those species and their fish prey resources co-occur. Although fish within these threshold distances may be injured or killed, resulting effects on marine mammals would be limited in extent and short term in duration relative to natural variability. For example, capelin are a primary forage species targeted by fin whales when they are available in abundance. Capelin and other marine forage fish like herring, anchovies, and sardines have short lifespans and variable recruitment rates. Species with this type of reproductive strategy commonly display rapid and dramatic changes in abundance from year to year in response to environmental variability (Leggett and Frank 1990; Sinclair 1988; Shikon et al. 2019), and shifts in distribution in response to changing climatic conditions (Carscadden et al. 2013). Fin whale predation on capelin is preferential, reflecting adaptation to the natural variability of this resource. In this context, the loss of even large schools of capelin to underwater noise is unlikely to have a significant effect on fin whales. Similarly, sperm whales are wide ranging adaptive predators that only occasionally prey on types of organisms likely to occur in the action area (Leatherwood et al. 1988; Pauly et al. 1998). This species would likely be able to adapt to short-term and localized changes in availability of fish prey.

Based on the nature and limited extent of underwater noise effects on prey organisms, the effects of this impact mechanism on ESA-listed marine mammals are expected to be insignificant.

Sea Turtle Noise Exposure

The biological significance of hearing in sea turtles is not well studied and a subject of debate (Piniak et al. 2016; Popper et al. 2014). Although sea turtles have relatively unspecialized ears relative to other vertebrate species, their auditory organs appear to be specifically adapted to underwater hearing (Dow Piniak et al. 2012). Studies indicate that hearing in sea turtles is confined to lower frequencies, below 1,600 Hz, with the range of highest sensitivity between 100 and 700 Hz (Dow Piniak et al. 2012), with some variation between species (Bartol and Ketten 2006; Dow Piniak et al. 2012; Martin et al. 2012; Piniak et al. 2016). Available information on species-specific hearing ranges and peak hearing sensitivity are summarized by species in this section.

The current literature and effect analysis guidance regarding sensitivity to underwater noise effects vary depending on the source. Popper et al. (2014) suggest that exposure thresholds of 207 dB_{PEAK} or 210 dB_{SEL} would likely protect sea turtles from physical injury. Exposure modeling was completed that applied these threshold criteria to sea turtles. Since modeling was completed, new thresholds developed by the U.S. Navy are the recommended criteria to be used for sea turtles (Department of the Navy 2017) (Tables 19–22). Exposure modeling will be updated as may be required through consultation with NMFS. For potential behavioral effects, a threshold of 175 dB_{RMS} for impulsive sounds based on observed avoidance behavior during airgun blasts for all sound types.

Table 19. Acoustic Thresholds for Potential Injury and Temporary Threshold Shifts for Sea Turtles (Threshold SPLpk) from Impact Pile Driving

Faunal Group	Threshold SPL_{pk} (dB re 1 µPa)	Mean Acoustic Range (m) to Threshold			
		0-dB Attenuation	6-dB Attenuation	10-db Attenuation	12-db attenuation
Sea turtles[M]	207	633	226	115	87

Notes: Mean acoustic ranges to zero to peak SPL (SPL_{pk}) acoustic threshold criteria, sea turtles (Popper et al. 2014), due to impact pile driving of an 11-m monopile with 0, 6, 10, and 12 dB broadband noise attenuation (Denes et al. 2018).

[M] = threshold for mortality or potential mortality; dB re 1 µPa^2 s = decibel referenced to 1 micropascal squared second;
SELcum = sound exposure level accumulated over 24 hours.

Table 20. Acoustic Thresholds for Potential Injury for Sea Turtles (Threshold SEL_{cum}) from Impact Pile Driving

Faunal Group	Threshold SEL_{cum} (dB re 1 µPa^2 s)	Mean Acoustic Range (m) to Threshold							
		0-dB Attenuation		6-dB Attenuation		10-dB Attenuation		12-dB Attenuation	
		Standard	Difficult	Standard	Difficult	Standard	Difficult	Standard	Difficult
Sea turtles[M]	210	1,972	2,755	883	1,317	447	709	291	514

Note: Mean acoustic ranges to cumulative sound exposure level (SEL_{cum}) acoustic thresholds for sea turtles (Popper et al. 2014), due to impact pile driving of an 11-m pile for a standard scenario (~4,500 strikes) and a difficult to drive pile scenario (~8,000 strikes) with 0, 6, 10, and 12 dB broadband noise attenuation (Denes et al. 2018).

[M] = threshold for mortality or potential mortality; dB re 1 µPa^2 s = decibel referenced to 1 micropascal squared second;
SEL_{cum} = sound exposure level accumulated over 24 hours.

Table 21. Acoustic Thresholds for Potential Behavioral Disturbance for Sea Turtles (Threshold SPL_{rms}) from Impact Pile Driving

Faunal Group	Threshold SPL_{rms} (dB re 1 µPa)	Mean Acoustic Range (m) to Threshold			
		0-dB Attenuation	6-dB Attenuation	10-dB Attenuation	12-dB Attenuation
Sea turtles	175	3,492	2,283	1,685	1,322

Note: Mean acoustic range to unweighted root-mean-square SPL (SPL_{rms}) acoustic threshold for sea turtles (Blackstock et al. 2017), due to impact pile driving of an 11-m pile with 0, 6, 10, and 12 dB broadband noise attenuation (Denes et al. 2018).

dB re 1 µPa = decibel referenced to 1 micropascal; SPL_{rms} = root-mean-square SPL.

PROPOSED ACTION CONSTRUCTION

Denes et al. (2020b) modeled attenuation distances for impact pile driving, vibratory pile driving, and construction vessel noise to a selection of sea turtle effect thresholds. They considered a range of attenuation scenarios for impact pile driving of all 16 proposed piles. The 10-dB attenuation scenario results are the PDE analyzed in this BA. These results summarizing impacts due to the driving of all 16 piles for the Proposed Action are presented in Table 20. Turtles within 709 m (2,326 feet) of impact pile driving could experience hearing injury if using the Popper et al. (2014) 210-dBSEL threshold. Although the use of PSOs and other measures would effectively minimize the risk of exposure to injury-level effects, individual turtles could be harmed by impact pile-driving noise during Proposed Action construction.

Denes et al. (2020b) define an injury threshold of 180 dB_{RMS} for exposure of sea turtles to continuous sound sources like vibratory pile driving or vessel propulsion systems. This threshold assumes that a temporary hearing threshold shift could occur after 12 hours of continuous exposure at or above this level.

Applying a sound attenuation of -10 dB from the proposed mitigation measures to reduce the source level, sea turtles would have to be within 101.7 feet (31 m) of vibratory pile driving and would not experience any potentially injurious levels from construction vessels (Denes et al. 2020b). The likelihood of potential injury to sea turtles in discountable due to the small impact range and avoidance of the noise or vessel presence at greater distances from the non-impact pile driving construction activities. Although the avoidance response is expected to be advantageous to avoid potential hearing injury, the behavioral response may still disturb the natural behavior of sea turtles at a range of about 53 meters from the construction activity. Denes et al. (2019a) modeled only one sea turtle behavioral effect threshold: the 175-dB_{RMS} threshold defined by Blackstock et al. (2017). As shown in Denes et al. 2020b, sea turtles within 174 feet (53 m) of vibratory pile driving would likely be exposed noise level that could result behavioral responses including avoidance. Construction vessel noise is below the 175-dB_{RMS} behavioral effects threshold. This small disturbance distance will have discountable effects on the resting, foraging success, and other natural behaviors of sea turtles.

Although no adverse effects to sea turtles are expected during vibratory pile driving and cable construction, Denes et al. (2020) used a proprietary exposure model to estimate the number of individuals of each ESA-listed species that could be exposed to injury and behavioral-level noise effects from impact pile driving. The model uses species-specific sea turtle density information for the Mid-Atlantic OCS, and swimming speed and diving behavior parameters to characterize individual risk and duration of exposure to injury level effects. This exposure analysis considered the same PDE scenario as for marine mammals, described above. Model results for the 10-dB attenuation scenario are presented in Table 22.

Table 22. Weekly Maximum Estimated Number of Sea Turtles Exposed to Injury-Level Noise Effects from Impact Pile Driving of Six 11-m-Diameter Piles under a Standard and Difficult-to-Drive Pile Scenario, Assuming 10-dB Attenuation

Species	Estimated Number of Animals Exposed		
	Cumulative Injury (L_E)	Peak Injury (L_{pk})	Behavioral (L_p)
Kemp’s ridley sea turtle	< 0.01	< 0.01	2
Leatherback sea turtle	< 0.01	< 0.01	2
Loggerhead sea turtle	< 0.01	< 0.01	8

Source: Denes et al. (2020).

Note: Lpk = flat peak SPL re: 1 µPa; LE = cumulative SEL re: 1 µPa2s; Lp = Root mean square SPL greater than 175 dB re: 1 µPa2/s.

As shown, the Denes et al. (2020b) analysis predicted that less than one individual of each ESA-listed sea turtle species would be exposed to injury from cumulative and single pile strike exposure under the 10-dB attenuation scenario. Green sea turtles were not modeled due to the unavailability of reliable density estimates in this region. However, sea turtles may occur in the area in greater or lower numbers based on a number of oceanic and biological factors. Based on the modeling and uncertainty regarding green sea turtles, BOEM assumes that on a weekly basis 2 loggerheads and one individual of leatherbacks, Kemp’s ridleys, and green sea turtle may occur in the injury zone. However, implementation of the proposed measures to monitor for sea turtles with PSOs, delay pile driving when they are sighted, lowering power levels of the hammer (when possible) when turtles are sighted during pile driving, and some expected avoidance behavior of sea turtles during pile driving, the likelihood of injury is extremely low.

Denes et al. (2019a) estimated the number of individuals likely to be exposed to behavioral level noise effects using the density and behavioral modeling methods described above. As shown in Table 21 sea turtles within 5,528 feet (1,685 m) of impact pile driving would likely exhibit behavioral effects including avoidance. Based on this exposure modeling, it is estimated that up to two Kemp’s ridley, two leatherback, and eight loggerhead sea turtles could be exposed to behavioral effects from each PDE monopile installation (see Table 23). However, it is important to note that this analysis did not consider behavioral-level exposure to vibratory pile driving and vessel noise, which is far more extensive than the exposure area for impact pile driving. Therefore, these results underestimate the number of individuals of each of these species likely to be exposed to behavioral-level noise effects. Sea turtles may be displaced from the area during pile driving, may incur an energetic cost to swimming away, may experience stress, and may experience some reduced foraging rates that day due to engaging in avoidance rather than foraging behavior. Because these effects would only last during the duration of the pile (an average of 120 minutes), these effects are expected to last a short time and sea turtles would return to normal behavior once outside of the harassment area or when pile driving stops. Although some short-term effects resulting from behavioral responses are expected, no long-term adverse effects are anticipated from impact pile driving associated with the Proposed Action.

Similarly, sea turtle exposure to vibratory pile driving of a cofferdam was modeled. The use of a cofferdam is being proposed as a possible need for the nearshore SFEC connection and would require vibratory pile driving of sheet piles. This installation differs from impact pile driving used during SFWF construction in several ways. The location is close to shore, the duration of the installation is estimated to be short (roughly 12 to 18 hours), and the source type is non-impulsive rather than impulsive. Given these differences, both the propagation characteristics of vibratory pile-driving noise and the threshold criteria are different than for impact pile driving. The unmitigated range to the physiological threshold for sea turtles is 31 m, and the range to the behavioral threshold is 53 m. The occurrence of sea turtles within the small period of vibratory pile driving is expected to be low. Additionally, the small threshold ranges and proposed use of PSOs to watch for protected species would reduce the risk of any adverse effects to discountable levels.

Proposed Action Operation

Typical underwater noise levels from operating WTGs range from 110 to 130 dB_{RMS} (Betke et al. 2004; Jansen and de Jong 2016; Madsen et al. 2006; Marmo et al. 2013; Nedwell and Howell 2004; Tougaard et al. 2009). These levels are below the current cumulative injury and behavioral effects thresholds for sea turtles, indicating that operational noise effects on these species are likely to be insignificant.

EFFECTS ON PREY ORGANISMS

Underwater noise is unlikely to result in significant effects on the forage base for ESA-listed sea turtles occurring in the action area. These species are primarily invertivores or, in the case of green sea turtles, omnivorous vegetarians. As discussed above, invertebrates like crabs, jellyfish, and mollusks are insensitive to harmful underwater noise effects at the levels expected to result from the Proposed Action. Underwater noise could temporarily reduce the availability of fish prey species, but these effects would be limited in extent and duration. Although loggerhead and Kemp’s ridley sea turtles may periodically prey on fish, they represent a minor component of a flexible and adaptable diet (see species descriptions). On the basis of this information, underwater noise is not likely to result in significant effects on forage resources for ESA-listed sea turtles.

Marine Fish Noise Exposure

The ESA-listed marine fish species known or likely to occur in the action area, Atlantic sturgeon, is a hearing generalist that is relatively insensitive to sound when compared to fish species that are hearing specialists. Sturgeon also have different hearing sensitivities based on physiological differences in the structure of their hearing organs.

Sturgeons may use hearing to aid in migration and to search for prey. Male sturgeon vocalize during spawning, suggesting that these species use sounds to find potential mates (Fay and Popper 2000; Meyer et al. 2010). Sturgeon have a generalized hearing range from 50 to approximately 700 Hz, with greatest sensitivity between 100 and 300 Hz (Lovell et al. 2005; Meyer et al. 2010). Like other sturgeons, Atlantic sturgeon have a swim bladder that is physiologically isolated from the inner ear (Lovell et al. 2005; Meyer et al. 2010; Popper 2005). Following the classification system defined by Popper et al. (2014), sturgeon belong to the fish hearing group comprising species that possess a swim bladder that is not involved in hearing. FHWG (2008) suggests that exposure to underwater noise above 206 dB_{PEAK} or 187 dB_{SEL} could injure fish weighing more than 2 g, including fish in this hearing group (Table 23).

Table 23. Underwater Noise Levels Produced by PDE Scenario Assumptions for Pile Driving and Vessel Use during South Fork Wind Farm and South Fork Export Cable Construction, and Attenuation Distance to Biological Effects Thresholds for Atlantic Sturgeon

Species/Hearing Group	Biological Effect Thresholds			Attenuation Distance to Effect Threshold (m) by Source Type		
	Category	Metric*	Value†	Impact Pile Driving‡	Vibratory Pile Driving§	Construction Vessel**
Atlantic sturgeon	Cumulative SEL	L_E	187	10,554	–	–
	Peak injury	L_{pk}	206	132	–	–
	Behavioral	L_p	150	12,746	775	135
Forage/Prey Fish < 2 grams	Cumulative SEL	L_E	183	16,277	–	–
	Peak injury	L_{pk}	206	132	–	–
	Behavioral	L_p	150	12,746	775	135
Forage/Prey Fish ≥ 2 grams	Cumulative SEL	L_E	187	10,554	–	–
	Peak injury	L_{pk}	206	132	–	–
	Behavioral	L_p	150	12,746	775	135

Sources: Denes et al. (2020a, 2020b).

—Threshold not applicable to this source type

* Lpk = Flat peak SPL re: 1 µPa; Lp = Root mean square SPL re: 1 µPa; LE = cumulative sound exposure level (SEL) re: 1 µPa2s

† Threshold sources: Sturgeon and other fish: LE and Lpk (FHWG 2008); Lp (Andersson et al. 2007; Purser and Radford 2011; and Wysocki et al. 2007, as cited in NMFS 2020a).

‡ PDE maximum impact scenario for 11-m monopile; "difficult" installation requiring 8,000 strikes/pile over 4 hours using a 4,000- kilojoule impact hammer producing 245 peak dB SEL re: 1 µPa2/Hz/m at 10 m, 30-60 Hz frequency band, assuming 10 dB attenuation.

§ Vibratory installation of Z-type sheet pile, assuming 12 hours of activity producing 185 peak dB SEL re:1 µPa2/Hz/m at 10 m, 50-110 Hz frequency band with no attenuation.

** Continuous dynamic positioning thruster use producing 171 peak dB SEL re: 1 µPa2/Hz/m at 1 m, 300-1000 Hz frequency band with no attenuation.

PROPOSED ACTION CONSTRUCTION

Denes et al. (2020a) modeled noise attenuation distances for impact pile driving for fish with swim bladders not involved in hearing (Atlantic sturgeon) under the 10-dB attenuation PDE scenario (see Table 24). Values for fish greater and less than 2 grams were also modeled. As shown, Atlantic sturgeon would have to be within 132 m of impact pile driving to experience hearing injury from a single pile strike. Atlantic sturgeon would have to remain within 10,554 m of impact pile driving for one 4-hour pile installation over a 24-hour period to experience cumulative injury. Behavioral effects, including avoidance, would occur at much greater distance. Applying the 150-dB_{RMS} fish behavioral threshold (Andersson et al. 2007; Wysocki et al. 2007; and Purser and Radford 2011, as cited in NMFS 2020a), Atlantic sturgeon within 12,746 m of impact pile driving could experience behavioral effects including avoidance.

Continuous noise sources like vibratory pile driving and vessel noise are generally not associated with peak or cumulative injury in the fish hearing group containing sturgeon, and no associated noise effect thresholds have been developed (Popper et al. 2014). Unattenuated vibratory pile driving and vessel operation would produce noise levels exceeding the 150-dB_{RMS} behavioral threshold at distances up to 775 and 135 m, respectively.

The likelihood of behavioral avoidance of both pile-driving and vessel noise minimizes the potential for exposure to impact pile-driving noise over the duration required for cumulative injury, as well as the likelihood of exposure above the single-strike threshold, and this behavioral response would not significantly disrupt normal behavioral patterns. These factors render the likelihood of injury level exposure as insignificant for both species.

PROPOSED ACTION OPERATION

Underwater noise levels produced by operating WTGs range from 110 to 130 dB_{RMS} (Betke et al. 2004; Jansen and de Jong 2016; Madsen et al. 2006; Marmo et al. 2013; Nedwell and Howell 2004; Tougaard et al. 2009). As stated in the previous section, continuous noise sources are not associated with injury-level effects on the fish hearing group containing Atlantic sturgeon. Operational noise levels are also below the 150-dB_{RMS} fish behavioral effects threshold. Collectively, this information supports the conclusion that operational noise effects on Atlantic sturgeon are likely to be insignificant.

EFFECTS ON PREY ORGANISMS

Although Atlantic sturgeon occasionally eat small fish, the species preys primarily on invertebrates. Invertebrate sound sensitivity is restricted to particle motion and the affect dissipates rapidly such that any effects are highly localized to the immediate proximity (i.e., less than 1 m) from the noise source (Edmonds et al. 2016). This indicates that the invertebrate forage base for Atlantic sturgeon is unlikely to be measurably affected by underwater noise resulting from the Proposed Action. Although impact pile driving may temporarily reduce the abundance of forage fish, eggs, and larvae in proximity to the SFWF, this is unlikely to result in an effect on survival and fitness of either species based on the minimal contribution of fish to their overall diet.

Water Quality Effects

Construction of the SFWF and SFEC is likely to result in elevated levels of turbidity in the immediate proximity of bed-disturbing activities like pile driving, placement of scour protection, vessel anchoring, and burial of the SFEC and inter-array cable. Decommissioning may result in similar levels of turbidity due to removal of the turbine foundations and cables. Vinhateiro et al. (2018) modeled anticipated TSS levels and the time required to dissipate those levels to ambient conditions. Within the SFWF, they predicted that TSS concentrations greater than 10 mg/L would not extend more than 3 m from the disturbance source based on the coarser sediment conditions present in this portion of the action area. TSS levels along the SFEC are expected to remain below 30 mg/L within 100 m of the cable route under most circumstances. Vinhateiro et al. (2018) estimated that peak TSS concentrations could exceed 1,000 mg/L in the immediate proximity of the plow, with plumes in excess of 100 mg/L extending several hundred meters from areas where the hydroplow encounters pockets of fine sediments. These effects would be temporary, as TSS levels are predicted to return to normal within 1.4 hours of activity completion (Vinhateiro et al. 2018). However, these effects may be overestimated. Elliot et al. (2017) monitored TSS levels during construction of the nearby Vineyard Wind offshore energy facility. The observed TSS levels were far lower than model predictions based on the same methods used by Vinhateiro et al. (2018), dissipating to baseline levels within meters of disturbance. Given that both the modeled and observed TSS effects would be short term and within the range of baseline variability, the Proposed Actioned effects on ESA-listed marine mammal, reptile, and fish species in the action area are likely to be insignificant. Supporting rationale for this conclusion is provided in the following sections.

For the purpose of this consultation, construction, operation, and decommissioning, best management practices are expected to avoid and minimize water quality impacts from accidental spills or releases of pollutants over the life of the Proposed Action. Therefore, any associated water quality effects on ESA-listed species would be insignificant.

Marine Mammal Total Suspended Sediment Exposure

The NMFS Atlantic Region has developed a policy statement on turbidity and TSS effects on ESA-listed species for the purpose of Section 7 consultation (Johnson 2018). They concluded 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), but insufficient information is available to make ESA effect determinations. 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 excessive 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. Small-scale changes from one-time, localized activities are not likely to have significant effects.

As stated, anticipated TSS levels are limited in magnitude, short term in duration, and likely to be within the range of baseline variability in the action area; therefore, the resulting effects on ESA-listed marine mammals would be insignificant.

Sea Turtle Total Suspended Sediment Exposure

NMFS has concluded that, although scientific studies and literature are lacking, the effects of elevated TSS on ESA-listed sea turtles are likely to be similar to the expected effects on marine mammals (Johnson 2018). Physical or lethal effects are unlikely to occur because sea turtles are air-breathing and land-brooding, and therefore do not share the physiological sensitivities of susceptible organisms like fish and invertebrates. Turtles may alter their behavior in response to elevated TSS levels (e.g., moving away from an affected area). They may also experience behavioral stressors, like reduced ability to forage and avoid predators. However, turtles are migratory species that forage over wide areas and would likely be able to avoid short-term TSS impacts that are limited in severity and extent without consequence. Moreover, many sea-turtle species routinely forage in nearshore and estuarine environments with periodically high natural turbidity levels. Therefore, short-term exposure to elevated TSS levels is unlikely to measurably inhibit foraging (Michel et al. 2013). Given that anticipated TSS levels are expected to be within the range of variability in the action area, the resulting effects on ESA-listed sea turtle species would be insignificant.

Marine Fish Total Suspended Sediment Exposure

Studies of the effects of turbid water on fish suggest that concentrations of suspended solids can reach thousands of milligrams per liter before an acute reaction is expected (Wilber and Clark 2001). Directed studies of sturgeon TSS tolerance are currently lacking, but sturgeons, as a whole, are adapted to living in naturally turbid environments like large rivers and estuaries (Johnson 2018). Although it is difficult to generalize across species, many estuarine-oriented fish species can tolerate turbidity levels in excess of 1,000 mg/L for short periods without injury or noticeable sublethal effects (Wilber and Clark 2001). This suggests that sturgeon could tolerate TSS levels produced by the Proposed Action without injury. Given that Atlantic sturgeon are adapted to naturally turbid environments and the projected effects are within the range of baseline variability, the effects of elevated TSS levels on this species are likely to be insignificant.

Electromagnetic Field and Heat Effects

Once operational, the SFEC and SFWF inter-array cable would generate induced magnetic field and electrical field effects adjacent to the seabed along their respective lengths. Electricity transmission through the cables would also generate heat, sufficient to increase the temperature of the surrounding sediments and potentially the water column in immediate proximity to the cable. These effects would be most intense at locations where the cables cannot be buried and are laid on the bed surface covered by an armoring blanket. Potential EMF and heat effects on the environmental baseline are described below. Effects on ESA-listed species occurring in the action area are described in the following sections. Exponent Engineering (2018) modeled potential EMF effects from 34.5- and 138-kV transmission lines at the bed surface and buried to a depth of 6 feet for the COP. They concluded that the modeled alternatives would produce EMF effects equivalent or greater than the 66- or 230-kV options; therefore, they are considered the maximum impact for the purpose of this analysis. Modeled magnetic and induced electrical field strengths are summarized in Table 24.

Table 24. Modeled Magnetic and Electrical Field Effects from the South Fork Wind Farm Inter-Array Cable and Export Cable, Maximum Field Strength at Bed Surface Directly Above Cable

Proposed Action Element	Transmission Voltage (kV)	Magnetic Field Strength (mG)		Electrical Field Strength (millivolts/meter)	
		Surface*	Buried†	Surface*	Buried†
SFWF	34.5	65.13	9.14	17	1.4
SFEC	138	76.62	13.74	17	2.1

Source: Exponent Engineering (2018)

* Cable on bed surface, covered by concrete or rock armoring blanket

† Cable buried at depth of 6 feet

The baseline magnetic field strength in the action area at the seabed is on the order of 510 mG. This is the static magnetic field of the Earth oriented to magnetic north at a declination of approximately 5 degrees (NOAA 2018b). The interaction of currents and surface waves with the Earth's magnetic field are also likely to induce variable magnetic and electrical field effects on the order of 1 to 10 mG and 10 to 100 millivolts per meter (mV/m), respectively, at the seabed. These field effects operate at or near a frequency of 0 Hz consistent with the Earth's static magnetic field. The biological EMF produced by fish and other marine organisms ranges from 0 to approximately 10 Hz (Bedore and Kajiura 2013). Unlike natural magnetic field sources, electrical power transmission generates EMF effects at 60 Hz. Therefore, sufficiently strong EMF effects are potentially detectable by marine life even when EMF levels that are weaker than the natural levels are present under baseline conditions.

Normandeau (2011) and Taormina et al. (2018) reviewed potential EMF effects from offshore wind energy facilities on marine life. They concluded that most marine species may not sense very low-intensity electric or magnetic fields at the typical AC power transmission frequencies associated with offshore renewable energy projects. Broadly speaking, although there is some variation between species, the magnetite-based sensory organs in marine mammals, turtles, and fish are likely unable to detect AC magnetic fields at intensities below 50 mG (Normandeau 2011). Marine mammals and sea turtles are similarly unlikely to be able to detect weak induced electrical fields produced by the Proposed Action, whereas electrosensitive fish species like sturgeon may be able to detect these fields if they are close to the source.

The SFEC and inter-array cables are likely to produce induced magnetic fields ranging from 9.1 to 13.7 mG at the bed surface, reaching as high as 65.1 to 76.6 mG at locations where the cables lie on the bed surface (Exponent Engineering 2018). Field strength would diminish rapidly with distance, becoming indistinguishable from natural variability within 25 feet on either side of the cable path. The magnetic field effect from unburied cable segments would dissipate below the general 50-mG detection threshold within 3 feet of either side of the cable path (Exponent Engineering 2018). These results indicate that, at the seabed, the magnetic field produced by buried cable segments would be below the 50-mG detection threshold except in a few specific locations where it would fall below 50-mG within 3 feet of the cable. The biological significance of EMF exposure above this detection threshold is unclear but likely negligible for most species at the levels (≤ 76.6 mG) and distances (< 3 feet) involved. For example, Woodruff et al. (2012, 2013) exposed a variety of fish and invertebrate species to magnetic fields ranging from 1,500 to 30,000 mG, hundreds to thousands of times stronger than the EMF effects likely to result from the Proposed Action, and were unable to detect any significant physiological or behavioral changes from any test species.

Exponent Engineering (2018) also calculated induced electrical field strength in marine organisms exposed to the SFEC magnetic field under maximum transmission voltage. Induced field strength is a function of body size, with larger organisms having greater electrical potential across their longest body axis. They determined that the maximum induced electrical field experienced by any organism would be no greater than 0.48 mV/m.

Species-specific sensitivity and the potential effects of EMF exposure on ESA-listed species are summarized by species groupings in the following sections. The information and conclusions presented are drawn from the Proposed Action–specific analysis of potential EMF effects on marine life conducted by Exponent Engineering (2018), a general literature review and analysis of potential EMF effects from offshore renewable energy projects conducted by Normandeau (2011), and other available reviews and studies (Gill et al. 2005, 2012; Kilfoyle et al. 2018; Woodruff et al. 2012, 2013).

Heat generated by underwater transmission cables is emerging as a potential concern for wind energy facility development (Taormina et al. 2018). Buried transmission cables generate heat at levels sufficient to raise sediment and potentially water temperatures in immediate proximity, depending on the type of transmission (AC versus DC), power levels, and the types of substrates involved (Emeana et al. 2016; Taormina et al. 2018). The biological significance of these heat effects is unclear but is likely dependent on localized conditions. Substrate type has a strong influence on the extent of heat effects. Emeana et al. (2016) found that electrical cables buried in mixtures of fine to coarse sands and silts, the dominant substrate types present in the action area, increased substrate temperatures by more than 18°F (10°C) within 1.3 to 3.2 feet (40–100 centimeters) of the cable. Műller et al. (2016) modeled heat transmission from buried submarine cables and determined that heat effects were highly localized and within the range of natural seasonal variability in temperate environments. Exposed cables had no measurable effect on water temperatures more than a few inches from the cable in well-flushed open water environments. Given that most of the SFEC and inter-array cable would be buried at depths greater than 4 feet, the majority of heat effects would likely be undetectable at the bed surface, and any heat effects from unburied cable segments would be highly localized and limited in extent.

Although cable heat could theoretically affect benthic community structure, potentially affecting the composition and availability of invertebrate prey resources for species like sturgeon, the physical extent of these effects would be limited relative to the amount of unaffected foraging habitat available in and near the action area. Therefore, although cable heat effects remain a data gap, the available evidence suggests that any associated effects on ESA-listed species would be insignificant.

Marine Mammal Electromagnetic Field Exposure

Normandeau (2011) reviewed available evidence on marine mammal sensitivity to human-made EMF in the scientific literature. Although the scientific evidence is generally limited, available studies suggest that baleen and toothed whales, including the ESA-listed species known or likely to occur in the action area, are likely sensitive to magnetic fields based on the presence of magnetosensitive anatomical features and observed behavioral and physiological responses. Marine mammals are likely to orient to the Earth’s magnetic field for navigation, suggesting they may have the ability to detect induced magnetic fields from underwater electrical cables. Assuming a 50-mG sensitivity threshold (Normandeau 2011), marine mammals could theoretically be able to detect EMF effects from the inter-array and SFEC cables, but only in close proximity to cable segments lying on the bed surface. Individual marine mammals would have to be within 3 feet or less of those cable segments to encounter EMF above the 50-mG detection threshold. Given the low field intensities involved and the limited extent of detectable effects relative to body size and swimming speed, EMF effects on marine mammals are likely to be insignificant.

Sea Turtle Electromagnetic Field Exposure

Normandeau (2011) conducted a similar review of sea turtle sensitivity to human-made EMF in the scientific literature. The available evidence indicates that sea turtles are magnetosensitive and orient to the Earth’s magnetic field for navigation, but they are unlikely to detect magnetic fields below 50 mG. Normandeau (2011) summarized theoretical concerns in the literature that human-made EMF could disrupt adult migration to and juvenile migration from nesting beaches. Nesting beaches are not present within the action area. Although the Proposed Action would produce magnetic field effects above the 50-mG threshold at selected locations where transmission cables lie on the bed surface, the affected areas would be localized around unburied cable segments and limited to within 3 feet of the cable surface. Given the lack of sensitive life stages present, the limited field strength involved, and limited potential for highly mobile species like sea turtles to encounter field levels above detectable thresholds, the effects of Proposed Action–related EMF exposure on ESA-listed sea turtles are insignificant and discountable.

Marine Fish Electromagnetic Field Exposure

Atlantic sturgeon are electrosensitive but appear to have relatively low sensitivity to magnetic fields based on studies of other sturgeon species. Bevelhimer et al. (2013) studied behavioral responses of lake sturgeon, a species closely related to Atlantic sturgeon, to artificial EMF fields and identified a detection threshold between 10,000 and 20,000 mG, well above the levels likely to result from the Proposed Action (i.e. 9.1–76.6 mG). This indicates that Atlantic sturgeon are likely insensitive to magnetic field effects resulting from the Proposed Action. However, sturgeon may be sensitive to the induced electrical field generated by the cable.

Atlantic sturgeon have specialized electrosensory organs capable of detecting electrical fields on the order of 0.5 mV/m (Gill et al. 2012; Normandeau 2011). Exponent Engineering (2018) calculated that the maximum induced electrical field strength in Atlantic surgeon from the SFWF inter-array cable and the SFEC would be 0.43 mV/m or less, slightly below the detection threshold for the species. However, this analysis only considered the field associated with buried cable segments. Based on magnetic field strength, the induced electrical field in sturgeon in proximity to exposed cable segments is likely to exceed the 0.5-mV/m threshold. This suggests that Atlantic sturgeon would likely be able to detect the induced electrical fields in immediate proximity to exposed cable segments. Sturgeon species have been reported to respond to low-frequency AC electric signals. For example, migrating Danube sturgeon (*Acipenser gueldenstaedtii*) have been reported to slow down when crossing beneath overhead high voltage cables and speed up once past them (Gill et al. 2012). This is not a useful comparison, however, because overhead power cables are unshielded and generate relatively powerful induced electrical fields compared to shielded subsea cables. Insufficient information is available to associate exposure to induced electrical fields generated by subsea cables with behavioral or physiological effects (Gill et al. 2012). However, it is important to note that natural electrical field effects generated by wave and current actions are on the order of 10 to 100 µV/m, many times stronger than the induced field generated by buried cable segments. Given the range of baseline variability and limited area of detectable effects relative to available habitat on the OCS, the effects of Atlantic sturgeon exposure to Proposed Action-related EMF are therefore likely to be insignificant and discountable.

Artificial Light Effects

The SFWF would introduce stationary artificial light sources to the action area. Artificial light has been shown to alter the invertebrate epifauna and fish community composition and abundance in proximity to human-made structures (Davies et al. 2015; McConnell et al. 2010; Nightingale et al. 2006) and the vertical distribution of zooplankton in the water column (Orr et al. 2013). Artificial light in coastal environments is an established stressor for juvenile sea turtles, which use light to aid in navigation and dispersal and can become disoriented when exposed to artificial lighting sources, but the significance of artificial light in offshore environments is less clear (Gless et al. 2008). Collectively, these findings suggest the potential for effects on ESA-listed marine mammal, sea turtle, and fish species as a result of changes in the distribution of forage species and predator-prey dynamics. These effects would be limited to the area exposed to operational light effects over the lifetime of the Project. Orr et al. (2013) summarized available research on potential operational lighting effects from offshore wind energy facilities. They concluded that the operational lighting effects on marine mammal, marine turtle, and fish distribution, behavior, and habitat use were unknown but likely negligible when recommended design and operating practices are implemented. Specifically, using low-intensity shielded directional lighting on structures, activating work lights only when needed, and using red navigation lights with low strobe frequency would reduce the amount of detectable light reaching the water surface to negligible levels. The Applicant has committed to using the recommended EPMs to avoid and minimize artificial light effects from the SFWF. Therefore, the effects of artificial light on ESA-listed species are likely to be insignificant.

Vessel Traffic Effects

Construction and operation vessels pose a potential collision risk and generate noise and artificial light. Vessels also pose a theoretical risk of accidental spills, trash, and debris. Noise and artificial light effects on ESA-listed species have been addressed in their respective sections. This portion of the effects analysis addresses potential risks from vessel collisions, oil spills, and release of trash and debris.
Construction would involve approximately 25 vessels of various classes ranging from small inflatables to construction vessels and barges up to 300 feet in length (see Table 4). Construction vessels would operate in the action area over a period of approximately 1 year. Normal operations would involve two crew transport vessels periodically traveling to and from the SFWF from the O&M facility in Montauk Harbor (Deepwater Wind, LLC 2020).

Regular maintenance typically consists of routine inspections and preventative maintenance activities. It is anticipated that these activities would require the use of CTVs but would not require the use of other specialized vessels. The number of visits to the WTGs and OSS during a typical year may vary but is estimated to be approximately 5 to 10 visits per year per WTG and approximately 20 to 30 visits per year to the OSS. The use of specialized vessels (e.g., crane barge, feeder barge) would only be necessary for major repairs, which are assumed to be a few times over the life of the wind farm. Maintenance activities can occur year-round but are anticipated to be more active during summer months when weather conditions are more favorable.

Vessel Strike Risk

Vessel strikes are a known source of injury and mortality for cetaceans, sea turtles, and Atlantic sturgeon. Increased vessel activity in the action area associated with the construction, operation, and decommissioning of the Proposed Action would pose a theoretical risk of increased collision-related injury and mortality for ESA-listed species.

Vessel strike is relatively common with cetaceans (Kraus et al. 2005) and one of the primary causes of anthropogenic mortality in large whale species (Hayes et al. 2020; Hill et al. 2017; Waring et al. 2011, 2015). NARWs are particularly vulnerable to vessel strikes based on the distribution of preferred habitats near major shipping lanes and feeding and diving habits (Baumgartner et al. 2017). As much as 75% of known anthropogenic mortalities of NARWs likely resulting from collisions with large ships along the United States and Canadian eastern seaboard (Kite-Powell et al. 2007). Risk of collision injury is commensurate with vessel speed. The probability of a vessel strike increases significantly as speeds increase above 10 knots (Conn and Silber 2013; Kite-Powell et al. 2007; Laist et al. 2001; Vanderlaan and Taggart 2007). Vessels operating at speeds exceeding 10 knots under poor visibility conditions have been associated with the highest risk for vessel strikes of NARWs (Vanderlaan and Taggart 2007). Collision risk decreases significantly at speeds below 10 knots (Conn and Silber 2013); however, collisions at lower speeds are still capable of causing serious injury even when smaller vessels (<20 m length) are involved (Kelley et al. 2020).

Vessel strikes are also implicated in sea turtle mortality, with collision risk similarly commensurate with vessel speed although at much lower speeds (Hazel et al. 2007; Shimada et al. 2017). Hazel et al. (2007) found that green sea turtles were unlikely to actively avoid vessels traveling faster than 2.1 knots (4 km/hour), indicating that voluntary speed restrictions below 10 knots may not be protective for this and potentially other sea turtle species.

Atlantic sturgeon are also vulnerable to vessel collisions, but the risk is less clear. Vessel strikes are an identified source of mortality for the species in riverine habitats (Balazik et al. 2012), but the translation of this risk to open ocean environments is speculative at best.

In general, large vessels travelling at high speeds pose the greatest risk of mortality to ESA-listed marine mammals, whereas sea turtles and sturgeon are vulnerable to a range of vessel types depending on the environment. Large vessels used during Proposed Action construction would likely include a cable-laying vessel (1), a rock-dumping vessel (1), jack-up barge (1), material and feeder barges (6) and tow tugs (4), a work vessel (1), and a fuel bunkering vessel (1) (see Table 4). Similar vessels would be used during decommissioning. These vessels would largely remain on station or travel at speeds well below 10 knots during construction and decommissioning of the SFWF and SFEC. Other vessels used during construction and decommissioning would include crew transports and inflatable support vessels used for PSO monitoring. Two crew transport vessels would be used during operation. These vessels would adhere to speed restrictions and other mitigation measures outlined elsewhere in this document, and in general are smaller and more maneuverable. For this reason, these vessels would pose a minimal risk of collision with ESA-listed species.

The total estimated number of construction trips between local ports (311 trips) and trips outside the region (66) is 377 one-way trips. Of that total, large construction vessels would make an estimated 153 trips to and from area ports during the construction period, potentially traveling at higher speeds during transit. For the purpose of this analysis, these vessel trips are assumed to be evenly divided between baseline vessel traffic cross-sections 13, 17, and 20 when leaving the SFWF and SFEC construction areas, and all would travel through cross-section 5 to reach Rhode Island ports (see Figure 14). Following this assumption, this would increase annual vessel transits through cross-section 13 by 165% (relative to 31 baseline transits, see Figure 15, cross-section 17 by 85% (relative to 60 baseline transits), and cross-section 20 by 100% (relative to 51 baseline transits). Once in the shipping lanes, Proposed Action construction vessels would produce a modest increase in overall vessel traffic of 12% (relative to 1,296 baseline transits). These estimates do not consider fishing vessel traffic, which annually accounts for over 3,000 trips by over 200 vessels in the action area (NMFS 2020b) (see Figure 16).

Although construction activity would increase overall vessel traffic in and near the action area, this does not necessarily translate to an increase in collision risk for ESA-listed species. Towed barges account for 28 of the 153 vessel trips. Barges under tow would likely travel at speeds below 5 knots (CH2M 2018), posing a negligible risk of collisions with whales, sea turtles, and sturgeon. Other construction vessels can travel at higher speeds in transit to and from port. CH2M (2018) estimated large construction vessel speeds ranging from 10 to 12.4 knots during transit to and from port. However, the Applicant has agreed to adhere to all mandatory and voluntary vessel speed restrictions in posted Dynamic Management Areas and Seasonal Management Areas, limiting speeds to less than 10 knots. In addition, the applicant would rely on PSOs and adhere to additional speed restrictions to minimize collision risk with whales and sea turtles. When these factors are considered, Proposed Action construction is not likely to significantly increase risk of injury and mortality from vessel collisions for any ESA-listed species relative to the baseline level of risk in the action area. Therefore, the effects of this component of the Proposed Action on ESA-listed marine mammals, sea turtles, and fishes would be insignificant.

Spill Risk

Proposed Action vessels also pose a potential risk of accidental spills during fuel transfers or collisions with other vessels or structures during construction and operation. As stated in the water quality section, chronic low-level oil pollution associated with marine vessel traffic is likely to be present in and near the action area based on proximity to major shipping lanes and regular vessel traffic. The Applicant would prepare and adhere to strict spill prevention, control, and countermeasures (SPCC) procedures during all Proposed Action phases, effectively avoiding the risk of substantial amounts of hydrocarbons entering the marine environment. Based on the impact avoidance and minimization measures in place, the Proposed Action is unlikely to result in significant accidental spills of toxic substances in the marine environment over the lifetime of the Project. For this reason, the Proposed Action is not likely to measurably alter the baseline levels of oil pollution from existing vessel traffic in and near the action area. Therefore, the risk to ESA-listed marine mammals, sea turtles, and fishes from accidental spills resulting from the Proposed Action is insignificant.

Marine Debris and Pollution Risk

Marine debris is a known source of adverse effects on marine mammals (Laist 1997; NOAA-MDP 2014). BOEM prohibits the discharge or disposal of solid debris into offshore waters during any activity associated with the construction and operation of offshore energy facilities (30 CFR 250.300). The USCG similarly prohibits the dumping of trash or debris capable of posing entanglement or ingestion risk (MARPOL, Annex V, Pub. L.100–220 (101 Stat. 1458)). Given these restrictions, the Proposed Action would not measurably increase the amount of marine debris and pollution in the action area. Moreover, as described in Table 8, the additional mitigation measures for the Proposed Action include annual inspections of the SFWF over the lifetime of the Proposed Action to find and remove derelict fishing gear, creating a new mechanism for reducing the amount of marine debris in the action area. The Proposed Action would not result in a measurable increase in pollution and would incrementally reduce the amount of marine debris in the environment. Therefore, the effects of this impact mechanism on ESA-listed marine mammals, sea turtles, and fishes would be insignificant to beneficial.

CONCLUSIONS AND EFFECT DETERMINATIONS

BOEM has concluded that the construction, operation, and future decommissioning of the proposed SFWF and SFEC Proposed Action **may affect** and is **likely to adversely affect** all ESA-listed species under NMFS jurisdiction that are known to or could occur in the action area, with the exception of the sperm whale, green sea turtle, and Atlantic sturgeon. The likelihood of green turtle occurrence in the action area during construction is unlikely, and the operational effects of the action on this species would be insignificant. The mitigation measures in place, including soft start to pile driving, are anticipated to reduce the likelihood of impacts to Atlantic sturgeon such that they would not be likely to be adversely affected. Therefore, the Proposed Action **may affect** but is **not likely to adversely affect** these species. The supporting rationale for these effect determinations are summarized by species in Table 25 and described further below. No designated critical habitat for NMFS ESA-listed species occurs in the action area; therefore, the Proposed Action would have **no effect** on critical habitat.

Table 25. Effect Determination Summary for National Marine Fisheries Service Endangered Species Act–Listed Species Known or Likely to Occur in the Action Area

Species	Effect Determination	Rationale
Fin whale	May affect, likely to adversely affect	**The Proposed Action may affect fin whale because of the following:** The species is known to occur in the action area during all months of the year Proposed Action construction activities would take place in habitats known to be used by this species Fin whales could be exposed to underwater noise from impact and vibratory pile driving in excess of established effect thresholds The SFWF would operate in habitats known to be used by this species **The Proposed Action is likely to adversely affect fin whale because of the following:** Potential for exposure to underwater noise above behavioral and injury-level thresholds cannot be discounted Up to 1 fin whale could experience PTS injury from exposure to impact pile driving noise Up to 11 fin whales could be exposed to underwater noise in excess of behavioral effect thresholds from construction-related impact pile driving, vibratory pile driving and HRG surveys
NARW	May affect, likely to adversely affect	**The Proposed Action may affect NARW because of the following:** The species known to occur in the action area, primarily during winter. Proposed Action construction activities would take place in habitats known to be used by this species. Pile driving would take place when species is least likely to be present, but individual occurrences cannot be ruled out. The SFWF would operate in habitats known to be used by this species. **The Proposed Action is likely to adversely affect NARW because of the following:** Up to 10 NARW could be exposed to underwater noise in excess of behavioral effect thresholds from construction-related impact pile driving, vibratory pile driving and HRG surveys.

Species	Effect Determination	Rationale
Sei whale	May affect, likely to adversely affect	**<u>The Proposed Action may affect sei whale because of the following:</u>** The species known to occur in the vicinity, most commonly during winter and outside of the action area but presence in action area cannot be ruled out. Proposed Action construction activities would take place in habitats that could be used by this species. The SFWF would operate in habitats known to be used by this species. **<u>The Proposed Action is likely to adversely affect sei whale because of the following:</u>** Up to 1 sei whale could be exposed to underwater noise in excess of behavioral effect thresholds from construction-related impact pile driving, vibratory pile driving and HRG surveys.
Sperm whale	May affect, not likely to adversely affect	**<u>The Proposed Action may affect sperm whale because of the following:</u>** The species is known to occur in the action area and vicinity, primarily during summer months when construction would occur. **<u>The Proposed Action is not likely to adversely affect sperm whale because of the following:</u>** Sperm whales are unlikely to be exposed to construction-related underwater noise in excess of biological effect thresholds. All other construction related effects on sperm whale would be insignificant and/or discountable. Operational effects on sperm whale would be insignificant.
Green sea turtle	May affect, not likely to adversely affect	**<u>The Proposed Action may affect green sea turtle because of the following:</u>** This species has been documented in the action area and vicinity. **<u>The Proposed Action is not likely to adversely affect green sea turtle because of the following:</u>** The likelihood of occurrence during Proposed Action construction is discountable. The operational effects of the Proposed Action on sea turtles would be insignificant.
Kemp's ridley sea turtle Leatherback sea turtle NW Atlantic loggerhead sea turtle	May affect, likely to adversely affect	**<u>The Proposed Action may affect these ESA-listed sea turtles because of the following:</u>** The listed species addressed in this consultation are known or likely to occur in the action area. These species are most likely to be present during summer months. Impact pile driving would produce underwater noise above sea turtle injury and behavioral-level thresholds up to 0.58 and 1.6 miles from the source, respectively. Denes et al. (2019a) estimate that 0.5 and 2.65 Kemp's ridley, 0.27 and 3.16 leatherback, and 0.39 and 8.33 loggerhead sea turtles could be exposed to injury and behavioral-level noise effects from impact pile driving, respectively. **<u>The Proposed Action is likely to adversely affect these ESA-listed sea turtles because of the following:</u>** Potential for exposure to underwater noise above injury and behavioral-level thresholds cannot be discounted.

Species	Effect Determination	Rationale
Atlantic sturgeon	May affect, not likely to adversely affect	**The Proposed Action may affect Atlantic sturgeon because of the following:** Adult and subadult sturgeon from all listed DPS could occur in the action area during any month of the year and could be exposed to operation effects. Impact pile driving would produce underwater noise above injury and behavioral-level thresholds. **The Proposed Action is not likely to adversely affect Atlantic sturgeon because of the following:** The operational effects of the Proposed Action with proposed mitigation measures in place on Atlantic sturgeon would be insignificant.

Based on the analysis in this assessment, the construction, O&M, and eventual decommissioning of the Proposed Action **may affect** and is **likely to adversely affect** NMFS ESA-listed species known or potentially occurring in the action area. This conclusion is based on the following rationale:

1. The Proposed Action **may affect** ESA-listed fin whale, sei whale, NARW, sperm whale, Kemp's ridley sea turtle, leatherback sea turtle, Northwest Atlantic DPS of loggerhead sea turtle, and Atlantic sturgeon because these species are known to occur in the action area and would be exposed to the effects of Proposed Action construction, operation, and decommissioning.
2. The Proposed Action is **likely to adversely affect** fin whale, NARW, and sei whale <u>because of the following</u>:
   - Individual animals could occur in the action area during construction-related pile driving (May to November).
   - Impact pile driving would generate underwater noise above LFC injury and behavioral-level thresholds up to 4.4 and 6.2 miles from the source, respectively.
   - Vibratory pile driving would produce underwater noise above the LFC injury and behavioral-level thresholds up to 0.93 and 22.9 miles from the source, respectively.
   - PSO monitoring may not prevent incidental exposure of individual whales to pile driving noise above injury and behavioral thresholds.
3. The Proposed Action is **likely to adversely affect** sperm whale <u>because of the following</u>:
   - Individual sperm whales could occur in the action area during construction-related pile driving.
   - Impact and vibratory pile driving would produce underwater noise above marine mammal behavioral-level thresholds up to 13 and 8.4 miles from the source, respectively.
   - PSO monitoring may not be able to prevent incidental exposure of individual whales to pile driving noise above behavioral thresholds.
   - Sperm whale are unlikely to be exposed to noise above MFC injury thresholds.
4. The Proposed Action is **not likely to adversely affect** green sea turtle <u>because of the following</u>
   - The likelihood of occurrence in the action area during construction and exposure to construction-related impacts on the environment is discountable.
   - The operational effects of the SFWF on green sea turtles would be insignificant and discountable.
   - The operational effects of the SFEC on green sea turtles would be insignificant.

5. The Proposed Action is **likely to adversely affect** Kemp's ridley, leatherback, and NW Atlantic loggerhead sea turtles because of the following:
   - These species are likely to occur in the action area when construction-related pile driving occurs.
     - Impact pile driving would produce underwater noise above sea turtle injury and behavioral-level thresholds up to 0.6 and 1.6 miles from the source, respectively.
     - PSO monitoring may not be able to prevent incidental exposure of individual turtles to pile driving noise above injury and behavioral thresholds.
6. The Proposed Action is **not likely to adversely affect** Atlantic sturgeon because of the following:
   - The operational effects of the SFWF on Atlantic sturgeon would be insignificant and discountable.
   - The operational effects of the SFEC on Atlantic sturgeon would be insignificant.

The remaining effects of the Proposed Action on ESA-listed species are likely to be insignificant or discountable because of the following:

1. Other than underwater noise, construction-related disturbance would be short term in duration and within the range of environmental baseline conditions in the action area (e.g., suspended sediment plumes) and therefore insignificant.
2. Proposed Action–related vessel activity would not measurably change the level of collision risk along already-busy transit corridors and construction vessels in the SFWF are anticipated to be anchored in place or moving at slow speed. Therefore, the risk of injury or death from vessel collisions would be insignificant and discountable.
3. There is no information to indicate that ESA-listed species would be measurably affected by the presence of WTG towers, scour protection, and cable armoring. These structures would not substantially alter marine habitat conditions for ESA-listed species in the action area and would therefore be insignificant.
4. Operational underwater noise is below behavioral effects thresholds for marine mammals, fish, and turtles and is therefore insignificant.
5. Operational EMF would be within the range of environmental baseline conditions in the action area, in most areas below species detectability thresholds, and therefore insignificant.

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