Empire Wind Offshore Wind
Empire Wind Project

Revised Biological Assessment

March 2023

For 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

°C	Degrees Celsius
°F	Degrees Fahrenheit
ADLS	Aircraft Detection Lighting System
AIS	Automatic Information System
AMP	Alternative Monitoring Plan
Applicant	Empire Offshore Wind, LLC
BA	Biological assessment
BACI	Before-After-Control-Impact
BAG	Before-After Gradient
BiOp	Biological Opinion
BOEM	Bureau of Ocean Energy Management
BSEE	Bureau of Safety and Environmental Enforcement
CFR	Code of Federal Regulations
CO_2	Carbon dioxide
COP	Construction and operations plan
CTV	Crew transport vessel
DAS/DVS	Distributed Acoustic/Vibration Sensing
DO	Dissolved oxygen
DPS	Distinct population segment
EA	Environmental Assessment
eDNA	Environmental DNA
EIS	Environmental Impact Statement
EMF	Electromagnetic field
Empire	Empire Offshore Wind, LLC
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
EW	Empire Wind
EW 1	Empire Wind 1 Project
EW 2	Empire Wind 2 Project
FAA	Federal Aviation Administration
G&G	Geotechnical and geophysical
HDD	Horizontal directional drilling
HRG	High-resolution geophysical
HVAC	High voltage alternating current
km^2	Square kilometer
kV	Kilovolt
LAA	Likely to adversely affect
Lease Area	BOEM Renewable Energy Lease Area OCS-A 0512

LFC	Low-frequency cetacean
LOA	Letter of Authorization
MFC	Mid-frequency cetacean
mg/L	Milligrams per liter
MLLW	Mean lower low water
MMPA	Marine Mammal Protection Act
MW	Megawatt
NARW	North Atlantic right whale
NEPA	National Environmental Policy Act
NLAA	Not likely to adversely affect
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
O&M	Operation and maintenance
OCS	Outer Continental Shelf
OSS	Offshore substation
PAM	Passive acoustic monitoring
PATON	Private Aid to Navigation
PBF	Physical and biological feature
PDE	Project Design Envelope
POI	Point of interconnection
Project	EW Project on the OCS offshore of New York
PTS	Permanent threshold shift
ROV	Remotely Operated Vehicle
SAP	Site assessment plan
SCADA	Supervisory Control and Data Acquisition
TSS	Total suspended sediment
TTS	Temporary threshold shift
U.S.C.	United States Code
USACE	U.S. Army Corps of Engineers
USCG	U.S. Coast Guard
USFWS	U.S. Fish and Wildlife Service
UXO	Unexploded ordinance
WEA	Wind Energy Area
WTG	Wind turbine generator

1. Introduction

Empire Offshore Wind, LLC (Empire or the Applicant), has submitted the construction and operations plan (COP) for the Empire Wind (EW) Project to the Bureau of Ocean Energy Management (BOEM) for review and approval. Consistent with the requirements of 30 Code of Federal Regulations (CFR) 585.620 to 585.638, COP submittal occurs after BOEM grants a lease for the Proposed Action and the Applicant completes all studies and surveys defined in their site assessment plan (SAP). BOEM's renewable energy development process is described Section 2.

The EW Project includes the 816-megawatt (MW) Empire Wind 1 Project (EW 1) with up to 57 wind turbine generators (WTGs) and the 1,260-MW Empire Wind 2 Project (EW 2) with up to 90 WTGs. All WTGs and associated offshore substations (OSSs) and submarine transmission cable networks connecting the WTGs to the OSS (inter-array cables) would be located in BOEM Renewable Energy Lease Area OCS-A 0512 (Lease Area), located within the New York Wind Energy Area (WEA).

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

The Proposed Action in this BA entails the construction, operation and maintenance (O&M), and decommissioning of the EW Project on the Outer Continental Shelf (OCS) offshore of New York (the Project). Empire is proposing to construct and operate a commercial offshore wind energy facility within the Lease Area that would generate approximately 2,076 MW of electricity, including EW 1 and EW 2. BOEM is the lead federal agency for purposes of Section 7 consultation and coordination under the National Environmental Policy Act (NEPA) (42 U.S.C. § 4321 et seq.). The co-action agencies for section 7 consultation under the ESA include the Bureau of Safety and Environmental Enforcement (BSEE), the U.S. Army Corps of Engineers (USACE), the U.S. Coast Guard (USCG), and the U.S. Environmental Protection Agency (EPA), and the National Marine Fisheries Service (NMFS) (see Section 2.1 for a description of the role of each agency as it relates to the Proposed Action).

2. Regulatory Background and Consultation History

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 OCS for the purpose of 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 Empire's COP.

Under BOEM's renewable energy regulations, the issuance of leases and subsequent approval of wind energy development on the OCS is a phased decision-making process. BOEM's wind energy program occurs in four distinct phases, defined below. Phases 1 through 3 have already been completed for the EW Project:

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 the U.S. Fish and Wildlife Service (USFWS) with evaluating the impacts of future offshore wind facilities on threatened and endangered birds, migratory birds, and bats.

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

As part of the first phase, BOEM prepared a BA on the issuance of commercial wind leases and site characterization activities on the Atlantic OCS within the identified WEAs off of Massachusetts, Rhode Island, and New Jersey and the unsolicited proposed development areas off New York in October 2012. 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 (NMFS 2013). Site assessment activities offshore of New York were not addressed in this biological opinion. On May 28, 2014, BOEM published a Notice of Intent (NOI) to prepare an Environmental Assessment (EA) for potential commercial wind lease issuance and site assessment activities on the Atlantic OCS offshore New York (79 FR 30643). The purpose of this EA was to determine whether there would be significant impacts associated with issuing commercial wind leases and conducting site characterization surveys and site assessment activities within the BOEM-identified Call Area under consideration for future wind energy leasing, which includes the Lease Area for the Project. The EA was published on June 6, 2016 (BOEM 2016a). In response to public comments, a revised EA was published on October 31, 2016 (BOEM 2016b) with a Finding of No Significant Impact.

As part of the fourth phase, the Applicant has completed site characterization activities and has developed a COP in accordance with BOEM regulations. Empire filed their COP with BOEM on January 10, 2020. An updated COP was submitted on April 14, 2021. BOEM is consulting on the proposed approval of the COP for the EW Project as well as other permits and approvals from other agencies that are associated with the approval of the COP. BOEM issued an NOI to prepare an Environmental Impact Statement

(EIS) under NEPA on June 24, 2021, to assess the potential impacts of the Proposed Action and Alternatives (86 FR 33351). A draft EIS was published on November 18, 2022.

This BA is being submitted concurrently with a request for initiation of ESA Section 7 consultation. The request for consultation includes: EPA's proposal to issue an OCS Air Permit; USACE's proposal to issue a permit for in-water work, structures, and fill under Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. § 403) and Section 404 of the Clean Water Act (33 U.S.C. § 1251 et seq.); NMFS' proposal to issue a Marine Mammal Protection Act (MMPA) Letter of Authorization (LOA); and USCG's proposal to issue a Private Aid to Navigation (PATON) Authorization.

2.1. Action Agencies and Regulatory Authorities

As described in Section 2, BOEM has the authority to issue leases, easements, and rights-of-way on the OCS for renewable energy development and has responsibility for determining whether to approve, approve with modifications, or disapprove Empire's COP. Other action agencies associated with approval of the COP include BSEE (Section 2.1.1), USACE (Section 2.1.2), USCG (Section 2.1.3), EPA (Section 2.1.4), and NMFS (Section 2.1.5). The action agencies and additional agencies may coordinate with BOEM on issuance of permits related to the Proposed Action. These may include a Section 10/404 permit from USACE and an air permit from the EPA. Additional consultation may occur under Section 106 of the National Historic Preservation Act, as well as additional consultation with indigenous nations. The Applicant is also coordinating with NMFS and has applied for issuance of an LOA under the MMPA

2.1.1. Bureau of Safety and Environmental Enforcement

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

2.1.2. U.S. Army Corps of Engineers

USACE regulates discharges of dredged or fill material into waters of the United States and structures or work in navigable waters of the United States under Section 10 of the Rivers and Harbors Act of 1899 and Section 404 of the Clean Water Act, which would include the construction of offshore WTGs, scour protection around the base of the WTGs, OSSs, inter-array cables, offshore export cables, and port modifications. Empire has applied for permits from USACE to construct up to 147 offshore WTGs, scour protection around the base of the WTGs, two OSSs, inter-array cables connecting the WTGs to the OSSs, and offshore export cables. The cable routes would originate from the OSSs and would make landfall in Kings County and Nassau County, New York. Empire submitted the pre-construction notification/application to USACE on October 3, 2022, and it was deemed complete on November 3, 2022 (USACE application numbers NAN-2022-00901-EMI and NAN-2022-00902-EMI). USACE will enforce ESA terms and conditions landward of the Submerged Lands Act boundary. Additionally, the New York City Economic Development Corporation has applied for permits from USACE for port upgrades at South Brooklyn Marine Terminal (NAN-2022-00900), including bulkhead improvements, dredging, and construction of new pile supported and floating platforms and new fenders for vessel mooring, which is considered a connected action to the Proposed Action.

2.1.3. U.S. Coast Guard

The USCG administers the permits for PATONs located on structures positioned in or near navigable waters of the United States. PATONS and federal aids to navigation, including radar transponders, lights, sound signals, buoys, and lighthouses, are located throughout the Project area. It is anticipated that USCG approval of additional PATONs during construction of the WTGs and OSSs, and along the offshore export cable corridors may be required. These aids serve as a visual reference to support safe maritime navigation. Empire anticipates requesting PATON authorization in August 2023.

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

2.1.4. U.S. Environmental Protection Agency

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 (42 U.S.C. § 7401 et seq.). EPA issues OCS Air Permits. Emissions from Project activities on the OCS would be permitted as part of an OCS air permit and must demonstrate compliance with National Ambient Air Quality Standards. Empire submitted an application to EPA for the OCS Air Permit on August 10, 2022.

2.1.5. National Marine Fisheries Service

The MMPA of 1972 as amended and its implementing regulations (50 CFR 216) allow, upon request, the incidental take of small numbers of marine mammals by U.S. citizens who engage in a specified activity (other than commercial fishing) within a specified geographic region. Incidental take is defined under the MMPA (50 CFR 216.3) as, "harass, hunt, capture, collect, or kill, or attempt to harass, hunt, capture, collect, or kill any marine mammal. This includes, without limitation, any of the following: The collection of dead animals, or parts thereof; the restraint or detention of a marine mammal, no matter how temporary; tagging a marine mammal; the negligent or intentional operation of an aircraft or vessel, or the doing of any other negligent or intentional act which results in disturbing or molesting a marine mammal; and feeding or attempting to feed a marine mammal in the wild."

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

On July 28, 2022, Empire submitted a request for a rulemaking and LOA pursuant to Section 101(a)(5) of the MMPA and 50 CFR § 216 Subpart I to allow for the incidental harassment of marine mammals resulting from the installation of WTGs and OSSs; installation and removal of cofferdams or goal posts at locations of export cable route to landfall transitions; marina activities, including removal of berthing piles and bulkhead repair; and performance of high-resolution geophysical (HRG) surveys (Empire 2022b). Empire is including activities in the LOA request that could cause acoustic disturbance to marine mammals during construction of the Project pursuant to 50 CFR § 216.104. The application was reviewed and considered complete on August 11, 2022. NMFS published a Notice of Receipt in the Federal Register on September 9, 2022.

3. Proposed Action

The Proposed Action addressed in this BA is the proposed issuance of authorizations and permits for the construction, O&M, and decommissioning of the EW Project in the New York WEA. The Project would be sited 14 miles (22.5 kilometers) south of Long Island, New York and 19.5 miles (31.4 kilometers) east of Long Branch, New Jersey in the Lease Area (OCS-A 0512). The Project includes a maximum of 147 WTGs, 2 OSSs, 260 nautical miles (481 kilometers) of inter-array cables, and 66 nautical miles (122 kilometers) of export cables. Export cable landfalls would be located at South Brooklyn Marine Terminal and at either Long Beach or Lido Beach. Prior to construction, additional geotechnical and geophysical surveys would be conducted to inform final selection and design of foundations, micrositing of export cables, and selection and design of scour and cable protection. Construction is expected to begin with work on the onshore substations in the fourth quarter of 2023 and is expected to finish in fourth quarter of 2027 when WTG installation for EW 2 would be completed. Once construction is completed, a complete as-built survey would be conducted, and regular surveys would be conducted during the O&M phase to identify Project components requiring maintenance.

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 (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 NEPA, the PDE covers the range of alternatives being considered in the EIS in preparation for this Proposed Action.

The applicant has elected to use a PDE approach for describing the Proposed Action consistent with BOEM policy. Therefore, this BA and associated outcomes of the ESA consultation will cover the menu of potential alternatives that may be authorized by BOEM in the record of decision and approval of the COP. For the purpose of this ESA consultation, BOEM assumes that the Applicant may select the design alternative resulting in the greatest potential impact to the environment. Construction, O&M, and decommissioning activities are described in Section 3.1. The impact-producing factors (IPFs) associated with these activities are described in Section 3.2, and mitigation measures included in the Proposed Action are described in Section 3.3.

3.1. Description of Activities Proposed for COP Approval

3.1.1. Action Area

The action area is defined as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action" (50 CFR 402.02) and also includes all consequences to listed species or critical habitat that are caused by the Federal action, including actions that would occur outside the immediate area involved in the action (50 CFR 402.17). The action area for the Proposed Action encompasses all areas to be directly or indirectly affected by construction, O&M, and decommissioning of the EW Project, including the immediate Project area, defined below, as well as vessel transit routes between the immediate Project area and local ports, vessel transit routes between the immediate Project area and ports and facilities in Goose Creek, South Carolina, Corpus Christi, Texas, and Europe, and areas affected by noise, electromagnetic field (EMF), water quality, benthic, and other impacts associated with the Proposed Action. This action area encompasses all effects of the Proposed Action considered here.

The immediate Project area includes the Lease Area, which encompasses the wind farm footprint within the WEA, where the majority of construction and survey activities would occur, as well as the export cable routes from the OSSs to shore (**Figure 1**). The wind farm footprint, including WTG and OSS foundations and inter-array cables, would encompass the majority of the 65,458-acre (265-square kilometer) WEA. The 66 nautical miles (122 kilometers) of export cables, with a 7-foot (2.1-meter) disturbance width, are expected to occupy an additional 64.5 acres (0.3 square kilometers), resulting in a total area of approximately 65,522.5 acres (265.3 square kilometers) for the immediate Project area. The immediate Project area includes coastal nearshore habitats off New York, adjacent New York state waters, and ocean habitats in the WEA.

Though the majority of activities associated with the Proposed Action would occur in the immediate Project area, Project vessels would travel between the immediate Project area and local ports. During construction some vessels are also likely to travel to and from ports and facilities in South Carolina, Texas, and Europe, where most industry-specific vessels are currently located. Although specific ports have not been identified where equipment and components may originate, the following local ports may be used for fabrication, assembly, deployment, or decommissioning activities for the EW Project: South Brooklyn Marine Terminal, New York; Port of Coeymans, New York; and Port of Albany, New York. The action area includes the ancillary vessel routes between these ports and the immediate Project area. The transport of some Project components and/or Project vessels may originate from the cable facility in Goose Creek, South Carolina (north of Charleston) or ports in Corpus Christi, Texas in the Gulf of Mexico or Europe. The use of specific ports in these areas are not yet known; therefore, potential (but not definite) routes to and from the Gulf of Mexico and Europe are included in the action area for the purposes of this BA. The selection of final ports is not expected to increase the number of anticipated vessel trips but may affect the origin and destination locations and transit distances.

The most geographically extensive impacts associated with construction under the Proposed Action would be impacts associated with vessel operations and underwater noise associated with impact and vibratory pile driving. The extent of underwater noise impacts associated with Project construction activities would occur during 35- and 44-month periods for EW1 and EW2, respectively (**Figure 2**).

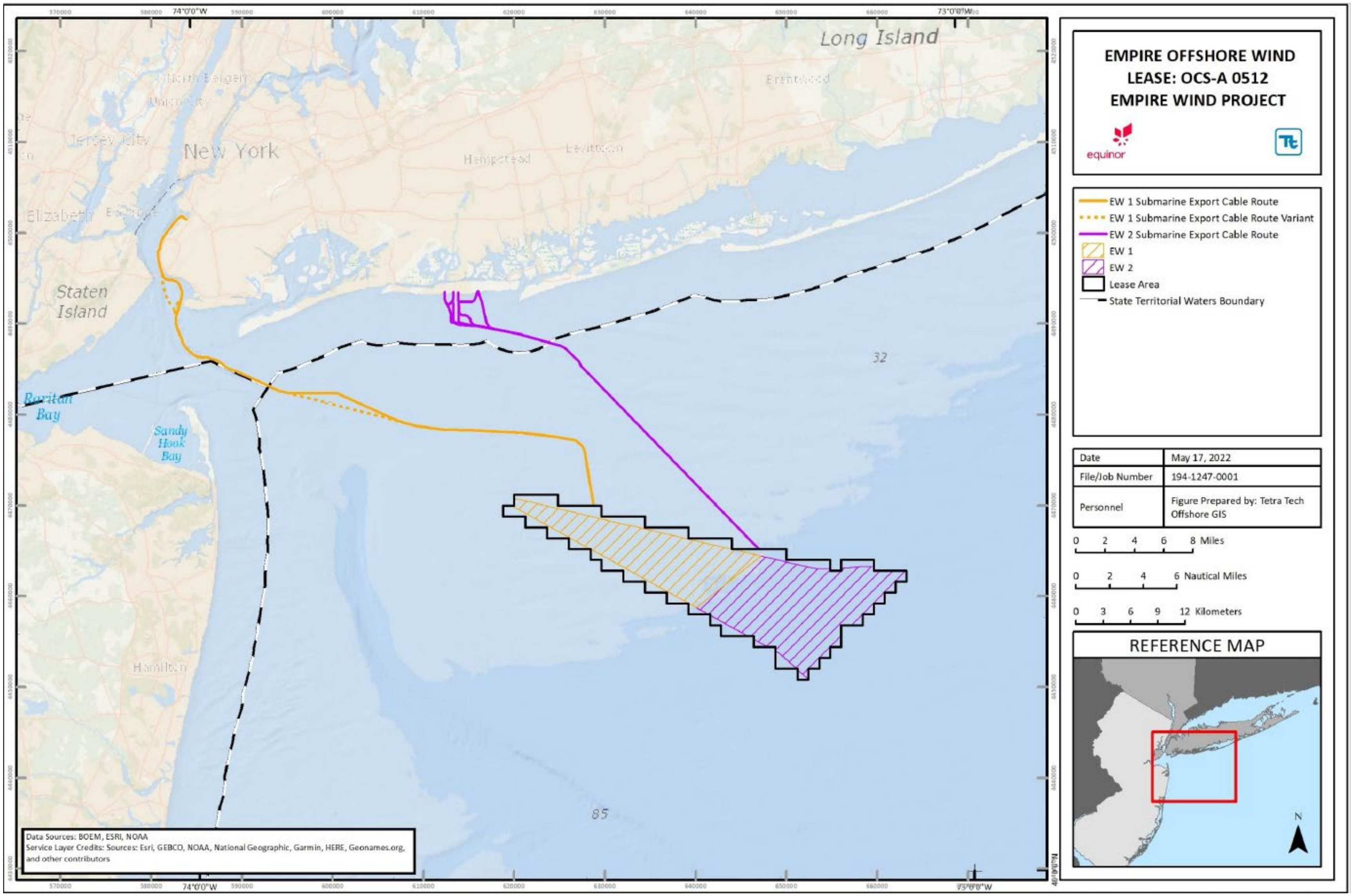
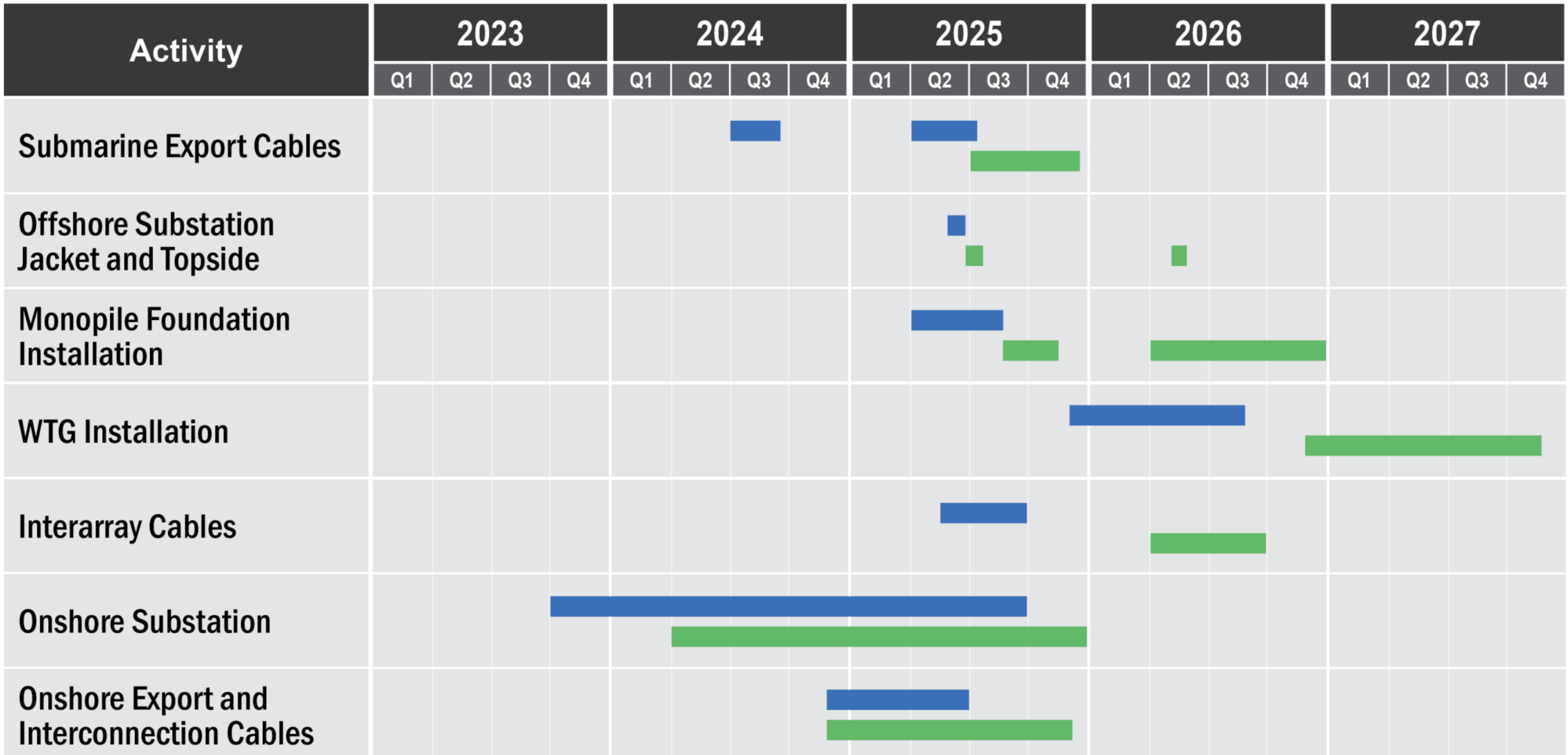


Figure 1 Immediate Project Area for the Proposed Action

3.1.2. Identification of Activities Considered

Activities considered in this BA include aquatic and terrestrial activities during the construction, O&M, and decommissioning phases of the Project. The construction of the EW Project would result in impacts on aquatic species in river, nearshore, and offshore waters of the mid-Atlantic OCS associated with aquatic activities and in the nearshore estuarine waters of Upper New York Harbor associated with terrestrial activities for the proposed O&M facility. Aquatic activities for the construction of the EW Project would include installation of WTGs (Section 3.1.2.1) and OSSs, including their foundations (Section 3.1.2.2), and installation of inter-array and export cables (Section 3.1.2.3). Terrestrial activities for the construction of the EW Project would include upgrades or expansions at port facilities, described in the following paragraph, and installation of onshore cables (Section 3.1.2.3). As noted in Section 3, Empire has elected to use a PDE approach for this Project, which is reflected in the description of the Proposed Action in this BA. PDE parameters for the EW Project are summarized in **Table 1**. The general construction schedule is provided on **Figure 2** and in **Table 2**. This schedule is approximated based on several assumptions, including the estimated timeframe in which permits are received, anticipated regulatory seasonal restrictions, environmental conditions, planning, and logistics. Construction and installation activities for the Proposed Action may be based out of more than one port, and Empire has not yet finalized selection of construction ports, staging areas, and other onshore facilities. South Brooklyn Marine Terminal has been selected as the location for the EW 1 export cable landfall and onshore substation, as well as a staging area for wind turbine components (e.g., blades, turbines, nacelles), foundation transition pieces, and other facility parts during construction of the EW Project. The final port selection for staging and construction will be determined based upon which ports are able to accommodate Empire's schedule and workforce and equipment needs. To contribute to development and build-out of the offshore industry in New York, the owner/operator of South Brooklyn Marine Terminal is proposing to conduct upgrades to the port facility that would allow offshore wind developers, such as Empire, to utilize the facility as a construction and staging area. These upgrades are considered a Connected Action to the Proposed Action. Empire would also make improvements to the bulkhead at South Brooklyn Marine Terminal to utilize this location for the onshore substation for the EW 1 Project. Marina activities would also be completed along inshore Long Island on the Wreck Lead Channel to utilize this area for the onshore substation for the EW 2 Project. Marina activities would include bulkhead repairs and removal of berthing piles. To repair the bulkhead, 24-inch (61-centimeter) z-type steel sheet piles would be installed using a vibratory pile driver. Twenty sheet piles would be driven per day over a 35-day installation period, with one hour of vibratory driving each day. To remove berthing piles, a combination of a crane and vibratory pile driver would be used. Up to 130 12-inch (30-centimeter) timber berthing piles would be removed over the course of two weeks, with up to 15 piles removed per day.

The O&M of the EW Project would result in impacts on aquatic species in the nearshore and offshore waters of the mid-Atlantic OCS associated with aquatic activities. The O&M activities that are pertinent to this BA are described in Sections 3.1.2.1, 3.1.2.2, 3.1.2.3, and 3.1.2.5, as appropriate. Additional information about Project O&M requirements is provided in the COP (Empire 2022a). Decommissioning activities, described in Section 3.1.2.6, are expected to result in similar, or lesser, impacts on ESA-listed species as construction activities.



Project activities are anticipated to start no earlier than Q3 2023. EW 1 EW 2

Figure 2 Construction Schedule for Proposed Action

Table 1 PDE Parameters for the Proposed Action

PDE Element	Parameter	Maximum Impact
Turbine selection/spacing	WTG size	18 MW
Turbine selection/spacing	Number of turbines	147
Turbine selection/spacing	Blade tip height above highest astronomical tide	951 ft (290 m)
Turbine selection/spacing	Spacing	0.65 nm (1.2 km)
Turbine selection/spacing	Array area	65,559 ac (257 km^2)
Monopile foundation installation	Number of monopiles	147
Monopile foundation installation	Monopile diameter	36 ft (11 m)
Monopile foundation installation	Footprint area total (with scour protection)	135.2 ac (0.5 km^2)
Monopile foundation installation	Installation method	5,225 kJ maximum impact hammer strength
Monopile foundation installation	Installation method	7,335 hammer strikes/pile
Monopile foundation installation	Installation method	3 hours per pile
Monopile foundation installation	Installation method	147 days of pile driving
Piled jacket foundation installation	Pile diameter	13 ft (4 m)
Piled jacket foundation installation	Footprint area total (with scour protection)	4.3 ac (0.02 km^2)
Piled jacket foundation installation	Installation method	3,200 kJ maximum impact hammer strength
Piled jacket foundation installation	Installation method	4,340 hammer strikes/pile
Piled jacket foundation installation	Installation method	4.2 hours per pile
Piled jacket foundation installation	Installation method	12 days of pile driving
Goal post installation	Number of steel piles	18
Goal post installation	Pile diameter	12 in (30 cm)
Goal post installation	Installation method	Maximum impact hammer strength not specified
Goal post installation	Installation method	2,000 hammer strikes/pile
Goal post installation	Installation method	2 hours per pile
Goal post installation	Installation method	1 day of pile driving
Inter-array cable construction	Total length	260 mi (481 km)
Inter-array cable construction	Length for EW 1	116 nm (214 km)
Inter-array cable construction	Length for EW 2	144 nm (267 km)
Inter-array cable construction	Installation method	Cable trenching burial to 6 ft (1.8 m) minimum
Inter-array cable construction	Total cable protection	58 ac (0.2 km^2)
Inter-array cable construction	Cable protection for EW 1	26 ac (0.1 km^2)
Inter-array cable construction	Cable protection for EW 2	32 ac (0.1 km^2)
Inter-array cable construction	Total disturbance area	423 ac (1.7 km^2)

PDE Element	Parameter	Maximum Impact
Inter-array cable construction	Disturbance area for EW 1	534 ac (2.2 km^2)
Inter-array cable construction	Disturbance area for EW 2	633 ac (2.6 km^2)
Inter-array cable construction	Total operating footprint	252 ac (1 km^2)
Inter-array cable construction	Operating footprint for EW 1	82 ac (0.3 km^2)
Inter-array cable construction	Operating footprint for EW 2	129 ac (0.5 km^2)
Export cable construction	Total length	66 mi (122 km)
Export cable construction	Length for EW 1	116 nm (214 km)
Export cable construction	Length for EW 2	144 nm (267 km)
Export cable construction	Installation method	Cable trenching burial to 6 ft minimum
Export cable construction	Total cable protection	23 ac (0.09 km^2)
Export cable construction	Cable protection for EW 1	33 ac (0.1 km^2)
Export cable construction	Cable protection for EW 2	32 ac (0.1 km^2)
Export cable construction	Total disturbance area	65 ac (0.3 km^2)
Export cable construction	Disturbance area for EW 1	368 ac (1.5 km^2)
Export cable construction	Disturbance area for EW 2	360 ac (1.5 km^2)
Export cable construction	Total operating footprint	61 ac (0.2 km^2)
Export cable construction	Operating footprint for EW 1	37 ac (0.1 km^2)
Export cable construction	Operating footprint for EW 2	24 ac (0.1 km^2)
Construction vessels	Number of vessels	18 for EW 1; 18 for EW 2
Construction vessels	Anchoring disturbance	7 ac (0.03 km^2)
Construction vessels	Number of round trips	2,396
Operation	Rotor swept area (per turbine/total)	571,463 ft^2 (53,091 m^2) / 99,434,562 ft^2 (9,237,834 m^2)
Operation	WTG oil and grease	711,138 gal (2,691,950 L)
Operation	WTG coolant	151,728 gal (574,353 L)
Operation	OSS oil and grease	264,172 gal (1,000,000 L)
Operation	OSS fuel	14,529 gal (54,998 L)
Operation	Transmission voltage	Export cable: 230 kV
Operation	Transmission voltage	Inter-array cable: 66 kV
Operation	Magnetic field	Peak export: 130 mG buried; 188 mG exposed
Operation	Magnetic field	Peak inter-array: 65 mG buried; 183 mG exposed
Operation	Induced electric field	Peak export: 4.8 mV/m buried; 5.8 mV/m exposed
Operation	Induced electric field	Peak inter-array: 2.2 mV/m buried; 3.8 mV/m exposed
Operation	Number of annual round trips by O&M vessels	518

Table 2 Anticipated Construction Schedule for the Proposed Action

Project Component	Activity	Expected Duration	Anticipated Timeframe
EW 1	Submarine export cable installation	6 months	Q3 2024 and Q2 through Q3 2025
EW 1	Foundation installation	5 months	Q2 through Q3 2025
EW 1	Offshore substation jacket and topside	1 month	Q2 2025
EW 1	WTG installation	9 months	Q4 2025 through Q3 2026
EW 1	Inter-array cable installation	4 months	Q2 through Q3 2025
EW 1	Onshore substation	24 months	Q4 2023 through Q3 2025
EW 1	Onshore export and interconnection cables	7 months	Q4 2024 through Q2 2025
EW 2	Submarine export cable installation	5 months	Q3 through Q4 2025
EW 2	Foundation installation	12 months	Q3 through Q4 2025 and Q2 through Q4 2026
EW 2	Offshore substation jacket and topside	2 months	Q2 through Q3 2025 and Q22026
EW 2	WTG installation	12 months	Q4 2026 through Q4 2027
EW 2	Inter-array cable installation	6 months	Q2 through Q3 2026
EW 2	Onshore substation	21 months	Q2 2024 through Q4 2025
EW 2	Onshore export and interconnection cables	12 months	Q4 2024 through Q4 2025

3.1.2.1. Wind Turbine Generators

3.1.2.1.1 Description

The Project would utilize WTGs specially designed for offshore use. The Proposed Action includes installation and operation of up to 147 WTGs (**Figure 3**), 57 WTGs for EW 1 and 90 WTGs for EW 2, with a nameplate capacity of up to 18 MW per WTG. Each WTG would extend up to 951 feet (290 meters) above highest astronomical tide. Minimum spacing between the WTGs would be 0.65 nautical miles (1.2 kilometers) within the 79,350-acre (321-square kilometer) Lease Area. Based on the presence of glauconite identified from geotechnical and geophysical (G&G) survey data, Empire has developed a preliminary WTG layout to avoid glauconite soils (**Figure 4**), which would make pile installation challenging.

The WTGs would consist of three components: the rotor, the nacelle, and the tower. The rotor extracts wind energy as it's turned by the wind, which is converted to electricity by the generator. For the Project, the rotor would be comprised of three blades attached to a hub. The rotor is attached to the nacelle and can be pitched to control thrust force and rotor speed. The maximum rotor diameter for the Project would be 853 feet (260 meters). The nacelle is a box-like structure that houses the electro-mechanical components of the WTG, as well as other equipment (e.g., transformers, yaw systems, and gearboxes). The nacelle is located at the top of the tower, which is a steel tubular structure that supports the rotor and nacelle. This component provides the height required to efficiently capture wind energy. The tower generally includes some control or electrical components either within the structure or at its base and provides access to the nacelle for servicing. The tower is connected to the foundation, which is described in Section 3.1.2.2.

Each WTG would contain oils, greases, and fuels used for lubrication, cooling, and hydraulic transmission. Volumes will vary depending on the WTG selected for the Project. Maximum anticipated volumes are provided in **Table 1**. The WTGs would be designed to minimize the potential for spills. At the end of their operational life, these fluids would be disposed of according to applicable regulations and guidelines.

Each WTG would also include a Supervisory Control and Data Acquisition (SCADA) system, to allow for remote control and monitoring, as well as safety and access measures for crew during operation. Additionally, WTGs would include marking and lighting in accordance with USCG and Federal Aviation Administration (FAA) guidelines and regulations. Empire has proposed the utilization of an Aircraft Detection Lighting System (ADLS) to minimize light emissions when aircraft are not in the area.

3.1.2.1.2 Operation and Maintenance

During operation, the WTGs will be remotely monitored from an onshore facility through the SCADA system, which acts as an interface for a number of sensors and controls throughout the wind farm. The SCADA system allows status and performance to be monitored and for systems to be controlled remotely, where required. The submarine export cables will be monitored through Distributed Temperature Sensing and Distributed Acoustic/Vibration Sensing (DAS/DVS) equipment. The WTGs will be regularly inspected and maintained by service technicians. A description of the use of vessels and aircraft during O&M activities is provided in Section 3.1.2.4. Generally, WTG O&M activities would include:

- Inspections of components for signs of corrosion, quality of coatings, and structural integrity of the wind turbine components
- Inspections and maintenance of the WTG electrical components/equipment
- Sampling and testing (e.g., lubricating oils)
- Replacement of consumable items (e.g., filters, hydraulic oils)
- Repair or replacement of worn, failed, or defective systems (e.g., wind turbine blades, gearboxes, bolts, corrosion protection systems, protective coatings, cables) and realigning machinery
- Updating or improving systems (e.g., control systems, sensors)
- Disposal of waste materials and parts in accordance with best practice and regulatory requirements

3.1.2.2. Foundation Types

Foundations refer to the steel structures that support both the WTGs and OSSs. The Proposed Action includes monopile foundations to support the 147 WTGs and piled jacket foundations to support the two OSSs. These foundations would be driven into the seabed.

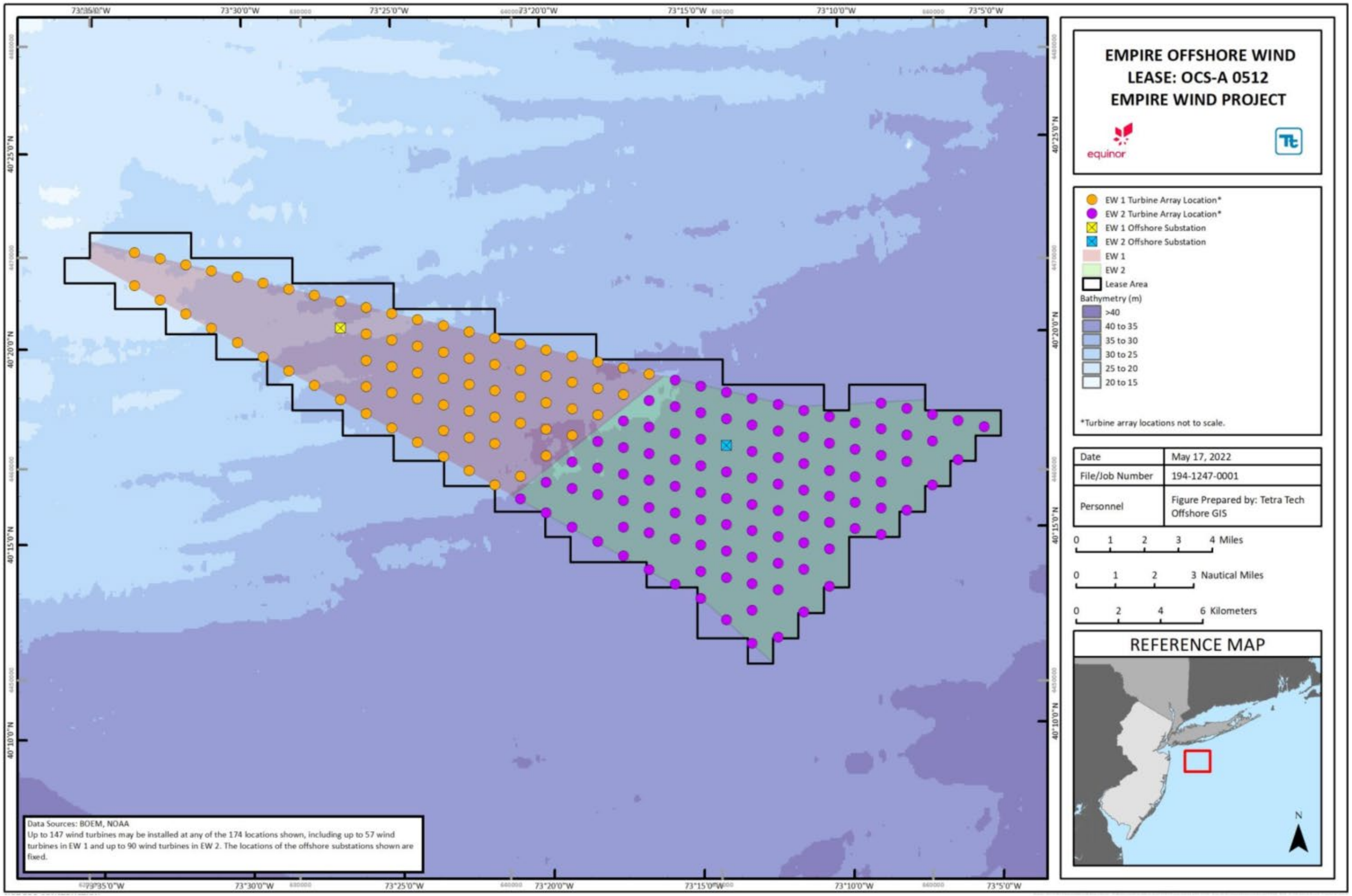


Figure 3 Potential Wind Turbine Generator Positions for the Proposed Action

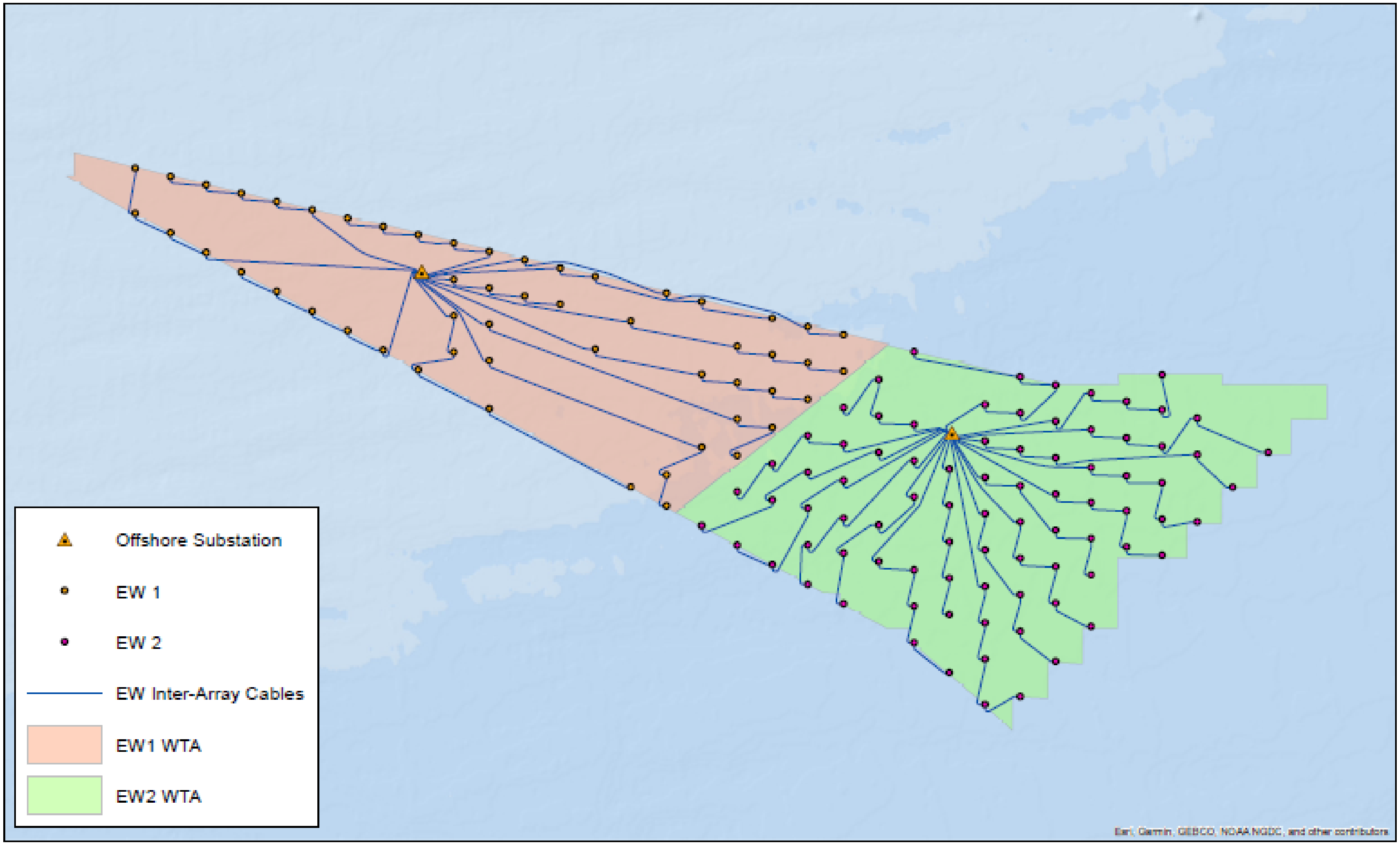


Figure 4 Preliminary Wind Turbine Generator Layout

3.1.2.2.1 Description

Monopiles consist of a single vertical, hollow steel pile connected to a transition piece, which attaches the WTG tower to the monopile above the water line. The monopile foundations for the Project would be tapered at the top with a maximum diameter of 49 feet (15 meters) at the opposite end.

Piled jacket foundations are vertical steel lattice structures with three or four legs connected by cross bracing. Each leg is secured to the seabed using piles. For the Proposed Action, each foundation is expected to have up to three 13-foot (4-meter) diameter piles per leg.

Scour protection would be installed around WTG and OSS foundations to prevent scouring of the seabed around the foundations. Installation would be completed using a fall pipe vessel. Locations requiring scour protection, the type of protection selected, and the amount of scour protection placed around each foundation would be based on a variety of factors, including foundation type, water flow, and substrate type. Proposed scour protection types for foundations include the following:

- Rock: The installation of crushed rock or boulders around a structure
- Rock bags: Pre-filled bags containing crushed rock to be placed around a structure
- Concrete blocks: The installation of pre-cast blocks of concrete around a structure

Scour protection would extend up to 226 feet (69 meters) in diameter at the base of each monopile and be placed to a depth of up to 8.2 feet (2.5 meters), depending on the chosen design. Placement of scour protection for WTG foundations would result in the modification of up to 160.2 acres (0.6 square kilometers) of seabed. For the OSS, scour protection would extend up to 105 feet (32 meters) in diameter at the base of each piled jacket leg and be placed to a depth of up to 6.6 feet (2 meters), resulting in the modification of up to 4.3 acres (0.02 square kilometers) of seabed. Empire anticipates that the installation of scour protection would take approximately four days per foundation.

3.1.2.2.2 Installation

During construction, Empire would receive equipment and materials to be staged and loaded onto installation vessels at one or more existing third-party port facilities (Section 3.1.1). Installation vessels would then transport equipment and materials to the Lease Area. Use of these vessels, and other construction vessels that would be used for installation of WTG and OSS foundations, is described in Section 3.1.2.4. Monopile foundations for the WTGs would be driven up to 180 feet (55 meters) into the seabed using a hydraulic impact hammer deployed on a jack-up or heavy-lift barge. The impact hammer utilized for installation of WTG foundations would have a maximum rated capacity of 5,500 kilojoules. The installation of one monopile would require approximately 3 hours of pile driving. Piled jacket foundations for the OSSs would be driven up to 295 feet (90 meters) into the seabed using the same impact pile driving methods utilized for monopile installation. If required, seabed preparation would be conducted to ensure that a flat seabed surface is provided for a piled jacket base. The installation of one jacket foundation would require approximately 4.2 hours of pile driving per pile.

Installation of the EW 1 WTG foundations would occur from April 2024 through March 2025, installation of the EW 1 WTGs would occur from October 2025 through June 2026, and construction of the EW 1 OSS would occur from April through June 2025 (**Figure 2**). Installation of the EW 2 WTG foundations would occur from April 2025 through March 2026, installation of the EW 2 WTGs would occur from October 2026 through August 2027, and construction of the EW 2 OSS would begin in July 2025 and resume in November 2025, continuing through January 2026. During this period, construction activities would occur 24 hours a day to minimize the overall duration of activities and the associated period of potential impact on marine species. Initiation of impact pile driving will commence only during daylight hours, beginning no later than 1.5 hours before civil sunset unless an approved alternative monitoring plan is implemented. Without an approved AMP for nighttime pile driving, pile driving may continue after dark when pile driving for a given pile was initiated within the time of day restriction and must continue for human safety or installation feasibility. Time of year restrictions would limit the impact pile driving period to May 1 through December 31 in a given year, with additional time constraints as needed for the protection of ESA-listed marine mammals and sea turtles (see Section 3.3 for a full list of mitigation measures for the protection of ESA-listed species). The installation scenario for the Project assumes the 147 WTG monopile foundations would be installed over a period of approximately 2 years.

3.1.2.2.3 Operation and Maintenance

Empire does not expect the WTG foundations to require maintenance over the lifetime of the Project. Should unplanned maintenance of the WTGs be required, the associated activities to repair or replace the damaged component would be similar to those described for the installation of an individual WTG. Catastrophic failure of monopile foundations from unanticipated events, such as a large vessel allision, could occur but is not anticipated (see Section 2.3 of the DEIS).

During operation, Empire would conduct inspections of scour protection for up to 10 percent of foundations in order to monitor and document habitat disturbance and recovery, every three years beginning in year three. Offshore wind foundations have been designed with consideration for marine growth in the offshore environment. Removal of subsea marine growth on the foundations is not expected to be required. If inspections indicate that remedial work to remove subsea growth is required, Empire anticipates that a water jet operated from a remotely operated vehicle or a dynamically positioned vessel would be used.

3.1.2.3. Cable Types

The Proposed Action includes the installation and operation of offshore and onshore cables. Offshore cabling for the Project includes up to 260 nautical miles (481 kilometers) of inter-array cables and 66 nautical miles (122 kilometers) of submarine export cables (Section 3.1.2.3.1). Onshore cabling for the Project includes up to 11.2 miles (18 kilometers) of export cables and 3.0 miles (5 kilometers) of interconnection cables (Section 3.1.2.3.2).

3.1.2.3.1 Offshore Cables

3.1.2.3.1.1 Description

The inter-array cables would connect the WTGs into strings and then connect these strings to the OSSs. The inter-array cables would consist of three-core high voltage alternating current (HVAC) cables with a maximum transmission capacity of 66 kilovolts (kV). The EW 1 and EW 2 inter-array cables would have lengths of 116 nautical miles (214 kilometers) and 144 nautical miles (267 kilometers), respectively. A preliminary inter-array cable layout is provided on **Figure 4**.

Two offshore export cables, each occupying their own corridor, would connect the proposed Project to the onshore electrical grid. Each offshore export cable would consist of three-core HVAC cables with a maximum transmission capacity of 230 kV that would deliver power from the OSSs to the onshore facilities. The EW 1 and EW 2 offshore export cables would have lengths of 40 nautical miles (74 kilometers) and 26 nautical miles (48 kilometers), respectively.

The export cable routes currently being considered include several routing options (**Figure 1**). The EW 1 export cable would depart the Lease Area along its northern boundary, continue north-northwest across the outbound lane of the Ambrose to Nantucket Traffic Separation Scheme, and then enter the Separation

Zone between the traffic lanes before turning to the west. The route would continue through the Traffic Separation Zone toward New York Harbor. Approaching Gravesend Bay, Empire has proposed route variants for the EW 1 submarine export cable that would either route the submarine cable within the maintained Ambrose Channel or through the charted Anchorage #25 area. North of the Anchorage #25 area, the EW 1 route would turn to the northeast and follow the Bay Ridge Channel to the EW 1 landfall. The EW 2 submarine export cable would exit the Lease Area from the central north edge and travel in a relatively straight, northwestern direction, then turn west seaward of the New York state water boundary before making landfall. At the EW 1 export cable landfall location, the submarine export cable would most likely connect directly into the onshore substation, as the onshore substation is proposed to be located at the export cable landfall location. At the export cable landfall location for EW 2, the submarine export cables would be joined to onshore export cables at the export cable landfall. As depicted in **Figures 5 and 6**, Empire is evaluating the following options for the EW 1 and EW 2 export cable landfalls:

- EW 1: The export cable landfall for the EW 1 export cable would occur at the South Brooklyn Marine Terminal site, located along the Brooklyn Waterfront and adjacent to 1st Avenue/2nd Avenue. The parcel is owned by New York City, leased to the New York City Economic Development Corporation, and is the same parcel in which the onshore substation is located.

- EW 2 Landfall A: This export cable landfall for the EW 2 export cable would occur within the City of Long Beach public right of way at Riverside Boulevard. Horizontal directional drilling (HDD) or Direct Pipe operations would be staged in a vacant, privately owned parcel adjacent to Riverside Boulevard and East Broadway.

- EW 2 Landfall B: This export cable landfall for the EW 2 export cable would occur within the City of Long Beach public right of way at Monroe Boulevard. HDD or Direct Pipe operations would be staged in a vacant privately owned parcel adjacent to Monroe Boulevard and East Broadway.

- EW 2 Landfall C: This export cable landfall for the EW 2 export cable would occur at an existing paved parking lot at the Lido West Town Park in Lido Beach, Town of Hempstead. The parking lot is owned by the Town of Hempstead.

- EW 2 Landfall E: This export cable landfall for the EW 2 export cable would occur within the City of Long Beach public right of way at the corner of Laurelton Boulevard and West Broadway. HDD or Direct Pipe operations may be staged in vacant privately owned parcels adjacent to the landfall.

Project cables would be buried to a target depth of 6 feet (1.8 meters) where possible. BOEM estimates that it would not be possible to bury up to 10 percent of export and inter-array cable lengths. Remedial surface protection (e.g., cable protection) would be installed on the seafloor above lengths of cable where adequate burial depth is not possible. Similar to scour protection, cable protection installation would be completed using a fall pipe vessel. Locations requiring cable protection, the type of protection selected, and the amount of cable protection placed around each submarine export and inter-array cable would be based on a variety of factors, including water flow, substrate type, and potential conflicting uses (e.g., commercial fishing). Proposed types of protection for cables include the following:

- Rock: The installation of crushed boulders over a cable

- Rock Bags: Pre-filled bags containing crushed rock to be placed over a cable

- Concrete Mattresses: Concrete blocks, or mats, connected via rope or cable

- Geotextile Mattress: Filled with rock or similar

Surficial use of mattresses is not a favored method of cable protection for the EW Project based on agency feedback. However, this approach may be the preferred solution at certain asset crossings in order to reduce shoaling. Inter-array cable protection would extend to a width of up to 16 feet (5 meters) at the base and to a depth of up to 3 feet (1 meter). Export cable protection would extend to a width of up to 15 feet (4.5 meters) and a depth of up to 5 feet (1.5 meters). Installation of cable protection for the export cables is expected to take up to six months each for EW 1 and EW 2. For the inter-array cables, installation of cable protection is expected to take two to three months each for EW 1 and EW 2.

3.1.2.3.1.2 Cable Installation

Seabed preparation activities may be conducted prior to the installation of cables to ensure that the submarine export cable and burial equipment will not be impacted by any natural or man-made debris or hazards during the burial process, which could cause equipment damage and/or delays, and to ensure sufficient burial depth. Seabed preparation activities may include grapnel runs, unexploded ordinance (UXO) clearance, pre-sweeping, pre-trenching, and localized dredging.

A pre-lay grapnel run may be completed to remove seabed debris (e.g., abandoned fishing gear, wires, etc.) from the siting corridor, where feasible. Where this is not feasible, the cable route will be altered slightly within the surveyed corridor to avoid these features. Empire conducted a UXO risk assessment and determined that the risk level for UXO is relatively low for most installation activities in the Lease Area. Risk level for UXO is medium along a portion of the EW 1 export cable route. Empire continues to evaluate the potential for UXO presence in the immediate Project area. It is anticipated that portions of the export cable route(s) would be surveyed and potentially cleared for UXO. Avoidance is the preferred approach for any identified UXO. When avoidance is not possible, UXO may be relocated to a safe location out of the work area using a lift and shift technique. Empire has not proposed a plan detailing removal of identified UXO with any other methods in the COP.

In certain limited areas of the export cable siting corridors, where underwater megaripples and sand waves are present on the seafloor, pre-sweeping may be necessary prior to cable lay activities. Pre-sweeping involves smoothing the seafloor by removing ridges and edges, where present. The primary pre-sweeping method will involve using a mass flow excavator from a construction vessel to smooth excess sediment on the seafloor along the footprint of the cable route. However, a suction hopper dredge vessel or other types of dredging equipment may be used depending on regulatory requirements. Pre-sweeping is anticipated to be required primarily along the nearshore portions of the export cable route and within New York State waters. Preliminary areas where Empire anticipates pre-sweeping will be required are identified on **Figures 7 and 8**. Where required, pre-sweeping activities would occur up to a width of 164 feet (50 meters) along the length of the megaripples and sand waves. The total linear length of pre-sweeping for the EW 1 and EW 1 export cable routes is anticipated to be approximately 517 feet (158 meters) and 2,418 feet (737 meters), respectively. Megaripple and sand wave height vary depending on localized seabed and current characteristics. If mass flow excavation equipment is used for pre-sweeping, dredge material would be displaced. If a suction hopper dredge vessel is used, dredged material may either be sidecast near the site or placed in a barge and removed for disposal at an approved upland facility. Approximately 116,044 cubic yards (88,722 cubic meters) of sediment may be side-casted as a result of these pre-sweeping activities along the EW 1 submarine export cable route. Along the EW 2 submarine export cable route, approximately 88,127 cubic yards (67,378 cubic meters) may be side-casted.

Pre-trenching activities would be required in select locations along the EW 1 and EW 2 export cable routes in areas where deeper burial depths may be required and/or seabed conditions are not suitable for traditional cable burial methods. Pre-trenching involves running cable burial equipment over portions of the route in order to soften the seabed prior to cable burial and/or the use of a suction hopper dredge to excavate additional sediment. This activity helps facilitate an easier burial process in areas of greater water depths.

At locations where the EW 1 export cable crosses other assets, local dredging may be needed to reduce the shoaling of the crossing design. This local dredging would include the removal of approximately 8 feet (2.4 meters) of sediment to form a trench measuring approximately 33 by 585 feet (10 by 26 meters) at the bottom. Utilizing a 3:1 side slope, the maximum dredge area would be approximately 52.5 by 87 feet (16 by 26 meters). Approximately 735 cubic yards (562 cubic meters) of material is anticipated to be removed by suction hopper dredge and/or mass flow excavation at each crossing. The final depth of the dredged area will be governed by the vertical distance between the natural seabed and the assets to be crossed and will need to be approved by the asset owners through a crossing agreement.

Local dredging may also be required to facilitate the required burial depth along the EW 1 export cable route within the Bay Ridge Channel and at South Brooklyn Marine Terminal. In the Bay Ridge Channel, dredging may be required within an approximately 17.6-acre (0.07-square kilometer) area where the export cable makes its approach to South Brooklyn Marine Terminal. This area overlaps with the area proposed for maintenance dredging by the USACE in a Public Notice issued on March 11, 2021. Empire is currently consulting with the USACE on the anticipated channel maintenance activities and does not anticipate conducting additional dredging within these USACE-managed channel reaches prior to construction and installation activities. However, dredging in this area could be required if sedimentation or shoaling decreases the water depth prior to or during construction. Within the existing piers at South Brooklyn Marine Terminal, an area of approximately 36,147 square yards (30,207 square meters) may require dredging to elevations of approximately -26.5 feet (-8.0 meters) below mean lower low water (MLLW) plus 2 feet (0.6 meter) overdredge for access of the cable installation vessel. In addition, an area of approximately 0.6 acres (2,428 square meters) at the base of the cable landfall may need to be dredged to an elevation of -26 feet (-7.0 meters) MLLW plus 2 feet (0.6 meter) overdredge. Localized dredging at South Brooklyn Marine Terminal would be conducted using a barge-mounted clamshell dredge with an environmental bucket which would prevent any potentially contaminated sediments from leaking from the bucket. Dredged sediments would be placed in scows and dewatered on site within the submarine export cable. Sediments would be allowed to settle for at least 24 hours then decanted. Dewatered dredge material would then be transported to an approved upland disposal site. Localized dredging at South Brooklyn Marine Terminal would be conducted during the in-water work window of June 1 to December 15. Dredging conducted during June, October, or November would be performed in accordance with a Sturgeon Avoidance and Monitoring Plan.

In some areas, existing, out-of-service cables and pipelines may be cut-away and removed prior to export cable installation. This removal would only be completed upon pre-determined cables and pipelines in which written agreement is received from the owners and/or appropriate agencies. Should this be required, details of the cutting or removal would be agreed upon by all associated parties and would be consistent with sound engineering practices and relevant requirements.

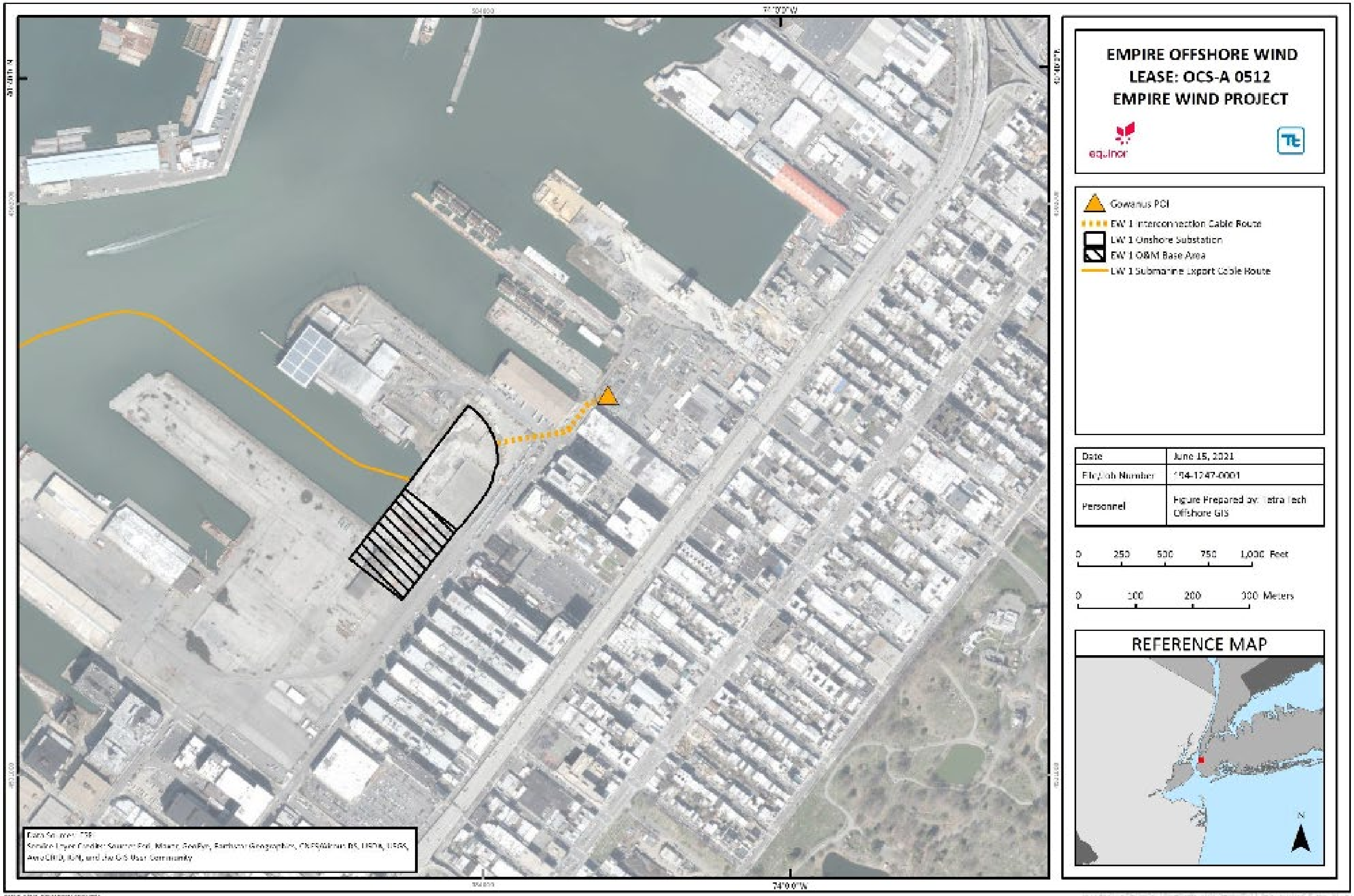


Figure 5 **Landfall Site and Onshore Export Cable Route for EW 1**

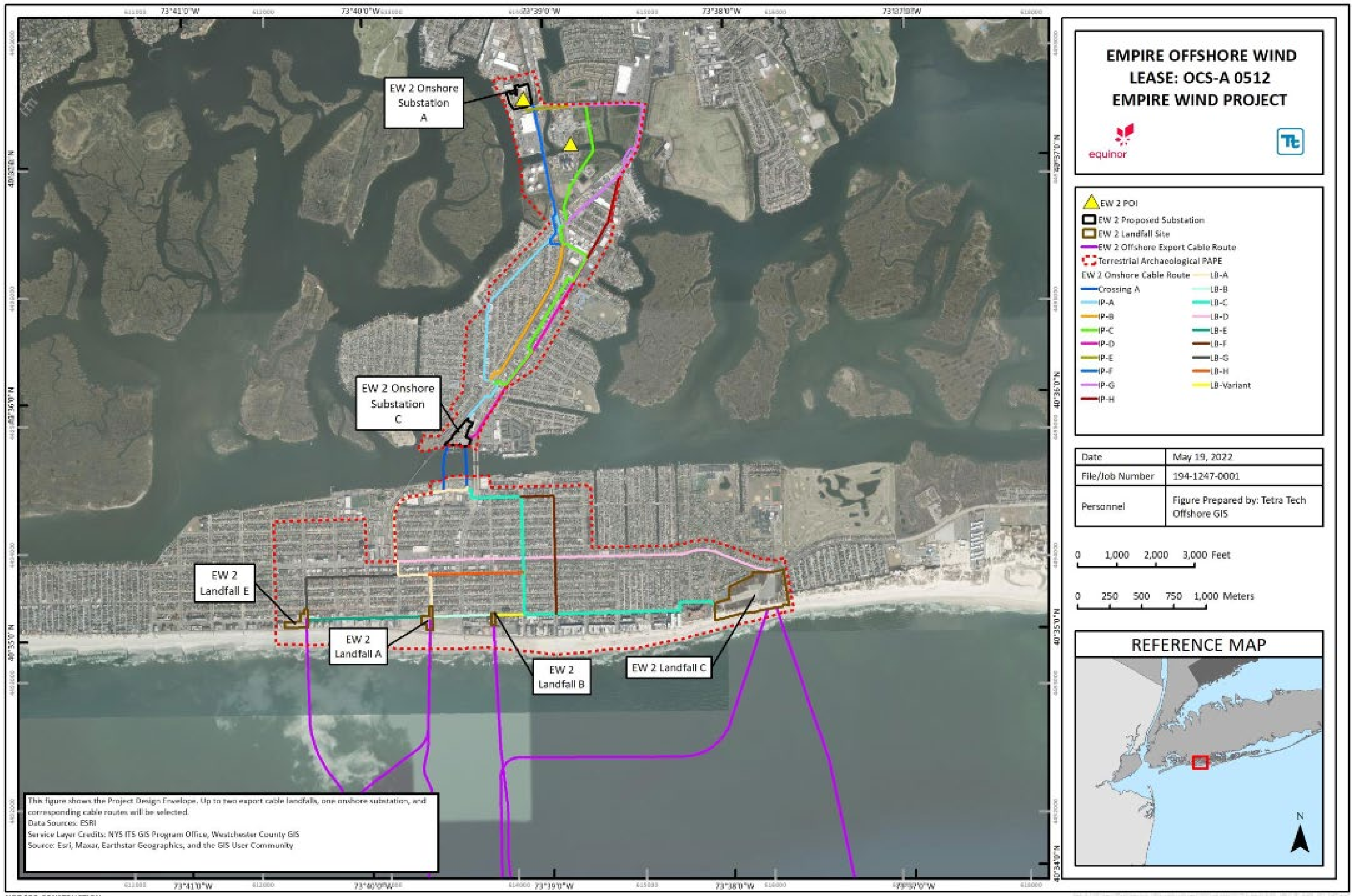


Figure 6 Potential Landfall Sites and Onshore Export Cable Routes for EW 2

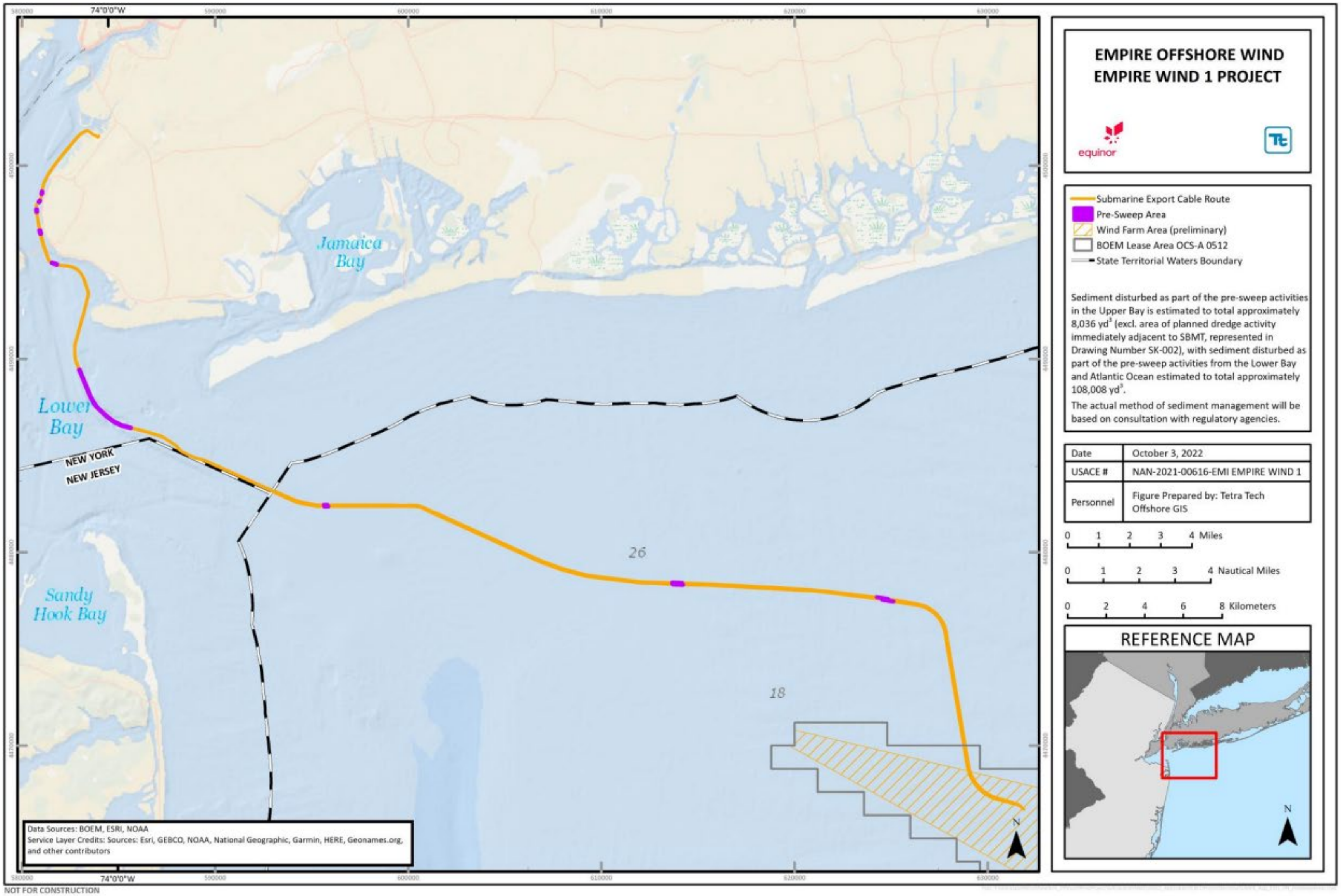


Figure 7 Preliminary Locations of Pre-Sweeping for Sand Waves/Megaripples for EW 1

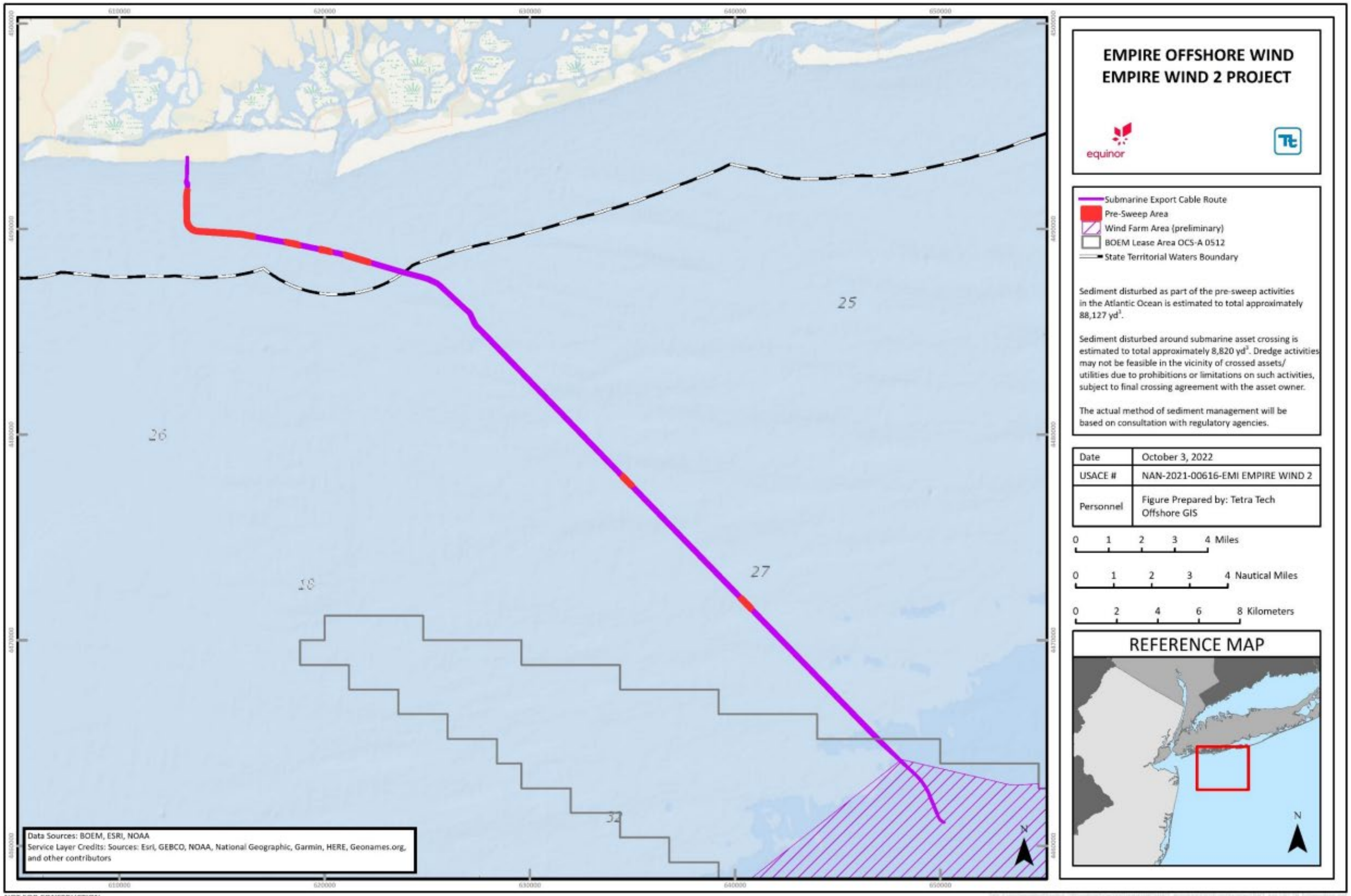


Figure 8 Preliminary Locations of Pre-Sweeping for Sand Waves/Megaripples for EW 2

Once any necessary seabed preparations are completed, Empire would install the inter-array cables linking each of the WTGs to the OSS for each project and the offshore export cables that would link the EW 1 and EW 2 OSSs to a sea-to-shore transition at their respective landfalls. Inter-array and export cables would be brought to the appropriate section of the cable siting corridor on a deep-sea cable laying vessel (see Section 3.1.2.4 for a description of the use of this vessel, and other construction vessels that would be used for cable installation). From there, the cables would be laid onto the seabed and either buried by the laying vessel or by a second vessel following the cable laying process. Cable burial would utilize one of the following methods:

- Jetting: Involves injecting pressurized water jets into the seabed, creating a trench. As the trench is created, the submarine export cable is able to sink into the seabed. The displaced sediment then resettles, naturally backfilling the trench. Jetting is considered the most efficient method of submarine cable installation. It would minimize the extent and duration of bottom disturbance along significant lengths of the submarine export cable routes.

- Plowing: As the cable plow is dragged along the seabed, a small trench is created. The submarine export cable is then placed in the trench and displaced sediment is either mechanically returned to the trench or backfills naturally under hydrodynamic forcing. Plowing is generally less efficient than jetting methods but may be used in limited site-specific conditions.

- Trenching (cutting): Used on seabed containing hard materials not suitable for plowing or jetting, as the trenching machine is able to cut through the material using a chain or wheel cutter fitted with picks. Once the cutter creates a trench, the submarine export cable is laid into it.

The final cable burial method(s) will be selected prior to finalizing the Facility Design Report. The equipment selected will depend on seabed conditions and the required burial depths, as well as the results of various cable burial studies. More than one installation and burial method may be selected per route and has the potential to be used pre-installation, during installation, and/or post-installation.

In shallow areas, specifically along the Rockaway sandbank in New York Harbor, the export cable may need to be floated into place for burial, as water depths along this stretch are too shallow for the cable lay vessel. Should this floating installation method be implemented, the cable lay vessel would be located approximately 1,312 feet (400 meters) from the burial location. The cable burial machine will then assist in lowering and burying the submarine export cable in place, as it moves along these shallower areas. The burial machine may also be run out of a separate construction vessel.

Burial of the inter-array and export cables would terminate before the OSSs, and J-tubes would be installed to protect the remaining portion of the cable. Depending on the final construction and installation schedule, it is possible that up to 3,000 feet (914 meters) of the submarine export cables will need to be wet-stored close to the OSS locations. This wet-storage concept would be required should the OSSs be installed after the export cables are buried along the cable route. In the event that this approach is taken, the submarine export cables would be cut, sealed, and fitted with corrosion resistant rigging. The cables would then be laid and/or buried on the seafloor until they could be pulled into and installed in the OSSs. The inter-array cables would be installed and buried either before the installation of the WTGs and J-tubes or at the same time, if needed.

HDD is being considered as a method for the installation of the export cable at the EW 1 and EW 2 export cable landfalls. Typically, HDD operations for an export cable landfall originate from an onshore landfall location and exit a certain distance offshore, which is determined by the water depth contour and total length considerations. To support this installation, both onshore and offshore work areas are required. Once the onshore work area is set up, the HDD activities would commence using a rig that drills a borehole underneath the surface. Once the drill for both HDDs (i.e., two circuits for EW 1 and three circuits for EW 2) exits onto the seafloor, the ducts in which the submarine cable would be installed would be floated out to sea and then pulled back onshore within the drilled borehole. The offshore exit location would require some seafloor preparation to collect any drilling fluids that localize during HDD completion. Preparation may include installation of a cofferdam or excavation (wet or dry).

Up to two cofferdams may be installed at EW 1 and up to three cofferdams may be installed at EW 2. If required, the temporary offshore cofferdams will be constructed by installing 0.61-m (24-inch) steel sheet piles in a tight configuration around an area of up to 30 m by 30 m (100 ft by 100 ft). Such installation would utilize vibratory pile driving and would require approximately 1 hour to complete. An alternative method to temporary cofferdam construction for cable landfall would be to install temporary goal posts used to assist in the installation of a casing pipe. A casing pipe through which the cable would be pulled would be supported by 3 to 5 goal posts. Two temporary 12-inch steel piles would be installed for each goal post, for a total of 6 to 10 piles for each cable (or 18 to 30 piles for both EW1 and EW2) using a hydraulic impact hammer. The installation of each pile would require approximately 2,000 strikes over a period of approximately 2 hours. Regardless of the method, the temporary sheet piles, goal posts, and associated materials would be removed from the site following completion of the offshore cable connection at the HDD exit points.

Open-cut alternatives are also being considered for the installation of the export cable at the EW 1 landfall due to potential limitations of an HDD alternative. Open-cut alternatives may require open-cut dredging or jetting to facilitate installation at target burial for approach to landside. Dredging may be completed using clamshell dredging, suction hopper dredging, and/or hydraulic dredging. During dredging activities, the material will be collected in an appropriate manner for disposal at an approved upland facility, depending on the nature of the material, and in accordance with applicable regulations. No backfilling is proposed for these activities if implemented for the purposes of landfall.

Installation of the EW 1 inter-array cables would occur from May through September 2025, installation of the EW 2 inter-array cables would occur from April through September 2026, installation of the EW 1 export cable would initially occur from July through September 2024 and be completed from April through July 2025, and installation of the EW 2 offshore export cable would occur from July through December 2025 (**Figure 2**). During cable installation, activities would occur 24 hours a day to minimize the overall duration of activities and the associated period of potential impact on marine species.

3.1.2.3.1.3 Operation and Maintenance

Empire does not expect the offshore export cables to require planned maintenance but will maintain a stockpile of equipment and materials for emergency repairs as needed in the unlikely event of substation equipment failure or 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 appropriate capabilities. Should the inter-array or export cables fault, the faulty portion of the cable will be spliced and replaced with a new, working segment. This will require the use of various cable installation equipment, as described for construction activities. Sedimentation over the cables during operations may also result in an exceedance of the depth limitations of the cables over time. In that case, maintenance dredging may be required during operations.

During operation, Empire would conduct surveys of the submarine export cable and inter-array cable routes, to confirm the cables have not become exposed or that the cable protection measures have not worn away (Section 3.1.2.5). If necessary, protection would be renewed using additional rock dumping via fall pipe vessel or mattress placement.

3.1.2.3.2 Onshore Cables

3.1.2.3.2.1 Description

The onshore export cable(s) would connect to the submarine export cable(s) at the landfall(s). For the Proposed Action, the EW 1 submarine export cable is expected to connect directly to the onshore substation, making an onshore export cable unnecessary. Onshore export cables are expected to connect the EW 2 onshore substation to the EW 2 submarine export cable. The onshore export cables for EW 2 would consist of three circuits of three single-core HVAC cables with a maximum transmission capacity of 230 kV. Up to two onshore cable routes of up to 5.6 miles (9.1 kilometers) each may be used for EW 2.

The interconnection cables would connect the onshore substations to their points of interconnection (POIs) to the bulk power grid. The interconnection cable for EW 1 would consist of two circuits of six single core HVAC cables with a maximum transmission capacity of 345 kV. For EW 1, the interconnection cable would consist of three circuits of 18 single core HVAC cables with a maximum transmission capacity of 138 kV. The EW 1 and EW 2 interconnection cables would have lengths of 0.2 miles (0.4 kilometers) and 2.8 miles (4.5 kilometers), respectively.

For EW 1, the interconnection cables would connect the onshore substation at South Brooklyn Marine Terminal to the Gowanus POI, traversing 2nd Avenue (**Figure 5**). Several onshore cable routes are currently being considered for EW 2 (**Figure 6**): nine onshore export cable route segments from landfall to the Reynolds Channel crossing, eight cable route segments from the Reynolds Channel crossing to Oceanside (which may be used for onshore export cables or interconnection cables), and one interconnection cable route from the substation to the POI. Potential EW 2 onshore cable routes from landfall to the Reynolds Channel crossing include the following:

- EW 2 Long Beach Route A (tan on **Figure 6**): From EW 2 Landfall A, the onshore export cables would traverse up Riverside Boulevard to East Park Avenue where the cables will turn west until Reverend JJ Evans Boulevard. From there, the cables would turn north, continuing along Reverend JJ Evans Boulevard, which becomes Park Place, until the crossing at Reynolds Channel

- EW 2 Long Beach Route B (pale blue on **Figure 6**): From EW 2 Landfall B, the onshore export cables would traverse up Monroe Boulevard to East Broadway where the cables would turn west until connecting into EW 2 Long Beach Route A

- EW 2 Long Beach Route C (robin's egg blue on **Figure 6**): From EW 2 Landfall C, the onshore export cables would traverse west through the park to Richmond Road, continuing west on Richmond Road until turning south on Maple Boulevard. The cables would immediately turn west on East Broadway then turn north onto Lincoln Boulevard or continue west on the EW 2 Long Beach variant. From Lincoln Boulevard, the cables would continue north until turning west on East Harrison Street, cross perpendicular to Long Beach Boulevard, then turn north onto Long Beach Road, continuing to the crossing at Reynolds Channel. From the EW 2 Long Beach variant, the cable would connect into EW 2 Long Beach Route B

- EW 2 Long Beach Route D (lavender on **Figure 6**): From EW 2 Landfall C, the onshore export cables would connect north into Lido Boulevard then traverse west as Lido Boulevard turns into East Park Avenue. Then the cables would turn north onto Lincoln Boulevard, either connected to EW 2 Long Beach Route C or continuing to Riverside Boulevard to connect to EW 2 Long Beach Route A

- EW 2 Long Beach Route E (teal on **Figure 6**): From EW 2 Landfall E, the onshore export cables would proceed east along West Broadway to reach EW 2 Landfall A, from which the route could connect into either EW 2 Long Beach Route A or EW 2 Long Beach Route B
- EW 2 Long Beach variant (yellow on **Figure 6**): a route along East Broadway between Monroe Boulevard and Lincoln Boulevard connecting EW 2 Long Beach Route C and EW 2 Long Beach Route B
- EW 2 Long Beach Route F (brown on **Figure 6**): From EW 2 Landfall C, the onshore export cables would follow EW 2 Long Beach Route C to East Broadway. From there, the route would turn north on Franklin Boulevard, then turn west onto East Harrison Street, continuing on to rejoin EW 2 Long Beach Route C
- EW 2 Long Beach Route G (gray on **Figure 6**): From EW 2 Landfall E, the onshore export cables would follow Laurelton Boulevard north, then turn east on West Walnut Street and continue onto Edwards Boulevard. Then the cables would turn north onto Edwards Boulevard and join EW 2 Long Beach Route A
- EW 2 Long Beach Route H (orange on **Figure 6**): From EW 2 Landfall A, the onshore export cables would proceed north on Riverside Boulevard then turn east onto East Walnut Street until it reaches Lincoln Boulevard to connect to EW 2 Long Beach Route C

Potential EW 2 onshore cable routes from the Reynolds Channel crossing to the onshore substation or the POI include the following:

- EW 2 Island Park Route A (light blue on **Figure 6**): From the crossing at Reynolds Channel, the onshore export or interconnection cables would follow the Long Island Rail Road northeast until crossing an existing parking lot along Warwick Road. Then the cables would turn north onto Long Beach Road until reaching the Long Island Rail Road again where the route would connect with EW 2 Island Park Route C or continue northwest along the railroad until connecting with EW 2 Island Park Route F
- EW 2 Island Park Route B (gold on **Figure 6**): From the crossing at Reynolds Channel, the onshore export or interconnections cables would follow EW 2 Island Park Route A until crossing an existing parking lot along Warwick Road then following the Long Island Rail Road northeast until connecting into EW 2 Island Park Route C or EW 2 Island Park Route F
- EW 2 Island Park Route C (green on **Figure 6**): From the crossing at Reynolds Channel, the onshore export or interconnection cables would follow EW 2 Island Park Route A until turning east through an existing parking lot then north onto Austin Boulevard. The cables would then turn west onto Sagamore Road, immediately turn north onto Industrial Place, then turn east onto Trafalgar Boulevard. From there, the cables would turn north onto Austin Boulevard before turning west onto Saratoga Road, crossing the Long Island Railway then continuing on D'Amato Drive. The cables would then turn northeast at Long Beach Road then turn northwest onto Ladomus Avenue to enter the Oceanside POI parcel. From there the cables would cross Barnums Channel to connect with EW 2 Island Park Route E
- EW 2 Island Park Route D (pink on **Figure 6**): From the crossing at Reynolds Channel, the onshore export or interconnection cables would enter Austin Boulevard and traverse north to connect into EW 2 Island Park Route C

- EW 2 Island Park Route E (olive on **Figure 6**): From the end of EW 2 Island Park Route C, the onshore export cables would continue through the Oceanside POI parcel, traversing west, parallel to Daly Boulevard, then cross the Long Island Rail Road before turning north, crossing Daly Boulevard, and connecting into EW 2 Onshore Substation A

- EW 2 Island Park Route F (blue on **Figure 6**): From the crossing at Reynolds Channel, the onshore export or interconnection cables would follow EW 2 Island Park Route A until crossing an existing parking lot along Warwick Road, from which it would follow EW 2 Island Park Route B until turning west on Parente Lane North. From there, the cables would turn north on Kildare Road, turn northeast on Long Beach Road, and turn north on North Nassau Lane. Then, the cables would continue across an industrial lot and private roads immediately west of Long Island Rail Road, cross Barnums Channel, and follow the Long Island Rail Road north before connecting into EW 2 Substation A or the POI

- EW 2 Island Park Route G (purple on **Figure 6**): From the crossing at Reynolds Channel, the onshore export or interconnection cables would follow EW 2 Island Park Route A until connecting with EW 2 Island Park Route C. At the intersection of Sherman Road and Long Beach Road, the cables would continue northeast along Long Beach Road, turn west on Daly Boulevard to connect with EW 2 Island Park Route E, and connect into the EW 2 Onshore Substation A or the POI

- EW 2 Island Park Route H (dark red on **Figure 6**): From the crossing at Reynolds Channel, the onshore export or interconnection cables would enter Austin Boulevard and continue north along EW 2 Island Park Route C or EW 2 Island Park Route D. From the intersection of Austin Boulevard and Saratoga Boulevard, the cables would follow Austin Boulevard northeast until connected with EW 2 Island Park Route G at the intersection of Long Beach Road and Austin Boulevard

Installation of the EW 1 onshore cables would occur from December 2024 through June 2025 and installation of the EW 2 onshore cables would occur from December 2024 through June 2026.

3.1.2.3.2.2 Cable Installation

Open-cut alternatives, described above for the installation of the onshore export cable at the EW 1 export cable landfall, are also being considered for inland waterway crossings for the EW 2 onshore export cable.

Jack and bore methodology or other non-HDD trenchless technologies may also be used for the installation of the onshore export cables. While jack and bore is not the preferred onshore installation methodology, Empire is proposing it as part of the PDE to be utilized in the event that HDD and open-cut alternatives are not technically or commercially feasible to complete installation activities. Jack and bore is completed by installing a steel pipe or casing under existing roads, railways, or other infrastructure. This is completed by excavating a bore (entry) pit and receiving (exit) pit on either side of the crossing. An auger boring machine then jacks a casing pipe through the earth while at the same time removing earth spoil from the casing by means of rotating auger inside the casing. The onshore cable will then be pulled through the crossing. Impacts from jack and bore methodology are not expected to affect ESA-listed species under NMFS jurisdiction. Therefore, these activities are not considered further in this BA.

3.1.2.4. Vessel and Aircraft Types

Probable vessel classes used to install WTGs and OSSs, with their associated foundations, include heavy lift and derrick barges, jack-up barges, material transport barges, a jack-up crane work vessel, fall pipe vessels, transport and anchor handling tugs, and safety vessels (**Table 3**). Monopile supply vessels would be used to transport monopile foundations, wind turbine supply vessels would be used to transport WTG components, and heavy transport vessels would be used to transport OSS topsides. Heavy lift vessels would be used for installation of the WTG and OSS foundations, wind turbine installation vessels would be used for installation of WTGs, and fall pipe vessels would be used for installation of scour protection. Additional barges, and accompanying tugboats, may be used for transporting other construction materials. Crew transport vessels (CTVs) would be used to rotate construction crews to and from area ports, and small support vessels would be used for construction monitoring.

Probable vessel classes used to install the inter-array and export cables include cable lay vessels, grapnel run vessels, fall pipe vessels, transport and anchor handling tugs, and safety vessels (**Table 3**). Cable lay vessels would be used to install submarine cables, cable lay support vessels would be used to support cable lay operations, pre-lay grapnel run vessels would be used for seabed clearance along cable routes, and fall pipe vessels will be used for installation of cable protection. CTVs would be used to rotate construction crews to and from area ports, and small support vessels would be used for construction monitoring. Up to 98 helicopter roundtrips lasting less than one hour may occur during export and inter-array cable installation. Up to 162 helicopter roundtrips may occur during WTG installation for the entire project.

During O&M activities, service technicians would be delivered to the Lease Area by service operations vessels and CTVs. Helicopters may be used to support O&M activities and potentially construction activities. Although the number of potential helicopter trips cannot be estimated for O&M at this time, it is assumed any use of helicopters would reduce the overall number of CTV trips described in this BA at any stage of construction and operations.

It is estimated that the Project will require approximately 18 vessels for construction of EW 1 and approximately 18 vessels for construction of EW 2. Fewer vessels would be required during O&M and a similar number of vessels is anticipated for decommissioning. Within the Lease Area, all vessels are anticipated to travel at speeds of up to 10 knots, with the exceptions of tugs and barges, which are anticipated to travel at speeds of up to 6 knots and crew transfer vessels which are expected to travel at an average speed of 17 knots within the Lease Area. Outside of the Lease Area, vessel speeds would be dependent on weather, vessel design, and any current regulations governing operational speeds. In international waters, Project vessels may travel at speeds of up to 15 knots, with the heavy transport vessel traveling at 6 to 8 knots and all other transport vessels traveling and 10 to 14 knots, dependent on schedule needs. As described in Section 3.3, all Project vessel operators will comply with vessel speed restrictions (i.e., 10 knots or less) in any Seasonal Management Area, Dynamic Management Area, or visually-triggered Slow Zone and will reduce speeds to 10 knots or less when any large whale, mother/calf pairs, whale or dolphin pods, or larger assemblages of cetaceans are observed in proximity (i.e., within 330 feet [100 meters]) of the vessel. Anticipated vessel utilization parameters, including estimated work duration, are provided in **Table 3**. Generalized characteristics for vessel types anticipated for use in offshore wind activities are provided in **Table 4**.

During construction, O&M, and decommissioning of the Project, vessels are expected to transit between multiple ports and facilities, including South Brooklyn Marine Terminal, the Port of Albany, the Port of Coeymans, the cable facility in Goose Creek, South Carolina, and the Port of Corpus Christi. South Brooklyn Marine Terminal is expected to serve as the primary port for the Project. During construction, up to 819 vessel round-trips are expected to occur to South Brooklyn Marine Terminal annually. Vessels utilizing this port during construction are expected to include an installation vessel, a heavy lift vessel, heavy transport vessels, fall pipe vessels, a bubble curtain vessel, cable laying vessels, a cable installation support vessel, dredger/tug combinations, a pre-lay grapnel run vessel, safety vessels, service operations vessels, CTVs, and a variety of tugs and barges. During O&M, 617 round trips are expected to occur to South Brooklyn Marine Terminal in a typical year. During this phase of the Project, a service operations vessel, a survey vessel, a heavy lift vessel, a cable laying vessel, CTVs, tugs, and a barge are expected to utilize this port. Once every 10 years, an additional cable laying vessel would be needed during O&M, increasing the total estimated annual round trips to South Brooklyn Marine Terminal to 635 in those years. During construction, a barge and two tugs are expected to utilize the Port of Albany for transportation of wind turbine towers, with one round trip for each of these vessels every two weeks. Empire expects to utilize the Port of Coeymans during the construction phase of the Project for transportation of rock scour protection, with approximately 15 total round trips by a fall pipe vessel from 2025 to 2026. An export cable lay vessel and an inter-array cable lay vessel are expected to travel to the cable facility in Goose Creek to pick up submarine cables for transport to the Lease Area. From 2025 to 2026, three export cable lay vessel round trips and seven inter-array cable lay vessel round trips to the facility are expected. The Port of Corpus Christi is expected to serve as the starting point for transport of OSS topsides. During construction, two round trips are anticipated for each of two heavy transport vessels (i.e., four total round trips to the Port of Corpus Christi). Vessel trip information is summarized in **Table 5**.

3.1.2.5. Pre- and Post-Construction Surveys

3.1.2.5.1 Geotechnical and Geophysical Surveys

HRG and geotechnical surveys would be required before and after construction. Survey activities would include the use of subsea positioning/ultra-short baseline, a multi-beam echosounder, side-scan sonar, a sub-bottom profiler, and obstacle avoidance sonar within the wind farm area and along the export cable route.

HRG surveys would be conducted prior to construction to support final engineering design for the Project. HRG survey results would provide information for further cable route refinement and micrositing. Post-construction, a full coverage as-built survey would be conducted to provide baseline conditions for future surveys conducted during the O&M phase. Following the full coverage as-built survey, annual, risk-based inspections of the inter-array and export cables would be conducted for the first three years to confirm that cables remain buried and cable protection measures remain in place. An estimated 121,254 line kilometers are anticipated to be surveyed from pre-construction through the three annual risk-based inspections post-construction. HRG surveys are anticipated to operate during any month of the year for a maximum of 682 vessel days, on average, 177.792 line kilometers per day.

Additional HRG surveys would occur following the third annual risk-based inspection. For the remainder of the O&M phase, risk-based bathymetric surveys would be conducted every two years. Risk-based burial depth surveys would be conducted every five years, with coverage to be determined through the use of Distributed Temperature and DAS/DVS systems. Additional survey activities would be completed on an as-needed basis, determined based upon various factors, such as extreme weather events. Surveys are not anticipated during the decommissioning phase.

Pre-construction geotechnical surveys would occur for further sediment testing at specific WTG locations to inform final selection and design of foundations. Pre-construction surveys would also be used to inform the selection and placement of scour and cable protection.

NMFS (2021b) has completed a programmatic consultation addressing the effects of site assessment and characterization activities anticipated to support siting of offshore wind energy development projects off the U.S. Atlantic coast, including HRG and geotechnical surveys. In its consultation, NMFS (2021b) evaluated potential effects of these activities, including effects to individual animals associated with survey noise exposure; effects of environmental data collection, buoy deployment, operation, and retrieval; effects to habitat; and effects of vessel use, and concluded that the site assessment and characterization activities considered are not likely to adversely affect any ESA-listed species or critical habitat. The pre- and post-construction HRG and geotechnical surveys that would be required for the

Proposed Action are anticipated to fall within the scope of the programmatic consultation (NMFS 2021b). Any HRG and geotechnical surveys conducted for the Proposed Action would be required to follow BOEM's (2021b) Project Design Criteria and Best Management Practices developed to address the mitigation, monitoring, and reporting conditions identified in the programmatic consultation (NMFS 2021b).

3.1.2.5.2 Biological Monitoring

Pre- and post-construction biological monitoring, including fisheries and benthic monitoring, would be conducted in the immediate Project area to monitor and evaluate construction impacts on fish and invertebrate communities.

3.1.2.5.2.1 Fisheries Monitoring

Fisheries monitoring would be conducted in the Lease Area and, for some techniques, in a reference site selected for its similarity to the Lease Area. Proposed fisheries monitoring surveys would utilize non-extractive techniques, such as passive and active acoustics and videography, to the greatest extent practicable and would utilize modifications to traditional techniques to reduce mortality of fish and invertebrate species and minimize interactions with protected species. Proposed fisheries monitoring techniques include trawl surveys, baited remote underwater video surveys, environmental DNA (eDNA) sampling, acoustic telemetry, and sea scallop plan view camera surveys.

Trawl Surveys

Trawl surveys targeting longfin squid (*Doryteuthis pealeii*) would be conducted within the Lease Area and a reference area during pre-construction, construction, and post-construction phases of the Project. The trawl surveys would be conducted in the fall (September and October) by a contracted commercial fishing vessel with experience targeting squid in the trawl fishery. The survey would utilize a Before-After-Control-Impact (BACI) design with two years of sampling in the pre-construction period (beginning Fall 2023), sampling throughout the construction period, and at least two years of sampling in the post-construction period. During each seasonal sampling period, four survey tows would be conducted in both the Lease Area and reference area twice each month, resulting in a total of 32 tows per sampling year.

The trawl survey would be conducted using a trawl net typical of the local squid fishery. The codend would be fitted with a 1-inch (2.5-centimeter) knotless codend liner to sample squid and other marine taxa across a broad range of size and age classes. All tows would be completed during daylight hours, and tow durations would be limited to 20 minutes. All gear restrictions, closures, and other regulations set forth by take reduction plans would be adhered to in order to reduce risks to protected species, and the proposed trawl survey would utilize a Turtle Excluder Device with a bottom-oriented escape outlet to reduce risks to sea turtles. Additionally, if any protected species are sighted in the vicinity of a trawl tow, sampling will be delayed at that location to minimize the risk of interaction. If interactions with protected species were to occur, sampling protocols described for the Northeast Fisheries Observer Program would be followed. If any protected species were to be captured in the proposed trawl surveys, sampling and release of these species would take priority over sampling of the rest of the catch.

Table 3 Anticipated Vessel Utilization for the Proposed Action

Vessel	Activity	Stage	Round Trips	Average Transit Duration (hr/trip)	Number of Operating Days
Heavy lift vessel	Installation of foundations	C, O&M	74	6	2,307
WTG installation vessel	Installation of WTG components	C	4	6	800
WTG supply vessel	Transport to WTG components	C	49	9	189
Heavy transport vessel	Transport of OSS topsides, monopile foundations	C	34	127.25	213
Cable lay vessel/barge	Installation of submarine cables	C, O&M	90	21	2,595
Cable lay support vessel	Support for cable lay operations	C	6	9	451
Pre-lay grapnel run vessel	Seabed clearance along cable routes	C	4	9	19
Fall pipe vessel	Installation of scour protection	C	79	6	764
Crew transfer vessel	Transporting workers to and from offshore work area	C, O&M	611	9	1,943
Support vessel	General construction and maintenance support	C, O&M	52	8	1,288
Tugboat	Transport/maneuvering of barges	C, O&M	428	12	7,329
Barge	Transport of construction materials	C, O&M	277	16.5	4,205
Safety vessel	Protection of construction areas	C	20	9	636

Source: Summarized from Attachment K-1, *Emissions Calculations*, to COP Appendix K (Empire 2022a)

Table 4 Generalized Vessel Characteristics for Offshore Wind Activities

Category	Activity	General Vessel Types	Example Vessels	Mean Width (m)	Mean Length (m)	Mean Gross Tonnage	Default Transit Speed (kn)	Mean Draft (m)	Percent Time Moving[1]	Mean Speed (kn)[2]
Crew Transfer	Crew transfer, service, refueling, guard vessel, multi-purpose support, MMO/biological surveys	High speed transfer/crew vessels	HSC, crew boats, pilot boats	10	25	150	25	2	42	17
Tugs	Component feeder, tug support, foundation installation, foundation transport, acoustic monitoring, ESP transport, secondary work, snag, anchor handling support	Limited mobility or companion vessels	Tugs, utility vessels, small dredges, guard vessels, small crane barge	18	68	1,200	14	4	44	7
Support Vessels <100 m	Noise mitigation, component feeder, repair vessel, grapnel run	Mooring/ anchor and equipment handlers	Anchor, buoy, mooring handlers, small jack ups	12	60	3,500	15	6	26	7
Heavy Cargo	Blade transport, WTG transport, boulder clearance/burial, nacelle and tower transport, crew hotel, trenching, foundation transport	Multipurpose offshore vessels	OSVs, support vessels, cargo vessels	20	115	7,650	15	6	38	8
Survey	Pre-installation G&G surveys	Survey vessels	Survey vessels	16	63	15,000	30	2	78	7

Category	Activity	General Vessel Types	Example Vessels	Mean Width (m)	Mean Length (m)	Mean Gross Tonnage	Default Transit Speed (kn)	Mean Draft (m)	Percent Time Moving[1]	Mean Speed (kn)[2]
Cable Lay	Cable lay, WTG installation, foundation transport, scour protection installation, rock concrete placement, scour protection repair, WTG commissioning	Cable and similar vessels	Cable lay, pipe lay, floatel, dive support vessels	39	152	22,250	15	7	39	9
Construction / Crane	Dredging, foundation installation, ESP transport	Large, limited-mobility vessels	Crane vessels, drill ships, large dredges (hopper), large jack ups	60	185	40,000	16	6	34	8

Source: CSA Ocean Sciences, Inc. 2021. *Risk Assessment to Model Encounter Rates between Large Whales and Sea Turtles and Vessel Traffic from Offshore Wind Energy on the Atlantic OCS.* OCS Study BOEM 2021-034.
[1] Within the Lease Area
[2] When moving within the Lease Area

Table 5 Vessel Trip Information for the Proposed Action

Project Phase	Port or Facility	Estimated Maximum Annual Round Trips
Construction	South Brooklyn Marine Terminal	819
Construction	Port of Albany	78
Construction	Port of Coeymans	8
Construction	Cable Facility in Goose Creek	6
Construction	Port of Corpus Christi	2
Construction	*Total*	*913*
O&M	SBMT	635
Decommissioning[1]	SBMT	819

[1] Estimated trips during decommissioning are assumed to be the same as those to South Brooklyn Marine Terminal during construction.

Baited Remote Underwater Video Survey

Baited remote underwater video surveys to document structure-oriented fish species would be conducted within the Lease Area during the pre-construction and post-construction phases of the Project. These surveys would be conducted seasonally, and the survey would utilize a Before-After Gradient (BAG) design with two years of sampling in the pre-construction period and two years of sampling in the post-construction period. During each seasonal sampling period, four baited remote underwater videos would be collected at eight turbine locations, resulting in a total of 128 samples per sampling year. During the survey, baited remote underwater video survey equipment, fitted with a vertical line and buoy to the surface to facilitate retrieval, will be deployed for approximately 60 minutes

eDNA Sampling

eDNA sampling would be conducted within the Lease Area concurrent with trawl and baited remote underwater video surveys (i.e., during pre-construction, construction, and post-construction phases of the Project). Therefore, 160 samples (32 during trawl surveys and 128 during baited remote underwater video surveys) would be collected during each year of the two-year pre-construction monitoring period, 32 samples would be collected during trawl surveys in each year of the construction monitoring period, and 160 samples would be collected during each year of the two-year post-construction monitoring period, with the potential for additional sample collection if the trawl survey is conducted in additional years during the post-construction phase. Additional surface samples would be collected at a subset of sampling stations during each sampling event.

During eDNA sampling, water samples would be collected with 1.2 liter Kemerer bottles. Samples would be collected within 6.5 feet (2 meters) of the bottom. As noted above, additional samples would be collected at the surface at some sampling stations.

Acoustic Telemetry

Acoustic telemetry monitoring would be conducted in the Lease Area to monitor movements, presence, and persistence of acoustically tagged fish. Tagged species include commercially and recreationally important species (e.g., black sea bass [*Centropristis striata*], summer flounder [*Paralichthys dentatus*], tautog [*Tautoga onitis*], winter flounder [*Pseudopleuronectes americanus*]) and ESA-listed Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*). For the proposed acoustic telemetry monitoring, an array of 34 acoustic release omnidirectional receivers would be deployed within the Lease Area. Receivers would be deployed year-round and would be retrieved twice per year for data downloads.

As part of the proposed acoustic telemetry monitoring program, fish would be captured for implantation of acoustic transmitters with a target of 325 transmitters deployed per year. Sampling to capture fish for acoustic tagging would occur throughout the Lease Area and along the export cable routes throughout summer and fall. Sampling would target striped bass (*Morone saxatilis*), black sea bass, summer flounder, winter flounder, and Atlantic sturgeon. At least 50 winter flounder and 50 juvenile striped bass would be targeted each year within New York State waters along the EW 1 export cable route in Lower Bay. Other species would be targeted in the larger sampling area. Capture would be completed using a variety of fishery sampling techniques, as appropriate for each target species. Empire intends to capture most fish for tagging via rod-and-reel or trawl. Trawl tows would be conducted for 5 to 10 minutes. Gillnets may be used for capture of sturgeon. If gillnets are utilized, deployed nets would be continuously monitored. All sampling for capture of animals would be conducted under applicable state and federal permits.

<u>Sea Scallop Plan View Camera Surveys</u>

Sea scallop plan view camera surveys would be conducted in the Lease Area and a reference area during pre-construction, construction, and post-construction phases of the Project.to document shifts in the abundance and density of sea scallops. The survey would utilize a BACI design with two years of sampling in the pre-construction period, sampling throughout the construction period, and at least two years of sampling in the post-construction period. During each seasonal sampling event, 60 stations would be sampled in both the Lease Area and reference area, resulting in a total of 120 samples per sampling year. At each sampling station, a plan view camera system would be deployed to capture downward-facing images of the sea floor. At least eight images would be collected at each sampling station.

3.1.2.5.2.2 Benthic Monitoring

Benthic monitoring would be conducted to monitor potential changes associated with benthic habitats resulting from the construction and installation of Project components, including WTG foundations and scour protection as well as the inter-array offshore export cables and cable protection. Proposed monitoring efforts include novel hard bottom monitoring, monitoring of structure-associated organic enrichment, and monitoring of cable-associated physical disturbance of soft sediments.

<u>Novel Hard Bottom Monitoring</u>

Novel hard bottom monitoring would be conducted in the Lease Area and offshore export cable corridor to measure changes in the nature and extent of macrobiotic cover of novel hard bottom associated with the Project, including WTG foundations, WTG scour protection, cable protection, and OSS foundations. Monitoring would be conducted in the late summer/early fall. The baseline survey would be conducted during the first late summer/early fall following construction. The survey would be repeated annually for the next three years and again five years after construction (i.e., skipping the fourth year after construction). During each sampling event, the eight turbine locations selected for the baited remote underwater video survey would be monitored.

Novel hard bottom monitoring would be conducted with a Remotely Operated Vehicle (ROV). The ROV would be equipped with a downward-facing camera, a forward-facing camera, and a video camera. The downward-facing camera would capture images of the seafloor surface. The forward-facing camera would collect images of vertical surfaces.

Structure-Associated Organic Enrichment Monitoring

Structure-associated organic enrichment monitoring would be conducted in the Lease Area to measure potential changes in the function of benthic habitats surrounding WTG and OSS foundations. Monitoring would be conducted in the late summer/early fall (August to October) during the pre-construction and post-construction phases of the Project. The monitoring would utilize a BAG design. The baseline survey would be conducted in the pre-construction phase. During the post-construction phase, surveys would be conducted during the first late summer/early fall following construction and repeated annually for the next three years and again five years after construction (i.e., skipping the fourth year after construction). During each survey, the eight turbine locations selected for the baited remote underwater video survey and novel hard bottom monitoring would be surveyed.

Each survey would include sediment profile and plan view imagery, as well as sediment grabs for sediment grain size analysis and organic matter characterization. Imagery would be conducted at nine stations extending outward along two transects from each turbine location during the pre-construction phase, resulting in a total of 144 imagery stations during the baseline survey. In the post-construction phase, the number of stations sampled along each transect would be reduced to eight, resulting in a total of 128 imagery stations during each post-construction survey. Sediment grabs would be conducted at three stations along each imagery transect, resulting in a total of 48 sediment samples per survey year.

Monitoring of Cable-Associated Physical Disturbance of Soft Sediments

Monitoring of physical disturbance of soft sediment associated with cable installation would be conducted along the offshore export cable corridors to document effects of the installation and operation of the offshore export cables on benthic habitat. Monitoring would be conducted during the pre-construction and post-construction phases utilizing a BAG design. The baseline survey would be conducted within 6 months prior to the initiation of construction. During the post-construction phase, surveys would be conducted during the first year following construction and repeated annually for the next two years. During each survey, sediment profile and plan view imagery would be used to collect images at 16 stations along 3 triplicate transects within each of 3 habitat strata, resulting in a total of 144 samples per survey year.

3.1.2.5.2.3 Passive Acoustic Monitoring

Moored passive acoustic monitoring (PAM) systems or mobile PAM platforms such as towed PAM, autonomous surface vehicles, or autonomous underwater vehicles may be used prior to, during, and following construction. PAM devices may be required in the COP, through USACE permits, under the MMPA LOA, or required as a condition of the biological opinion. PAM data may be used to characterize the presence of protected species, specifically marine mammals, through passive detection of vocalizations; to record ambient noise and marine mammal vocalizations in the lease area before, during, and after construction to monitor project impacts relating to vessel noise, pile driving noise, and WTG operational noise; and to document whale detections in the Lease Area. In addition to specific requirements for monitoring surrounding the construction period, periodic PAM deployments may occur over the life of the Project for other scientific monitoring needs. As it pertains to mitigation and monitoring, the use of mobile or moored PAM systems is considered in the BA as a mitigation measure for avoiding and minimizing impacts on ESA-listed species.

3.1.2.6. Decommissioning

BOEM's decommissioning requirements are stated in Section 13, *Removal of Property and Restoration of the Leased Area and Project Easements(s) on Termination of Lease*, of the October 2016 Lease for OCS-A 0512. Unless otherwise authorized by BOEM, pursuant to the applicable regulations in 30 CFR Part 585, Empire would be required to "remove or decommission all facilities, projects, cables, pipelines, and obstructions and clear the seafloor of all obstructions created by activities on leased area, including any project easement(s) within two years following lease termination, whether by expiration, cancellation, contraction, or relinquishment, in accordance with any approved SAP, COP, or approved Decommissioning Application and applicable regulations in 30 CFR Part 585."

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

In accordance with BOEM requirements, Empire would be required to remove and/or decommission all Project infrastructure and clear the seabed of all obstructions when the Project reaches the end of its 35-year designed service life. Before ceasing operation of individual WTGs or the entire Project and prior to decommissioning and removing Project components, Empire would consult with BOEM and submit a decommissioning plan for review and approval. Upon receipt of the necessary BOEM approval and any other required permits, Empire would implement the decommissioning plan to remove and recycle equipment and associated materials.

The decommissioning process for the WTGs and OSSs, with their associated foundations, is anticipated to be the reverse of installation, with Project components transported to an appropriate disposal and/or recycling facility. All foundations and other Project components would need to be removed 15 feet (4.6 meters) below the mudline, unless other methods are deemed suitable through consultation with the regulatory authorities (Section 2.1), including BOEM. Submarine export and inter-array cables would be retired in place or removed in accordance with the BOEM-approved decommissioning plan. Empire would need to obtain separate and subsequent approval from BOEM to retire any portion of the Project in place. Project components will be decommissioned using a similar suite of vessels, as described in Section 3.1.2.4.

Although EW 1 and EW 2 have an assumed a lifetime of approximately 35 years, some installations and components may remain fit for continued service after such time, when Empire may seek to repower such installations if extension is authorized by BOEM. Upon initiation of decommissioning activities, Empire would complete decommissioning within two years of termination of the Lease and either reuse, recycle, or responsibly dispose of all materials removed, unless otherwise authorized by BOEM.

3.2. Description of Stressors

The Proposed Action would result in various stressors that could affect ESA-listed species and critical habitat in the action area. **Table 6** identifies the stressors associated with the Proposed Action and differentiates between stressors that are NLAA and those that may be *Likely to Adversely Affect* (LAA) listed species and critical habitat.

Table 6 Stressors Associated with the Proposed Action Mapped to Species

Stressor	Fin Whale	NARW	Sperm Whale	Green Sea Turtle (North Atlantic DPS)	Kemp's Ridley Sea Turtle	Leatherback Sea Turtle	Loggerhead Sea Turtle (Northwest Atlantic DPS)	Atlantic Sturgeon
Underwater Noise – Impact Pile-Driving	LAA	LAA	LAA	No effect	LAA	LAA	LAA	NLAA
Underwater Noise – Vibratory Pile-Driving	No effect	No effect	No effect	NLAA	NLAA	NLAA	NLAA	NLAA
Underwater Noise – G&G Surveys	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
Underwater Noise – Cable Laying	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
Underwater Noise – Vessels	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
Underwater Noise – Aircraft	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
Underwater Noise – WTGs	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
Vessel Traffic – Risk of Vessel Strike	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
Vessel Traffic – Vessel Discharges	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
Habitat Disturbance / Modification – G&G Surveys	No effect	No effect	No effect	No effect	NLAA	No effect	No effect	NLAA
Habitat Disturbance / Modification – Fisheries and Habitat Surveys	NLAA	NLAA	NLAA	LAA	LAA	LAA	LAA	LAA
Habitat Disturbance / Modification – Habitat Conversion and Loss	NLAA	NLAA	NLAA	LAA	LAA	LAA	LAA	NLAA
Habitat Disturbance / Modification – Turbidity	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
Habitat Disturbance / Modification – Physical Presence of WTGs on Atmospheric/Oceanic Conditions	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
Habitat Disturbance / Modification – Physical Presence of WTGs on Listed Species	LAA	LAA	LAA	LAA	LAA	LAA	LAA	NLAA
Habitat Disturbance / Modification – EMF and Heat	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
Habitat Disturbance / Modification – Lighting and Marking of Structures	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
Habitat Disturbance / Modification – Offshore Substations	No effect	No effect	No effect	No effect	No effect	No effect	No effect	No effect
Air Emissions – Vessels	No effect	No effect	No effect	No effect	No effect	No effect	No effect	No effect
Air Emissions – WTG Installation Equipment	No effect	No effect	No effect	No effect	No effect	No effect	No effect	No effect
Port Modifications – Dredging	No effect	No effect	No effect	NLAA	NLAA	NLAA	NLAA	NLAA
Port Modifications – Shoreside Construction	No effect	No effect	No effect	NLAA	NLAA	NLAA	NLAA	NLAA
Port Modifications – Effects to Habitat and Prey	No effect	No effect	No effect	NLAA	NLAA	NLAA	NLAA	NLAA
Port Modifications – Pile Driving	No effect	No effect	No effect	NLAA	NLAA	NLAA	NLAA	NLAA
Repair and Maintenance Activities	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
Other Effects – Potential Shifts or Displacement of Ocean Users	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
Other Effects – Physical Interactions with Dredges	No effect	No effect	No effect	NLAA	NLAA	NLAA	NLAA	NLAA
Unexpected Events – Vessel Collision/Allision with Foundation	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
Unexpected Events – Failure of WTGs due to Weather Events	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
Unexpected Events – Oil Spill/Chemical Response	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
Unexpected Events – UXO Encounters / Response	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA

DPS = distinct population segment; EMF = electromagnetic field; G&G = geotechnical and geophysical; LAA = likely to adversely affect; NARW = North Atlantic right whale; NLAA = not likely to adversely affect; UXO = unexploded ordnance; WTG = wind turbine

3.3. Mitigation Measures that are Part of the Proposed Action

This section outlines the proposed mitigation, monitoring, and reporting conditions that are intended to minimize or avoid potential impacts to ESA-listed species. Mitigation measures committed to by Empire in the COP are considered a part of the Proposed Action. Additional marine mammal requirements for the Project will result from the June 2022 LOA application (Empire 2022b) (**Table 7**) and are evaluated as part of the Proposed Action. Measures would also be required under the ESA consultation process. Notably, the temporal scope of ESA consultation is broader than the LOA and covers the life of the Project, whereas the LOA regulations are valid for a duration of 5 years for construction and the initial years of O&M of the Project. Therefore, the scope of some measures such as vessel strike avoidance conditions and reporting requirements may apply beyond the scope of the LOA. Mitigation measures to which the Applicant commits as part of the MMPA process will be included as conditions of the final LOA and will be required. A requirement to follow final LOA conditions that apply to ESA-listed whales will also be included as a condition in the final record of decision. For consistency, some measures in the LOA are also proposed as minimization measures to reduce potential impacts to listed sea turtle and fish species (e.g., pile driving soft start minimizes potential effects to all listed species).

During the development of the draft BA, and in coordination with cooperating agencies, BOEM considered additional mitigation measures that could further avoid, minimize, or mitigate impacts on the physical, biological, socioeconomic, and cultural resources assessed in this document. These potential additional mitigation measures, which are evaluated as part of the Proposed Action, are described in **Table 8**. Some or all of these BOEM-proposed mitigation measures may be required as a result of consultation completed under Section 7 of the ESA. Mitigation imposed through consultations will be included in the final record of decision. The additional mitigation measures presented in **Table 8** may not all be within BOEM's statutory and regulatory authority to require; however, co-action agencies may require them under their regulatory authorities. BOEM may choose to incorporate one or more additional measures in the record of decision and adopt measures under their jurisdictional authorities as conditions of COP approval.

A full description of all proposed mitigation measures evaluated as part of the Proposed Action, including BOEM-proposed measures and measures included in any other agency permit (e.g., NMFS LOA), is provided in **Tables 7 and 8**.

Table 7 Proposed Mitigation, Monitoring, and Reporting Measures for Marine Mammals from the MMPA Application for Regulations and LOA received by NMFS (87 FR 55409), Included for Consultation by NMFS OPR as May be Amended, and by BOEM as Conditions in the ROD

Measure	Description	Project Phase	Expected Effects
Vessel strike avoidance procedures	Vessel operators and crew must maintain a vigilant watch for cetaceans and pinnipeds by slowing down or stopping their vessels to avoid striking these protected species. Vessel crew members responsible for navigation duties will receive site-specific training on marine mammal sighting/reporting and vessel strike avoidance measures. Vessel strike avoidance measures will include, but are not limited to the following, except under extraordinary circumstances when complying with these measures would put the safety of the vessel or the crew at risk: • Vessel operators and crew will maintain vigilant watch for cetaceans and pinnipeds, and slow down or stop their vessel to avoid striking these protected species; • All vessel operators will comply with 10 knot (18.5 km/hr) or less speed restrictions in any SMA, DMA or visually triggered Slow Zone; • All vessel operators will reduce vessel speed to 10 knots (18.5 km/hr) or less when any large whale, any mother/calf pairs, whale or dolphin pods, or larger assemblages of cetaceans are observed near (within 100 m [330 ft]) an underway vessel; • All vessels will maintain a separation distance of 500 m (1,640 ft) or greater from any sighted NARW; • If underway, vessels must steer a course away from any sighted NARW at 10 knots (18.5 km/hr) or less until the 500 m (1,640 ft) minimum separation distance has been established. If a NARW is sighted in a vessel's path, or within 100 m (330 ft) of an underway vessel, the underway vessel must reduce speed and shift the engine to neutral. Engines will not be engaged until the NARW has moved outside of the vessel's path and beyond 100 m. If stationary, the vessel must not engage engines until the NARW has moved beyond 100 m; • All vessels will maintain a separation distance of 100 m (330 ft) or greater of any sighted whales. If sighted, the vessel underway must reduce speed and shift the engine to neutral, and must not engage the engines until the whale has moved outside the vessel's path and beyond 100 m. If a survey vessel is stationary, the vessel will not engage engines until the whale has moved out of the vessel's path and beyond 100 m; • All vessels will maintain a separation distance of 50 m (164 ft) or greater from any sighted small cetacean. Any underway vessel must remain parallel to a sighted small cetacean's course whenever possible, and avoid excessive speed or abrupt changes in direction. Vessels may not adjust course and speed until the small cetaceans have moved beyond 50 m and/or the beam of the underway vessel; • All vessels underway will not divert or alter course in order to approach any whale, small cetacean, or pinniped. Any vessel underway will avoid excessive speed or abrupt changes in direction to avoid injury to the sighted cetacean or pinniped; and • All vessels will maintain a separation distance of 50 m (164 ft) or greater from any sighted pinniped. Vessel operators will use all available sources of information of NARW presence, including daily monitoring of the Right Whale Sightings Advisory System, WhaleAlert app, and monitoring of Coast Guard VHF Channel 16 to receive notifications of right whale detections to plan vessel routes to minimize the potential for co-occurrence with right whales. As part of vessel strike avoidance a training program will be implemented. The training program will be provided to NMFS for review and approval prior to the start of surveys. Confirmation of the training and understanding of the requirements will be documented on a training course log sheet. Signing the log sheet will certify that the crew members understand and will comply with the necessary requirements throughout the survey event.	C	Minimize vessel strike risk

Measure	Description	Project Phase	Expected Effects
Foundation installation: Seasonal pile driving restrictions	Impact pile driving of foundations will not occur from January 1 through April 30. In addition, pile driving will not occur from December 1 through December 31, unless unanticipated delays due to weather or technical issues arise that necessitate extending pile driving into December in which case Empire would notify NMFS and BOEM in writing by September 1 that circumstances are expected to necessitate pile driving in December.	C	Minimize impact pile driving effects
Foundation installation: Pile driving weather and time restrictions	Impact pile driving will commence only during daylight hours no earlier than one hour after (civil) sunrise. Impact pile driving will not be initiated later than 1.5 hours before (civil) sunset. Pile driving may continue after dark when the installation of the same pile began during daylight (1.5 hours before [civil] sunset), when clearance zones were fully visible for at least 30 minutes and must proceed for human safety or installation feasibility reasons. Impact pile driving will not be initiated in times of low visibility when the visual clearance zones cannot be visually monitored, as determined by the lead PSO on duty.	C	Minimize impact pile driving effects
Foundation installation: Visual monitoring	During impact pile driving visual monitoring will occur as follows: • A minimum of two PSOs must be on active duty at the impact pile driving vessel/platform from 60 minutes before, during, and for 30 minutes after all pile installation activity; and • A minimum of two PSOs must be on active duty on a dedicated PSO vessel from 60 minutes before, during, and for 30 minutes after all monopile installation activity, or, an alternate monitoring technology (e.g., UAS) that has been demonstrated as having greater visual monitoring capability compared to two PSOs on a dedicated PSO vessel and is approved by NMFS, will be employed from 60 minutes before, during, and for 30 minutes after all monopile installation activity. If a dedicated PSO vessel is selected, the vessel must be located at the best vantage point to observe and document marine mammal sightings in proximity to the Clearance/Shutdown zones.	C	Minimize impact pile driving effects
Foundation installation: Pre-start clearance	For impact pile driving, the Applicant will implement a 60-minute pre-start clearance period of the Clearance zones prior to the initiation of soft-start to ensure no marine mammals are in the vicinity of the pile. During this period the Clearance zones will be monitored by both PSOs and PAM. Pile driving will not be initiated if any marine mammal is observed within its respective Clearance zone. If a marine mammal is observed within a Clearance zone during the pre-start clearance period, impact pile driving may not begin until the animal(s) has been observed exiting its respective zone, or, until an additional time period has elapsed with no further sightings (i.e., 15 minutes for dolphins and pinnipeds and 30 minutes for all other species). In addition, impact pile driving will be delayed upon a confirmed PAM detection of a NARW, if the PAM detection is confirmed to have been located within the 5 km NARW PAM Clearance zone. Any large whale sighted by a PSO within 1,000 m of the pile that cannot be identified to species must be treated as if it were a NARW. Impact pile driving will not be initiated if the clearance zones cannot be adequately monitored (i.e., if they are obscured by fog, inclement weather, poor lighting conditions) for a 30-minute period prior to the commencement of soft start, as determined by the Lead PSO. If light is insufficient, the Lead PSO will call for a delay until the Clearance zone is visible in all directions. If a soft start has been initiated before the onset of inclement weather, pile driving activities may continue through these periods if deemed necessary to ensure human safety and/or the integrity of the Project.	C	Minimize impact pile driving effects
Foundation installation: Clearance and shutdown zones	Clearance and Shutdown zones will be established (see Table 42 of the LOA application [Empire 2022b]) and continuously monitored during impact pile driving to minimize impacts to marine mammals. These zones will be monitored as described under Foundation installation: Visual monitoring and mitigation enacted as described under Foundation installation: Shutdown and power down.	C	Minimize impact pile driving effects

Measure	Description	Project Phase	Expected Effects
Foundation installation: Passive acoustic monitoring	PAM will occur during all impact pile driving and will supplement the visual monitoring program. During impact pile driving, PAM will begin 60 minutes prior to the initiation of soft-start, throughout foundation installation, and for 30 minutes after impact pile driving has been completed. PAM will be conducted by a dedicated, qualified, and NMFS-approved PAM operator. The PAM operator will monitor the hydrophone signals in real time both aurally (using headphones) and visually (via the monitor screen displays). The PAM operator will communicate detections of any marine mammals to the Lead PSO on duty who will ensure the implementation of the appropriate mitigation measures (i.e., delay or shutdown of pile driving). PAM detection alone (i.e., in the absence of visual confirmation by a PSO of a marine mammal within a relevant Clearance/Shutdown zone) will not trigger mitigation measures (i.e., delay or shutdown of pile driving), with the exception of a confirmed PAM detection of a NARW within the relevant zone. The real-time PAM system will be designed and established such that detection capability extends to 5 km from the pile driving location, for all monopile installations. Real-time PAM will begin at least 60 minutes before pile driving begins. The real-time PAM system will be configured to ensure that the PAM operator is able to review acoustic detections within approximately 15 minutes of the original detection, in order to verify whether a NARW has been detected. Any possible NARW vocalization will be reported as a detection if the vocalization is determined by the PAM operator to be within the Clearance/Shutdown zones.	C	Minimize impact pile driving effects
Foundation installation: Soft start	A soft start refers to initiating the pile driving process at reduced hammer energy to provide marine mammals a warning and an opportunity to vacate the area prior to pile driving at full hammer energy. Soft start will occur at the beginning of the driving of each pile and at any time following the cessation of impact pile driving of 30 minutes or longer. The soft start requires an initial 30 minutes using a reduced hammer energy for pile driving.	C	Minimize impact pile driving effects
Foundation installation: Shutdown and power down	The Clearance and Shutdown zones around the pile driving activities will be maintained by PSOs for the presence of marine mammals before, during, and after impact pile driving activity. If a marine mammal is observed entering or within the respective zones after pile driving has commenced, a shutdown of impact pile driving will occur when practicable as determined by the lead engineer on duty, who must evaluate the following to determine whether shutdown is safe and practicable: • Use of site-specific soil data and real-time hammer log information to judge whether a stoppage would risk causing piling refusal at re-start of piling; • Confirmation that pile penetration is deep enough to secure pile stability in the interim situation, taking into account weather statistics for the relevant season and the current weather forecast; and •Determination by the lead engineer on duty will be made for each pile as the installation progresses and not for the site as a whole. If a shutdown is called for but the lead engineer determines shutdown is not practicable due to an imminent risk of injury or loss of life to an individual, or risk of damage to a vessel that creates risk of injury or loss of life for individuals, reduced hammer energy (power down) will be implemented, when the lead engineer determines it is practicable. Subsequent restart/increased power of the equipment can be initiated if the animal has been observed exiting its respective zone within 30 minutes of the shutdown, or, after an additional time period has elapsed with no further sighting of the animal that triggered the shutdown (i.e., 15 minutes for small odontocetes and 30 minutes for all other species). If pile driving shuts down for reasons other than mitigation (e.g., mechanical difficulty) for brief periods (i.e., less than 30 minutes), it may be activated again without ramp-up, if PSOs have maintained constant observation and no detections of any marine mammal have occurred within the respective zones.	C	Minimize impact pile driving effects

Measure	Description	Project Phase	Expected Effects
Foundation installation: Attenuation	The Applicant will employ noise mitigation techniques during all impact pile driving that will attenuate pile driving noise by a minimum of 10 dB, such that measured ranges to isopleth distances corresponding to relevant marine mammal harassment thresholds are consistent with those modeled based on 10 dB attenuation, determined via sound field verification. The Applicant will employ a double bubble curtain or an attenuation technology that achieves noise reduction equivalent to or greater than that achieved by a double bubble curtain.	C	Minimize impact pile driving effects
Foundation installation: Sound field verification	Sound field measurements will be conducted during the driving of at least two monopiles and at least one jacket pile over the course of construction to compare sound field measurements with modeled isopleth distances. Sound field measurements will be conducted at distances of approximately 750 meters, 2,500 meters, and 5,000 meters from the pile being driven, as well as at the extent of the modeled behavioral harassment zones to verify the accuracy of those modeled zones. The recordings will be continuous throughout the duration of all impacts hammering of each pile monitored. The measurement systems will have a sensitivity appropriate for the expected sound levels from pile driving received at the nominal ranges throughout the installation of the pile. The frequency range of the system will cover the range of at least 20 hertz to 20 kilohertz. The system will be designed to have omnidirectional sensitivity and will be designed so that the predicted broadband received level of all impact pile-driving strikes exceed the system noise floor by at least 10 decibels. The dynamic range of the will be sufficient such that at each location, pile driving signals are not clipped and are not masked by the noise floor. A Sound Field Verification Plan will be submitted to NMFS for review and approval at least 90 days prior to the planned start of pile driving. This plan will describe how Empire will ensure that the location selected is representative of the rest of the piles of that type to be installed and how the effectiveness of the sound attenuation methodology will be evaluated based on the results. The Applicant will provide the initial results of the field measurements to NMFS as soon as they are available.	C	Ensure that modeled isopleths used to establish clearance and shutdown zones and estimate marine mammal take are accurate
Cable landfall and marina activities: Visual monitoring	A minimum of two PSOs will be on active duty on the vibratory pile driving platform, or on a vessel nearby the construction vessel, from 30 minutes before, during, and 30 minutes after all pile driving.	C	Minimize vibratory pile driving effects
Cable landfall and marina activities: Pre-start clearance	For all pile driving, the Applicant will implement a 30-minute clearance period of the Clearance zones prior to the initiation of installation. During this period the Clearance zones will be monitored by the PSOs, using the appropriate visual technology for a 30-minute period. Installation may not be initiated if any marine mammal is observed within its respective Clearance zone. If a marine mammal is observed within a Clearance zone during the pre-start clearance period, installation may not begin until the animal(s) has been observed exiting its respective zone or until an additional time period has elapsed with no further sightings (i.e., 15 minutes for dolphins and pinnipeds and 30 minutes for all other species). Any large whale sighted by a PSO within 1,000 m of the pile that cannot be identified to species must be treated as if it were a NARW.	C	Minimize pile driving effects
Cable landfall and marina activities: Clearance and shutdown zones	Clearance and shutdown zones for vibratory pile driving will be established as described in Table 43 of the LOA application (Empire 2022b).	C	Minimize pile driving effects

Measure	Description	Project Phase	Expected Effects
Cable landfall and marina activities: Shutdown and power down procedures	The Clearance and Shutdown zones around pile driving activities will be maintained, as previously described, by PSOs for the presence of marine mammals before, during, and after pile driving activity. An immediate shutdown of the hammer will be required if a marine mammal is sighted within or approaching its respective Shutdown zone. The operator will comply immediately with any call for shutdown by the Lead PSO, except in cases where immediate shutdown would represent a human safety risk. Any disagreement between the Lead PSO and operator will be discussed only after shutdown has occurred. Subsequent restart of the equipment can be initiated if the animal has been observed exiting its respective Shutdown zone within 30 minutes of the shutdown, or, after an additional time period has elapsed with no further sighting (i.e., 15 minutes for small odontocetes and 30 minutes for all other species).	C	Minimize pile driving effects
HRG survey activities	The specific measures identified in The LOA application (Empire 2022b) included HRG survey mitigation measures for marine mammals from the 2021 programmatic ESA section 7 consultation regarding offshore wind geophysical and geotechnical surveys (NMFS 2021b).	C, O&M	Minimize HRG survey noise effects

BOEM = Bureau of Ocean Energy Management; dB = decibel; DMA = Dynamic Management Area; ft = foot; km/hr = kilometer per hour; m = meter; NARW = North Atlantic right whale; NMFS = National Marine Fisheries Service; PAM = passive acoustic monitoring; PSO = protected species observer; SMA = Seasonal Management Area
[1] Available at https://media.fisheries.noaa.gov/2022-09/Empirewind_2024LOA_App_OPR1.pdf

Table 8 BOEM-Proposed Mitigation, Monitoring, and Reporting Measures for ESA-Listed Species in the Action Area

Measure	Description	Project Phase	Expected Effects
Marine debris awareness and elimination	Marine Debris Awareness Training. The Lessee must ensure that vessel operators, employees, and contractors engaged in offshore activities pursuant to the approved COP complete marine trash and debris awareness training annually. The training consists of two parts: (1) viewing a marine trash and debris training video or slide show (described below); and (2) receiving an explanation from management personnel that emphasizes their commitment to the requirements. The marine trash and debris training videos, training slide packs, and other marine debris related educational material may be obtained at https://www.bsee.gov/debris or by contacting BSEE. The training videos, slides, and related material may be downloaded directly from the website. Operators engaged in marine survey activities will continue to develop and use a marine trash and debris awareness training and certification process that reasonably assures that their employees and contractors are in fact trained. The training process will include the following elements: • Viewing of either a video or slide show by the personnel specified above; • An explanation from management personnel that emphasizes their commitment to the requirements; • Attendance measures (initial and annual); and • Recordkeeping and the availability of records for inspection by DOI. Training Compliance Report. By January 31 of each year, the Lessee must submit to DOI an annual report that describes its marine trash and debris awareness training process and certifies that the training process has been followed for the previous calendar year. The Lessee must send the reports via email to BOEM (at renewable_reporting@boem.gov) and to BSEE (at marinedebris@bsee.gov). Marking. Materials, equipment, tools, containers, and other items used in OCS activities, which are of such shape or configuration that make them likely to snag or damage fishing devices or be lost or discarded overboard, must be clearly marked with the vessel or facility identification number, and properly secured to prevent loss overboard. All markings must clearly identify the owner and must be durable enough to resist the effects of the environmental conditions to which they may be exposed. Recovery and Prevention. The Lessee must recover marine trash and debris that is lost or discarded in the marine environment while performing OCS activities when such incident is likely to (1) cause undue harm or damage to natural resources, including their physical, atmospheric, and biological components, which particular attention to marine trash or debris that could entangle or be ingested by marine protected species; or (2) significantly interfere with OCS uses (e.g., the marine trash or debris is likely to damage fishing equipment, or present a hazard to navigation). The Lessee must notify DOI within 48 hours of the incident (using the email address listed on the DOI's most recent incident reporting guidance) if recovery activities are (a) not possible because conditions are unsafe; or (b) not practicable or not warranted because the marine trash and debris released is not likely to result in any of the conditions listed in (1) or (2) above. Notwithstanding this notification, DOI may still order the Lessee to recover the lost or discarded marine trash and debris if DOI finds the reasons provided by the Lessee in the notification unpersuasive. If the marine trash and debris is located within the boundaries of a potential archaeological resource/avoidance area, or a sensitive ecological/benthic resource area, the Lessee must contact DOI for concurrence before conducting any recovery efforts.	Pre-C, C, O&M, D	Decrease the loss of marine debris which may represent entanglement and/ or ingestions risk

Measure	Description	Project Phase	Expected Effects
Marine debris awareness and elimination (cont'd)	Recovery of the marine trash and debris should be completed as soon as practicable, but no later than 30 calendar days from the date on which the incident occurred. If the Lessee is not able to recover the marine trash or debris within 48 hours of the incident, the Lessee must submit a plan to DOI explaining the activities planned to recover the marine trash or debris (Recovery Plan). The Lessee must submit the Recovery Plan no later than 10 calendar days from the date on which the incident occurred. Unless DOI objects within 48 hours of the filing of the Recovery Plan, the Lessee can process with the activities described in the Recovery Plan. The Lessee must request and obtain a time extension if recovery activities cannot be completed within 30 calendar days from the date on which the incident occurred. The Lessee must enact steps to prevent similar incidents and must submit a description of these actions to BOEM and BSEE within 30 calendar days from the date on which the incident occurred. Reporting. The Lessee must report to DOI (using the email address listed on DOI's most recent incident reporting guidance) all lost or discarded marine trash and debris. This report must be made monthly and submitted no later than the fifth day of the following month. The Lessee is not required to submit a report for those months in which no marine trash and debris was lost or discarded. The report must include the following: • Project identification and contact information for the Lessee and for any operators or contractors involved • The date and time of the incident • The lease number, OCS area and block, and coordinates of the object's location (latitude and longitude in decimal degrees) • A detailed description of the dropped object, including dimensions (approximate length, width, height, and weight) and composition (e.g., plastic, aluminum, steel, wood, paper, hazardous substances, or defined pollutants) • Pictures, data imagery, data streams, and/or a schematic/illustration of the object, if available • An indication of whether the lost or discarded item could be detected as a magnetic anomaly of greater than 50 nanotesla, a seafloor target of greater than 1.6 feet (0.5 meters), or a sub-bottom anomaly of greater than 1.6 feet (0.5 meters) when operating a magnetometer or gradiometer, side scan sonar, or sub-bottom profiler in accordance with DOI's most recent, applicable guidance • An explanation of the how the object was lost • A description of immediate recovery efforts and results, including photos In addition to the foregoing, the Lessee must submit a report within 48 hours of the incident (48-hour Report) if the marine trash or debris could (1) cause undue harm or damage to natural resources, including their physical, atmospheric, and biological components, which particular attention to marine trash or debris that could entangle or be ingested by marine protected species; or (2) significantly interfere with OCS uses (e.g., the marine trash or debris is likely to damage fishing equipment, or present a hazard to navigation). The information in the 48-hour Report must be the same as that listed for the monthly report, but only for the incident that triggered the 48-hour Report. The Lessee must report to DOI (using the email address listed on DOI's most recent incident reporting guidance) if the object is recovered and, as applicable, describe any substantial variance from the activities described in the Recovery Plan that were required during the recovery efforts. The Lessee must include and address information on unrecovered marine trash and debris in the description of the site clearance activities provided in the decommissioning application required under 30 CFR §585.906.	Pre-C, C, O&M, D	Decrease the loss of marine debris which may represent entanglement and/ or ingestions risk

Measure	Description	Project Phase	Expected Effects
Marine debris awareness and elimination (cont'd)	Option to Comply with Most Current Non-Required Measures. The Lessee may opt to comply with the most current non-required measures (e.g., measures in a programmatic consultation that are not binding on the Lessee) related to protected species and habitat in place at the time an activity is undertaken under the Lease. At least 30 calendar days prior to undertaking an activity, the Lessee must notify DOI of its intention to comply with such measures in lieu of those required under the terms and conditions above. DOI reserves the right to object or request additional information on how the Lessee intends to comply with such measures. If DOI does not respond with objections within 15 calendar days of receipt of the Lessee's notification, then the Lessee may conclude the DOI has concurred.	Pre-C, C, O&M, D	Decrease the loss of marine debris which may represent entanglement and/ or ingestions risk
PAM Plan	BOEM, BSEE, and USACE will require Empire to prepare a detailed PAM Plan that describes: all proposed PAM equipment (including sensitivity and detection range); procedures, and protocols (if new systems are proposed proof of concept materials should be provided); a description of the PAM hardware and software used for marine mammal monitoring (including software version) (if new systems are proposed proof of concept materials should be provided); calibration data, bandwidth capability and sensitivity of hydrophone(s); any filters planned for use in hardware or software, and known limitations of the equipment; and deployment locations, procedures, detection review methodology, and protocols. . This plan must be submitted to NMFS (at nmfs.gar.incidental- take@noaa.gov)), BOEM (at renewable_reporting@boem.gov), and BSEE (at OSWsubmittals@bsee.gov) for review and concurrence at least 180 days prior to the planned start of PAM activities. BOEM will review the PAM Plan and provide comments, if any, on the plan within 45 calendar days, but no later than 90 days after it is submitted. Empire must resolve all comments on the PAM Plan to BOEM's satisfaction before implementation of the plan. If BOEM does not provide comments on the PAM Plan within 90 calendar days of its submittal, Empire may conclude that BOEM has concurred with the PAM Plan.	C, O&M	Ensure the efficacy of PAM placement for appropriate monitoring
Pile Driving Monitoring Plan	BOEM will require Empire to prepare and submit a *Pile Driving Monitoring Plan* to NMFS and BSEE (at OSWsubmittals@BSEE.gov) for review at least 180 days before start of pile driving. The plan will detail all plans and procedures for sound attenuation as well as for monitoring ESA-listed whales and sea turtles during all impact and vibratory pile driving. Empire must obtain BOEM, BSEE, USACE (for pile driving in State waters), and NMFS' concurrence with this plan prior to starting any pile driving.	C	Ensure adequate monitoring and mitigation is in place during pile driving
PSO coverage	BOEM, BSEE, and USACE will ensure that PSO coverage is sufficient to reliably detect whales and sea turtles at the surface in clearance and shutdown zones so that Empire can execute any pile driving delays or shutdown requirements. If, at any point before or during construction, the PSO coverage that is included by Empire as part of the Proposed Action is determined not to be sufficient to reliably detect ESA-listed whales and sea turtles within the clearance and shutdown zones, additional PSOs or platforms will be deployed. Determinations prior to construction will be based on review of the *Pile Driving Monitoring Plan* before construction begins. Determinations during construction will be based on review of the weekly pile driving reports and other information, as appropriate.	C	Ensure adequate monitoring of zones

Measure	Description	Project Phase	Expected Effects
Sound field verification	The Lessee must ensure that the distance to the PTS and behavioral thresholds for marine mammals. sea turtle injury and harassment thresholds, and Atlantic sturgeon injury and harassment thresholds no larger than those modeled assuming 10 dB re 1 μPa noise attenuation are met by conducting field verification during pile driving. At least 90 calendar days before beginning the first pile driving activities for the Project, the Lessee must submit a Sound Field Verification Plan (SFVP) for each EW1 and EW2 for review and comment to USACE, BOEM (at renewable_reporting@boem.gov), and NMFS (at nmfs.gar.incidental-take@noaa.gov). DOI will review the SFVP and provide any comments on the plan within 30 calendar days of its submittal. The Lessee must resolve all comments on the SFVP to DOI's satisfaction before implementing the plan. The Lessee may conclude that DOI has concurrence in the SFVP if DOI provides no comments on the plan within 90 calendar days of its submittal. The Lessee must execute the SFVP and report the associated findings to BOEM for three monopile foundations, or as specified under the corresponding IHA for this action. The Lessee must conduct additional field measurements if it installs piles with a diameter greater than the initial piles, if it uses a greater hammer size or energy, or if it measures any additional foundations to support any request to decrease the distances specified for the clearance and shutdown zones. The Lessee must implement the SFVP requirements for verification of noise attenuation for at least three foundations for BOEM for EW1 and for EW2, in coordination with NMFS, to consider reducing zone distances. The Lessee must ensure that locations identified in the SFVP for each pile type are representative of other piles of that type to be installed and that the results are representative for predicting actual installation noise propagation for subsequent piles. The SFVP must describe how the effectiveness of the sound attenuation methodology will be evaluated. The SFVP must be sufficient to document impacts in the behavioral harassment zones for marine mammals and injury and behavioral disturbance zones for sea turtles and Atlantic sturgeon.	C	Ensure adequate monitoring of clearance zones
Shutdown zones	BOEM, BSEE, and USACE may reduce clearance and shutdown zones for ESA-listed sei, fin, or sperm whales based upon sound field verification of a minimum of 3 piles. However, the shutdown zone for sei, fin, and sperm whales will not be reduced to less than 1,000 m, or less than 500 m for ESA-listed sea turtles. The clearance or shutdown zones for NARWs will not be reduced regardless of the results of sound field verification of a minimum of three piles.	C	Ensures that shut down zones are sufficiently conservative
Monitoring zone for sea turtles	To ensure that any "take" is documented, BOEM, BSEE, and USACE will require Empire to monitor and record all observations of ESA-listed sea turtles over the full extent of any area where noise may exceed 175 dB rms (based on modeling or as may be approved by sound field verification results) during any pile driving activities and for 30 minutes following the cessation of pile driving activities.	C	Ensures accurate monitoring of sea turtle take

Look out for sea turtles and reporting	a. For all vessels operating north of the Virginia/North Carolina border, between June 1 and November 30, Empire must have a trained lookout posted on all vessel transits during all phases of the Projects to observe for sea turtles. The trained lookout must communicate any sightings, in real time, to the captain so that the requirements in (e) below can be implemented. b. For all vessels operating south of the Virginia/North Carolina border, year-round (reflecting year-round sea turtle presence), Empire must have a trained lookout posted on all vessel transits during all phases of the Projects to observe for sea turtles. The trained lookout would communicate any sightings, in real time, to the captain so that the requirements in (e) below can be implemented. c. The trained lookout will review https://seaturtlesightings.org/ before each trip and report any observations of sea turtles in the vicinity of the planned transit to all vessel operators or captains and lookouts on duty that day. d. The trained lookout will maintain a vigilant watch and monitor a 500-m Vessel Strike Avoidance Zone at all times to maintain this minimum separation distance between the vessel and ESA-listed sea turtle species. Alternative monitoring technology, such as night vision and thermal cameras, will be available to ensure effective watch at night and in any other low visibility conditions. If the trained lookout is a vessel crew member, lookout will be their designated role and primary responsibility while the vessel is transiting. Any designated crew lookouts will receive training on protected species identification, vessel strike minimization procedures, how and when to communicate with the vessel captain, and reporting requirements. e. If a sea turtle is sighted within 100 m or less of the operating vessel's forward path, the vessel operator must slow down to 4 knots (unless unsafe to do so) and then proceed away from the turtle at a speed of 4 knots or less until there is a separation distance of at least 100 m between the vessel and the sea turtle at which time the vessel may resume normal operations. If a sea turtle is sighted within 50 m of the forward path of the operating vessel, the vessel operator must shift to neutral when safe to do so and then proceed away from the turtle at a speed of 4 knots. The vessel may resume normal operations once it has passed the turtle. f. Vessel captains or operators must avoid transiting through areas of visible jellyfish aggregations or floating sargassum lines or mats. If operational safety precludes avoiding such areas, vessels must slow to 4 knots when transiting. g. All vessel crew members must be briefed on identification of sea turtles, applicable regulations, and best practices for avoiding vessel collisions with sea turtles. Reference materials for identification of sea turtles must be available aboard all Project vessels. The requirement and process for reporting sea turtles (including live, entangled, and dead individuals) must be clearly communicated, including posting in highly visible locations aboard all Project vessels. This communication must clearly convey that sea turtle observations are to be reported to the designated vessel contact (such as the lookout or the vessel captain) and provide a communication channel and process for crew members to do so. h. If a vessel is carrying a PSO or trained lookout for the purposes of maintaining watch for NARWs, an additional lookout is not required so long as the PSO or trained lookout maintains watch for both whales and sea turtles. i. Vessel transits to and from the Wind Farm Area that require PSOs will maintain a speed commensurate with weather conditions and effectively detecting sea turtles prior to reaching the 100 m avoidance measure. j. Exceptions to the requirements of this mitigation measure (Look out for sea turtles and reporting) are allowed only if the safety of the vessel or crew necessitates deviation from the requirements on an emergency basis. Any such exceptions must be reported to NMFS and BSEE within 24 hours after they occur.	Pre-C, C, O&M, D	Minimizes risk of vessel strikes to sea turtles

Measure	Description	Project Phase	Expected Effects
Gear identification	To facilitate identification of gear on any entangled animals, all trap/pot gear used in any Project survey must be uniquely marked to distinguish it from other commercial or recreational gear. Gear must be marked with a 3-foot-long strip of black and white duct tape within 2 fathoms of a buoy attachment. In addition, 3 additional marks must be placed on the top, middle and bottom of the line using black and white paint or duct tape. No variation from these marking requirements may be made without notification and approval from NMFS.	Pot/trap surveys	Distinguishes survey gear from other commercial or recreational gear
Lost survey gear	All reasonable efforts that do not compromise human safety must be undertaken to recover any lost survey gear. Any lost gear must be reported to NMFS (nmfs.gar.incidental-take@noaa.gov) and BSEE (OSWsubmittals@bsee.gov) within 24 hours after the gear is documented as missing or lost. This report must include information on any markings on the gear and any efforts undertaken or planned to recover the gear.	All fisheries surveys	Promotes recovery of lost gear
Survey training	For any vessel trips where gear is set or hauled for trawl or ventless trap surveys, at least one of the survey staff onboard must have completed NEFOP observer training within the last 5 years or completed other equivalent training in protected species identification and safe handling (inclusive of taking genetic samples from Atlantic sturgeon). Reference materials for identification, disentanglement, safe handling, and genetic sampling procedures must be available on board each survey vessel. Empire must prepare a training plan that addresses how these survey requirements will be met and must submit that plan to NMFS in advance of any trawl or trap surveys.	Trawl and ventless trap surveys	Promotes safe handling and release of Atlantic sturgeon
Gillnets in support of sturgeon tagging	If gillnets are utilized to capture sturgeon for acoustic tagging, deployed nets must be continuously monitored for the capture of sturgeon or sea turtles. All gillnet soaks must be limited to 24 hours or less to reduce the potential for serious injury and mortality of entangled sea turtles and sturgeon. All gillnet gear must be in compliance with the Atlantic Large Whale Take Reduction Plan, Bottlenose Dolphin Take Reduction Plan, and the Harbor Porpoise Take Reduction Plan.	Tagging	Avoid entanglement of sea turtles and sturgeon
Sea turtle disentanglement	Vessels deploying fixed gear (e.g., pots/traps) must have adequate disentanglement equipment onboard, such as a knife and boathook. Any disentanglement must occur consistent with the Northeast Atlantic Coast STDN Disentanglement Guidelines at https://www.reginfo.gov/public/do/DownloadDocument?objectID=102486501 and the procedures described in “Careful Release Protocols for Sea Turtle Release with Minimal Injury” (NOAA Technical Memorandum 580; https://repository.library.noaa.gov/view/noaa/3773).	Pot/trap surveys	Requires disentanglement of sea turtles caught in gear

Measure	Description	Project Phase	Expected Effects
Sea turtle/Atlantic sturgeon identification and data collection	Any sea turtles or Atlantic sturgeon caught or retrieved in any fisheries survey gear must first be identified to species or species group. Each ESA-listed species caught or retrieved must then be documented using appropriate equipment and data collection forms. Biological data collection, sample collection, and tagging activities must be conducted as outlined below. Live, uninjured animals must be returned to the water as quickly as possible after completing the required handling and documentation. a. The Sturgeon and Sea Turtle Take Standard Operating Procedures must be followed (https://media.fisheries.noaa.gov/2021-11/Sturgeon%20%26%20Sea%20Turtle%20Take%20SOPs_external_11032021.pdf). b. Survey vessels must have a passive integrated transponder (PIT) tag reader onboard capable of reading 134.2 kHz and 125 kHz encrypted tags (e.g., Biomark GPR Plus Handheld PIT Tag Reader). This reader must be used to scan any captured sea turtles and sturgeon for tags, and any tags found must be recorded on the take reporting form (see below). c. Genetic samples must be taken from all captured Atlantic sturgeon (alive or dead) to allow for identification of the DPS of origin of captured individuals and tracking of the amount of incidental take. This must be done in accordance with the Procedures for Obtaining Sturgeon Fin Clips (https://media.fisheries.noaa.gov/dam-migration/sturgeon_genetics_sampling_revised_june_2019.pdf). i. Fin clips must be sent to a NMFS-approved laboratory capable of performing genetic analysis and assignment to DPS of origin. Empire must cover all reasonable costs of the genetic analysis. Arrangements for shipping and analysis must be made before samples are submitted and confirmed in writing to NMFS within 60 days of the receipt of the Project BiOp with ITS. Results of genetic analyses, including assigned DPS of origin must be submitted to NMFS within 6 months of the sample collection. ii. Subsamples of all fin clips and accompanying metadata forms must be held and submitted to a tissue repository (e.g., the Atlantic Coast Sturgeon Tissue Research Repository) on a quarterly basis. The Sturgeon Genetic Sample Submission Form is available for download at: https://media.fisheries.noaa.gov/2021-02/Sturgeon%20Genetic%20Sample%20Submission%20sheet%20for%20S7_v1.1_Form%20to%20Use.xlsx?nullhttps://www.fisheries.noaa.gov/new-england-mid-atlantic/consultations/section-7-take-reporting-programmatics-greater-atlantic. d. All captured sea turtles and Atlantic sturgeon must be documented with required measurements and photographs. The animal's condition and any marks or injuries must be described. This information must be entered as part of the record for each incidental take. Particularly, a NMFS Take Report Form must be filled out for each individual sturgeon and sea turtle (download at: https://media.fisheries.noaa.gov/2021-07/Take%20Report%20Form%2007162021.pdf?null) and submitted to NMFS as described in the take notification measure below.	All fisheries surveys	Requires standard data collection and documentation of any sea turtle/ Atlantic sturgeon caught during surveys

Measure	Description	Project Phase	Expected Effects
Sea turtle/Atlantic sturgeon handling and resuscitation guidelines	Any sea turtles or Atlantic sturgeon caught and retrieved in gear used in fisheries surveys must be handled and resuscitated (if unresponsive) according to established protocols provided at-sea conditions are safe for those handling and resuscitating the animal(s) to do so. Specifically: a. Priority must be given to the handling and resuscitation of any sea turtles or sturgeon that are captured in the gear being used. Handling times for these species must be minimized, and if possible kept to 15 minutes or less to limit the amount of stress placed on the animals. b. All survey vessels must have onboard copies of the sea turtle handling and resuscitation requirements (found at 50 CFR 223.206(d)(1)) before beginning any on-water activity (download at: https://media.fisheries.noaa.gov/dam-migration/sea_turtle_handling_and_resuscitation_measures.pdf). These handling and resuscitation procedures must be carried out any time a sea turtle is incidentally captured and brought onboard the vessel during survey activities. c. If any sea turtles that appear injured, sick, or distressed, are caught and retrieved in fisheries survey gear, survey staff must immediately contact the Greater Atlantic Region Marine Animal Hotline at 866-755-6622 for further instructions and guidance on handling the animal, and potential coordination of transfer to a rehabilitation facility. If survey staff are unable to contact the hotline (e.g., due to distance from shore or lack of ability to communicate via phone), the USCG must be contacted via VHF marine radio on Channel 16. If required, hard-shelled sea turtles (i.e., non-leatherbacks) may be held on board for up to 24 hours and managed in accordance with handling instructions provided by the Hotline before transfer to a rehabilitation facility. d. Survey staff must attempt resuscitate any Atlantic sturgeon that are unresponsive or comatose by providing a running source of water over the gills as described in the Sturgeon Resuscitation Guidelines (https://media.fisheries.noaa.gov/dam-migration/sturgeon_resuscitation_card_06122020_508.pdf). e. If appropriate cold storage facilities are available on the survey vessel, any dead sea turtle or Atlantic sturgeon must be retained on board the survey vessel for transfer to an appropriately permitted partner or facility on shore unless NMFS indicates that storage is unnecessary or storage is not safe. f. Any live sea turtles or Atlantic sturgeon caught and retrieved in gear used in any fisheries survey must ultimately be released according to established protocols including safety considerations.	All fisheries surveys	Ensures the safe handling and resuscitation of sea turtles and Atlantic sturgeon following established protocols

Measure	Description	Project Phase	Expected Effects
Take notification	GARFO PRD must be notified as soon as possible of all observed takes of sea turtles, and Atlantic sturgeon occurring as a result of any fisheries survey. Specifically: a. GARFO PRD must be notified within 24 hours of any interaction with a sea turtle or sturgeon (nmfs.gar.incidental-take@noaa.gov). The report will include at a minimum: (1) survey name and applicable information (e.g., vessel name, station number); (2) GPS coordinates describing the location of the interaction (in decimal degrees); (3) gear type involved (e.g., bottom trawl, gillnet, longline); (4) soak time, gear configuration and any other pertinent gear information; (5) time and date of the interaction; and (6) identification of the animal to the species level. Additionally, the e-mail will transmit a copy of the NMFS Take Report Form (download at: https://media.fisheries.noaa.gov/2021-07/Take%20Report%20Form%2007162021.pdf?null) and a link to or acknowledgement that a clear photograph or video of the animal was taken (multiple photographs are suggested, including at least one photograph of the head scutes). If reporting within 24 hours is not possible due to distance from shore or lack of ability to communicate via phone, fax, or email, reports must be submitted as soon as possible; late reports must be submitted with an explanation for the delay. b. At the end of each survey season, a report must be sent to NMFS that compiles all information on any observations and interactions with ESA-listed species. This report will also contain information on all survey activities that took place during the season including location of gear set, duration of soak/trawl, and total effort. The report on survey activities must be comprehensive of all activities, regardless of whether ESA-listed species were observed.	All fisheries surveys	Establishes procedures for immediate reporting of sea turtle/ Atlantic sturgeon take
Monthly/annual reporting requirements	Empire must implement the following reporting requirements to document the amount or extent of take that occurs during all phases of the Proposed Action: a. All reports must be sent to: NMFS at nmfs.gar.incidental-take@noaa.gov and BSEE at OSWsubmittals@bsee.gov. b. During the construction phase and for the first year of operations, Empire must compile and submit monthly reports summarizing all Project activities carried out in the previous month, including vessel transits (number, type of vessel, and route), piles installed, and all observations of ESA-listed species. Monthly reports are due on the 15th of the month for the previous month. c. Beginning in year 2 of operations, Empire must compile and submit annual reports that summarize all Project activities carried out in the previous year, including vessel transits (number, type of vessel, and route), repair and maintenance activities, survey activities, and all observations of ESA-listed species. These reports are due by April 1 of each year (i.e., the 2026 report is due by April 1, 2027). Upon mutual agreement of NMFS and BOEM, the frequency of reports can be changed.	C, O&M	Establishes reporting requirements and timing to document take and operator activities
Geophysical and Geotechnical Surveys	Empire must comply with all the Project Design Criteria and Best Management Practices for Protected Species at https://www.boem.gov/sites/default/files/documents//PDCs%20and%20BMPs%20for%20Atlantic%20Data%20Collection%2011222021.pdf that implement the integrated requirements for threatened and endangered species in the June 29, 2021, programmatic consultation under the ESA, revised November 22, 2021.	C, O&M, D	Minimize effects of sound exposure and vessel encounters with whales and sea turtles during surveys.

Measure	Description	Project Phase	Expected Effects
Data Collection BA BMPs	BOEM will ensure that all Project Design Criteria and Best Management Practices as they may apply to HRG surveys, geotechnical surveys designed to characterize benthic and subsurface conditions and deployment, survey vessel transits, and retrieval of environmental data collection buoys as required in the Atlantic Data Collection consultation for Offshore Wind Activities (June 29, 2021) shall be applied to activities associated with the construction, maintenance and operations of the Empire Wind project as applicable.	Pre-C, C, O&M, D	Incorporates previously determined best management practices to reduce the likelihood of take of listed species during surveys, vessel operations, and maintenance in the Atlantic OCS.
Alternative Monitoring Plan (AMP) for pile driving	Empire must not conduct pile driving operations at any time when lighting or weather conditions (e.g., darkness, rain, fog, sea state) prevent visual monitoring of the clearance and shutdown zones unless BOEM and NMFS have approved an AMP. Empire must submit an AMP to BOEM and NMFS for review and approval at least 180 days prior to the planned start of pile-driving. This plan may include deploying additional observers, alternative monitoring technologies such as night vision, thermal, and infrared technologies, or use of PAM and must demonstrate the ability and effectiveness of the proposed equipment and methods to monitor clearance and shutdown zones. The AMP must address daytime conditions when lighting or weather (e.g., fog, rain, sea state) conditions prevent effective visual monitoring of clearance and shutdown zones, and nighttime condition (if permitted), daytime being defined as one hour after civil sunrise to 1.5 hours before civil sunset. The lead PSO will determine as to when there is sufficient light to ensure effective visual monitoring can be accomplished in all directions and when the alternative monitoring plan will be implemented. If a marine mammal or sea turtle is observed entering or found within the shutdown zones after impact pile-driving has commenced, Empire must follow the shutdown procedures outlined in the Protected Species Mitigation Monitoring Plan. Empire must notify BOEM and NMFS of any shutdown occurrence during pile driving operations with 24 hours of the occurrence unless otherwise authorized by BOEM and NMFS. The AMP must include, but is not limited to the following information: • Identification of night vision devices, such as mounted thermal or IR camera systems, hand-held or wearable NVDs, and IR spotlights, if proposed for use to detect marine mammals and sea turtles. • The AMP must demonstrate the capability of the proposed monitoring methodology to detect sea turtles within the clearance and shutdown zones. Only devices and methods demonstrated as being effective of detecting marine mammals and sea turtles within the clearance and shutdown zones will be acceptable. • Evidence and discussion of the efficacy (range and accuracy) of each device proposed for low visibility monitoring must include an assessment of the results of field studies, as well as supporting documentation regarding the efficacy of all proposed alternative monitoring methods (e.g., best scientific data available). • Reporting procedures, contacts and timeframes. BOEM may request additional information, when appropriate, to assess the efficacy of the AMP	C	Establishes requirement for low visibility impact pile driving approval

Measure	Description	Project Phase	Expected Effects
Periodic underwater surveys, reporting of monofilament and other fishing gear around WTG foundations	Empire must monitor potential loss of fishing gear in the vicinity of WTG foundations by surveying at least ten different WTGs in each EW 1 and EW 2 project area annually. Survey design and effort may be modified based upon previous survey results after review and concurrence by BOEM. Empire must conduct surveys by remotely operated vehicles, divers, or other means to determine the locations and amounts of marine debris. Empire must report the results of the surveys to BOEM (at renewable_reporting@boem.gov) and BSEE (at marinedebris@bsee.gov) in an annual report, submitted by April 30 for the preceding calendar year. Annual reports must be submitted in Microsoft Word format. Photographic and videographic materials must be provided on a portable drive in a lossless format such as TIFF or Motion JPEG 2000. Annual reports must include survey reports that include: the survey date; contact information of the operator; the 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	Establishes requirement for monitoring and reporting of lost monofilament and other fishing gear around WTGs
PDC minimize vessel interactions with listed species (from HRG Programmatic)	All vessels associated with survey activities (transiting [i.e., travelling between a port and the survey site] or actively surveying) must comply with the vessel strike avoidance measures specified below. The only exception is when the safety of the vessel or crew necessitates deviation from these requirements. •If any ESA-listed marine mammal is sighted within 500 m of the forward path of a vessel, the vessel operator must steer a course away from the whale at <10 knots (18.5 km/hr) until the minimum separation distance has been established. Vessels may also shift to idle if feasible. •If any ESA-listed marine mammal is sighted within 200 m of the forward path of a vessel, the vessel operator must reduce speed and shift the engine to neutral. Engines must not be engaged until the whale has moved outside of the vessel’s path and beyond 500 meters. If stationary, the vessel must not engage engines until the large whale has moved beyond 500 m. •If a sea turtle or manta ray is sighted at any distance within the operating vessel’s forward path, the vessel operator must slow down to 4 knots and steer away, unless unsafe to do so. The vessel may resume normal operations once the vessel has passed the sea turtle or manta ray.	Pre-C, C, O&M, D	Establishes requirement for vessel strike avoidance measures

AMP = Alternative Monitoring Plan; BMP = best management practice; BOEM = Bureau of Ocean Energy Management; BSEE = Bureau of Safety and Environmental Enforcement; C = construction period; CFR = Code of Federal Regulations; COP = Construction and Operations Plan; D = decommissioning period; dB = decibels; DOI = Department of the Interior; DPS = distinct population segment; ESA = Endangered Species Act; GARFO = Greater Atlantic Regional Fisheries Office; GPR = Global Pocket Reader; GPS = global positioning system; IR = infrared; kHz = kilohertz; km/hr = kilometers per hour; m = meters; NEFOP = Northeast Fisheries Observer Program; NMFS = National Marine Fisheries Service; NOAA = National Oceanic and Atmospheric Administration; NVD = night vision device; O&M = operation and maintenance period; PAM = passive acoustic monitoring; PIT = passive integrated transponder; PRD = Protected Resources Division; Pre-C = pre-construction period; PSO = protected species observer; rms = root mean squared; STDN = Sea Turtle Disentanglement Network; USACE = U.S. Army Corps of Engineers; USCG = U.S. Coast Guard; VHF = very high frequency; WTG = wind turbine generator

4. Environmental Baseline

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

- All federal, state, or private actions and other human activities that have influenced the condition of the action area
- The anticipated impacts of all proposed federal 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)

Empire conducted detailed surveys of the immediate Project area during COP development, and results of these surveys are presented in the COP (Empire 2022a). Those surveys are the most current information available for characterizing baseline conditions and are relied upon here and supported by other appropriate sources of information where available.

4.1. Benthic Habitat

Empire collected geophysical and geotechnical survey data throughout the immediate Project area. These data indicate that the seabed in the Lease Area is generally flat with a typical slope gradient of less than 1 degree (Empire 2022a). In the northwestern portion of the Lease Area, the seafloor is characterized as undulating. Interpretation of survey data indicates that sand is present throughout the Lease Area. These surficial sediments also include silt and occur to sediment depths of 1.2 to 20 feet (0.5 to 6 meters). In the eastern portion of the Lease Area, slightly gravelly sand is present in depressions and pockets located between bedforms. In this portion of the immediate Project area, megaripples with a typical height of less than 3.2 feet (1 meter) are present. These megaripples have a general north northwest/south southeast orientation (Empire 2022a).

Along the EW 1 export cable route, shoaling increases approaching the shore. Closer to shore, more significant variation in bathymetry exists, where dredging patterns influence the seabed (Empire 2022a). Generally, the slope gradient is less than 1 degree but may reach 5 degrees along nearshore portions of the cable route. Interpretation of survey data indicates that sediments are comprised primarily of sand with accumulations of slightly gravelly sand in bathymetric lows between bedforms and small depressions. Megaripples are typically associated with these slightly gravelly areas with heights of up to 1.6 feet (0.5 meters) and wavelengths of 13 to 49 feet (4 to 15 meters). Closer to shore, there are isolated outcroppings of glacial till. Boulders in these areas are typically between 3.3 and 7.2 feet (1 and 2.2 meters) in height. Mobile bedforms have been observed near these outcroppings.

Along the EW 2 export cable route, shoaling also increases approaching the shore (Empire 2022a). The maximum slope along the route is 1 degree. Similar to the EW 1 export cable route, sediments are interpreted to be comprised of sand with accumulations of slightly gravelly sand in bathymetric lows. Megaripples are generally observed in these bathymetric lows.

4.2. Pelagic Habitat

The action area includes coastal and offshore areas in the New York Bight, as well as offshore and coastal areas utilized by vessels transiting to ports and facilities in South Carolina, Texas, and Europe. Within the Lease Area, water depths range from 78 to 144 feet (24 to 44 meters) (Empire 2022a). Along the EW 1 and EW 2 export cable routes, water depths vary between 19.4 and 104 feet (5.9 and 31.7 meters) and 70 and 116 feet (21.5 and 35.5 meters), respectively. Within the immediate Project area, ocean currents are neither strong nor constant. In the offshore portion of the immediate Project area, currents are considered moderate (Empire 2022a).

Water temperatures in the immediate Project area range from approximately 43 to 75 degrees Fahrenheit (°F) (6 to 24 degrees Celsius [°C]) (NOAA 2013). The warmest temperatures occur from July through September, when temperatures range from 48 to 75°F (9 to 24°C), depending on depth.[1] The coldest temperatures occur from February through April, when temperatures range from 41 to 45°F (5 to 7°C), depending on depth. Surface waters experience the greatest temperature variation throughout the year while deeper waters maintain more consistent temperatures.

4.3. Water Quality

Water quality in the immediate offshore waters of the New York Bight is generally classified as 'fair' by the EPA (Empire 2022a). Most pollutants in the region originate from inshore areas. Contaminants originating in the Atlantic Ocean are limited to discharges from ships. Water quality generally improves with distance from shore.

Collection of water quality data in the New York Bight is limited, with the most recent data collected in the early 2000s. These data indicate that suspended sediment concentrations range from 1.78 to 7.85 milligrams per liter (mg/L) (Litten 2003). Particulate organic matter ranges from 0.1 to 0.13 mg/L, and dissolved organic matter ranges from 1.5 to 19.03 mg/L. Dissolved oxygen (DO) concentrations are fairly consistent, typically varying between 7 and 9 mg/L (Balthis et al. 2009). During summer stratification, DO oxygen levels in the bottom water layer may fall to 4 mg/L. Salinity generally varies between 30 and 35 parts per thousand (Balthis et al. 2009; NYSDEC 2005).

The EW 1 export cable route traverses New York Bay. Sediment loads to New York Harbor are high (USACE and PANYNJ 2016). DO levels in New York Harbor have improved since 1970, and summertime DO levels now exceed 5 mg/L in surface and bottom waters (HEP 2011). Contaminant concentrations have decreased since 1970, but legacy contaminants persist in the sediment, including mercury, polychlorinated biphenyls, dichlorodiphenyltrichloroethane, and dioxin. These contaminants could be resuspended in the water column during major storm events or anthropogenic activities (e.g., dredging) (Steinberg et al. 2004).

4.4. Underwater Noise

Ambient noise levels in the New York Bight were characterized using passive acoustic monitoring data collected from October 2017 to July 2018 (Estabrook et al. 2019). The study focused on characterizing noise levels within frequency ranges corresponding to the hearing ranges of large whales found in the area and found that the highest noise levels occurred at monitoring locations closest to New York Harbor, where vessel traffic was highest. Noise levels at each of the monitoring sites were relatively consistent throughout the monitoring period (Estabrook et al. 2019). The range of ambient noise levels recorded by Estabrook et al. (2019) within frequency ranges that correspond to hearing ranges of large whale species are provided in **Table 9**.

[1] Empire analyzed water temperatures to a maximum depth of 131 feet (40 meters).

Table 9 Recorded Ambient Noise Levels in the New York Bight

Frequency Range (Hz)	Ambient Noise Level (dB re 1 μPa)
14 – 22	74 – 146
17 – 28	82 – 148
28 – 89	83 – 149
28 – 708	90 – 152
44 – 355	86 – 147
70 – 224	84 – 143

Hz = hertz; dB re 1 μPa = decibels referenced to one micropascal
Source: Estabrook et al. 2019

4.5. EMF

There are currently six submarine cables charted on National Oceanographic and Atmospheric Administration (NOAA) navigational charts in the Lease Area, but none of these cables are active (Empire 2022a). An additional three uncharted cables were identified in the Lease Area during geophysical surveys. Five active cables or cable bundles cross the submarine export cable routes:

- One bundle of two 345 kilovolt HVAC transmission lines in the New York Harbor southern utility corridor
- Two bundles of 138 kilovolt HVAC transmission lines in the New York Harbor northern utility corridor
- The Neptune Regional Transmission System
- The FLAG Atlantic South telecommunications cable

An additional two planned cables would cross the submarine export cable routes, including the Poseidon Transmission Cable and The Wall New Jersey to Long Island fiber optic telecommunications cable (Empire 2022a). A New York Telephone Cable between Fort Hamilton and Fort Wadsworth was identified as potentially crossing the cable routes, but this cable was not found during geophysical surveys and its status is unknown. The export cable routes also cross several uncharted cables that are out of service.

4.6. Artificial Light

Vessel traffic and safety lighting on marine structures (i.e., buoys and meteorological towers) are the only sources of artificial light in the offshore portion of the action area. Land-based artificial light sources are generally predominant in nearshore areas.

4.7. Vessel Traffic

The New York Bight is one of the busiest areas for commercial vessel traffic on the East Coast of the United States, and many vessels transiting through the region utilize the Port of New York and New Jersey. In addition to commercial vessel traffic, commercial and recreational fishing vessels, as well as other recreational vessels (e.g., sail boats, dive boats, sightseeing boats, pleasure craft), transit the area. The Lease Area is located between two traffic separation scheme lanes for the Port of New York and New Jersey (**Figure 9**).

Based on Automatic Information System (AIS) data, tankers and cargo vessels largely follow the traffic separation scheme lanes, though some vessels in this class transit through the Lease Area. Between August 2017 and July 2018 (i.e., the AIS data period), cargo vessels accounted for 34 percent of vessel traffic within a 15 nautical mile (27.8 kilometer) buffer around the Lease Area and 16 percent of traffic within the Lease Area (Empire 2022a). On average, 18 unique cargo vessels transited the buffered area each day, and one cargo vessel transited the Lease Area every 11 days. Tug and barge vessels generally disregard the traffic separation scheme lanes in favor of minimizing miles traveled (Empire 2022a). These vessels transit primarily along the coastline with some diagonal transits across the New York Bight (**Figure 10**). Passenger vessels (i.e., passenger ferries and cruise ships) generally travel regular, predetermined routes. Cruise vessels generally utilize the traffic separation scheme lanes entering and exiting the Port of New York and New Jersey (**Figure 11**). Over the AIS data period, an average of 3 to 4 unique passenger vessels transited the buffered area daily (Empire 2022a). Over the entire AIS data period, only 5 passenger vessels transited the Lease Area. AIS data show heavy fishing vessel traffic across the Lease Area (**Figure 12**), but Vessel Monitoring System data from the Northeast Ocean Data Portal show more segmented use of the Lease Area and surrounding waters (Empire 2022a). Fishing vessels accounted for approximately 8 percent of AIS vessel traffic over the AIS data period. However, AIS vessel data do not account for all fishing vessels. Recreational vessels off of New York generally travel within 3 nautical miles (5.5 kilometers) of the coastline. This vessel class accounted for 7 percent of AIS vessel traffic over the AIS data period (Empire 2022a).

4.8. Description of Critical Habitat in the Action Area

There is no critical habitat designated for any ESA-listed species within the immediate Project area. However, designated critical habitat is found within the portion of the action area that includes potential vessel routes to and from ports on the Hudson River, in South Carolina, and in Texas, including critical habitat for the Carolina and New York Bight distinct population segments (DPSs) of Atlantic sturgeon, North Atlantic right whale (NARW, *Eubalaena glacialis*), and the Northwest Atlantic Ocean DPS of loggerhead sea turtle (*Caretta caretta*).

4.8.1. Critical Habitat for North Atlantic Right Whale

NMFS designated critical habitat for the NARW on January 27, 2016 (NMFS 2016b). This designation included two units: a foraging area in the Gulf of Maine and Georges Bank region (Unit 1) and a calving area off the southeastern coast of the United States (Unit 2). The portion of the action area that includes potential vessel routes to and from the cable facility in South Carolina and the port of Corpus Christi may overlap Unit 2, which includes waters off the coasts of North Carolina, South Carolina, Georgia, and the Atlantic coast of Florida (**Figure 13**).

The physical and biological features (PBFs) of calving habitat essential to conservation of the species include:

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

Vessel traffic through this portion of the action area would not affect any of these essential PBFs and would not affect the simultaneous co-occurrence of these features in Unit 2 from November through April. Project vessels transiting along the Atlantic coast between North Carolina and Florida could use routes located offshore of the designated critical habitat and would not need to travel through that area. Therefore, the Proposed Action would not affect designated critical habitat for NARW, and this critical habitat is discounted from further evaluation in this BA.

4.8.2. Critical Habitat for Northwest Atlantic Ocean DPS of Loggerhead Sea Turtle

NMFS designated critical habitat for the Northwest Atlantic Ocean DPS on August 11, 2014 (NMFS 2014a). This designation included nearshore reproductive habitat, wintering habitat, breeding habitat, constricted migratory corridors, and/or *Sargassum* habitat in the Atlantic Ocean and Gulf of Mexico (**Figure 14**). Vessels transiting routes to and from the cable facility in South Carolina and the port of Corpus Christ may travel through wintering habitat, breeding habitat, migratory habitat, and/or *Sargassum* habitat.

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

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

Vessel traffic through this portion of the action area would not affect any of these essential PBFs. Therefore, the Proposed Action would not affect designated critical habitat for the Northwest Atlantic Ocean DPS of loggerhead sea turtle, and this critical habitat is discounted from further evaluation in this BA.

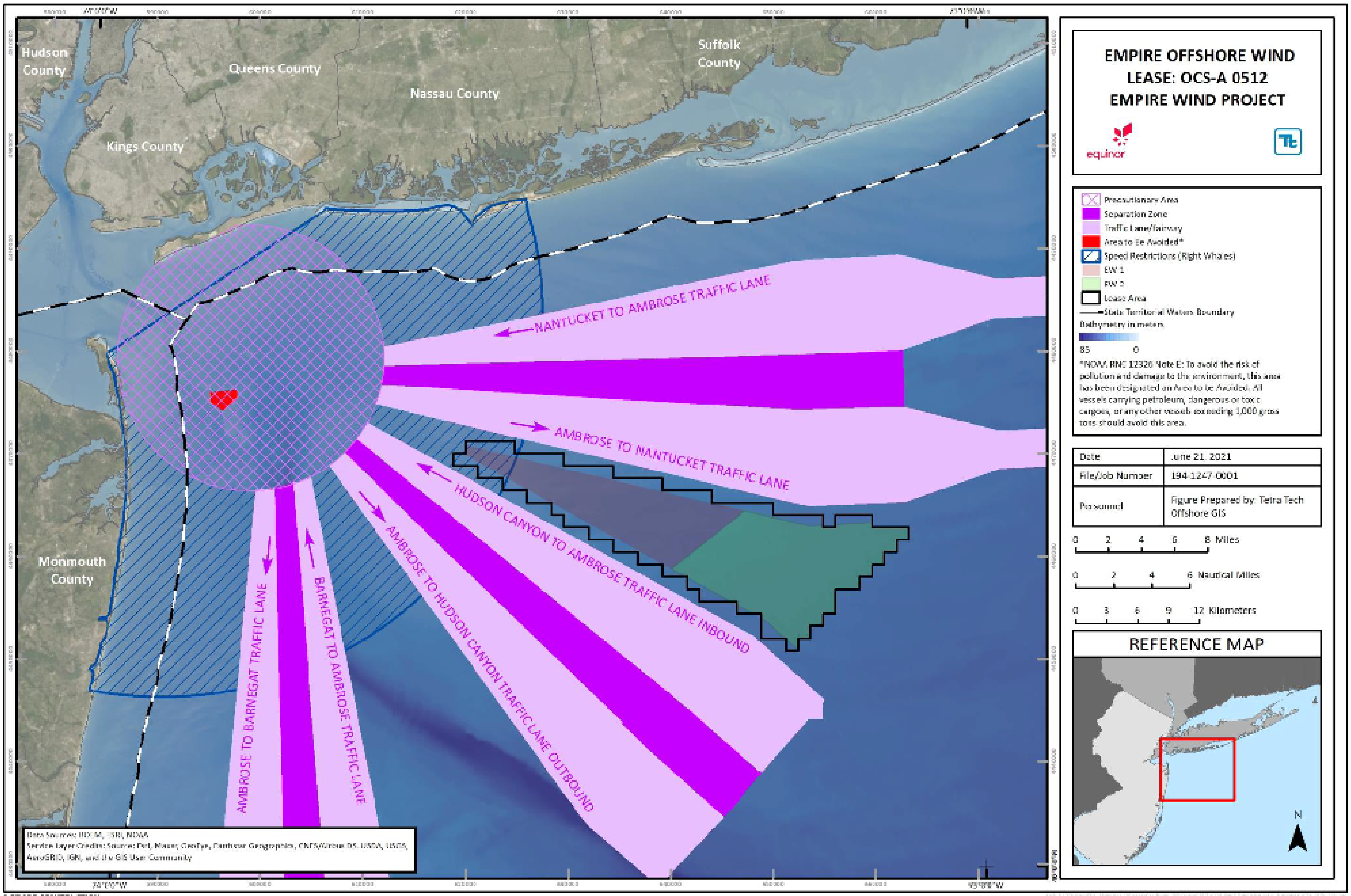


Figure 9 **Traffic Separation Scheme Lanes around the Lease Area**

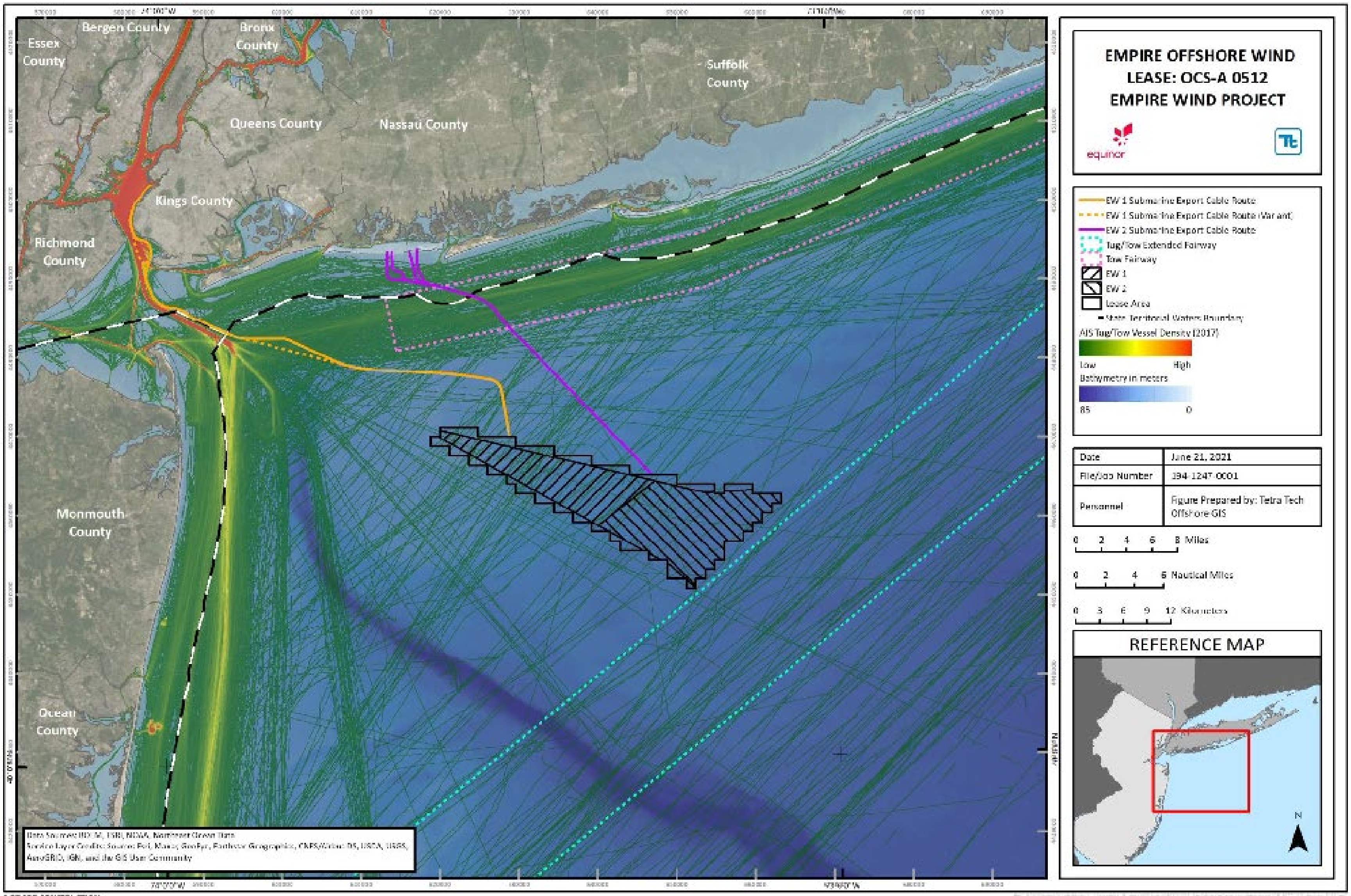


Figure 10 Tug Transit Routes around the Immediate Project Area

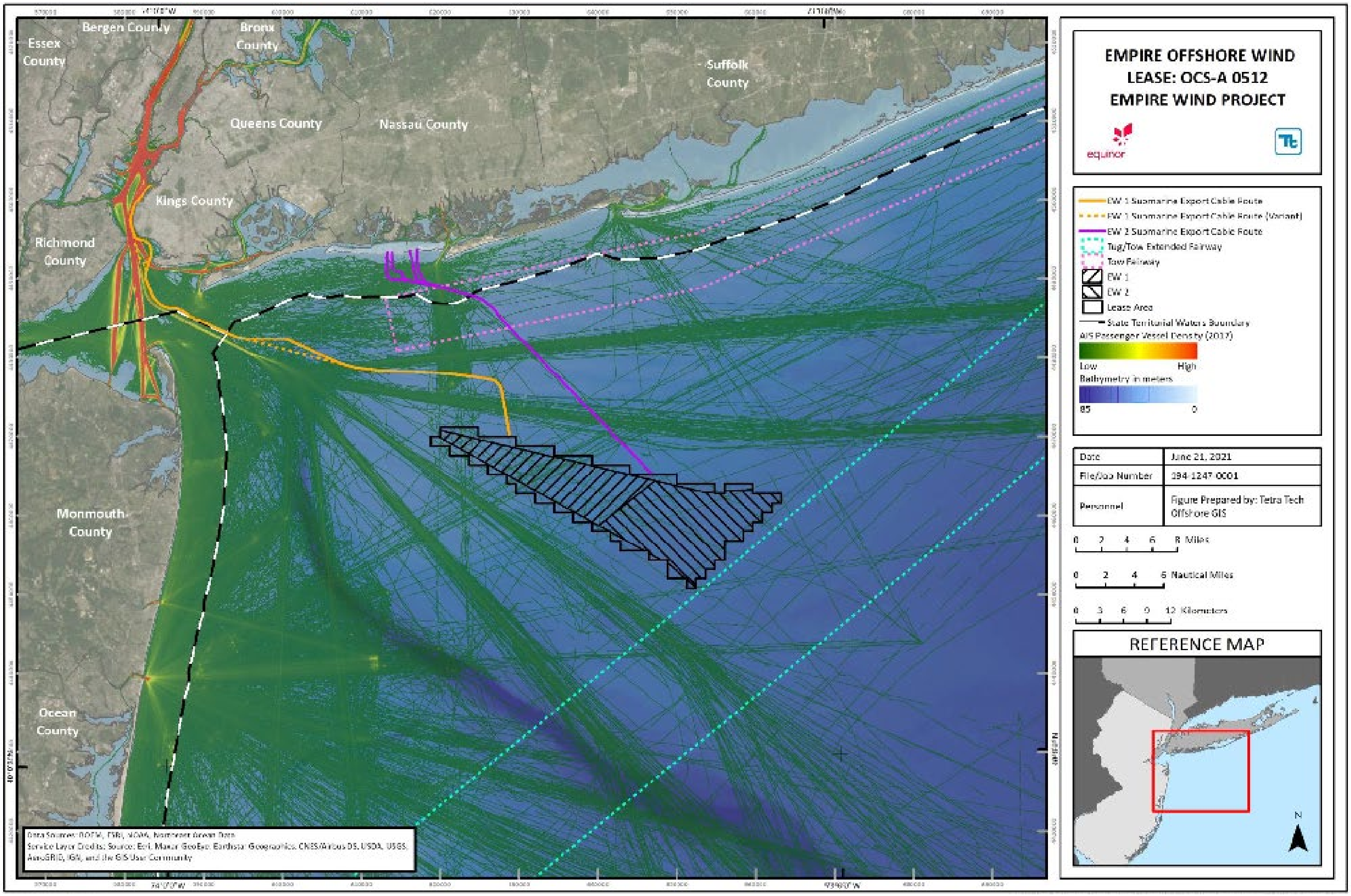


Figure 11 **Passenger Vessel Transit Routes around the Immediate Project Area**

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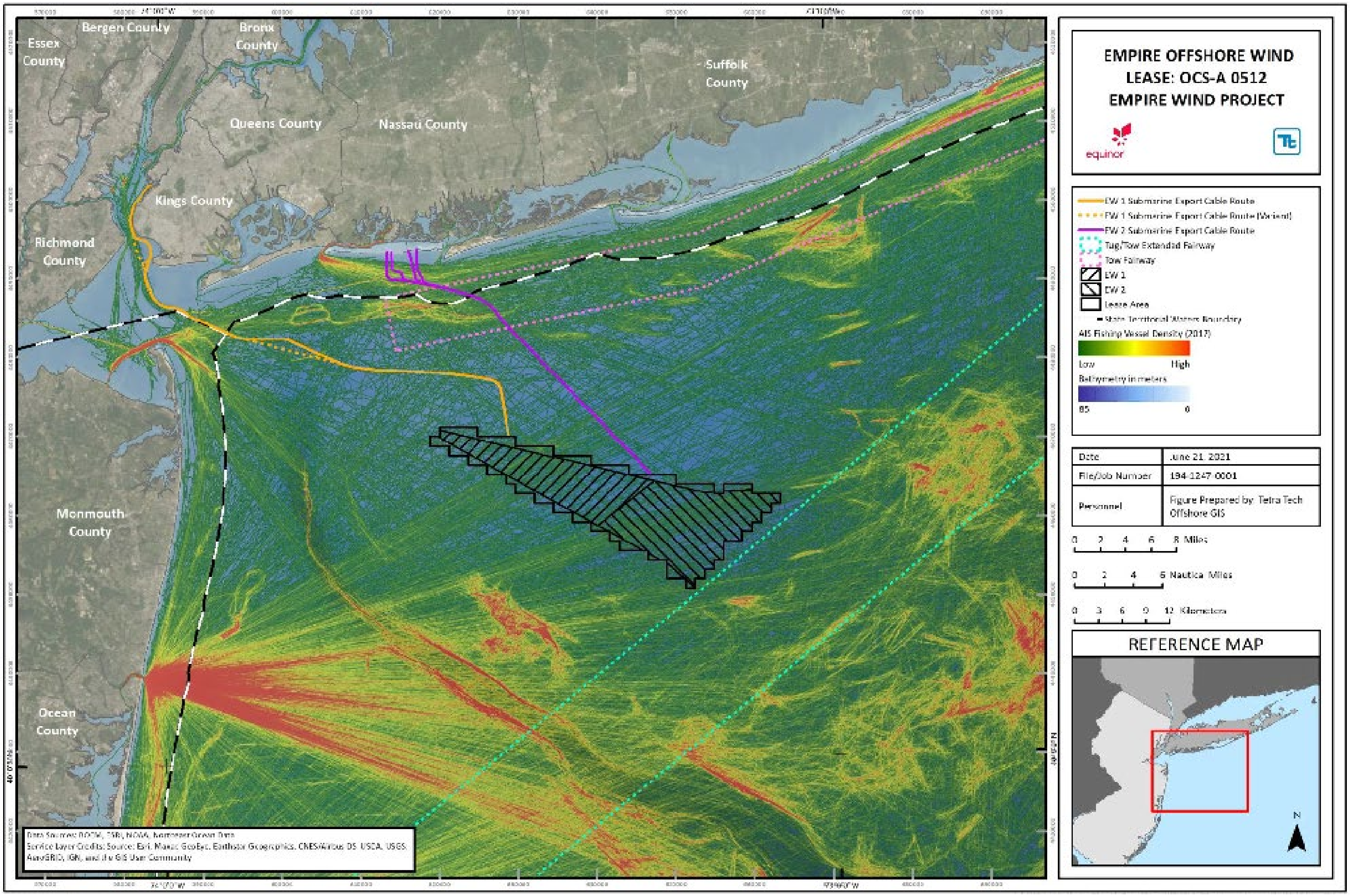

Figure 12 Fishing Vessel Transit Routes around the Immediate Project Area

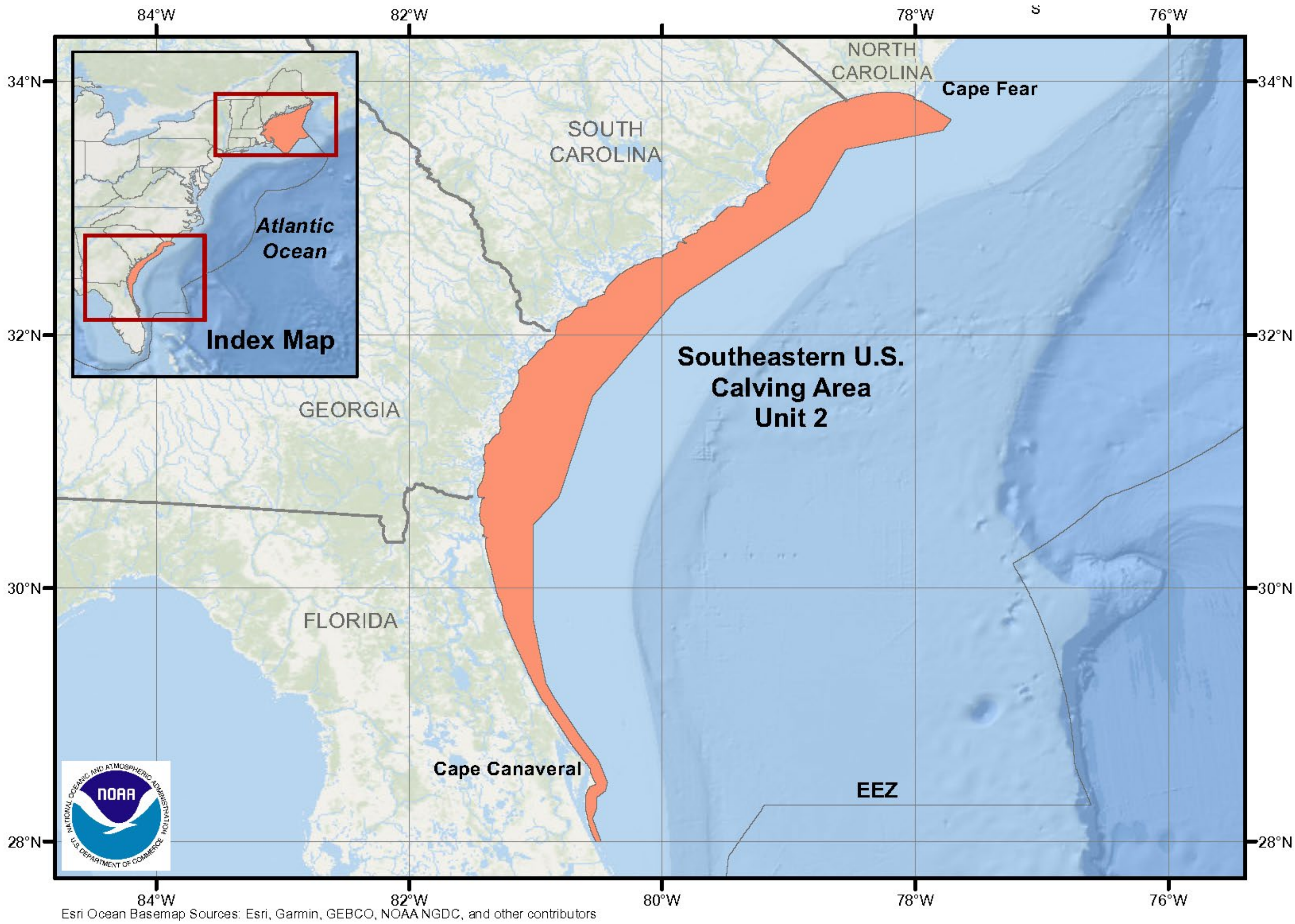

Figure 13 North Atlantic Right Whale Critical Habitat in the Action Area

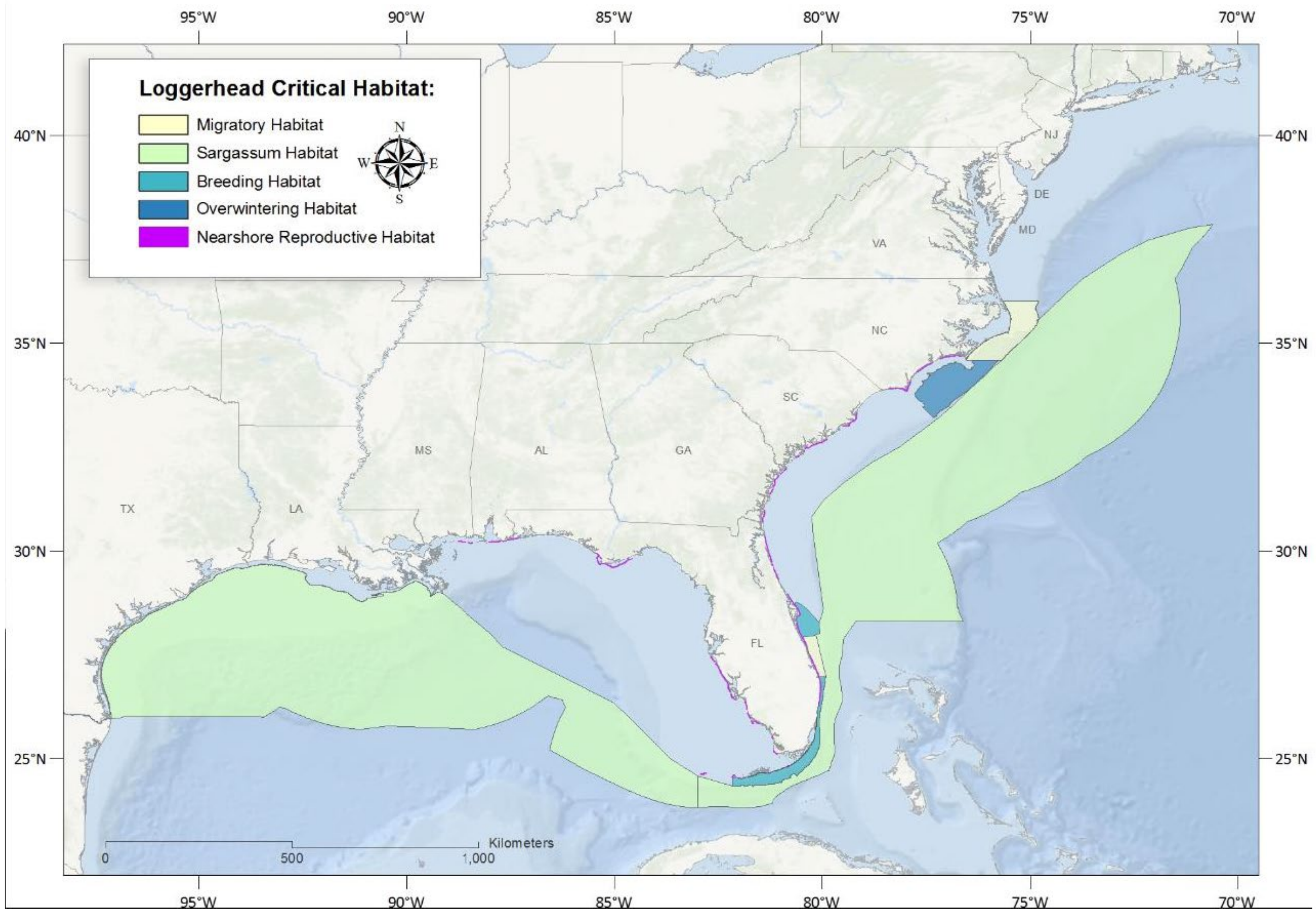

Figure 14 **Critical Habitat for the Northwest Atlantic Distinct Population Segment of Loggerhead Sea Turtles**

4.8.3. Critical Habitat for Carolina and New York Bight DPSs of Atlantic Sturgeon

NMFS designated critical habitat for the New York Bight and Carolina DPSs of Atlantic sturgeon on August 17, 2017. This designation encompassed 340 miles (547 kilometers) of aquatic habitat in rivers in Connecticut, Massachusetts, New York, New Jersey, Pennsylvania, and Delaware for the New York Bight DPS and approximately 1,205 miles (1,939 kilometers) of aquatic habitat in rivers in North and South Carolina for the Carolina DPS. New York Bight Unit 3 includes the Hudson River from the Troy Lock Dam downstream to where the main stem river discharges at its mouth into New York City Harbor (**Figure 15**), which overlaps the portion of the action area that includes vessel routes to the Port of Coeymans and Port of Albany. Carolina Unit 7 includes the Cooper River from the confluence of the West Branch Cooper River and East Branch Cooper River to the river mouth (**Figure 15**), which overlaps the portion of the action area that includes potential vessel routes to a manufacturing facility on the Cooper River just north of Charleston, South Carolina.

The PBFs essential to conservation of the New York Bight DPS include:

- PBF 1 – Hard bottom substrate (e.g., rock, cobble, gravel, limestone, boulder, etc.) in low salinity waters (i.e., 0.0 to 0.5 parts per thousand [ppt] range) for settlement of fertilized eggs and refuge, growth, and development of early life stages
- PBF 2 – Aquatic habitat with a gradual downstream salinity gradient of 0.5-30.0 ppt and soft substrate (e.g., sand, mud) downstream of spawning sites for juvenile foraging and physiological development
- PBF 3 – Water with appropriate depths and without physical barriers to passage between the river mouth and spawning sites necessary allow unimpeded movement of adults to and from spawning sites; movement of juvenile Atlantic sturgeon to appropriate salinity zones within the river estuary; and staging, resting, or holding of subadults or spawning condition adults. Water depths in main river channels must also be deep enough (e.g., ≥1.2 meters) to ensure continuous flow in the main channel at all times when any sturgeon life stage would be in the river
- PBF 4 – Water, especially in the bottom meter of the water column, with the temperature, salinity, and oxygen values that, combined, support critical life history functions, including spawning, annual and interannual survival of juvenile and older sturgeon, and larval, juvenile, and subadult growth, development, and recruitment (e.g., 13°C to 26°C [55.4°F to 78.8°F] for spawning habitat and ≤ 30°C [86°F] and 6 mg/L dissolved oxygen for juvenile rearing habitat)

All four of these PBFs occur within the action area. Vessel traffic would not affect bottom substrate (PBFs 1 and 2), salinity (PBFs 1, 2, and 4), water depth (PBF 3), temperature (PBF 4), or dissolved oxygen (PBF 4) and would not serve as a barrier to passage of Atlantic sturgeon (PBF 3). Given the lack of vessel impacts on PBFs 1, 2, 3, and 4, the Proposed Action would not affect designated habitat for the New York Bight DPS of Atlantic sturgeon, and this critical habitat is discounted from further evaluation in this BA.

The PBFs essential to conservation of the Carolina DPS include PBF 1 through 3 for the New York Bight DPS and a fourth PBF distinct from PBF 4 for the New York Bight DPS:

- PBF 4 – Water quality conditions, especially in the bottom meter of the water column, between the river mouths and spawning sites with temperature and oxygen values that support: (1) spawning; (2) annual and inter-annual adult, subadult, larval, and juvenile survival; and (3) larval, juvenile, and subadult growth, development, and recruitment. Appropriate temperature and oxygen values will vary interdependently and depending on salinity in a particular habitat. For example, 6.0 mg/L dissolved oxygen or greater likely supports juvenile rearing habitat, whereas dissolved oxygen less than 5.0 mg/L for longer than 30 days is less likely to support rearing when water temperature is greater than 25°C. In temperatures greater than 26°C, dissolved oxygen greater than 4.3 mg/L is needed to protect survival and growth. Temperatures 13°C to 26°C (55.4°F to 78.8°F) likely support spawning habitat.

PBFs 2 through 4 occur within the action area. As described for critical habitat for the New York Bight DPS, vessel traffic would not affect salinity, water depth, temperature, or dissolved oxygen and would not serve as a barrier to passage of Atlantic sturgeon. Therefore, the Proposed Action would not have an impact on PBF 2, 3, or 4 for the Carolina DPS and would not affect designated habitat for the Carolina DPS of Atlantic sturgeon, and this critical habitat is discounted from further evaluation in this BA.

4.9. Description of ESA-listed Species in the Action Area

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

- Site-specific aerial survey data collected by Empire (see Appendix P of the COP; Empire 2022a)
- Protected Species Observer data collected in the immediate Project area (AIS 2019; AOSS 2019)
- Aerial survey data collected by NYSERDA and the New York State Department of Environmental Conservation (APEM and Normandeau 2018; Tetra Tech and Smultea Sciences 2018; Tetra Tech and LGL 2019, 2020)
- Sighting data retrieved from the Ocean Biodiversity Information System (Halpin et al. 2009; Roberts et al. 2016a, 2016b, 2017, 2018, 2020)
- Data from NOAA's Atlantic Marine Assessment Program for Protected Species surveys (NEFSC and SEFSC 2018, 2020)
- Fisheries data collected by federal and state agencies, including BOEM (Guida et al. 2017), the Northeast Fisheries Science Center, the Northeast Area Monitoring and Assessment Program, and the New Jersey Department of Environmental Protection
- Other regional data (CETAP 1982; Davis et al. 2017; DiGiovanni and DePerte 2013; Ecology and Environment Engineering 2017; Estabrook et al. 2019; Hare et al. 2016; Kenney and Vigness-Raposa 2010; Kraus et al. 2016; MAFMC 2017; Mid-Atlantic Regional Ocean Council 2019; Muirhead et al. 2018; NAS 2018; Northeast Regional Ocean Council 2018; Stone et al. 2017; Whitt et al. 2013, 2015)

Based on this information, 17 ESA-listed species could occur in the action area (**Table 10**): seven marine mammal species, five sea turtle species, and five fish species. The West Indian manatee (*Trichechus manatus*) is under the jurisdiction of the USFWS and will therefore not be addressed in this BA. Descriptions of the remaining species under NMFS jurisdiction are provided in Sections 4.2.1 through 4.2.4.

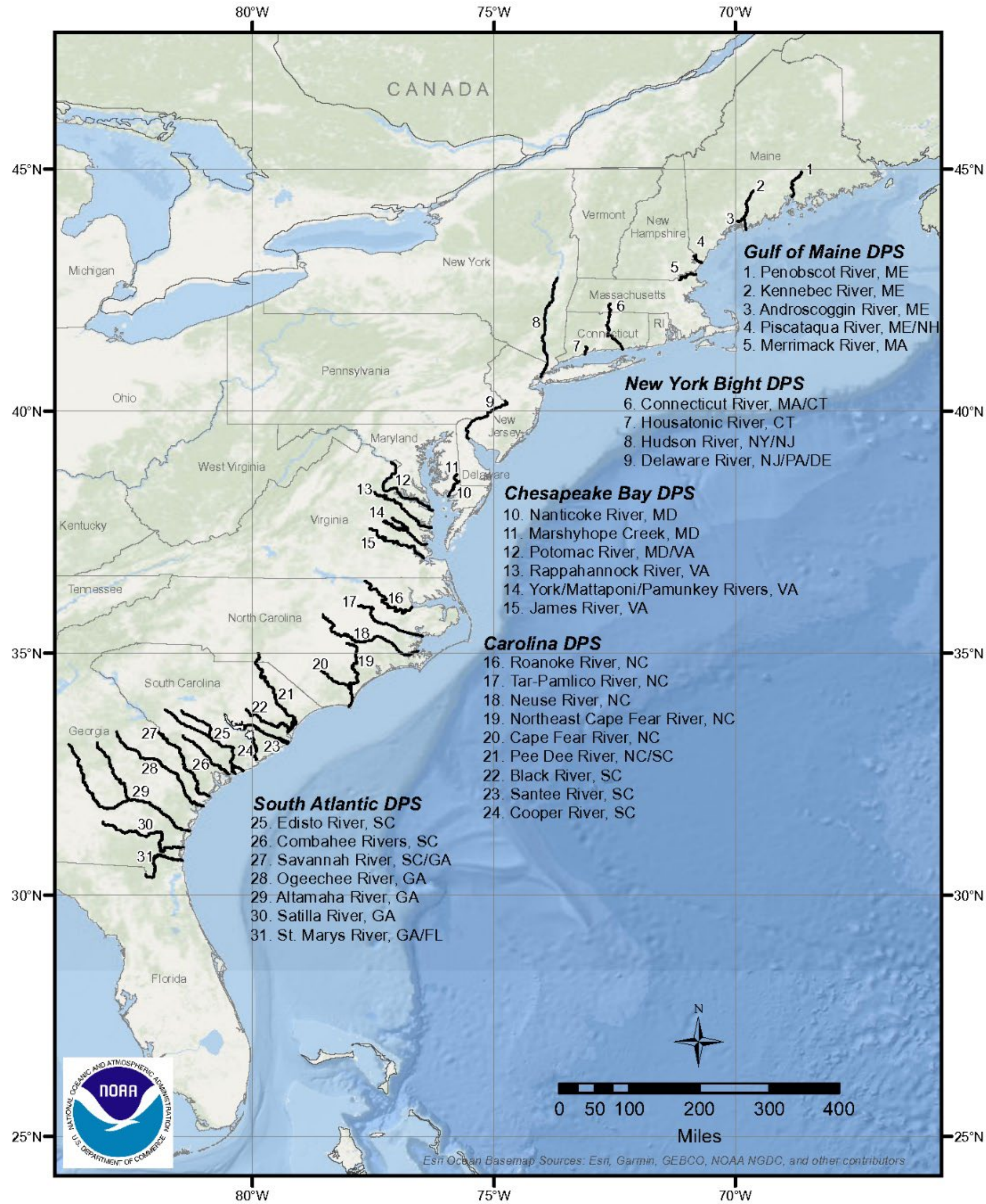

Figure 15 Atlantic Sturgeon Critical Habitat

4.9.1. Species Considered but Discounted from Further Analysis

Several species that could occur in the action area are either unlikely to occur or their occurrence would be limited to a portion of the action area outside the impact area of most Project activities. For species unlikely to occur, the potential for adverse effects is discountable. For species with limited occurrence, potential effects of the Proposed Action are limited to interactions with vessels outside the immediate Project area during the small number of trips expected to and from ports and facilities in South Carolina, Texas, or Europe. Brief descriptions of each of these species are provided below. Species that are likely to occur in the action area are discussed in more detail in Sections 4.2.2, 4.2.3, and 4.2.4.

Table 10 ESA-Listed Species in the Action Area

Species	Distinct Population Segment	ESA Status	ESA Listing Date	Critical Habitat Status	Species in Action Area	Critical Habitat in Action Area
Blue whale	NA	Endangered	1970	Not designated	Unlikely	NA
Fin whale	NA	Endangered	1970	Not designated	Likely	NA
North Atlantic right whale	NA	Endangered	1970	Designated	Likely	Yes
Rice's whale	NA	Endangered	2019	Not designated	Limited	NA
Sei whale	NA	Endangered	1970	Not designated	Limited	NA
Sperm whale	NA	Endangered	1970	Not designated	Likely	NA
West Indian manatee	NA	Threatened	1967	Designated	Limited	No
Green sea turtle	North Atlantic	Threatened	2016	Designated	Likely	NA
Hawksbill sea turtle	NA	Endangered	1970	Designated	Limited	No
Kemp's ridley sea turtle	NA	Endangered	1970	Not designated	Likely	NA
Leatherback sea turtle	NA	Endangered	1970	Designated	Likely	No
Loggerhead sea turtle	Northwest Atlantic Ocean	Threatened	2011	Designated	Likely	Yes
Atlantic salmon	Gulf of Maine	Endangered	2000	Designated	Unlikely	No
Atlantic sturgeon	Gulf of Maine, New York Bight, Chesapeake Bay, Carolina, and South Atlantic	Threatened, Endangered	2012	Designated	Likely	No
Giant manta ray	NA	Threatened	2018	Not designated	Limited	NA
Oceanic whitetip shark	NA	Threatened	2018	Not designated	Limited	NA
Shortnose sturgeon	NA	Endangered	1967	Not designated	Unlikely	NA

4.9.1.1. Blue Whale

The blue whale (*Balaenoptera musculus*) is listed as endangered throughout its range (USFWS 1970). Blue whales have not been observed in the Lease Area, but they have been seen offshore of the Lease Area, and passive acoustic monitoring equipment in the Lease Area has detected blue whales from the fall through the spring, though the calls were not localized to the Lease Area (Empire 2022a). This species is expected to occur in deeper waters (at least 328 feet [100 meters]) than those found in the Lease Area (Waring et al. 2011).

Blue whales have been acoustically detected throughout much of the North Atlantic. Most of these detections occurred around the Grand Banks off Newfoundland and west of the British Isles. This species is considered an occasional visitor in U.S. Atlantic waters (Hayes et al. 2020). Therefore, this species is unlikely to occur in the action area, and this occurrence would likely be limited to the portion of the action area associated with vessel transits to and from Europe.

Given the rarity of blue whales in the action area and the limited number of vessel transits through the portion of the action area where this species could occur, Project vessels are not expected to encounter blue whales. If a Project vessel were to co-occur with a blue whale in the action area, any effects are extremely unlikely. All Project vessels will utilize dedicated, trained lookouts to reduce the risk of vessel collision, will maintain 328-foot (100-meter) separation distances from large whales, and adhere to vessel strike avoidance measures as advised by NMFS. Based on the unexpected co-occurrence of blue whales and Project vessels in the action area and the mitigation measures to avoid vessel strikes, any effects to blue whales are extremely unlikely to occur.

4.9.1.2. Rice's Whale

Rice's whale (*B. ricei*) is listed as endangered throughout its range (NMFS 2019a). This species was originally classified as the Gulf of Mexico subspecies of Bryde's whale (*B. edeni*) at the time of listing but was reclassified as a distinct species in 2021 (NMFS 2021i). This species is not found within the immediate Project area or within the portion of the action area where vessels transit to and from local ports.

Rice's whale only occurs in the Gulf of Mexico and has been consistently sighted in the northeastern Gulf of Mexico. They are generally distributed along the continental shelf break between 328 and 1,312 feet (100 and 400 m) depth (NMFS 2022d). Therefore, occurrence of this species would be limited to the portion of the action area where vessel transits to and from Corpus Christ would occur.

Given the rarity of this species (estimated abundance of 51 individuals; Hayes et al. 2021) and the limited number of vessel transits through the Gulf of Mexico, it is extremely unlikely that a Project vessel would encounter Rice's whales. If a Project vessel were to co-occur with a Rice's whale in the action area, any effects are extremely unlikely. All Project vessels will utilize dedicated, trained lookouts to reduce the risk of vessel collision, will maintain 328-foot (100-meter) separation distances from large whales, and adhere to vessel strike avoidance measures as advised by NMFS. Based on the unexpected co-occurrence of Rice's whales and Project vessels in the action area and the mitigation measures to avoid vessel strikes, any effects to Rice's whales are extremely unlikely to occur.

4.9.1.3. Sei Whale

The sei whale (*B. borealis*) is listed as endangered throughout its range (USFWS 1970). Sei whales have not been observed in the Lease Area, but they have been seen offshore of the Lease Area (Empire 2022a). Passive acoustic monitoring equipment in New York waters have detected sei whales from the fall through the spring, though the calls were not localized to New York waters (WHOI 2018; WCS Ocean Giants 2020). This species is generally expected to occur around the continental shelf edge beyond the Lease Area (Hayes et al. 2021 citing Mitchell 1975). Therefore, the occurrence would likely be limited to the portion of the action area associated with vessel transits to and from Europe.

Given the limited number of vessel transits through the portion of the action area where this species could occur, Project vessels are not expected to encounter sei whales. If a Project vessel were to co-occur with a sei whale in the action area, any effects are extremely unlikely. All Project vessels will utilize dedicated, trained lookouts to reduce the risk of vessel collision, will maintain 328-foot (100-meter) separation distances from large whales, and adhere to vessel strike avoidance measures as advised by NMFS. Based on the unexpected co-occurrence of sei whales and Project vessels in the action area and the mitigation measures to avoid vessel strikes, any effects to this species are extremely unlikely to occur.

4.9.1.4. Hawksbill Sea Turtle

The hawksbill sea turtle (*Eretmochelys imbricata*) is listed as endangered throughout its range (USFWS 1970). Though hawksbill sea turtles have been documented in OCS waters of the northwest Atlantic Ocean, they are rare in this region and have not been documented in the vicinity of the Lease Area (Empire 2022a). Therefore, this species is considered unlikely to occur in the immediate Project area or the portion of the action area associated with vessel transits to local ports.

Hawksbill sea turtles occur regularly in the Gulf of Mexico and could therefore occur in the portion of the action area associated with vessel transits to and from this region. However, this species generally inhabits nearshore foraging grounds and is often associated with coral reefs (NMFS 2022b). Therefore, hawksbill sea turtle densities along vessel transit routes are expected to be low.

Given the limited number of vessel transits through the portion of the action area where this species could occur and low expected densities in the action area, Project vessels are not expected to encounter hawksbill sea turtles. Therefore, the Proposed Action is not expected to result in any adverse effects to this species.

4.9.1.5. Atlantic Salmon

The Gulf of Maine DPS of Atlantic salmon (*Salmo salar*) is listed as endangered under the ESA (NMFS 2000). Atlantic salmon is an anadromous species that inhabits waters of North America, Iceland, Greenland, Europe, and Russia. In the U.S., remaining wild populations of Atlantic salmon are found in coastal rivers in Maine and comprise the Gulf of Maine DPS (NMFS 2022a). This species is not found in the immediate Project area.

The Gulf of Maine DPS of Atlantic salmon occupies waters of the western North Atlantic when in its oceanic habitat, migrating through waters off Canada to reach wintering and feeding areas off Greenland (NMFS 2022a). Vessel transit routes between the immediate Project area and Europe are unlikely to pass through Atlantic salmon habitat. If Project vessels were to encounter Atlantic salmon in the North Atlantic, they are unlikely to have any effect on the species as vessel strikes have not been identified as a threat to the species (USFWS and NMFS 2019).

Given that Project vessels are unlikely to encounter Atlantic salmon, the Proposed Action is not expected to result in any adverse effects to this species.

4.9.1.6. Giant Manta Ray

The giant manta ray (*Manta birostris*) is listed as threatened throughout its range (NMFS 2018d). This highly-migratory species is found in temperate, subtropical, and tropical oceans worldwide. Sightings of giant manta rays in the Mid-Atlantic and in New England are rare, though individuals have been documented as far north as New Jersey and Block Island (Gudger 1922; Miller and Klimovich 2017). This species could transit through the immediate Project area but is considered unlikely to occur there or in the portion of the action area associated with vessel transits to local ports (Empire 2022a).

Giant manta rays may occur in the portions of the action area where vessel transits to and from Europe and vessel transits to and from Corpus Christi would occur. However, the encounter rate between this species and Project vessels is expected to be low.

Given the limited number of vessel transits through the portion of the action area where this species is most likely to occur (i.e., the portion associated with vessel transits to and from Europe and Corpus Christi) and the low encounter rate (i.e., the frequency with which vessels and giant manta rays would co-occur), the Proposed Action is not expected to result in any adverse effects to this species.

4.9.1.7. Oceanic Whitetip Shark

The oceanic whitetip shark (*Carcharhinus longimanus*) is listed as threatened throughout its range (NMFS 2018e). This species is generally found in subtropical and subtropical oceans worldwide, inhabiting deep, offshore waters (NMFS 2022c). In the western Atlantic, oceanic whitetips occur as far north as Maine (NMFS 2016c). This species could transit through the immediate Project area, but given the species' preference for deep, offshore waters, is unlikely to occur there or in the portion of the action area where vessel transits to local ports would occur (Empire 2022a).

Oceanic whitetip sharks may occur in the portions of the action area associated with vessel transits to and from Europe and vessel transits to and from Corpus Christi. However, vessel strikes have not been identified as a threat to the species (NMFS 2016c), and there is no information to indicate that vessels have adverse effects on this species (BOEM 2021c). Therefore, the Proposed Action is not expected to result in any adverse effects to oceanic whitetip shark.

4.9.1.8. Shortnose Sturgeon

The shortnose sturgeon (*Acipenser brevirostrum*) is listed as endangered throughout its range (USFWS 1967). This species is not expected to occur in the Lease Area but could transit through the EW 1 landfall and state waters along the EW 1 export cable route (Empire 2022a). However, shortnose sturgeon rarely leave their natal rivers (Bemis and Kynard 1997; Zydlewski et al. 2011). The Hudson River population is almost exclusively confined to the river (Kynard et al. 2016; Pendleton et al. 2019), differing from other populations that may use coastal waters to move into smaller coastal rivers nearby. Therefore, this species is unlikely to occur in the immediate Project area.

Project vessels could encounter shortnose sturgeon when traveling from the Lease Area to ports on the Hudson River, including the Port of Coeymans and the Port of Albany. Project vessel traffic (**Table 5**) would represent only small increase in vessel traffic relative to existing traffic on the Hudson River. Given the small increase in vessel traffic due to the Proposed Action, the likelihood of a Project vessel strike of a shortnose sturgeon is extremely low. Therefore, potential impacts of the Proposed Action on shortnose sturgeon are expected to be insignificant.

4.9.2. Marine Mammals

The fin whale (*B. physalus*) and NARW, both listed as endangered, are likely to occur in the action area. As noted in Section 4.1, there is designated critical habitat for NARW within the action area. There is also a Seasonal Management Area for NARW and a biologically important area for NARW migration within the action area (**Figure 16**). The Seasonal Management Area is in effect from November through April; during this period, vessels 65 feet (19.8 meters) or longer cannot exceed 10 knots during transit. Critical habitat has not been designated for fin whales.

4.9.2.1. Fin Whale

4.9.2.1.1 Description and Life History

The fin whale is the second-largest species of whale, reaching a maximum weight of 40 to 80 tons (36 to 73 metric tons) and a maximum length of 75 to 85 feet (23 to 26 meters) (NMFS 2021d). This species reaches physical maturity at 25 years of age. Age of sexual maturity varies between sexes; males reach sexual maturity at 6 to 10 years of age, and females mature between the age of 7 and 12 years. The gestation period for fin whales is 11 to 12 months, and females give birth in tropical and subtropical areas in midwinter (NMFS 2021d).

Fin whales are mysticetes (i.e., baleen whales) and forage using lunge or skim feeding. This species feeds during summer and fasts during the winter migration (NMFS 2021d). Primary prey species include krill, squid, herring, sand lance, and copepods (Kenney and Vigness-Raposa 2010).

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

4.9.2.1.2 Status and Population Trend

The fin whale was listed as endangered in 1970, as part of a pre-cursor to the ESA (USFWS 1970). The status of this species was most recently reviewed as part of its 5-year status review in 2019, and NMFS (2019b) determined that the species should be downlisted from endangered to threatened. However, no rulemaking has been proposed to reclassify the species under the ESA. Fin whales found in the action area belong to the Western North Atlantic stock. The best abundance estimate for the Western North Atlantic stock is 6,802 individuals (NMFS 2021c). There are currently insufficient data to determine a population trend for this species.

Threats to fin whales include vessel strikes, entanglement, anthropogenic noise, and climate change. This species is likely the second most vulnerable species to vessel strikes following NARW (NMFS 2021d). In a study evaluating historic and recent vessel strike reports, fin whales were involved in collisions the most frequently of the 11 large species evaluated (Laist et al. 2001). Though entanglement can result in injury or mortality in this species, fin whales may be less susceptible to entanglement than other large whale species (Glass et al. 2010; Nelson et al. 2007).

4.9.2.1.3 Distribution and Habitat Use

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

Fin whales may occur in the action area year-round. Aerial surveys have documented the species in the action area in all seasons, and fin whales have been sighted in the immediate Project area from May through December (Empire 2022a). Fin whale densities are expected to be highest in the spring and summer months. Seasonal density of fin whales is provided on Figure 5.6-5 in Volume 2b of the COP (Empire 2022a). Mean monthly densities for this species within a 5.5-kilometer buffer around the Lease Area range from 0.084 animals per 100 square kilometers (km^2) in December to 0.258 animals per 100 km^2 in June (**Table 11**).

4.9.2.2. North Atlantic Right Whale

4.9.2.2.1 Description and Life History

The NARW is a large mysticete that can reach lengths up to 52 feet (16 meters) and weights up to 70 tons (64 metric tons) (NMFS 2021h). This species may live to 70 years of age or more. Female NARWs reach sexual maturity at approximately age 10 and have a calf every three to four years, though in recent years the time span between calvings has increased to six to ten years (NMFS 2021h). The gestation period is approximately one year, and calves are born in the coastal waters of South Carolina, Georgia, and Florida.

NARWs feed throughout the water column and may skim feed through dense patches of prey at the surface (NMFS 2021h). This species feeds primarily on copepods belonging to the *Calanus* and *Pseudocalanus* genera (McKinstry et al. 2013).

As noted in Section 4.2.2.1.1, marine mammals are organized into groups based on their hearing physiology and sensitivity (NMFS 2018a). All mysticetes, including NARWs, are classified as low-frequency cetaceans. This hearing group has a generalized hearing range of 7 hertz to 35 kilohertz.

4.9.2.2.2 Status and Population Trend

The NARW was listed as endangered in 1970, as part of a pre-cursor to the ESA (USFWS 1970). The status of this species was most recently reviewed during 2012 as part of the species' 5-year status review, and its endangered status remains unchanged (NMFS 2012b). NARWs found in the immediate Project area belong to the Western North Atlantic stock. The most recent stock assessment for NARW was conducted in 2021. The best abundance estimate for the Western North Atlantic stock is 368 individuals (NMFS 2021c). The species is considered critically endangered, and the Western North Atlantic stock experienced a decline in abundance between 2011 and 2019 with an overall decline of 23.5 percent.

Threats to NARW include vessel strikes, entanglement, anthropogenic noise, and climate change. NARW has been undergoing an unusual mortality event since 2017, attributed to vessel strikes and entanglement in fisheries gear (NMFS 2021a). Vessel strike and entanglement are leading causes of death in this species (Kite-Powell et al. 2007; Knowlton et al. 2012). From 2002 to 2006, NARW was subject to the highest proportion of vessel strikes and entanglements of any species evaluated (Glass et al. 2010). As this species spends a relatively high proportion of time at the surface and is a slow swimmer, NARW are particularly vulnerable to vessel strike, and most strikes are fatal to this species (Jensen and Silber 2004). Seventy-two percent of NARWs show evidence of past entanglements (Johnson et al. 2005), and entanglement may be limiting population recovery (Knowlton et al. 2012).

4.9.2.2.3 Distribution and Habitat Use

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

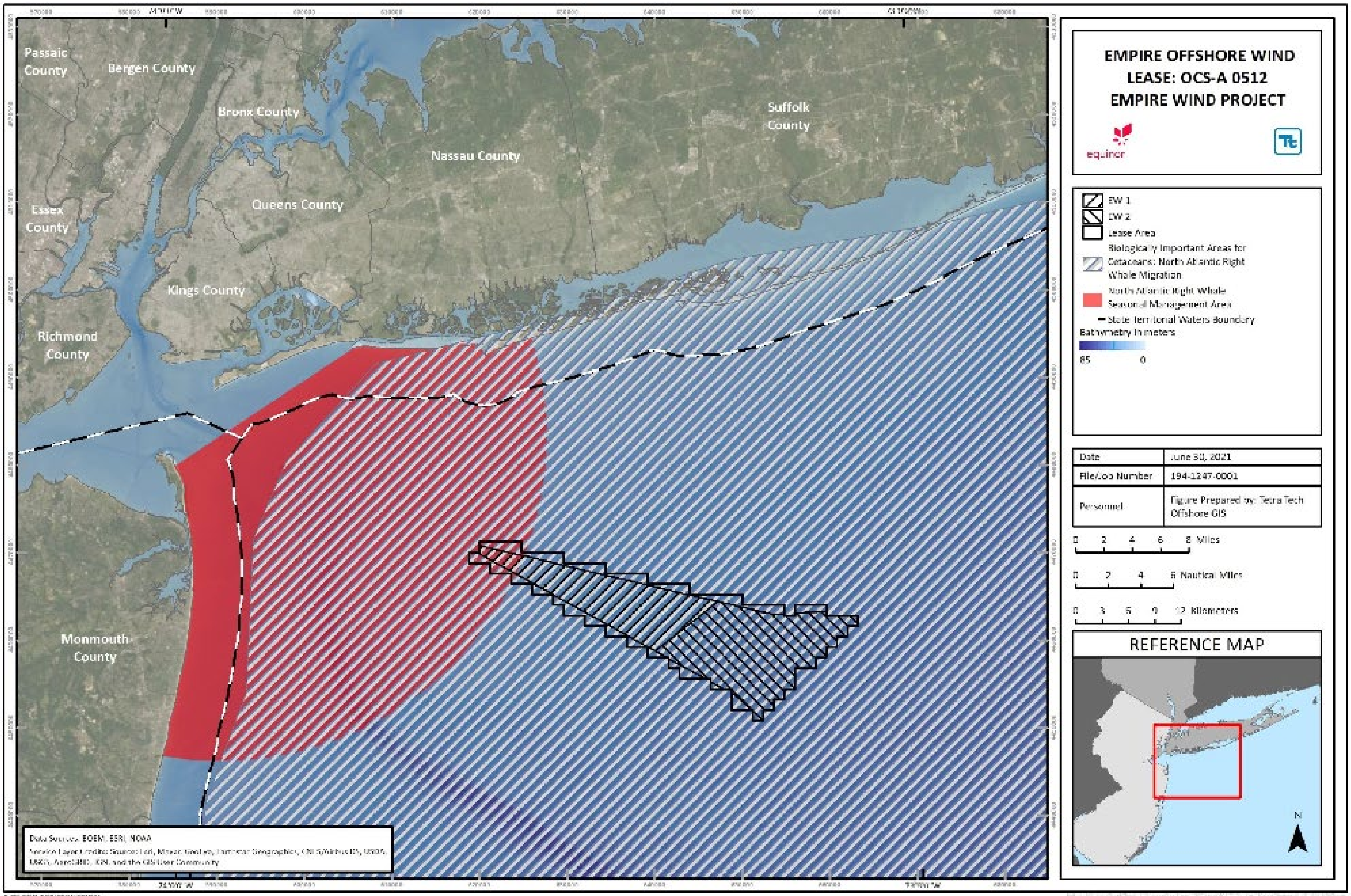

Figure 16 **Seasonal Management Area and Biologically Important Area for North Atlantic Right Whales in the Action Area**

NARW could be found in the action area throughout the year. Aerial surveys documented NARW offshore of the Lease Area in winter and spring and in waters south of the Lease Area in winter, spring, and fall (Empire 2022a). NARW has been acoustically detected in waters off of New Jersey and New York during all months of the year (Estabrook et al. 2019; Whitt et al. 2013). Species densities in the immediate Project area are expected to be highest in the spring. Seasonal density of NARW is provided on Figure 5.6-3 in Volume 2b of the COP (Empire 2022a). Mean monthly densities for this species within a 5.5-kilometer buffer around the Lease Area range from 0.002 animals per 100 km^2 in July, August, and September to 0.726 animals per 100 km^2 in April (**Table 11**).

4.9.2.3. Sperm Whale

4.9.2.3.1 Description and Life History

The sperm whale (*Physeter macrocephalus*) is the largest odontocete, reaching lengths of up to 52 feet and weighing up to 45 tons. Sperm whales are predatory specialists known for hunting prey in deep water. The species is among the deepest diving of all marine mammals. Males have been known to dive 3,936 feet (1,200 meters), whereas females dive to at least 3,280 feet (1,000 meters); both can continuously dive for more than 1 hour. Their diet includes squid, sharks, skates, and fish that occupy deep waters.

As noted in Section 4.2.2.1.1, marine mammals are organized into groups based on their hearing physiology and sensitivity (NMFS 2018a). Sperm whales are classified as mid-frequency cetaceans. This hearing group has a generalized hearing range of 150 hertz to 160 kilohertz.

4.9.2.3.2 Status and Population Trend

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

4.9.2.3.3 Distribution and Habitat Use

Sperm whale is expected to occur year-round in deeper waters near the shelf break (Tetra Tech and SES 2018; Tetra Tech and LGL 2019, 2020). This species as not been observed in the Lease Area but has been observed offshore of the Lease Area (Empire 2022a). Water depths in the Lease Area are generally too shallow for sperm whales. Species densities in the immediate Project area are expected to be low, ranging from 0.001 animals per 100 km^2 in from December through April to 0.042 animals per 100 km^2 in July (**Table 11**)

Table 11 Monthly Marine Mammal Densities Within a 5.5-Kilometer Buffer around the Lease Area (animals/100 km^2)

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Fin whale	0.099	0.095	0.115	0.189	0.236	0.258	0.232	0.172	0.163	0.189	0.105	0.084
NARW	0.479	0.548	0.645	0.726	0.122	0.007	0.002	0.002	0.002	0.005	0.031	0.230
Sperm whale	0.001	0.001	0.001	0.001	0.006	0.027	0.042	0.029	0.027	0.009	0.007	0.001

Source: COP Appendix M-2, Table 21 (Empire 2022a)

4.9.3. Sea Turtles

Four federally-listed species of sea turtle are likely to occur in the action area: green sea turtle (*Chelonia mydas*), Kemp's ridley sea turtle (*Lepidochelys kempii*), leatherback sea turtle (*Dermochelys coriacea*), and loggerhead sea turtle. Green and loggerhead sea turtles are listed as threatened, and Kemp's ridley and leatherback sea turtles are listed as endangered. As noted in Section 4.1, there is designated critical habitat for loggerhead sea turtle within the action area. Critical habitat has also been designated for green and leatherback sea turtles but lies outside the action area. Critical habitat has not been designated for Kemp's ridley sea turtles.

4.9.3.1. Green Sea Turtle

4.9.3.1.1 Description and Life History

The green sea turtle is the largest hard-shelled sea turtle, reaching a maximum weight of 350 pounds (150 kilograms) and having a carapace length of up to 3.3 feet (1 meter) (NMFS 2021e). Green sea turtles generally reach sexual maturity between the age of 25 and 35. Female green sea turtles nest every two to five years while males breed annually (NMFS 2021e). In the U.S., breeding occurs in late spring and early summer, and nesting occurs in the Southeast between June and September, peaking in June and July (USNRC 2010 citing NOAA 2010b; NMFS 2021e). During the nesting season, females come ashore to nest approximately every two weeks with clutch sizes of approximately 100 eggs (NMFS 2021e). Hatchlings emerge after approximately two months and swim to offshore, pelagic habitats. Young green sea turtles remain in these pelagic habitats for five to seven years before returning to coastal habitats as juveniles (NMFS 2021e).

During their pelagic phase, green sea turtles are omnivorous, foraging in drift communities. Once juveniles return to coastal habitats, they become benthic foragers. As benthic foragers, this species is primarily herbivorous, consuming mostly algae and seagrasses, though sponges and other invertebrates may also contribute to their diet (NMFS 2021e).

The hearing range of sea turtles is limited to low frequencies, typically below 1,600 hertz. The hearing range for green sea turtles is from 50 to 1,600 hertz, with peak sensitivity between 200 and 400 hertz (Dow Piniak et al. 2012a).

4.9.3.1.2 Status and Population Trend

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

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

4.9.3.1.3 Distribution and Habitat Use

Green sea turtles inhabit tropical and subtropical waters around the globe. In the U.S., green sea turtles occur from Texas to Maine, as well as the Caribbean (NMFS 2021e). Hatchling and early juvenile sea turtles inhabit open waters of the Atlantic Ocean. Late juveniles and adults are typically found in nearshore waters of shallow coastal habitats (NMFS 2021e). Seasonal distribution is governed by water temperatures (NMFS 2018b). As temperatures warm in the spring, sea turtles migrate into mid-Atlantic waters. This seasonal movement is reversed as water temperatures cool in the fall and sea turtles migrate to warm waters further south. In the mid-Atlantic, juvenile and adult green sea turtles regularly occur in shallow, estuarine waters to forage between May and November (NMFS 2019c).

Green sea turtles have the potential to occur in the action area year-round. This species generally occurs seasonally in the immediate Project area between June and November. Compared to other sea turtle species, green sea turtles have been sighted in the vicinity of the immediate Project area in relatively low numbers. Seasonal densities of this species were derived from NYSERDA annual reports (Normandeau and APEM 2018, 2019a, 2019b, 2019c, 2020).[2] Green sea turtles have a seasonal density of 0.038 animals per km^2 during the summer and seasonal densities of 0.000 animals per km^2 during the rest of the year (**Table 12**).

4.9.3.2. Kemp's Ridley Sea Turtle

4.9.3.2.1 Description and Life History

The Kemp's ridley sea turtle is a hard-shelled turtle and the smallest of all sea turtle species. The species reaches a maximum weight of 100 pounds (45 kilograms) and grows to 2.3 feet (0.7 meters) in length (NMFS 2020b). Kemp's ridley sea turtles reach sexual maturity at approximately 13 years of age. This species exhibits synchronized nesting behavior, coming ashore during daylight hours in large groups called arribadas. Females nest every one to three years and will lay two to three clutches over the course of the nesting season from May to July. Average clutch size is 100 eggs (NMFS 2020b). Hatchlings emerge after 1.5 to 2 months and enter the ocean, traveling to deep, offshore habitats where they will drift in *Sargassum* for one to two years. After completing their oceanic phase, juvenile Kemp's ridley sea turtles move to nearshore waters to mature (NMFS 2020b).

In their oceanic phase, early life stage Kemp's ridley sea turtles are omnivorous, foraging on floating plants and animals near the surface. Once they recruit to nearshore waters, juveniles and adults consume primarily crabs; mollusks, shrimp, fish, and vegetation also contribute to their diet (Ernst et al. 1994; NMFS 2020b). This species is also known to scavenge on dead fish and discarded bycatch (NMFS 2020b).

The hearing range of sea turtles is limited to low frequencies, typically below 1,600 hertz. The Kemp's ridley hearing range extends from 100 to 500 hertz, with peak sensitivity between 100 and 200 hertz (Bartol and Ketten 2006).

[2] See COP Appendix M-2, Section 3.4 for additional information on the derivation of sea turtle densities.

4.9.3.2.2 Status and Population Trend

The Kemp's ridley sea turtle is one of the least abundant sea turtle species in the world. This species was listed as endangered in 1970, as part of a pre-cursor to the ESA (USFWS 1970). The status of this species was most recently assessed for its 5-year status review completed in 2015,[3] and its endangered status remained unchanged (NMFS and USFWS 2015b). In 2012, the population of individuals age-two and up was estimated at 248,307 turtles (NMFS and USFWS 2015b citing Gallaway et al. 2013). Based on hatchling releases in 2011 and 2012, Galloway et al. (2013, as cited in NMFS and USFWS 2015b) postulated that the total population size, including turtles younger than two years of age, could exceed 1,000,000. However, the number of nests recorded in 2012 was the highest of any year in the monitoring period, and the number of nests declined by almost 50% between 2012 and 2014. Therefore, the current population may be significantly lower than the population estimate from 2012 (NMFS and USFWS 2015b). The status review also included an updated age-based model to evaluate trends in the Kemp's ridley population. Results of the model indicated that the population is not recovering and suggested there is a persistent reduction in survival and/or recruitment to the nesting population (NMFS and USFWS 2015b citing Heppell 2005).

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

4.9.3.2.3 Distribution and Habitat Use

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

Kemp's ridley sea turtles could occur in the action area year-round. They are mainly in the immediate Project area during the summer and fall. Annual density of Kemp's ridley sea turtles is provided on Figure 5.7-4 in Volume 2b of the COP (Empire 2022a). Seasonal densities of this species were derived from NYSERDA annual reports (Normandeau and APEM 2018, 2019a, 2019b, 2019c, 2020).[4] Kemp's ridley sea turtles are most abundant in the immediate Project area during summer (0.991 animals per km^2) and less abundant during other seasons (**Table 12**).

[3] Another 5-year status review was initiated in June 2021, but this review has not been completed.
[4] See COP Appendix M-2, Section 3.4 for additional information on the derivation of sea turtle densities.

4.9.3.3. Leatherback Sea Turtle

4.9.3.3.1 Description and Life History

The leatherback sea turtle is the largest sea turtle species and the only one lacking a hard shell. They can grow to 5.5 feet (1.7 meters) in length and weigh up to 2,200 pounds (998 kilograms) (NMFS 2021f). This species reaches sexual maturity between 9 and 29 years of age. The inter-nesting period for leatherback sea turtles is two to three years. In the United States, the nesting season extends from March to July. In a single nesting season, females will lay an average of five to seven clutches of eggs with an average clutch size of 100 eggs (NMFS and USFWS 2020a citing Eckert et al. 2015; NMFS 2021f). Hatchlings emerge from the nest after approximately two months and disperse into offshore habitats (NMFS and USFWS 2020a). Unlike other sea turtle species, juvenile leatherback sea turtles do not undergo an ontogenetic shift in distribution to shallower habitats and continue to use mid-ocean and continental shelf habitats (NMFS and USFWS 2020a), though older life stages may occur in nearshore waters (NMFS and USFWS 1992).

Leatherback sea turtles often forage in upwelling areas (NMFS and USFWS 2020a citing Saba 2013), though they are known to utilize a variety of habitats for feeding (NMFS and USFWS 2020a citing Robinson and Paladino 2015). Unlike other sea turtle species, leatherbacks have tooth-like cups and sharp jaws, along with backward-pointing spines in their mouth and throat, all adaptations for their unique diet. This species consumes gelatinous prey almost exclusively from the post-hatchling to adult life stage (NMFS 2021f; NMFS and USFWS 2020a citing Salmon et al. 2004).

The hearing range of sea turtles is limited to low frequencies, typically below 1,600 hertz. The leatherback sea turtle's hearing range extends from approximately 50 to 1,200 hertz, with peak sensitivity between 100 and 400 hertz (Dow Piniak et al. 2012b).

4.9.3.3.2 Status and Population Trend

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

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

4.9.3.3.3 Distribution and Habitat Use

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

Leatherback sea turtles could occur in the action area throughout the year. Annual density of leatherback sea turtles is provided on Figure 5.7-6 in Volume 2b of the COP (Empire 2022a). Seasonal densities of this species were derived from NYSERDA annual reports (Normandeau and APEM 2018, 2019a, 2019b, 2019c, 2020)[5] and are provided in **Table 12**. Leatherback sea turtles are most abundant in the immediate Project area during summer (0.331 animals per km^2) and fall (0.789 animals per km^2).

4.9.3.4. Loggerhead Sea Turtle

4.9.3.4.1 Description and Life History

The loggerhead sea turtle is a large, hard-shelled sea turtle that can reach 3 feet (1 meter) in carapace length and weigh up to 250 pounds (113 kilograms) (NMFS 2021g). Adults reach sexual maturity at approximately 35 years of age. This species nests every 2 to 3 years on ocean beaches. Nesting occurs in the southeastern United States between April and September, peaking in June and July (Hopkins and Richardson 1984; Dodd 1988). During the nesting season, females will lay two to three clutches of eggs, with each clutch containing 35 to 180 eggs. After approximately 1.5 to 2 months, hatchlings emerge from the nests (Hopkins and Richardson 1984). Hatchlings travel offshore and remain in the open ocean until they return to coastal and continental shelf waters as juveniles. Loggerheads continue to use the same coastal and oceanic waters through adulthood.

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

The hearing range of sea turtles is limited to low frequencies, typically below 1,600 hertz. The loggerhead sea turtle's hearing range extends from approximately 50 to 100 hertz up to 800 to 1,120 hertz (Martin et al. 2012).

4.9.3.4.2 Status and Population Trend

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

[5] See COP Appendix M-2, Section 3.4 for additional information on the derivation of sea turtle densities.

these recovery units have not met their recovery criteria for annual increases in nest abundance (Bolten et al. 2019).

All sea turtle species in the action area, including loggerhead sea turtles, are subject to regional, pre-existing threats, including habitat loss or degradation, fisheries bycatch and entanglement in fishing gear, vessel strikes, predation and harvest, disease, and climate change. Coastal development, artificial lighting, and erosion control structures negatively affect nesting habitat and pose a significant threat to the persistence of the Northwest Atlantic DPS of loggerhead sea turtles (NMFS and USFWS 2010). Fisheries bycatch, particularly in gillnet, trawl, and longline fisheries, is also a significant threat to this DPS. Vessel strikes have become more common for loggerhead sea turtles. Stranded sea turtles with vessel strike injuries increased from approximately 10 percent in the 1980s to a high of 20.5 percent in 2004 (NMFS and USFWS 2010). Though this species is vulnerable to fibropapillomatosis, prevalence is low in loggerheads. Loggerhead sea turtles are also vulnerable to cold stunning, but cold stunning is not a major source of mortality for this species (NMFS and USFWS 2010).

4.9.3.4.3 Distribution and Habitat Use

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

Loggerhead sea turtles are the most abundant sea turtle species in the action area and have the potential to occur there year-round. Annual density of loggerhead sea turtles is provided on Figure 5.7-2 in Volume 2b of the COP (Empire 2022a). Seasonal densities of this species were derived from NYSERDA annual reports (Normandeau and APEM 2018, 2019a, 2019b, 2019c, 2020)[6] and are provided in **Table 12**. Loggerhead sea turtles are most abundant in the immediate Project area during the summer (26.799 animals per km^2), but only occur in very low abundance the rest of the year.

Table 12 Seasonal Sea Turtle Densities in the Immediate Project Area (animals/100 km^2)

Species	Spring	Summer	Fall	Winter
Green sea turtle	0.000	0.038	0.000	0.000
Kemp's ridley sea turtle	0.050	0.991	0.190	0.000
Leatherback sea turtle	0.000	0.331	0.789	0.000
Loggerhead sea turtle	0.254	26.799	0.190	0.025

Source: COP Appendix M-2, Table 23 (Empire 2022a)

4.9.4. Fish

One ESA-listed fish species, Atlantic sturgeon, is likely to occur in the action area. Critical habitat has been designated for this species but lies outside the action area.

[6] See COP Appendix M-2, Section 3.4 for additional information on the derivation of sea turtle densities.

4.9.4.1. Atlantic Sturgeon

4.9.4.1.1 Description and Life History

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

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

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

The sturgeon family (Acipenseridae) have a well-developed inner ear that lacks a connection to the swim bladder, indicating that the swim bladder is not involved in hearing. The hearing capabilities of Atlantic sturgeon are unknown. However, inferences may be drawn from hearing studies in other sturgeon species, including the closely-related lake sturgeon (*Acipenser fulvescens*). These studies indicate a generalized hearing range from 50 to approximately 700 Hz, with the greatest sensitivity between 100 and 300 Hz (Lovell et al. 2005; Meyer et al. 2010). Studies measuring the physiological responses of the ear of European sturgeon (*A. sturio*) suggest sturgeon may be capable of detecting sounds ranging in frequency from below 300 Hz to about 1 kHz (Popper 2005).

4.9.4.1.2 Status and Population Trend

Atlantic sturgeon in the United States are divided into five DPSs: Gulf of Maine, New York Bight, Chesapeake Bay, Carolina, and South Atlantic. In 2012, the New York Bight, Chesapeake Bay, Carolina, and South Atlantic DPSs were listed as endangered, and the Gulf of Maine DPS was listed as threatened (NMFS 2012a, 2012c). Based on genetic analysis of Atlantic sturgeon collected in the vicinity of the New York WEA, sturgeon from the Gulf of Maine, New York Bight, Chesapeake Bay, and South Atlantic DPSs could occur in the immediate Project area. Individuals from the Carolina DPS could also occur in the portion of the action area associated with vessel transits to and from the cable facility in South Carolina and the port of Corpus Christi.

4.9.4.1.2.1 Gulf of Maine DPS

The Gulf of Maine DPS encompasses all Atlantic sturgeon spawned in watersheds from the Maine/Canada border south to Chatham, MA. For its 2020 Biological Opinion (BiOp) on the utilization of New York Offshore Borrow Areas, NMFS (2020a) estimated oceanic abundance for the Gulf of Maine DPS at 7,455 fish, based on data from NEAMAP. This DPS has not shown any significant trend in abundance since 2000 and is currently depleted relative to historic levels (ASMFC 2017). Fisheries bycatch and habitat disturbance associated with dredging and other in-water activities are the primary threats for the Gulf of Maine DPS. This DPS may also be affected by degraded water quality (NMFS 2020a).

4.9.4.1.2.2 New York Bight DPS

The New York Bight DPS encompasses all Atlantic sturgeon spawned in watersheds from Chatham, MA south to the Delaware-Maryland border on Fenwick Island. For its 2020 BiOp on the utilization of New York Offshore Borrow Areas, NMFS (2020a) estimated oceanic abundance for the New York Bight DPS at 34,566 fish, based on NEAMAP data. Though this DPS has displayed an increasing trend in abundance since 1998, it is currently depleted relative to historic levels (ASMFC 2017). Degraded water quality, habitat disturbance, fisheries bycatch, and vessel strikes are significant threats for the New York Bight DPS (NMFS 2020a).

4.9.4.1.2.3 Chesapeake DPS

The Chesapeake DPS is composed of all Atlantic sturgeon spawned in Chesapeake Bay watersheds as well as coastal watersheds from Fenwick Island at the Delaware-Maryland border to Cape Henry, VA. Using NEAMAP data, NMFS (2020a) estimated the oceanic population abundance of the Chesapeake DPS at 8,811 fish for its BiOp for New York Offshore Borrow Areas. This DPS has not shown any significant trend in abundance since 1998 and is depleted relative to historic levels (ASMFC 2017). Similar to the New York Bight DPS, impaired water quality, habitat disturbance, bycatch, and vessel strikes pose threats to the Chesapeake DPS (NMFS 2020a).

4.9.4.1.2.4 Carolina DPS

The Carolina DPS encompasses all Atlantic sturgeon spawned in watersheds from Albemarle Sound south to Charleston Harbor. For its 2020 BiOp on the utilization of New York Offshore Borrow Areas, NMFS (2020a) estimated oceanic abundance for the Carolina DPS at 1,353 fish, based on NEAMAP data. Though some indices for this DPS have displayed an increasing trend in abundance, the Carolina DPS is currently depleted relative to historic levels (ASMFC 2017). Habitat disturbance or inaccessibility and fisheries bycatch are significant threats for this DPS (NMFS 2020a).

4.9.4.1.2.5 South Atlantic DPS

The South Atlantic DPS is made up of Atlantic sturgeon spawned from the Ashepoo, Combahee, and Edisto Rivers basin in South Carolina south to the St. Johns River, FL. As part of its BiOp for New York Offshore Borrow Areas, NMFS (2020a) estimated that the oceanic population abundance for the South Atlantic DPS is 14,911, based on NEAMAP data. This population is considered depleted relative to historic levels and has been stable since 2004 (ASMFC 2017). Main threats to this species include bycatch, habitat disturbance, degraded water quality, and water allocation issues (NMFS 2020a).

4.9.4.1.3 Distribution and Habitat Use

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

Juvenile, subadult, and adult Atlantic sturgeon are expected to occur seasonally in the immediate Project area. Passive acoustic monitoring data indicate that this species occurs throughout the Lease Area with peak abundance occurring from November through January (Empire 2022a). Atlantic sturgeon were virtually absent from the Lease Area from July through September (Ingram et al. 2019). Generally, this species is expected to migrate in spring from marine habitats to inshore coastal waters and return to marine habitats in the fall.

4.10. Climate Change Considerations

Climate change is an ongoing and developing phenomenon that has been shown to affect marine ecosystems. Warming sea temperature is a key feature of global climate change caused by atmospheric greenhouse effects from global greenhouse gas emissions including carbon dioxide (CO_2). Warming water temperatures, in combination with sea level rise, could affect ESA-listed species in the action area. Warming and sea level rise could affect these species through increased storm frequency and severity, altered habitat/ecology, changes in prey distribution, altered migration patterns, increased disease incidence, increased erosion and sediment deposition, and development of protective measures (e.g., seawalls and barriers). Increased storm severity or frequency may result in increased energetic costs for marine mammals, particularly for young life stages, reducing individual fitness. Altered habitat/ecology associated with warming has resulting in northward distribution shifts for some prey species (Hayes et al. 2021); marine mammals are altering their behavior and distribution in response to these alterations (Davis et al. 2017, 2020; Hayes et al. 2020, 2021). Warming is also expected to influence the frequency of marine mammal diseases. Warming and sea level rise could lead to changes sea turtle distribution, habitat use, migratory patterns, nesting periods, nestling sex ratios, nesting habitat quality or availability, prey distribution or abundance, and availability of foraging habitat (Fuentes and Abbs 2010; Janzen 1994; Newson et al. 2009; Witt et al. 2010). Northward shifts in fish communities, including demersal finfish and shellfish, have been documented to occur concurrently with rises in sea surface temperature (Gaichas et al. 2015; Hare et al. 2016; Lucey and Nye 2010).

Ocean acidification is another major problem caused by the release of anthropogenic CO_2 into the atmosphere (Doney et al. 2020). The ocean serves as a major sink for anthropogenic CO_2 (Doney et al. 2020). Once deposited in seawater, CO_2 lowers pH levels, increasing its acidity. Ocean acidification may have negative impacts on zooplankton and benthic organisms, especially the many species that have calcareous shells or exoskeletons (e.g., shellfish, copepods) by reducing the growth of these species (PMEL 2020). Ocean acidification may affect ESA-listed marine mammal, sea turtle, and fish species through negative effects on their prey.

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

5. Effects of the Proposed Action

The effects of the Proposed Action are analyzed in this section based on the PDE described in Section 3. Effects of the Proposed Action include all consequences to ESA-listed species or designated critical habitat caused by the Proposed Action across all phases of the Project, including pre-construction, construction, O&M, and decommissioning. This includes consequences of other activities that would not occur but for the Proposed Action that are reasonably certain to occur. Effects are considered relative to the likelihood of species' exposure to each effect and the biological significance of that exposure. Biological significance is evaluated based on the extent and duration of exposure relative to established effects thresholds or relative to baseline conditions described in Section 4. Effects evaluated for the Proposed Action, including impacts from noise (Sections 5.1 and 5.2), vessel traffic (Section 5.3), habitat disturbance and modification (Section 5.4), air emissions (Section 5.5), port modifications (Section 5.6), repair and maintenance activities (Section 5.7), and other or unexpected/unanticipated impacts (Sections 5.8 and 5.9). Each of these impacts is evaluated separately for ESA-listed marine mammals, sea turtles, and fish.

5.1. Underwater Noise

High levels of underwater noise have the potential to result in take of ESA-listed species in the action area. The Proposed Action would generate temporary noise during the construction phase and long-term noise during the O&M phase. Underwater noise sources associated with the Proposed Action would include impact pile driving (Section 5.1.1), vibratory pile driving (Section 5.1.2), geotechnical and geophysical surveys (Section 5.1.3), and cable laying (Section 5.1.4). Following the assessment of these noise sources, a summary of overall underwater noise effects to ESA-listed species is provided (Section 5.1.5).

5.1.1. Impact Pile Driving

Impact pile driving would occur during construction to install WTG and OSS foundations (Section 3.1.2.2.2). Impact pile driving generates intense, impulsive underwater noise that may result in physiological or behavioral effects in aquatic species. The severity of the effect is dependent on the received sound level (i.e., the sound level to which the organism is exposed), which is a function of the sound level generated by the noise source, the distance between the source and the organism, and the duration of sound exposure.

Underwater sound propagation modeling for impact pile driving was conducted in support of the COP (COP Appendix M-2; Empire 2022a) and is summarized in Appendix J of the EIS. Hydroacoustic modeling was done for 31.5- and 36.1-foot (9.6- and 11-meter) diameter monopiles for WTG foundations, assuming penetration depths of 125 and 180 feet (38 and 55 meters), respectively. As up to 17 potential locations for 31.5-foot (9.6-meter) monopiles may be more difficult to install, modeling for that monopile size included both a typical (maximum hammer energy of 2,300 kJ) and difficult-to-drive (maximum hammer energy of 5,225 kJ) scenario. Modeling for the 36.1-foot (11-meter) monopile only included a typical scenario (maximum hammer energy of 2,500 kJ). Modeling was also performed for 8.2-foot (2.5-meter) pin piles for OSS foundations. Four potential construction schedules were modeled to capture the range of possible installation scenarios: one monopile or two pin piles per day; one monopile or three pin piles per day; two monopiles or two pin piles per day; and two monopiles or three pin piles per day.

5.1.1.1. Marine Mammals

Cetaceans (i.e., mysticetes and odontocetes) rely heavily on sound for essential biological functions, including communication, mating, foraging, predator avoidance, and navigation (Madsen et al. 2006;

Weilgart 2007). Anthropogenic underwater noise may have adverse impacts on marine mammals if the sound frequencies produced by the noise sources overlap with marine mammals' hearing ranges (NSF and USGS 2011). If such overlap occurs, underwater noise can result in behavioral and/or physiological effects, potentially interfering with essential biological functions (Southall et al. 2007).

The intense, impulsive noise (i.e., noise with rapid changes in sound pressure) associated with impact pile driving can cause behavioral and physiological effects in marine mammals. Potential behavioral effects of pile-driving noise include avoidance and displacement (Dähne et al. 2013; Lindeboom et al. 2011; Russell et al. 2016; Scheidat et al. 2011). Potential physiological effects include temporary threshold shift (TTS) or permanent threshold shift (PTS) in an animal's hearing ability. Literature indicates that marine mammals would avoid disturbing levels of noise. However, individual responses to pile-driving noise are unpredictable and likely context specific. Behavioral effects and most physiological effects (e.g., stress responses and TTS) are expected to be short term and localized to the ensonified area, although some sounds may be detected by marine mammals at a distance greater than 100 km. Given that pile driving would occur on the OCS, marine mammals would be able to escape from disturbing levels of noise. Any disruptions to foraging or other normal behaviors would be short term, and increased energy expenditures associated with this displacement are expected to be small. PTS could permanently limit an individual's ability to locate prey, detect predators, navigate, or find mates and could therefore have long-term effects on individual fitness.

To estimate acoustic ranges to PTS thresholds (i.e., injury isopleths) for impact pile driving, NMFS (2018a) hearing-group-specific, dual-metric thresholds for impulsive noise were used (**Table 13**). ESA-listed marine mammals evaluated in this Biological Assessment (i.e., fin whales and NARWs) belong to the low-frequency cetacean (LFC) group (fin whales and NARWs) or mid-frequency cetacean (MFC) group (sperm whales). For 31.5-foot (9.6-meter) monopiles in summer months, LFC that remain within 3.0 miles (4.78 kilometers) of pile driving throughout a single pile-driving event could experience PTS without noise mitigation under the typical scenario (**Table 14**). Assuming 10 decibels of noise attenuation due to noise mitigation technology, which is the typical level of attenuation generally achievable by a single noise attenuation system (Bellman et al. 2020), LFC that remain within 1.4 miles (2.20 kilometers) of pile driving throughout a single pile-driving event could experience PTS. Under the difficult-to-drive scenario, LFC that remain within 3.9 miles (6.31 kilometers) of pile driving throughout a single pile-driving event could experience PTS without noise mitigation. Assuming 10 decibels of noise attenuation, LFC that remain within 2.1 miles (3.44 kilometers) of pile driving throughout a single pile-driving event could experience PTS. MFC are not expected to experience PTS due to impact pile driving of 31.5-foot (9.6-meter) monopiles under either scenario, with or without noise mitigation

For 36.1-foot (11-meter) monopiles in summer months, LFC that remain within 2.7 miles (4.42 kilometers) of pile driving throughout a single pile-driving event could experience PTS without noise mitigation (**Table 15**). Assuming 10 decibels of noise attenuation due to noise mitigation technology, LFC that remain within 1.2 miles (1.96 kilometers) of pile driving throughout a single pile-driving event could experience PTS. MFC are not expected to experience PTS due to impact pile driving of 36.1-foot (11-meter) monopiles, with or without noise mitigation.

For 8.2-foot (2.5-meter) pin piles in summer months, LFC that remain within 1.9 miles (3.06 kilometers) of pile driving throughout a day with two pin piles driven could experience PTS without noise mitigation (**Table 16**). Assuming 10 decibels of noise attenuation due to noise mitigation technology, LFC that remain within 1.2 miles (1.96 kilometers) of pile driving throughout a single pile-driving event could experience PTS. MFC are not expected to experience PTS due to impact pile driving of pin piles, with or without noise mitigation.

To estimate acoustic ranges to behavioral thresholds (i.e., behavioral isopleths), NMFS' impulsive noise thresholds were used (**Table 13**). Under the typical scenario, marine mammals, including LFC and MFC, within 4.1 miles (6.62 kilometers) of active pile driving of 31.5-foot (9.6-meter) monopiles using maximum hammer energy could experience behavioral effects without noise mitigation (**Table 14**). Assuming 10 decibels of noise mitigation, marine mammals within 2.2 miles (3.51 kilometers) of active pile driving could experience behavioral effects. Under the difficult-to-drive scenario, marine mammals within 5.1 miles (8.23 kilometers) of active pile driving using maximum hammer energy could experience behavioral effects without noise mitigation. Assuming 10 decibels of noise mitigation, marine mammals within 3.1 miles (5.05 kilometers) of active pile driving could experience behavioral effects.

For 36.1-foot (11-meter) monopiles, marine mammals, including LFC and MFC, within 4.1 miles (6.59 kilometers) of active pile driving using maximum hammer energy could experience behavioral effects without noise mitigation (**Table 15**). Assuming 10 decibels of noise mitigation, marine mammals within 2.3 miles (3.64 kilometers) of active pile driving could experience behavioral effects.

For 8.2-foot (2.5-meter) pin piles, marine mammals, including LFC and MFC, within 1.7 miles (2.66 kilometers) of active pile driving using maximum hammer energy could experience behavioral effects without noise mitigation (**Table 16**). Assuming 10 decibels of noise mitigation, marine mammals within 0.6 miles (0.89 kilometers) of active pile driving could experience behavioral effects.

Given the large acoustic ranges to PTS and behavioral thresholds, noise impacts associated with pile driving for the Proposed Action could occur. The numbers of individual marine mammals predicted to receive sound levels above threshold criteria were determined using animal movement modeling, as described in Appendix J of the EIS, and acoustic ranges for the 31.5-foot (9.6-meter) monopile, as this pile size resulted in the greater ranges than the 36.1-foot (11-meter) monopiles.[7] As the construction schedule with one monopile or two pin piles driven per day had a longer duration in terms of total days, this schedule resulted in the greatest modeled exposures by Level B harassment[8] and was determined to be the maximum-case construction schedule. Under the maximum-case construction schedule; up to 12 fin whales and 6 NARWs may experience sound levels above injury thresholds without noise mitigation (**Table 17**). Assuming 10 decibels of noise attenuation, up to 3 fin whales may experience sound levels above injury thresholds. An estimated 56 fin whales, 213 NARWs, and 8 sperm whales may experience sound levels above behavioral thresholds without noise mitigation. With 10 decibels of noise attenuation, an estimated 18 fin whales, 16 NARWs, and 3 sperm whales may experience sound levels above behavioral thresholds.

Table 13 Marine Mammal Acoustic Thresholds for Impulsive Noise Sources

Hearing Group	*PTS Onset* L_{pk}[1]	*PTS Onset* $L_{E,\,24h}$[2]	Behavior L_p[1]
Low-Frequency Cetaceans	219 dB	183 dB	160 dB
Mid-Frequency Cetaceans	230 dB	185 dB	160 dB

[1] In decibels (dB) referenced to 1 micropascal
[2] In decibels referenced to 1 micropascal squared second
Sources: GARFO 2020; NMFS 2018a

[7] Though larger diameter monopiles typically result in larger acoustic ranges, the relationship between diameter and rate of sound level increase is likely to decrease with increasing diameter (Bellman et al. 2020). The larger ranges modeled for the smaller of the two monopiles are likely due to the fact that the larger monopiles would be installed only in softer sediments, requiring less hammer energy or number of strikes.
[8] Modeled exposures to sound levels exceeding injury thresholds were similar across all modeled construction schedules and were not used to identify the maximum-case construction schedule.

Table 14 Maximum Acoustic Ranges (km) to Injury (PTS) and Behavioral Disturbance Thresholds for Marine Mammals for Impact Pile Driving of 9.6-meter WTG Monopiles under Summer Conditions with 0 and 10 dB of Noise Attenuation

Functional Hearing Group	PTS L_{pk} (0 dB)	PTS $L_{E,\ 24h}$ (0 dB)	Behavior L_p (0 dB)	PTS L_{pk} (10 dB)	PTS $L_{E,\ 24h}$ (10 dB)	Behavior L_p (10 dB)
LFC – Typ.	0.02	4.78	6.62	0.00	2.20	3.51
LFC – Dif.	0.07	6.31	8.23	0.00	3.44	5.05
MFC – Typ.	0.00	0.00	6.62	0.00	0.00	3.51
MFC – Dif.	0.00	0.00	8.23	0.00	0.00	5.05

dB = decibel; Dif. = difficult-to-drive scenario; km = kilometer; LFC = low-frequency cetacean; MFC = mid-frequency cetacean; Typ. = typical scenario
Source: Summarized from Appendix H, *Acoustic Ranges*, to COP Appendix M-2 (Empire Wind 2022a)

Table 15 Maximum Acoustic Ranges (km) to Injury (PTS) and Behavioral Disturbance Thresholds for Marine Mammals for Impact Pile Driving of 11-meter WTG Monopiles under Summer Conditions with 0 and 10 dB of Noise Attenuation

Functional Hearing Group	PTS L_{pk} (0 dB)	PTS $L_{E,\ 24h}$ (0 dB)	Behavior L_p (0 dB)	PTS L_{pk} (10 dB)	PTS $L_{E,\ 24h}$ (10 dB)	Behavior L_p (10 dB)
LFC	0.02	4.42	6.59	0.00	1.96	3.64
MFC	0.00	0.00	6.59	0.00	0.00	3.64

dB = decibel; km = kilometer; LFC = low-frequency cetacean; MFC = mid-frequency cetacean
Source: Summarized from Appendix H, *Acoustic Ranges*, to COP Appendix M-2 (Empire Wind 2022a)

Table 16 Maximum Acoustic Ranges (km) to Injury (PTS) and Behavioral Disturbance Thresholds for Marine Mammals for Impact Pile Driving of 2.5-meter OSS Pin Piles under Summer Conditions with 0 and 10 dB of Noise Attenuation

Functional Hearing Group	PTS L_{pk} (0 dB)	PTS[1] $L_{E,\ 24h}$ (0 dB)	Behavior L_p (0 dB)	PTS L_{pk} (10 dB)	PTS[1] $L_{E,\ 24h}$ (10 dB)	Behavior L_p (10 dB)
LFC	0.00	3.06	2.66	0.00	1.01	0.89
MFC	0.00	0.00	2.66	0.00	0.00	0.89

dB = decibel; km = kilometer; LFC = low-frequency cetacean; MFC = mid-frequency cetacean
[1]Assumes two pin piles driven per day
Source: Summarized from Appendix H, *Acoustic Ranges*, to COP Appendix M-2 (Empire Wind 2022a)

Table 17 Maximum Exposure Estimates for Injury and Behavioral Disturbance Thresholds for Marine Mammals for Impact Pile Driving with 0 and 10 dB of Noise Attenuation

Species	Injury (0 dB)	Behavior (0 dB)	Injury (10 dB)	Behavior (10 dB)
Fin whale	12	56	3	18
NARW	5	43	0	16
Sperm whale	0	8	0	3

dB = decibel
Source: Summarized from Appendix I, *Animal Movement and Exposure Modeling*, to COP Appendix M-2 (Empire Wind 2022a)

Empire has proposed measures to avoid, minimize, and mitigate impacts of pile-driving noise on marine mammals, including utilization of protected species observers to monitor and enforce appropriate monitoring and exclusion zones (APM 108, APM 109, APM 110, APM 111), soft-start procedures (APM 107), noise-reduction technologies (APM 112), and seasonal pile-driving restrictions (APM 106) with no pile driving occurring between January and April. Based on the anticipated construction schedules provided in the Vineyard Wind Final EIS (BOEM 2021c), concurrent pile driving at other offshore wind lease areas in New York and New Jersey is not anticipated during construction of the Proposed Action.

As noted in **Table 17**, takes due to auditory injury are anticipated for fin whale, and takes due to behavioral disturbance are anticipated for fin whale, NARW, and sperm whale, with mitigation measures in place. Given the anticipated take, the effects of underwater noise associated with impact pile driving for the Project leading to injury or behavioral disturbance is *likely to adversely affect* fin whale, NARW, and sperm whale.

5.1.1.2. Sea Turtles

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

To estimate acoustic ranges to injury and behavioral thresholds (i.e., isopleths) for impact pile driving, peak SPLs and frequency-weighted accumulated SELs for the onset of PTS in sea turtles from Finneran et al. (2017) and behavioral response thresholds from McCauley et al. (2000) were used (**Table 18**). For 31.5-foot (9.6-meter) monopiles under typical driving conditions in summer months, impact pile driving sound levels could exceed recommended sea turtle injury thresholds within up to 1.1 miles (1.71 kilometers), without sound mitigation. Assuming 10 decibels of noise attenuation due to noise mitigation technology, which is the level of attenuation generally achievable by a single noise attenuation system (Bellman et al. 2020), the distance to the recommended sea turtle injury thresholds could be reduced to 1,148 feet (350 meters) of pile driving (**Table 19**). Without mitigation, sound levels could exceed recommended sea turtle behavioral thresholds within up to 1.4 miles (2.31 kilometers) of pile driving. Assuming the use of 10 decibels of noise attenuation due to noise-mitigation technology, the distance to recommended sea turtle behavioral thresholds could be reduced to 2,526 feet (770 meters) from the source of pile driving. Under the difficult-to-drive scenario, impact pile driving sound levels could exceed recommended sea turtle injury thresholds within up to 1.8 miles (2.84 kilometers), without sound mitigation. Assuming 10 decibels of noise attenuation, the distance to the recommended sea turtle injury thresholds could be reduced to 2,559 feet (780 meters) of pile driving (**Table 19**). Without mitigation, sound levels could exceed recommended sea turtle behavioral thresholds within up to 2.3 miles (3.73 kilometers) of pile driving. Assuming the use of 10 decibels of noise attenuation due to noise-mitigation technology, the distance to recommended sea turtle behavioral thresholds could be reduced to 1.0 miles (1.59 kilometers) from the source of pile driving.

For 36.1-foot (11-meter) monopiles, impact pile driving sound levels in summer months could exceed recommended sea turtle injury thresholds within up to 1.0 miles (1.58 kilometers), without sound mitigation. Assuming 10 decibels of noise attenuation, the distance to the recommended sea turtle injury thresholds could be reduced to 984 feet (300 meters) of pile driving (**Table 20**). Without mitigation, sound levels could exceed recommended sea turtle behavioral thresholds within up to 1.5 miles (2.45 kilometers) of pile driving. Assuming the use of 10 decibels of noise attenuation due to noise-mitigation technology, the distance to recommended sea turtle behavioral thresholds could be reduced to 2,756 feet (840 meters) from the source of pile driving.

For 8.2-foot (2.5-meter) pin piles, impact pile driving sound levels in summer months could exceed recommended sea turtle injury thresholds within up to 0.3 miles (0.54 kilometers), without sound mitigation. Assuming 10 decibels of noise attenuation, the distance to the recommended sea turtle injury thresholds could be reduced to 427 feet (130 meters) of pile driving (**Table 21**). Without mitigation, sound levels could exceed recommended sea turtle behavioral thresholds within up to 0.3 miles (0.42 kilometers) of pile driving. Assuming the use of 10 decibels of noise attenuation due to noise-mitigation technology, the distance to recommended sea turtle behavioral thresholds could be reduced to 394 feet (120 meters) from the source of pile driving.

The numbers of individual sea turtles predicted to receive sound levels above threshold criteria were determined using animal movement modeling, as described in Appendix J of the EIS. Without noise mitigation, up to 5 Kemp's ridley sea turtles, 3 leatherback sea turtles, and 12 loggerhead sea turtles may be exposed to sound levels exceeding recommended injury thresholds (**Table 22**). Up to 1 green sea turtle, 33 Kemp's ridley sea turtles, 18 leatherback sea turtles, and 538 loggerhead sea turtles could be exposed to sound levels exceeding recommended behavioral thresholds. Assuming 10 decibels of noise attenuation, no sea turtles are expected to be exposed to sound levels exceeding recommended injury thresholds. Up to 8 Kemp's ridley sea turtles, 1 leatherback sea turtle, and 96 loggerhead sea turtles could be exposed to sound levels exceeding recommended behavioral thresholds.

Table 18 Acoustic Metrics and Thresholds for Fish and Sea Turtles

Faunal Group	Injury PTS L_{pk}[1]	Injury PTS $L_{E,\ 24hr}$[2,3]	Impairment TTS L_{pk}[1]	Impairment TTS $L_{E,\ 24hr}$[2,3]	Behavior L_p[1]
Fish equal to or greater than 2 grams	206	187	--	--	150
Fish with swim bladder not involved in hearing	207	203	--	--	--
Sea turtles	232	204	226	189	175

[1] Measured in decibels referenced to 1 micropascal
[2] Measured in decibels referenced to 1 micropascal squared second
[3] Threshold is frequency-weighted for sea turtles but not fish
Sources: Andersson et al. 2007; Finneran et al. 2017; Fisheries Hydroacoustic Working Group 2008; McCauley et al. 2000; Mueler-Blenkle et al. 2010; Popper et al. 2014; Purser and Radford 2011; Stadler and Woodbury 2009; Wysocki et al. 2007

Table 19 Maximum Acoustic Ranges (km) to Injury and Behavioral Disturbance Thresholds for Sea Turtles for Impact Pile Driving of 9.6-meter WTG Monopiles under Summer Conditions with 0 and 10 dB of Noise Attenuation

Faunal Group	Injury L_{pk} (0 dB)	Injury $L_{E,\ 24h}$ (0 dB)	Behavior L_p (0 dB)	Injury L_{pk} (10 dB)	Injury $L_{E,\ 24h}$ (10 dB)	Behavior L_p (10 dB)
Sea turtles – Typ.	0.00	1.71	2.31	0.00	0.35	0.77
Sea turtles – Dif.	0.00	2.84	3.73	0.00	0.78	1.59

dB = decibel; Dif. = difficult-to-drive scenario; Typ. = typical scenario
Source: Summarized from Appendix H, *Acoustic Ranges*, to COP Appendix M-2 (Empire Wind 2022a)

Table 20 Maximum Acoustic Ranges (km) to Injury and Behavioral Disturbance Thresholds for Sea Turtles for Impact Pile Driving of 11-meter WTG Monopiles under Summer Conditions with 0 and 10 dB of Noise Attenuation

Faunal Group	Injury L_{pk} (0 dB)	Injury $L_{E,\ 24h}$ (0 dB)	Behavior L_p (0 dB)	Injury L_{pk} (10 dB)	Injury $L_{E,\ 24h}$ (10 dB)	Behavior L_p (10 dB)
Sea turtles	0.00	1.58	2.45	0.00	0.30	0.84

dB = decibel
Source: Summarized from Appendix H, *Acoustic Ranges*, to COP Appendix M-2 (Empire Wind 2022a)

Table 21 Maximum Acoustic Ranges (km) to Injury and Behavioral Disturbance Thresholds for Sea Turtles for Impact Pile Driving of 2.5-meter OSS Pin Piles under Summer Conditions with 0 and 10 dB of Noise Attenuation

Faunal Group	Injury L_{pk} (0 dB)	Injury[1] $L_{E,\ 24h}$ (0 dB)	Behavior L_p (0 dB)	Injury L_{pk} (10 dB)	Injury[1] $L_{E,\ 24h}$ (10 dB)	Behavior L_p (10 dB)
Sea turtles	0.00	0.54	0.42	0.00	0.13	0.12

dB = decibel
[1]Assumes two pin piles driven per day
Source: Summarized from Appendix H, *Acoustic Ranges*, to COP Appendix M-2 (Empire Wind 2022a)

Table 22 Maximum Exposure Estimates for Recommended Injury and Behavioral Thresholds for Sea Turtles for Impact Pile Driving with 0 and 10 dB of Noise Attenuation

Species	Injury (0 dB)	Behavior (0 dB)	Injury (10 dB)	Behavior (10 dB)
Green sea turtle	0	1	0	0
Kemp's ridley sea turtle	5	33	0	8
Leatherback sea turtle	3	18	0	1
Loggerhead sea turtle	12	538	0	96

dB = decibel
Source: Summarized from Appendix I, *Animal Movement and Exposure Modeling*, to COP Appendix M-2 (Empire Wind 2022a)

Empire has proposed measures to avoid, minimize, and mitigate impacts of pile driving noise on sea turtles, including utilization of protected species observers to monitor and enforce appropriate monitoring and exclusion zones (APM 108, APM 109, APM 110, APM 111), soft-start procedures (APM 107), and noise-reducing technologies (APM 112).

As noted in **Table 22**, takes due to behavioral disturbance are anticipated for Kemp's ridley, leatherback, and loggerhead sea turtles, with mitigation measures in place. Given the anticipated take, the effects of underwater noise associated with impact pile driving for the Project leading to behavioral disturbance is *likely to adversely affect* Kemp's ridley, leatherback, and loggerhead sea turtle. Given that no injury or behavioral disturbance is expected to occur for green sea turtle, underwater noise associated with impact pile driving for the Project is expected to have *no effect* on this species.

5.1.1.3. Fish

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

To estimate radial distances to injury thresholds for impact pile driving, fish injury thresholds for different sized fish from the Fisheries Hydroacoustic Working Group (2008) and Stadler and Woodbury (2009) and for fish with different hearing capabilities (i.e., without swim bladder, with swim bladder not involved in hearing, and with swim bladder involved in hearing) from Popper et al. (2014) were used (**Table 18**). Fish with a swim bladder involved in hearing (e.g., herrings, gadids) are most susceptible to pile-driving noise while those without swim bladders (e.g., flatfish, rays, sharks) are least susceptible (Popper et al. 2014). ESA-listed fish evaluated in this BA (i.e., subadult and adult Atlantic sturgeon) would be larger than 2 grams and have a swim bladder not involved in hearing. To estimate radial distances to behavioral thresholds for fish, criteria developed by the NMFS Greater Atlantic Regional Fisheries Office (Andersson et al. 2007; Mueller-Blenkle et al. 2010; Purser and Radford 2011; Wysocki et al. 2007) were used (**Table 18**). For 31.5-foot (9.6-meter) monopiles under typical driving conditions during summer months, impact pile driving sound levels could exceed recommended injury thresholds for Atlantic sturgeon within up to 3.9 miles (6.26 kilometers), without sound mitigation. Assuming 10 decibels of noise attenuation due to noise mitigation technology, distances to injury thresholds for Atlantic sturgeon could be reduced to within 2.0 miles (3.19 kilometers) of pile driving (**Table 23**). Without mitigation, sound levels could exceed recommended behavioral thresholds for Atlantic sturgeon within 7.0 miles (11.22 kilometers) of pile driving. Assuming 10 decibels of noise attenuation due to noise-mitigation technology, the distance to behavioral thresholds could be reduced to within 4.1 miles (6.62 kilometers) of pile driving. Under the difficult-to-drive scenario, impact pile driving sound levels could exceed recommended injury thresholds for Atlantic sturgeon within up to 5.1 miles (8.14 kilometers), without sound mitigation. Assuming 10 decibels of noise attenuation due to noise mitigation technology, distances to injury thresholds for Atlantic sturgeon could be reduced to within 3.0 miles (4.77 kilometers) of pile driving (**Table 24**). Without mitigation, sound levels could exceed recommended behavioral thresholds for Atlantic sturgeon within 8.0 miles (12.85 kilometers) of pile driving. Assuming 10 decibels of noise attenuation due to noise-mitigation technology, the distance to behavioral thresholds could be reduced to within 5.1 miles (8.23 kilometers) of pile driving.

For 36.1-foot (11-meter) monopiles, impact pile driving sound levels in summer months could exceed recommended injury thresholds for Atlantic sturgeon within up to 3.6 miles (5.80 kilometers), without sound mitigation. Assuming 10 decibels of noise attenuation due to noise mitigation technology, distances to injury thresholds for Atlantic sturgeon could be reduced to within 1.8 miles (2.91 kilometers) of pile driving (**Table 25**). Without mitigation, sound levels could exceed recommended behavioral thresholds for Atlantic sturgeon within 6.7 miles (10.86 kilometers) of pile driving. Assuming 10 decibels of noise attenuation due to noise-mitigation technology, the distance to behavioral thresholds could be reduced to within 4.1 miles (6.59 kilometers) of pile driving.

For 8.2-foot (2.5-meter) monopiles, impact pile driving sound levels in summer months could exceed recommended injury thresholds for Atlantic sturgeon within up to 2.4 miles (3.94 kilometers), without sound mitigation. Assuming 10 decibels of noise attenuation due to noise mitigation technology, distances to injury thresholds for Atlantic sturgeon could be reduced to within 0.9 miles (1.41 kilometers) of pile driving (**Table 26**). Without mitigation, sound levels could exceed recommended behavioral thresholds for Atlantic sturgeon within 3.8 miles (6.14 kilometers) of pile driving. Assuming 10 decibels of noise attenuation due to noise-mitigation technology, the distance to behavioral thresholds could be reduced to within 1.7 miles (2.66 kilometers) of pile driving.

Table 23 Maximum Acoustic Ranges (km) to Injury and Behavioral Disturbance Thresholds for Fish for Impact Pile Driving of 9.6-meter WTG Monopiles under Typical Driving Conditions in Summer with 0 and 10 dB of Noise Attenuation

Faunal Group	Injury L_{pk} (0 dB)	Injury $L_{E,\ 24h}$ (0 dB)	Behavior L_p (0 dB)	Injury L_{pk} (10 dB)	Injury $L_{E,\ 24h}$ (10 dB)	Behavior L_p (10 dB)
Fish ≥ 2 grams	0.19	6.26	11.22	0.06	3.19	6.62
Fish with swim bladder not involved in hearing	0.15	1.86	--	0.05	0.54	--

km = kilometer; dB = decibel
Source: Summarized from Appendix H, *Acoustic Ranges*, to COP Appendix M-2 (Empire Wind 2022a)

Table 24 Maximum Acoustic Ranges (km) to Injury and Behavioral Disturbance Thresholds for Fish for Impact Pile Driving of 9.6-meter WTG Monopiles under the Difficult to Drive Scenario in Summer with 0 and 10 dB of Noise Attenuation

Faunal Group	Injury L_{pk} (0 dB)	Injury $L_{E,\ 24h}$ (0 dB)	Behavior L_p (0 dB)	Injury L_{pk} (10 dB)	Injury $L_{E,\ 24h}$ (10 dB)	Behavior L_p (10 dB)
Fish ≥ 2 grams	0.45	8.14	12.85	0.10	4.77	8.23
Fish with swim bladder not involved in hearing	0.40	3.12	--	0.09	1.21	--

km = kilometer; dB = decibel
Source: Summarized from Appendix H, *Acoustic Ranges*, to COP Appendix M-2 (Empire Wind 2022a)

Table 25 Maximum Acoustic Ranges (km) to Injury and Behavioral Disturbance Thresholds for Fish for Impact Pile Driving of 11-meter WTG Monopiles in Summer with 0 and 10 dB of Noise Attenuation

Faunal Group	Injury L_{pk} (0 dB)	Injury $L_{E,\ 24h}$ (0 dB)	Behavior L_p (0 dB)	Injury L_{pk} (10 dB)	Injury $L_{E,\ 24h}$ (10 dB)	Behavior L_p (10 dB)
Fish ≥ 2 grams	0.30	5.80	10.86	0.07	2.91	6.59
Fish with swim bladder not involved in hearing	0.19	1.74	--	0.09	1.21	--

km = kilometer; dB = decibel
Source: Summarized from Appendix H, *Acoustic Ranges*, to COP Appendix M-2 (Empire Wind 2022a)

Table 26 Maximum Acoustic Ranges (km) to Injury and Behavioral Disturbance Thresholds for Fish for Impact Pile Driving of 2.5-meter OSS Pin Piles in Summer with 0 and 10 dB of Noise Attenuation

Faunal Group	Injury L_{pk} (0 dB)	Injury[1] $L_{E,\,24h}$ (0 dB)	Behavior L_p (0 dB)	Injury L_{pk} (10 dB)	Injury[1] $L_{E,\,24h}$ (10 dB)	Behavior L_p (10 dB)
Fish ≥ 2 grams	0.02	3.94	6.14	0.01	1.41	2.66
Fish with swim bladder not involved in hearing	0.02	0.65	--	0.01	0.15	--

km = kilometer; dB = decibel
[1]Assumes two pin piles driven per day
Source: Summarized from Appendix H, *Acoustic Ranges*, to COP Appendix M-2 (Empire Wind 2022a)

Empire would implement measures to avoid, minimize, and mitigate impacts of pile-driving noise on fish, including using soft-start procedures (APM 94) and implementing seasonal work windows that avoid construction during periods when sensitive species and life stages would be present in the immediate Project area (APM 92, APM 100)., these effects would be temporary,

As shown in **Tables 23 through 26**, noise levels exceeding cumulative injury thresholds for fish may extend several kilometers from the area of active pile driving. However, Atlantic sturgeon would have to remain within these distances for the duration of the activity. Given the mitigation measures in place and anticipated avoidance of disturbing sound levels, exposure to cumulative noise that could result in injury is extremely unlikely to occur. Noise levels exceeding peak injury thresholds would only occur within very short distances of active pile driving. Given the mitigation measures in place and the small size of the area where exposure to peak noise could occur, exposure to peak noise levels that could result in injury is also extremely unlikely to occur. Noise levels exceeding behavioral thresholds would extend several kilometers from the area of active pile driving, and Atlantic sturgeon that are present in the Lease Area may experience behavioral disturbance. Given anticipated avoidance of disturbing levels of sound, exposure to these sound levels is expected to be temporary, as fish are expected to resume normal behaviors following the completion of pile driving (Jones et al. 2020; Shelledy et al. 2018). Any effects of this exposure would be too small to be meaningfully measured, detected, or evaluated. Based on the small scale of anticipated effects, the effects of underwater noise associated with impact pile driving for the Project leading to behavioral disturbance is *not likely to adversely affect (insignificant*) Atlantic sturgeon.

5.1.2. Vibratory Pile Driving

Vibratory pile driving may occur during construction to install temporary offshore cofferdams at the exit point of HDD for the export cable landfalls (Section 3.1.2.3.1.2). Vibratory pile driving generates non-impulsive underwater noise with lower source levels than impact pile driving. Noise impacts from non-impulsive noise sources are generally less severe compared to impacts from impulsive noise sources, but physiological effects may still occur in proximity to the noise source if source levels are sufficiently high and/or if animals remain in the vicinity and are exposed to those levels for a sufficient duration. Underwater sound propagation modeling for vibratory pile driving was conducted in support of the COP (COP Appendix M-1; Empire 2022a) and is summarized in Appendix J of the EIS.

5.1.2.1. Marine Mammals

To estimate ranges to PTS and behavioral thresholds for vibratory pile driving, NMFS (2018a) hearing-group-specific injury thresholds for non-impulsive noise and NMFS non-impulsive noise threshold for Level B harassment under the MMPA were used (**Table 27**). For vibratory pile driving without noise mitigation, LFC that remain within less than 400 feet (122 meters) of pile driving throughout a single pile-driving event could experience PTS without noise mitigation (**Table 28**). LFC within 1.2 miles (1.985 kilometers) of active pile driving could experience behavioral effects.

Table 27 Marine Mammal Acoustic Thresholds for Non-Impulsive Noise Sources

Hearing Group	PTS Onset $L_{E,\ 24h}$[1]	Behavior L_p[2]
Low-Frequency Cetaceans	199 dB	120 dB
Mid-Frequency Cetaceans	198 dB	120 dB

Sources: GARFO 2020; NMFS 2018a.
[1] Measured in decibels (dB) referenced to 1 micropascal squared second
[2] Measured in dB referenced to 1 micropascal

Table 28 Ranges (km) to Injury (PTS) and Behavioral Disturbance Thresholds for Marine Mammals for Vibratory Pile Driving of Temporary Cofferdams

Functional Hearing Group	PTS $L_{E,\ 24h}$	Behavior L_p
LFC	0.122	1.985
MFC	0.000	1.985

Source: Request for Rulemaking and Letter of Authorization for Taking of Marine Mammals Incidental to Construction Activities on the Outer Continental Shelf (OCS) within Lease OCS-A 0512 and Associated Submarine Export Cable Routes, Table 30 (Empire 2022b)

Given the short ranges to injury thresholds and relatively shallow waters in which vibratory pile driving would occur, ESA-listed marine mammals are not expected to be exposed to noise levels exceeding injury criteria. Based on the large ranges to behavioral thresholds, the vibratory pile driving associated with the Proposed Action may result in behavioral effects on ESA-listed marine mammals. Exposure estimates developed for vibratory pile driving (COP Appendix M-1; Empire 2022a) indicate that no fin whales, NARWs, or sperm whales would experience sound levels above behavioral thresholds.

The Project's LOA includes mitigation measures for vibratory pile driving to reduce impacts on marine mammals (Section 3.3, **Table 8**) requiring the use of PSOs to monitor and enforce clearance and shut down zones around vibratory pile driving activities, further reducing the likelihood of marine mammal injury. Behavioral effects may occur, but these effects would be temporary and are expected to dissipate once vibratory pile driving is complete. No stock or population-level effects are expected.

As no takes due to auditory injury or behavioral disturbance are anticipated for fin whale, NARW, or sperm whale, underwater noise associated with vibratory pile driving for the Project would have *no effect* on fin whale, NARW, or sperm whale.

5.1.2.2. Sea Turtles

To estimate ranges to injury and behavioral thresholds for vibratory pile driving, peak SPLs and frequency-weighted accumulated SELs for the onset of PTS in sea turtles from Finneran et al. (2017) and behavioral response thresholds from McCauley et al. (2000) were used (**Table 17**). For vibratory pile driving without noise mitigation, sea turtles that remain within 459 feet (140 meters) of vibratory pile driving throughout a 24-hour pile-driving event could experience PTS without noise mitigation (**Table 29**). Sea turtles within 394 feet (120 meters) of active pile driving could experience behavioral effects.

Table 29 Ranges (km) to Injury and Behavioral Disturbance Thresholds for Sea Turtles for Vibratory Pile Driving of Temporary Cofferdams

Faunal Group	Injury $L_{E,\ 24h}$	Behavior L_p
Sea turtles	0.14	0.12

Source: Summarized from Appendix H, *Acoustic Ranges*, to COP Appendix M-2 (Empire Wind 2022a)

Given the short ranges to injury and behavioral thresholds and the activity's location close to the shoreline, ESA-listed sea turtle exposure to noise levels exceeding injury or behavioral criteria is extremely unlikely to occur. Based on the low likelihood of exposure, the effects of underwater noise associated with vibratory pile driving for the Project leading to injury or behavioral disturbance is *not likely to adversely affect (discountable)* green, Kemp's ridley, leatherback, or loggerhead sea turtles.

5.1.2.3. Fish

To estimate ranges to injury and behavioral thresholds for vibratory pile driving, fish injury thresholds from the Fisheries Hydroacoustic Working Group (2008), Stadler and Woodbury (2009), and Popper et al. (2014) and fish behavioral thresholds developed by the NMFS Greater Atlantic Regional Fisheries Office (Andersson et al. 2007; Mueller-Blenkle et al. 2010; Purser and Radford 2011; Wysocki et al. 2007) were used (**Table 17**). For vibratory pile driving without noise mitigation, sound levels could exceed recommended injury thresholds for Atlantic sturgeon within up to 1,345 feet (410 meters) (**Table 30**). Sound levels could exceed recommended behavioral thresholds within up to 2,001 feet (610 meters) of vibratory pile driving.

Table 30 Ranges (km) to Injury and Behavioral Disturbance Thresholds for Fish for Vibratory Pile Driving of Temporary Cofferdams

Faunal Group	Injury $L_{E,\ 24h}$	Behavior L_p
Fish ≥ 2 grams	0.41	0.61
Fish with swim bladder not involved in hearing	< 0.10	--

Source: Summarized from Appendix H, *Acoustic Ranges*, to COP Appendix M-2 (Empire Wind 2022a)

Given the relatively short range to injury thresholds and that fish are expected to move away from disturbing levels of noise, it is unlikely that Atlantic sturgeon would remain in sufficient proximity to vibratory pile driving for the duration of a 24-hour pile driving event to experience injury. Therefore, injuries associated with vibratory pile driving are not expected. Behavioral effects could occur in proximity to vibratory pile driving. Any behavioral effects would be temporary and limited to the small area ensonified with sound levels above the behavioral threshold. As shown in **Table 30**, noise levels exceeding cumulative injury thresholds for fish may extend a relatively short distance from the area of active pile driving, and Atlantic sturgeon would have to remain within these distances for the duration of the activity to experience auditory injury. Given the anticipated avoidance of disturbing sound levels, exposure to cumulative noise that could result in injury is extremely unlikely to occur. Noise levels exceeding behavioral thresholds would also extend a relatively short distance, but Atlantic sturgeon that are present in the vicinity of vibratory pile driving may experience behavioral disturbance. Given anticipated avoidance of disturbing levels of sound, exposure to these sound levels is expected to be temporary. Any effects of this exposure would be too small to be meaningfully measured, detected, or evaluated. Based on the small scale of anticipated effects, the effects of underwater noise associated with vibratory pile driving for the Project leading to behavioral disturbance is *not likely to adversely affect (insignificant*) Atlantic sturgeon.

5.1.3. Geotechnical and Geophysical Surveys

G&G surveys for the Proposed Action would occur prior to installation of offshore cables and during the O&M phase of the Project (Section 3.1.2.5). Such surveys can generate high-intensity, impulsive noise that has the potential to result in physiological or behavioral effects in aquatic organisms. G&G surveys for the Proposed Action include HRG surveys. Compared to other G&G survey equipment, HRG survey equipment produces less-intense noise and operates in smaller areas.

5.1.3.1. Marine Mammals

Geotechnical and geophysical survey noise associated with offshore wind in the Atlantic may affect marine mammals through behavioral responses. TTS or PTS is not likely to occur to marine mammals due to the low sound pressure levels and small isopleths associated with the survey activities. HRG survey equipment is unlikely to result in injury given that sound levels diminish rapidly with distance from the survey equipment (BOEM 2018). Empire (2022b) estimated exposures of marine mammals to sound levels exceeding regulatory thresholds due to HRG surveys based on isopleths calculated for injury and behavioral thresholds as part of its LOA application for the Project. Calculated isopleth distances to injury thresholds were considered de minimis. The maximum calculated isopleth distance to the behavioral threshold for HRG survey equipment was 164.2 feet (50.05 meters). Resulting exposures due to behavioral disturbance over five years of HRG survey activities were estimated at 17 fin whales, 28 NARWs, and 3 sperm whales (Empire 2022b). Any behavioral impacts on individual ESA-listed marine mammals are expected to be temporary.

The Project's LOA includes mitigation measures for HRG survey activities when operating equipment that produces sound within marine mammals' hearing range (i.e., less than 180 kilohertz) (Section 3.3, **Table 8**). These measures require the use of PSOs to monitor and enforce clearance and shut down zones around HRG survey activities and utilization of ramp-up procedures prior to commencement of survey activities, further reducing the likelihood of marine mammal injury. Empire will also be required to comply with the Project Design Criteria and Best Management Practices in the programmatic consultation for offshore wind data collection (BOEM 2021b), which includes the requirement for an Alternative Monitoring Plan (AMP) if surveys are to be conducted at night or during low-visibility conditions. In order for geophysical surveys to be conducted at night or during low-visibility conditions, PSOs must be able to effectively monitor the clearance and shut down zones. No surveys may occur if the clearance and shutdown zones cannot be reliably monitored for the presence of ESA-listed species. The AMP must detail the monitoring methodology that will be used during nighttime and low-visibility conditions and an explanation of how it will be effective at ensuring that the shutdown zones can be maintained during nighttime and low-visibility survey operations. The plan must include technologies capable of detecting whales at night within these zones, including night vision equipment (i.e., night vision goggles and/or infrared technology), and these technologies must be available for use during night time monitoring. PSOs must be trained and experienced with any AMP technology used, and the AMP must describe how calibration of the equipment will be performed. PSOs must make nighttime observations from a platform with no visual barriers to reduce the potential for interference with night vision equipment.

The mitigation measures in the Project's LOA and implementation of the Project Design Criteria and Best Management Practices from the programmatic consultation (BOEM 2021b) would minimize the potential for adverse effects associated with G&G surveys conducted under the Proposed Action. Therefore, the effects of underwater noise associated with G&G surveys for the Project leading to behavioral disturbance is *not likely to adversely affect (insignificant)* fin whale, NARW, and sperm whale.

5.1.3.2. Sea Turtles

G&G survey noise has the potential to affect sea turtles through auditory injuries, stress, disturbance, and behavioral responses. TTS or PTS could occur if sea turtles are close to survey activities. However, TTS and PTS are considered unlikely, as sea turtles are expected to avoid survey activities. At-sea monitoring data collected during monitoring and mitigation programs associated with seismic activities generally indicate that sea turtles exhibit local avoidance during surveys (NSF and USGS 2011 citing Holst et al. 2006; NSF and USGS 2011 citing Weir 2007). Though these seismic surveys produce higher sound levels than expected for G&G surveys associated with offshore wind projects, sea turtles are expected to avoid disturbing levels of sound generated by survey activities. Additionally, survey vessels would travel quickly (4 to 5 knots) relative to sea turtle swim speeds (NSF and USGS 2011).

Based on expected sea turtle avoidance, the speed of the survey vessels, and the lower noise levels and smaller operational scales of HRG survey equipment, exposure to injurious sound levels during G&G surveys associated with the Proposed Action is extremely unlikely to occur. Given the 200-meter minimum separation distance required between survey vessels and sea turtles in the programmatic consultation for offshore wind data collection (BOEM 2021b) and the very temporary responses that may occur while a survey vessel passes, the effects of G&G surveys associated with the Project is *not likely to adversely affect (discountable)* green, Kemp's ridley, leatherback, or loggerhead sea turtle.

5.1.3.3. Fish

Seismic noise from G&G surveys has been shown to create varying behavioral responses in fish. These responses in fishes have been documented but careful evaluations of their impacts and examinations of physiological injury are lacking (Carroll et al. 2017). Given that HRG survey equipment produces less-intense noise, HRG surveys for the Proposed Action are not expected to exceed the threshold for injury to finfish. Behavioral impacts to Atlantic sturgeon from Project-related G&G surveys may occur, but effects would be localized and temporary. Based on the mobile nature of the noise source, any exposure would be brief, and the temporary effects would be too small to be meaningfully measured or detected. Given the small scale of anticipated effects, the effects of underwater noise associated with G&G surveys for the Project leading to behavioral disturbance is *not likely to adversely affect (insignificant*) Atlantic sturgeon.

5.1.4. Cable Laying

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

5.1.4.1. Marine Mammals

Foraging cetaceans are not expected to interrupt foraging activity when exposed to cable-laying noise but may forage less efficiently due to increased energy spent on vigilance behaviors (NMFS 2015). Decreased foraging efficiency could have short-term metabolic effects resulting in physiological stress, but these effects would dissipate once the prey distribution no longer overlaps the mobile ensonified area.

Given the mobile nature of the ensonified area and associated temporary ensonification of a given habitat area, any effects due to behavioral disturbance are expected to be small. Based on the small scale of anticipated effects, the effects of underwater noise associated with cable laying for the Project leading to behavioral disturbance is *not likely to adversely affect (insignificant*) fin whale, NARW, or sperm whale.

5.1.4.2. Sea Turtles

As previously noted, the ensonified area associated with cable laying would be dynamic, and a given location would not be ensonified for more than a few hours. Any behavioral effects would be temporary, dissipating once the turtle is outside of the ensonified area. Therefore, any effects due to behavioral disturbance are expected to be small. Given the small scale of anticipated effects, the effects of underwater noise associated with cable laying for the Project leading to behavioral disturbance is *not likely to adversely affect (insignificant*) green, Kemp's ridley, leatherback, or loggerhead sea turtles.

5.1.4.3. Fish

Noise levels associated with cable laying may cause temporary stress and behavioral changes in finfish in the ensonified area but are insufficient to pose a risk of injury or mortality. Because the cable-laying vessel and equipment would be continually moving and the ensonified area would move with it, any behavioral responses to cable-laying noise are expected to be temporary and localized and any effects due to behavioral responses would be small. Given the small scale of anticipated effects, the effects of underwater noise associated with cable laying for the Project leading to behavioral disturbance is *not likely to adversely affect (insignificant*) Atlantic sturgeon.

5.1.5. Summary of Effects

5.1.5.1. Marine Mammals

Noise associated with vibratory pile driving, G&G surveys, and cable laying for the Proposed Action are not expected to result in injury of ESA-listed marine mammals based on the source levels or small ranges to injury thresholds. Impact pile driving has the potential to cause injury in ESA-listed marine mammals. However, the mitigation measures described in Section 3.3 (**Tables 7 and 8**) and summarized in this section are expected to minimize injury risk for ESA-listed marine mammals. Impact pile driving, vibratory pile driving, G&G surveys, and cable laying could all result in behavioral effects on ESA-listed marine mammals. These effects would be temporary but could occur over relatively large distances for some noise sources.

5.1.5.2. Sea Turtles

Noise associated with vibratory pile driving, G&G surveys, and cable laying for the Proposed Action are not expected to result in injury of ESA-listed sea turtles based on the source levels or small ranges to injury thresholds. Impact pile driving has the potential to cause injury in ESA-listed sea turtles. However, the implementation of the mitigation measures described in Section 3.3 (**Tables 7 and 8**) and summarized in this section, specifically the use of noise mitigation systems or techniques that achieve a 10-decibel reduction in sound levels, would avoid sea turtle exposure to sound levels exceeding recommended injury thresholds. Impact pile driving, vibratory pile driving, G&G surveys, and cable laying could all result in behavioral effects on ESA-listed sea turtles. These effects would be temporary but could occur beyond a localized area for impact pile driving of difficult-to-drive piles.

5.1.5.3. Fish

Noise associated with vibratory pile driving, G&G surveys, and cable laying for the Proposed Action are not expected to result in injury of Atlantic sturgeon based on the source levels or small ranges to injury thresholds. Impact pile driving has the potential to cause injury in Atlantic sturgeon. However, the mitigation measures described in Section 3.3 (**Tables 7 and 8**) and summarized in this section (e.g., soft start procedures) are expected to minimize injury risk for this species. Impact pile driving, vibratory pile driving, G&G surveys, and cable laying could all result in behavioral effects on Atlantic sturgeon. These effects would be temporary but could occur over relatively large distances during impact pile driving.

5.2. Other Noise Impacts

In addition to the activities evaluated in Section 5.1, the Proposed Action includes other noise sources that have the potential to affect aquatic species during construction, O&M, and decommissioning. These additional noise sources would include vessels (Section 5.2.1), helicopters (Section 5.2.2), and WTGs (Section 5.2.3). Following the assessment of these noise sources, a summary of overall noise effects to ESA-listed species is provided (Section 5.2.4).

5.2.1. Vessels

The Proposed Action includes the use of vessels during construction, O&M, and decommissioning, as described in Section 3.1.2.4. Vessels generate low-frequency (10 to 100 Hz) (MMS 2007), non-impulsive noise that could affect aquatic species.

5.2.1.1. Marine Mammals

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

Vessel activity associated with the Proposed Action is expected to cause repeated, intermittent impacts on ESA-listed marine mammals resulting from short-term, localized behavioral responses. These responses would dissipate once the vessel or individual leaves the area and are expected to be infrequent given the patchy distribution of marine mammals in the action area. Any behavioral effects in response to vessel noise are not expected to be biologically significant (Navy 2018). Given that behavioral effects would not be biologically significant for individual marine mammals exposed to vessel noise, the effects of underwater noise associated with Project vessel traffic leading to behavioral disturbance is *not likely to adversely affect (insignificant*) fin whale, NARW, or sperm whale.

5.2.1.2. Sea Turtles

Vessel noise overlaps with the hearing range of sea turtles and may elicit behavioral responses, including startle responses and changes in diving patterns, or a temporary stress response (NSF and USGS 2011; Samuel et al. 2005). Vessel noise associated with the Proposed Action could cause repeated, intermittent impacts on sea turtles resulting from short-term, localized behavioral responses. These responses would dissipate once the vessel leaves the area. Any effects of behavioral responses to vessel noise are expected to be too small to be meaningfully measured or detected. Given the small scale of anticipated effects, the effects of underwater noise associated with Project vessel traffic leading to behavioral disturbance is *not likely to adversely affect (insignificant*) green, Kemp's ridley, leatherback, or loggerhead sea turtle.

5.2.1.3. Fish

Vessel noise may result in brief periods of exposure near the surface of the water column but is not expected to cause injury, hearing impairment, or long-term masking of biologically relevant cues in fish. Behavioral responses of fish to vessel noise are variable but include avoidance or scattering of schooling fishes (Misund and Aglen 1992). Impacts from vessel noise associated with the Proposed Action are expected to be temporary and localized. Given that Atlantic sturgeon are benthic feeders, exposure of this species to vessel noise would be infrequent, and effects of any brief behavioral responses would be too small to be meaningfully measured or detected. Given the small scale of anticipated effects, the effects of underwater noise associated with Project vessel traffic leading to behavioral disturbance is *not likely to adversely affect (insignificant*) Atlantic sturgeon.

5.2.2. Helicopters

Helicopters may be used to support construction or O&M of the Proposed Action. Though helicopters produce in-air noise, a small portion of the produced sound can be transmitted through the water surface and propagate in the aquatic environment. Underwater sound produced by helicopters is generally low frequency (less than 500 hertz) and non-impulsive with sound levels at or below 160 decibels referenced to 1 micropascal (Richardson et al. 1995). Underwater helicopter noise has the potential to elicit behavioral responses in aquatic species.

5.2.2.1. Marine Mammals

When traveling at relatively low altitude, helicopter noise that propagates underwater has the potential to elicit short-term behavioral responses in marine mammals, including altered dive patterns and percussive behaviors (i.e., breaching or tail slapping) (Efroymson et al. 2000; Patenaude et al. 2002). Helicopters transiting to and from the action area are expected to fly at sufficiently high altitudes to avoid behavioral effects on marine mammals, with the exception of WTG inspections, take-off, and landing. Additionally, Project aircraft would comply with current approach regulations for NARWs. Any behavioral responses elicited during short periods of low-altitude flight would be temporary, dissipating once the aircraft leave the area. However, co-occurrence of ESA-listed marine mammals in surface waters with helicopters flying at low altitude is unlikely given the short periods of low altitude flight. Therefore, exposure to disturbing sound levels is extremely unlikely to occur. Given the low likelihood of exposure, the effects of underwater noise associated with Project helicopters leading to behavioral disturbance is *not likely to adversely affect (discountable)* fin whale, NARW, or sperm whale.

5.2.2.2. Sea Turtles

When traveling at relatively low altitude, helicopter noise that propagates underwater has the potential to elicit stress or behavioral responses in sea turtles (e.g., diving or swimming away or altered dive patterns) (BOEM 2017; NSF and USGS 2011; Samuel et al. 2005). Helicopters transiting to and from the Lease Area are expected to fly at sufficiently high altitudes to avoid behavioral effects on sea turtles, with the exception of WTG inspections, take-off, and landing. Any behavioral responses elicited during the short periods of low-altitude flight would be temporary, dissipating once the aircraft leave the area. However, co-occurrence of ESA-listed sea turtles in surface waters with helicopters flying at low altitude is unlikely given the short periods of low altitude flight. Therefore, exposure to disturbing sound levels is extremely unlikely to occur. Given the low likelihood of exposure, the effects of underwater noise associated with Project helicopters leading to behavioral disturbance is *not likely to adversely affect (discountable*) green, Kemp's ridley, leatherback, or loggerhead sea turtles.

5.2.2.3. Fish

Noise from helicopters may cause behavioral changes in fish in the immediate vicinity of the noise source. Near-surface pelagic fish may detect helicopter noise that has transmitted through the water surface, but noise levels from aircraft would be greatly diminished. Due to the impedance difference between air and water, mot sound waves are reflected at the surface of the sound level of underwater sound transmitted into the water column is greatly diminished. Helicopters transiting to and from the Lease Area are expected to fly at sufficient altitudes to avoid behavioral effects on fish, with the exception of WTG inspections, take-off, and landing. Any behavioral responses that occur during low-altitude flight would be temporary, dissipating once the aircraft leave the area, and are not expected to be biologically significant. However, as Atlantic sturgeon are demersal, they are extremely unlikely to experience sound levels above behavioral thresholds due to helicopter noise. Given the low likelihood of exposure, the effects of underwater noise associated with Project helicopters leading to behavioral disturbance is *not likely to adversely affect (discountable*) Atlantic sturgeon.

5.2.3. Wind Turbine Generators

WTGs operating during the O&M phase of the Proposed Action would generate non-impulsive, underwater noise. Existing monitoring data indicate that SPL_{RMS} produced by operating 0.2 to 6.15 WTGs generally ranges from 110 to 125 decibels referenced to 1 micropascal in the 10-Hz to 8-kilohertz frequency range (Tougaard et al. 2020). Stöber and Thomsen (2021) used published measurements from operational turbines to determine the relationship between nominal power and source level. Based on this relationship, Stöber and Thomsen (2021) predicted that a turbine with a nominal power of 10 MW would have a broadband source level of 170 dB re 1 µPa and a spectral band source level of 177 dB re 1 µPa. Given the larger turbines anticipated for the Proposed Action (up to 18 MW), broadband source levels could exceed 170 decibels re 1 µPa (Stöber and Thomsen 2021).

5.2.3.1. Marine Mammals

Based on direct field measurements of 6 MW WTG noise at the Block Island Wind Farm, underwater noise could be audible to marine mammals. For smaller WTGs at the Block Island Wind Farm, turbine noise reached ambient noise levels within 164 feet (50 meters) of the turbine foundations (Miller and Potty 2017). Based on modeled source levels for a 10-MW turbine, Stöber and Thomsen (2021) estimated that sound levels could exceed the behavioral threshold for marine mammals at distances up to 0.9 mile (1.4 kilometers) from the turbine, assuming the turbine operates with a direct drive. However, these authors used predictive modeling, and the estimated sound levels based on these model predictions are uncertain and have not been verified in the field. ESA-listed marine mammals may be exposed to noise levels above the behavioral threshold. However, such exposure would be brief as marine mammals pass through the wind farm. Any effects associated with behavioral responses to these brief exposures are expected to be too small to be meaningfully measured or detected and are not expected to result in any foraging impacts to marine mammals. Given the small scale of anticipated effects, the effects of underwater noise generated by WTGs for the Project leading to behavioral disturbance is *not likely to adversely affect (insignificant*) fin whale, NARW, or sperm whale.

5.2.3.2. Sea Turtles

Based on predicted source levels for a 10-MW turbine from Stöber and Thomsen (2021), noise levels anticipated from operating WTGs for the Proposed Action may exceed 170 decibels re 1 µPa. Therefore, there is the potential for source levels to exceed the recommended behavioral threshold for sea turtles (175 decibels re 1 µPa). Behavioral impacts to sea turtles could occur if the recommended threshold is exceeded. If exposure to disturbing levels of sound were to occur, such exposure is expected to be brief as sea turtles are expected to avoid sound levels above their recommended behavioral threshold. Based on direct field measurements of 6 MW WTG noise at the Block Island Wind Farm, underwater noise could be audible to sea turtles. For smaller WTGs at the Block Island Wind Farm, turbine noise reached ambient noise levels within 164 feet (50 meters) of the turbine foundations (Miller and Potty 2017). Any effects associated with behavioral responses to these brief exposures are expected to be too small to be meaningfully measured or detected. Given the small scale of anticipated effects, the effects of underwater noise generated by WTGs for the Project leading to behavioral disturbance is *not likely to adversely affect (insignificant)* green, Kemp's ridley, leatherback, or loggerhead sea turtles.

5.2.3.3. Fish

Based on predicted theoretical source levels for a 10-MW turbine from Stöber and Thomsen (2021), noise levels anticipated from operating WTGs for the Proposed Action may exceed 170 decibels re 1 µPa. Therefore, Atlantic sturgeon may be exposed to sound levels above their behavioral threshold for non-impulsive noise in relatively close proximity to the WTG. However, WTG noise for these 10 MW WTGs has not been measured in the field, and if these theoretical values are realized, such exposure would be brief as Atlantic sturgeon are expected to avoid disturbing levels of sound. Any effects associated with behavioral responses to these brief exposures are expected to be too small to be meaningfully measured or detected and may be much smaller than those modeled in this paper. Given the small scale of anticipated effects, the effects of underwater noise generated by WTGs for the Project leading to behavioral disturbance is *not likely to adversely affect (insignificant)* Atlantic sturgeon.

5.2.4. Summary of Effects

5.2.4.1. Marine Mammals

Underwater noise generated by vessels, helicopters, and WTGs associated with the Proposed Action is not expected to result in injury to ESA-listed marine mammals given anticipated sound levels; however, these noise sources do have the potential to elicit behavioral responses in these species. Based on expected avoidance of potentially disturbing levels of WTG or vessel noise, any exposure to noise above the behavioral threshold would be brief and any effects of associated behavioral responses are expected to be too small to be meaningfully measured. Behavioral effects associated with helicopter noise are extremely unlikely to occur given the unlikelihood of co-occurrence of marine mammals at the surface with helicopters during brief periods of low-altitude flight. Project vessel noise may also result in temporary stress responses and masking, which could affect individual ESA-listed species but are not expected to result in stock or population-level effects based on the small number of Project vessels anticipated for the Proposed Action.

5.2.4.2. Sea Turtles

Underwater noise generated by vessels, helicopters, and WTGs associated with the Proposed Action would not result in injury to ESA-listed sea turtles given anticipated sound levels. Vessel and WTG noise may result in behavioral effects. However, any potential behavioral responses would be extremely localized, and effects of these responses would be too small to be meaningfully measured or detected. Behavioral effects associated with helicopter noise are extremely unlikely to occur given the unlikelihood of co-occurrence of sea turtles at the surface with helicopters during brief periods of low-altitude flight.

5.2.4.3. Fish

Underwater noise generated by vessels, helicopters, and WTGs associated with the Proposed Action would not result in injury to ESA-listed Atlantic sturgeon given anticipated sound levels. Helicopter noise has the potential to result in behavioral effects, but such effects are extremely unlikely given Atlantic sturgeon's demersal life history. Vessel noise may cause behavioral effects, but such effects would be most likely to occur in the upper portion of the water column where demersal Atlantic sturgeon are unlikely to occur. Any behavioral effects on Atlantic sturgeon would be infrequent, temporary, and localized, and these effects would be too small to be meaningfully measured or detected. Any exposure to WTG noise above the behavioral threshold for Atlantic sturgeon would be brief, and effects of behavioral responses to these brief exposures would be too small to be meaningfully measured or detected.

5.3. Effects of Vessel Traffic

As detailed in Section 3.1.2.4, a variety of vessels would be used to construct, operate, and decommission the Proposed Action. A maximum of 18 vessels are expected to be in use during any phase of the Project. Vessel traffic associated with the Proposed Action could affect ESA-listed species through vessel strikes (Section 5.3.1) or discharges of fuel, fluids, hazardous material, trash, or debris from Project vessels (Section 5.3.2). Following the assessment of these effects, a summary of overall vessel traffic effects to ESA-listed species is provided (Section 5.3.3). In addition to increased risk of vessel strike and accidental vessel discharges, vessels produce underwater noise, which was evaluated in Section 5.2.1. Vessels would also produce artificial lighting, which is addressed in Section 5.4.8, and air emissions, which are addressed in Section 5.5.1.

5.3.1. Risk of Vessel Strike

The Proposed Action would result in increased vessel trip numbers in the area and a potential increased risk of vessel interactions with some ESA-listed species as a result of Project vessel traffic during the construction, O&M, and decommissioning phases of the Project. Additionally, recreational vessel traffic may increase in the Lease Area, with a commensurate decrease in other areas, due to increased recreational fishing associated with artificial reef effects around the WTG and OSS foundations (see Section 5.4.3.1). Vessel strikes are a known source of injury and mortality for mysticetes, sea turtles, and Atlantic sturgeon.

5.3.1.1. Marine Mammals

Vessel strikes are a significant concern for mysticetes, including fin whales and NARWs, which are relatively slow swimmers. Vessel strikes are relatively common for cetaceans (Kraus et al. 2005) and are a known or suspected cause of the three active unusual mortality events in the Atlantic Ocean for cetaceans (humpback whale, minke whale, and NARW). Vessel strikes may be particularly significant for NARWs, for which vessel strikes are a primary cause of death (Kite-Powell et al. 2007). Marine mammals are expected to be most vulnerable to vessel strikes when within the vessel's draft and not detectable by visual observers (e.g., animal below the surface or poor visibility conditions such as bad weather or low light), and probability of vessel strike increases with increasing vessel speed (Pace and Silber 2005; Vanderlaan and Taggart 2007). NARWs are at highest risk for vessel strike when vessels travel in excess of 10 knots (Vanderlaan and Taggart 2007); serious injury to cetaceans due to vessel collision rarely occurs when vessels travel below 10 knots (Laist et al. 2001).

Average vessel speeds for Project vessels are generally expected to be below 10 knots (Section 3.1.2.4), reducing the risk of vessel interactions between ESA-listed marine mammals and Project vessels. Generally, large vessels pose the greatest risk for ESA-listed marine mammals. Large vessels that would be used for the Proposed Action include heavy lift vessels, monopile supply vessels, WTG installation vessels, heavy transport vessels, cable lay vessels, pre-lay grapnel run vessels, fall pipe vessels, construction support vessels, and tugs and barges (**Table 3**). The other Project vessels (i.e., CTVs, safety vessels) would be smaller and more maneuverable, making it easier to avoid ESA-listed marine mammals. However, CTVs would operate at relatively high speeds compared to other Project vessels.

During construction, up to a total of 2,396 vessel round trips could occur between the Lease Area and ports utilized by EW1 and EW2 combined (**Table 5**), with the majority of those trips expected to occur between the South Brooklyn Marine Terminal and the Lease Area. This increase in vessel traffic would be small relative to the level of traffic in the heavily trafficked waters in the region (**Figures 10 through 12**), which includes the Port of New York and New Jersey. During the O&M phase, an estimated 518 vessel round trips are expected to occur annually (**Table 5**). Based on the density of ESA-listed marine mammals in the vicinity of the Lease Area (**Table 11**) and an estimated 44 trips per month over the operational life of the Project, there are periods of time where there is a minor risk of encountering an ESA-listed marine mammal, particularly NARWs and fin whales.

As described in Section 5.4.3.1, the installation of WTG and OSS foundations may have an artificial reef effect, potentially resulting in increased recreational fishing activity. Though the Proposed Action is not expected to result in an overall increase in recreational vessel traffic in the region, it may result in concentration of traffic in the Lease Area. As no increase in overall recreational vessel traffic is anticipated and ESA-listed marine mammals are not expected to concentrate in the Lease Area, any shifts in recreational vessel traffic associated with the Proposed Action would not result in an increased vessel strike risk for ESA-listed marine mammals.

Empire has proposed measures to avoid, minimize, and mitigate impacts associated with Project vessel traffic, including vessel speed restrictions (APM 113 and APM 114) and collision avoidance measures. These collision avoidance measures include maintaining separation distances for marine mammals (APM 115), reporting as part of the Mandatory Ship Reporting System for NARWs (APM 117), checking for active Dynamic Management Areas or Slow Zones daily (APM 118), reporting NARW sightings to the North Atlantic Right Whale Sighting Advisory System (APM 119), implementing crew member training on vessel strike avoidance measures (APM 120), and using a PSO or Trained Lookout to reduce collision risk (APM 123). Additional measures to address vessel strike are included in the Project's LOA and are proposed by BOEM in this BA (Section 3.3, **Tables 7 and 8**). Vessel strikes are not anticipated when mitigation measures are effectively implemented; thus, the potential for vessel strikes to ESA-listed cetaceans species is extremely unlikely. Given the low likelihood of vessel strike, the effects of vessel strikes from Project vessel activities leading to injury or mortality is *not likely to adversely affect (discountable)* fin whale, NARW, or sperm whale.

5.3.1.2. Sea Turtles

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

Data are lacking on the types of vessels most commonly involved in sea turtles strikes. However, correlation between sea turtles strikes and levels of recreational boat traffic have been observed (NMFS 2018b citing NRC 1990). As noted in Section 3.1.2.4, average vessel speeds for Project vessels are expected to be below 10 knots. This slow speed would reduce risk of vessel strike for sea turtles, but these species would still be vulnerable when vessels travel over 2 knots.

As described in Section 5.3.1.2, the increase in vessel traffic during construction (i.e., 2,396 trips) would be small relative to the level of traffic in the heavily trafficked waters in the region. Based on the small increase in vessel traffic and the density of sea turtles in the vicinity of the Lease Area (**Table 12**), there would be a low risk of collisions with sea turtles during the construction phase of the Project. During the O&M phase of the Project, there would be an estimated 44 vessel trips per month. Given the level of traffic during this phase and sea turtle densities in the vicinity of the Lease Area, there are periods of time where there is a minor risk of a vessel encountering an ESA-listed sea turtle, particularly Kemp's ridley, leatherback, and loggerhead sea turtles.

As described in Section 5.4.3.1, the installation of WTG and OSS foundations may have an artificial reef effect, potentially resulting in increased recreational fishing activity. Though the Proposed Action is not expected to result in an overall increase in recreational vessel traffic in the region, it may result in concentration of traffic in the Lease Area. The artificial reef effect may also attract sea turtles to WTG and OSS foundations. Though no increase in overall recreational vessel traffic is anticipated, the potential concentration of recreational vessel traffic and ESA-listed sea turtles in the same area may result in an increased vessel strike risk for ESA-listed sea turtles in the Lease Area. The potential increase in vessel strike risk associated with recreational vessel traffic cannot be quantified at this time as recreational vessel use of the Lease Area following construction of the Project is unknown.

Empire has proposed the use of dedicated lookouts to reduce the risk of collisions with marine mammals and sea turtles (APM 123) and site-specific training on vessel strike avoidance measures for all crew members (APM 120). Empire has proposed additional measures to avoid, minimize, and mitigate impacts associated with vessel traffic on marine mammals, including vessel speed restrictions and collision avoidance measures (APM 113 and115), which may also benefit sea turtles. Additional measures to address vessel strike are proposed by BOEM in this BA (Section 3.3, **Table 8**). Vessel strikes are not anticipated when mitigation measures are implemented; thus the potential for vessel strikes to ESA-listed sea turtle species is extremely unlikely. Given the low likelihood of vessel strike, the effects of vessel strikes from Project vessel activities leading to injury or mortality is *not likely to adversely affect (discountable)* the North Atlantic DPS of green sea turtle, Kemp's ridley sea turtle, leatherback sea turtle, and the Northwest Atlantic Ocean DPS of loggerhead sea turtle.

5.3.1.3. Fish

Vessel strikes are a documented source of mortality for Atlantic sturgeon in riverine habitats (Balazik et al. 2012; Brown and Murphy 2010; Krebs et al. 2019). Deep-draft vessels may be most likely to result in sturgeon injury or mortality in these habitats, but vessel interactions are not limited to deep-draft vessels (NMFS 2018c). In the marine environment, where demersal Atlantic sturgeon would have much more separation from vessel hulls due to deeper water and less constrained ability to avoid vessels (i.e., as opposed to within the confines of a shallower river), the risk of vessel strike may be significantly lower. As noted in Section 3.1.2.4, average vessel speeds for Project vessels are expected to be below 10 knots, which may reduce the risk of vessel strike for Atlantic sturgeon. As described in Section 5.3.1.1, vessel traffic to and from the Lease Area associated with the Proposed Action would be small relative to the level of traffic in the heavily trafficked waters in the region, which includes the Port of New York and New Jersey. There is the potential for Project vessels to encounter Atlantic sturgeon in the Hudson River during trips to the Port of Coeymans or Port of Albany during the construction phase of the Project. However, Project vessel trips in the Hudson River are expected to represent a very small portion of the existing traffic on the Hudson River.

Empire has proposed measures to avoid or reduce vessel strike risk for marine mammals and sea turtles (APM 113, APM 115, APM 120, and APM 123), some of which may also benefit Atlantic sturgeon. Additional measures to address vessel strike are proposed by BOEM in this BA (Section 3.3, **Table 8**). Given the small incremental increase in vessel traffic due to Project vessels compared to existing traffic and the limited time when Project vessels would travel in the Hudson River (i.e., the two-year construction phase), the increased collision risk for Atlantic sturgeon is expected to be very small. Given the very small increase in collision risk, the effects of vessel strikes from Project activities leading to injury or mortality are *not likely to adversely affect (insignificant)* Atlantic sturgeon.

5.3.2. Vessel Discharges

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

5.3.2.1. Marine Mammals

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

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

The Proposed Action would comply with all laws regulating at-sea discharges of vessel-generated waste (APM 121), further reducing the likelihood of an accidental release. Empire has developed an OSRP (see COP Appendix F; Empire 2022a) with measures to avoid accidental releases and a protocol to respond to such a release if one occurs. Additional measures to address accidental releases are proposed by BOEM in this BA (Section 3.3, **Table 8**). Therefore, accidental releases are considered unlikely. Given the low likelihood of occurrence, effects of vessel discharges associated with the Proposed Action leading to injury or mortality are *not likely to adversely affect (discountable)* fin whale, NARW, or sperm whale.

5.3.2.2. Sea Turtles

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

All sea turtle species are known to ingest trash and debris, including plastic fragments, tar, paper, polystyrene foam, hooks, lines, and net fragments (Bugoni et al. 2001; Hoarau et al. 2014; Nelms et al.

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

The Proposed Action would comply with all laws regulating at-sea discharges of vessel-generated waste (APM 121), and Empire has developed an OSRP with measures to avoid accidental releases and a protocol to respond to such a release if one occurs. Additional measures to address accidental releases are proposed by BOEM in this BA (Section 3.3, **Table 8**). Therefore, accidental releases are considered unlikely. Given the low likelihood of occurrence, effects of vessel discharges associated with the Proposed Action leading to injury or mortality are *not likely to adversely affect (discountable)* green, Kemp's ridley, leatherback, or loggerhead sea turtles.

5.3.2.3. Fish

Accidental releases of fuel, fluids, and hazardous materials can cause temporary, localized impacts on finfish, including increased mortality, decreased fitness, and contamination of habitat. The Proposed Action would comply with all laws regulating at-sea discharges of vessel-generated waste (APM 121) and includes BOEM-proposed measures to address accidental releases (Section 3.3, **Table 8**). Additionally, Empire has developed an OSRP with measures to avoid accidental releases and a protocol to respond to such releases. Therefore, accidental releases are considered unlikely. Given the low likelihood of occurrence, effects of vessel discharges associated with the Proposed Action leading to injury or mortality are *not likely to adversely affect (discountable)* Atlantic sturgeon.

5.3.3. Summary of Effects

5.3.3.1. Marine Mammals

With effective implementation of the mitigation measures to avoid vessel strike, vessel strikes of ESA-listed marine mammals are unlikely to occur. Project vessel discharges are also unlikely to occur given the measures in place to avoid or minimize accidental releases. Therefore, effects of Project vessel traffic on ESA-listed marine mammals are considered unlikely to occur.

5.3.3.2. Sea Turtles

With effective implementation of the mitigation measures that would be undertaken to avoid vessel strike, vessel strikes of ESA-listed sea turtles are unlikely to occur. Project vessel discharges are also unlikely to occur given the measures in place to avoid or minimize accidental releases. Therefore, effects of Project vessel traffic on ESA-listed sea turtles are considered unlikely to occur.

5.3.3.3. Fish

Vessel strike is a documented source of Atlantic sturgeon mortality in riverine habitats. The risks posed by vessel strike in oceanic habitats are uncertain, but are presumably less due to the deeper, more open-water environment on the OCS. The increased risk of vessel strike for Atlantic sturgeon associated with the Proposed Action would be small based on the small increase in vessel traffic expected for the Project relative to existing traffic in the region, and the limited time Project vessels would travel in the Hudson

River. Project vessel discharges are unlikely to occur given the measures in place to avoid or minimize accidental releases.

5.4. Habitat Disturbance/Modifications

Activities included in the Proposed Action would result in habitat disturbance or modifications that may cause impacts to benthic and water column habitat. Anticipated habitat disturbance or alterations may result from G&G surveys (Section 5.4.1), fisheries and habitat surveys and monitoring (Section 5.4.2), habitat conversion and loss associated with the placement of WTGs and OSSs, and cable protection and scour protection (Section 5.4.3), turbidity (Section 5.4.4), the presence of offshore structures (Sections 5.4.5 and 5.4.6), the addition of EMFs and heat (Section 5.4.7), lighting (Section 5.4.8), and the offshore substations (Section 5.4.9). Individual activities and impacts are addressed in the following subsections. Following the assessment of these potential sources of habitat disturbance/modification, a summary of overall effects to ESA-listed species is provided (Section 5.4.10).

5.4.1. Geotechnical and Geophysical Surveys

As described in Section 3.1.2.5, HRG and geotechnical surveys would be conducted during the pre-construction and O&M phases of the Proposed Action. HRG surveys would not result in habitat disturbance or modification. Geotechnical surveys may cause benthic disturbance as a result of physical seafloor sampling. Geotechnical surveys would be limited to the pre-construction phase of the Project and would be conducted at specific WTG locations.

Each individual geotechnical sampling event would disturb a 10.8 to 107.6-square foot (1 to 10-square meter) area of seabed (BOEM 2014). Assuming all 147 WTG locations require geotechnical sampling, an area of up to 0.4 acres (1,740 square meters) would be disturbed.

5.4.1.1. Marine Mammals

Given that ESA-listed marine mammals do not forage on benthic prey species, effects of G&G surveys associated with the Proposed Action leading to benthic disturbance would have *no effect* on fin whale, NARW, or sperm whale.

5.4.1.2. Sea Turtles

Benthic disturbance associated with geotechnical surveys for the Proposed Action has the potential to reduce foraging habitat or prey availability for ESA-listed sea turtle species that forage in soft bottom habitats (i.e., Kemp's ridley sea turtle). These effects would be localized and short-term. Recolonization and recovery of prey species is expected to occur within 2 to 4 years (Van Dalfsen and Essink 2001) but could occur in as little time as 100 days (Dernie et al. 2003). Given the small size of individual disturbed areas and expected occurrence of similar, undisturbed benthic communities in the adjacent seabed, recolonization may occur relatively quickly following geotechnical surveys. Based on the short-term and localized nature of effects, the small area of disturbance, and the availability of similar foraging habitat throughout the action area, the effect of benthic habitat disturbance associated with geotechnical surveys for the Proposed Action on Kemp's ridley sea turtles would be too small to be meaningfully measured or detected. Given the small scale of anticipated effects, the effects of G&G surveys associated with the Proposed Action leading to benthic disturbance is *not likely to adversely affect (insignificant*) Kemp's ridley sea turtle. As green, leatherback, and loggerhead sea turtles do not forage in soft bottom habitats, the effects of G&G surveys associated with the Proposed Action leading to benthic disturbance would have *no effect* on these species.

5.4.1.3. Fish

Benthic disturbance associated with geotechnical surveys for the Proposed Action has the potential to reduce foraging habitat or prey availability for Atlantic sturgeon in the action area. These effects would be localized and short-term. Recolonization and recovery of prey species is expected to occur within 2 to 4 years (Van Dalfsen and Essink 2001) but could occur in as little as 100 days (Dernie et al. 2003). As noted in Section 5.4.1.2, recolonization may occur relatively quickly following geotechnical surveys. Based on the short-term and localized nature of effects, the small area of disturbance, and the availability of similar foraging habitat throughout the action area, the effect of benthic habitat disturbance associated with geotechnical surveys for the Proposed Action would be too small to be meaningfully measured or detected. Given the small scale of anticipated effects, the effects of G&G surveys associated with the Proposed Action leading to benthic disturbance is *not likely to adversely affect (insignificant*) Atlantic sturgeon.

5.4.2. Fisheries and Habitat Surveys and Monitoring

As described in Section 3.1.2.5, fisheries and benthic monitoring for the Proposed Action may include trawl surveys, baited remote underwater video surveys, eDNA sampling, acoustic telemetry, sea scallop plan view camera surveys, novel hard bottom monitoring, monitoring of structure-associated organic enrichment, and monitoring of cable-associated physical disturbance of soft sediments.

5.4.2.1. Risk of Capture/Entanglement

Trawl surveys have the potential to capture or entangle ESA-listed species.

5.4.2.1.1 Marine Mammals

Large whale species, including fin whale and NARW, have the speed and maneuverability to avoid oncoming mobile gear (NMFS 2016a) (e.g., trawls), and observations during mobile gear use have shown that capture or entanglement of large whales is extremely rare and unlikely (NMFS 2016a). For fisheries surveys associated with the Proposed Action, trawling would be delayed if any protected species are sighted in the vicinity of a trawl tow to minimize risk of interaction.

Given that survey activities anticipated are unlikely to pose an entanglement risk to ESA-listed marine mammals and the mitigation measures required for the survey activities (i.e., delaying trawling if marine mammals are sighted in the area), entanglement of ESA-listed marine mammals during fisheries surveys would be extremely unlikely to occur. Given the low likelihood of occurrence, the effects of fisheries and habitat surveys associated with the Proposed Action leading to capture or entanglement is *not likely to adversely affect (discountable*) fin whale, NARW, or sperm whale.

5.4.2.1.2 Sea Turtles

Sea turtle species are susceptible to capture in trawl nets or gillnets, which may result in injury or death. Limiting tow times to less than thirty minutes is expected to prevent mortality of sea turtles in trawl nets (Epperly et al. 2002; Sasso and Epperly 2006). Trawl surveys conducted as part of fisheries monitoring for the Project would be limited to tow times of 20 minutes or less.[9] All tows would be completed during daylight hours, and trawling would be delayed if any protected species are sighted in the vicinity of the trawl tow. Additionally, the proposed trawl survey would utilize a Turtle Excluder Device with a bottom-oriented escape outlet to reduce risks to sea turtles. If a sea turtle were captured in the proposed trawl surveys, sampling and release take priority over sampling of the rest of the catch. Based on the limited tow times and the prioritization of release of any captured sea turtles, mortality of sea turtles due to

[9] Trawling to support acoustic tagging would have tow times of 5 to 10 minutes.

fisheries surveys is not anticipated. Though sea turtles have the potential to be captured in the otter trawls under consideration for fisheries monitoring, BOEM considers likelihood of capture to be discountable and expects that any captured sea turtles would resume normal behaviors upon release and not suffer any biologically significant effects. If gillnets are utilized to capture fish for acoustic tagging, deployed nets would be continuously monitored and soaks would be limited to 24 hours or less to reduce the potential for serious injury and mortality of entangled sea turtles. All gillnet gear would be required to be in compliance with the Atlantic Large Whale Take Reduction Plan, Bottlenose Dolphin Take Reduction Plan, and the Harbor Porpoise Take Reduction Plan. The capture of sea turtles is possible. However, any captured animals are expected to be released alive and without any significant injury according to the proposed capture, handling, and release requirements in **Table 8**.

Based on the potential survey methods identified, sea turtles may be captured or entangled during fisheries surveys for the Project. With effective implementation of the mitigation measures to minimize impacts of fisheries and habitat surveys, mortality of sea turtles is not anticipated. Given that take may occur during fisheries surveys, the effects of fisheries and habitat surveys associated with the Proposed Action leading to injury due to capture or entanglement is *likely to adversely affect* green, Kemp's ridley, leatherback, and loggerhead sea turtles.

5.4.2.1.3 Fish

Atlantic sturgeon are susceptible to capture in trawl nets and gillnets, which may result in injury or death. However, the use of trawl gear has been used as a safe and reliable method to capture sturgeon if tow time is limited (NMFS 2014b). Trawl surveys conducted as part of fisheries monitoring for the Project would be limited to tow times of 20 minutes or less. Any captured sturgeon are expected to be released alive and without significant injury (NMFS 2016a). If gillnets are utilized to capture sturgeon for acoustic tagging, deployed nets would be continuously monitored for the capture of sturgeon and soaks would be limited to 24 hours or less to reduce the potential for serious injury and mortality of entangled sturgeon. The capture of sturgeon is possible. However, any captured animals are expected to be released alive and without any significant injury according to the proposed capture, handling, and release requirements in **Table 8**.

Given the anticipated mitigation requirements, including short tow times for trawl surveys, fisheries and habitat surveys are not expected to result in Atlantic sturgeon mortality. However, trawl surveys or gillnets may result in capture of some Atlantic sturgeon and potential minor injuries associated with their capture. Given that take may occur during fisheries surveys, the effects of fisheries and habitat surveys associated with the Proposed Action leading to injury due to capture is *likely to adversely affect* Atlantic sturgeon.

5.4.2.2. Effects to Prey and/or Habitat

Survey methods that capture organisms or result in habitat disturbance have the potential to affect prey or habitat for ESA-listed species. As noted in Section 3.1.2.5, fisheries monitoring surveys would utilize non-extractive techniques, to the extent possible.

5.4.2.2.1 Marine Mammals

Prey species of ESA-listed marine mammals are not subject to capture in the survey methods proposed for the Project, and ESA-listed marine mammal species do not utilize benthic habitats which may be disturbed during monitoring efforts. Therefore, the effects of fisheries and habitat surveys associated with the Proposed Action leading to impacts to prey and/or habitat are expected to have *no effect* on fin whale, NARW, or sperm whale.

5.4.2.2.2 Sea Turtles

Though the majority of biological survey methods proposed for the Project would be non-extractive, sea turtle prey items may be captured in trawl surveys. However, any species collected with this gear would be returned to the water, where they may be consumed by sea turtles. Therefore, effects of prey capture during fisheries surveys on ESA-listed sea turtles are expected to be too small to be meaningfully measured or detected. Disturbance of soft-bottom habitat in the action area during biological monitoring could potentially affect Kemp's ridley sea turtles, which forage in this type of habitat. However, such disturbance would be temporary and would affect a relatively small area of available habitat in the action area. Therefore, effects of benthic habitat disturbance during fisheries and habitat surveys on Kemp's ridley sea turtles would be too small to be meaningfully measured or detected. Given the small scale of anticipated effects, the effects of fisheries and habitat surveys associated with the Proposed Action leading to impacts on prey is *not likely to adversely affect (insignificant*) green, Kemp's ridley, leatherback, or loggerhead sea turtles. Given the small scale of anticipated effects, the effects of fisheries and habitat surveys associated with the Proposed Action leading to impacts on benthic habitat is *not likely to adversely affect (insignificant*) Kemp's ridley sea turtle. As green, leatherback, and loggerhead sea turtles do not utilize soft bottom habitats that may be disturbed during fisheries and habitat surveys, effects of fisheries and habitat surveys associated with the Proposed Action leading to impacts on benthic habitat would have *no effect* on these species.

5.4.2.2.3 Fish

Though the majority of biological survey methods proposed for the Project would be non-extractive, Atlantic sturgeon prey items (e.g., mollusks or fish), may be captured in trawl surveys. However, species collected with this gear would be returned to the water, where they may be consumed by sturgeon. Therefore, effects of prey capture during fisheries surveys on Atlantic sturgeon are expected to be too small to be meaningfully measured or detected. Trawls and grabs have the potential to disturb benthic habitat. However, such disturbance would be temporary and would affect a relatively small area of available habitat in the action area. Therefore, effects of benthic habitat disturbance during fisheries and habitat surveys on Kemp's ridley sea turtles would be too small to be meaningfully measured or detected. Given the small scale of anticipated effects, the effects of fisheries and habitat surveys associated with the Proposed Action leading to impacts on prey or benthic habitat is *not likely to adversely affect (insignificant*) Atlantic sturgeon.

5.4.3. Habitat Conversion and Loss

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

5.4.3.1. Wind Turbine Generators/Substations

The installation of up to 147 WTGs for the Proposed Action would result in the loss of up to 7.6 acres (30,798 square meters) of soft-bottom habitat in the foundation footprints. The installation of 2 OSSs would result in the loss of up to 1.3 acres (5,400 square meters) of soft-bottom habitat in the foundation footprints. Though the installation of WTGs and OSSs would result in the loss of soft-bottom habitat, it would also result in the conversion of open-water habitat to hard, vertical habitat. The hard, vertical structure attracts and aggregates prey species, which in turn attracts larger species (Causon and Gill 2018; Taormina et al. 2018), essentially creating an artificial reef. Studies of operating offshore wind farms have shown that this artificial reef effect results in increased species density, biomass, and biodiversity in the vicinity of offshore wind structures compared to the surrounding habitat (Degraer et al. 2020; Dong Energy et al. 2006).

5.4.3.1.1 Marine Mammals

The loss of soft-bottom habitat in the action area would not affect ESA-listed marine mammals, which do not use soft-bottom habitats. The aggregation of prey at artificial reefs could result in increased foraging opportunities for some marine mammal species, attracting them to the structures (Degraer et al. 2020; Pezy et al. 2018; Raoux et al. 2017; Wang et al. 2019). However, increased foraging opportunities would likely be limited to pinnipeds and small odontocetes. ESA-listed marine mammals likely to occur in or near the Lease Area (i.e., fin whale, NARW, sperm whale) are not expected to benefit from increased foraging opportunities and are therefore not expected to aggregate around offshore Project structures.

Aggregation of species at WTG and OSS foundations may result in increased recreational fishing activity in the vicinity of the structures. An increase in recreational fishing activity increases the risk of marine mammals becoming entangled in lost fishing gear, which could result in injury or mortality due to infection, starvation, or drowning (Moore and van der Hoop 2012). However, risk of injury or mortality to ESA-listed marine mammals associated with the small gear utilized by recreational fishers would be low and the effect of increased risk of entanglement would be too small to be meaningfully measured or detected. Given the small scale of anticipated effects, the effects of habitat loss and conversion associated with WTG and OSS foundations for the Proposed Action leading to injury due to entanglement in recreational fishing gear is *not likely to adversely affect (insignificant*) fin whale, NARW, or sperm whale.

5.4.3.1.2 Sea Turtles

The loss of soft-bottom habitat in the action area could potentially affect Kemp's ridley sea turtles, which forage in this type of habitat. However, the habitat loss would be small relative to similar habitat available in the action area. Therefore, habitat loss associated with WTGs and OSSs would have an insignificant effect on Kemp's ridley sea turtles. No effects of habitat loss are expected for other ESA-listed sea turtle species.

Aggregation of prey species at WTG and OSS foundations may benefit ESA-listed sea turtles due to prey aggregation, which may result in increased foraging opportunities for these species, attracting them to the structures. In the Gulf of Mexico, green, Kemp's ridley, leatherback, and loggerhead sea turtles have been documented in the presence of offshore oil and gas platforms (Gitschlag and Herczeg 1994; Gitschlag and Renauld 1989; Hastings et al. 1976; Rosman et al. 1987), indicating that sea turtles are likely to use habitat created by in-water structures to forage. However, increased foraging opportunities are not expected to be biologically significant given the broad geographic range used by sea turtles on their annual foraging migrations compared to the localized scale of artificial reef effects for the Proposed Action.

As noted in Section 5.4.3.1.1, aggregation of species may also result in increased recreational fishing activity in the vicinity of the WTGs and OSSs. An increase in recreational fishing activity increases the risk of sea turtles becoming entangled in or ingesting lost fishing gear, which could result in injury or death. Specifically, entanglement and hooking can cause abrasions, loss of limbs, or increased drag resulting in reduced swimming efficiency and decreased ability to forage or avoid predators (Berreiros and Raykov 2014; Gregory 2009; Vegter et al. 2014). Data from the Sea Turtle Stranding and Salvage Network show that 186 sea turtles were observed to have been hooked or entangled by recreational fishing gear between 2016 and 2018. Given that entanglement could occur, the effects of habitat loss and conversion associated with WTG and OSS foundations for the Proposed Action leading to injury or mortality due to entanglement in recreational fishing gear is *likely to adversely affect* green, Kemp's ridley, leatherback, and loggerhead sea turtles.

5.4.3.1.3 Fish

The loss of soft-bottom habitat in the action area could potentially affect Atlantic sturgeon, which forage in this type of habitat. However, the habitat loss would be small relative to similar habitat available in the action area. Therefore, effects of habitat loss associated with WTGs and OSSs would be too small to be meaningfully measured or detected. Given the small scale of anticipated effects, the effects of habitat loss associated with the WTG and OSS foundations for the Proposed Action leading to reductions in foraging habitat is *not likely to adversely affect (insignificant*) Atlantic sturgeon.

5.4.3.2. Anchoring

Vessel anchoring during construction and decommissioning of the Proposed Action may temporarily disturb approximately 7 acres of benthic habitat but is not expected to result in habitat loss or conversion in the action area.

5.4.3.3. Scour Protection

For the Proposed Action, the installation of scour protection around WTG foundations would result in the conversion of 127.6 acres (0.5 square kilometers) of soft-bottom habitat to hard-bottom habitat. The installation of scour protection around OSS foundations would result in the conversion of 3.0 acres (0.01 square kilometers) of soft-bottom habitat to hard-bottom habitat. The conversion of soft-bottom habitat to hard, vertical habitat would attract and aggregate prey species through the artificial reef effect (Causon and Gill 2018; Taormina et al. 2018).

5.4.3.3.1 Marine Mammals

The effect of habitat conversion associated with scour protection for the Proposed Action on ESA-listed marine mammals is expected to be similar to the effect of habitat conversion associated with WTGs and OSSs (Section 5.4.3.1.1). The loss of soft-bottom habitat would not affect ESA-listed marine mammals, which do not use this type of habitat. The aggregation of prey at artificial reefs could result in increased foraging opportunities for pinnipeds and small odontocetes (Degraer et al. 2020; Pezy et al. 2018; Raoux et al. 2017; Wang et al. 2019). However, ESA-listed marine mammals likely to occur in or near the Lease Area are not expected to benefit from increased foraging opportunities and are therefore not expected to aggregate around areas with scour protection.

Aggregation of species around scour protection may result in increased recreational fishing activity in the vicinity of the structures, which increases the risk of injury or mortality due to entanglement in lost fishing gear. However, risk of injury or mortality to ESA-listed marine mammals associated with the small gear utilized by recreational fishers would be low and the effect of increased risk of entanglement would be too small to be meaningfully measured or detected. Given the small scale of anticipated effects, the effects of habitat loss and conversion associated with scour protection for the Proposed Action leading to injury due to entanglement in recreational fishing gear is *not likely to adversely affect (insignificant*) fin whale, NARW, or sperm whale.

Aggregation of prey species is not expected to result in increased foraging opportunities for fin whales or NARWs, and the increased risk of entanglement associated with increased recreational fishing effort would be insignificant for these species.

5.4.3.3.2 Sea Turtles

The effect of habitat conversion associated with scour protection for the Proposed Action on ESA-listed sea turtles is expected to be similar to the effect of habitat conversion associated with WTGs and OSSs (Section 5.4.3.1.2). The loss of soft-bottom habitat in the action area could potentially affect Kemp's ridley sea turtles, which forage in this type of habitat. However, the habitat loss would be small relative to similar habitat available in the action area. Therefore, habitat loss associated with scour protection would have an insignificant effect on Kemp's ridley sea turtles. No effects of habitat loss are expected for other ESA-listed sea turtle species.

Aggregation of prey species in areas with scour protection may benefit ESA-listed sea turtles due to prey aggregation, which may result in increased foraging opportunities for these species, attracting them to the structures. In the Gulf of Mexico, green, Kemp's ridley, leatherback, and loggerhead sea turtles have been documented in the presence of offshore oil and gas platforms (Gitschlag and Herczeg 1994; Gitschlag and Renauld 1989; Hastings et al. 1976; Rosman et al. 1987), indicating that sea turtles are likely to use habitat created by in-water structures to forage. However, increased foraging opportunities are not expected to be biologically significant given the broad geographic range used by sea turtles on their annual foraging migrations compared to the localized scale of artificial reef effects for the Proposed Action.

Aggregation of species may also result in increased recreational fishing activity around areas with scour protection. An increase in recreational fishing activity increases the risk of sea turtles becoming entangled in or ingesting lost fishing gear, which could result in injury or death. Specifically, entanglement and hooking can cause abrasions, loss of limbs, or increased drag resulting in reduced swimming efficiency and decreased ability to forage or avoid predators (Berreiros and Raykov 2014; Gregory 2009; Vegter et al. 2014). Data from the Sea Turtle Stranding and Salvage Network show that 186 sea turtles were observed to have been hooked or entangled by recreational fishing gear between 2016 and 2018. Given that entanglement could occur, the effects of habitat loss and conversion associated with scour protection for the Proposed Action leading to injury or mortality due to entanglement in recreational fishing gear is *likely to adversely affect* green, Kemp's ridley, leatherback, and loggerhead sea turtles.

5.4.3.3.3 Fish

The effect of habitat conversion associated with scour protection for the Proposed Action on Atlantic sturgeon is expected to be similar to the effect of habitat loss associated with WTGs and OSSs (Section 5.4.3.1.3). The loss of soft-bottom habitat in the action area could potentially affect Atlantic sturgeon, which forage in this type of habitat. However, the habitat loss would be small relative to similar habitat available in the action area. Therefore, effects of habitat loss associated with scour protection would be too small to be meaningfully measured or detected. Given the small scale of anticipated effects, the effects of habitat loss associated with the scour protection for the Proposed Action leading to reductions in foraging habitat is *not likely to adversely affect (insignificant*) Atlantic sturgeon.

5.4.3.4. Cable Presence/Protection

For the Proposed Action, the installation of cable protection for the export cables would result in the conversion of 23 acres (0.09 square kilometers) of soft-bottom habitat to hard-bottom habitat. No cable protection is anticipated for the inter-array cables. This conversion of soft-bottom habitat to hard, vertical habitat would attract and aggregate prey species through the artificial reef effect (Causon and Gill 2018; Taormina et al. 2018).

5.4.3.4.1 Marine Mammals

The effect of habitat conversion associated with cable protection for the Proposed Action on ESA-listed marine mammals is expected to be similar to the effect of habitat conversion associated with WTGs and OSSs (Section 5.4.3.1.1) and scour protection (Section 5.4.3.3.1). Aggregation of prey species is not expected to result in increased foraging opportunities for fin whales or NARWs, and effects of the increased risk of entanglement associated with increased recreational fishing effort would be too small to be meaningfully measured or detected. Given the small scale of anticipated effects, the effects of habitat loss and conversion associated with cable protection for the Proposed Action leading to injury due to entanglement in recreational fishing gear is *not likely to adversely affect (insignificant*) fin whale, NARW, or sperm whale.

5.4.3.4.2 Sea Turtles

The effect of habitat conversion associated with cable protection for the Proposed Action on ESA-listed sea turtles is expected to be similar to the effect of habitat conversion associated with WTGs and OSSs (Section 5.4.3.1.2) and scour protection (Section 5.4.3.3.2). Aggregation of prey species would likely increase foraging opportunities for these species. However, this increase is not expected to be biologically significant. Increased recreational fishing effort may result in an increase in entanglement risk for sea turtles. Given that entanglement could occur, the effects of habitat loss and conversion associated with cable protection for the Proposed Action leading to injury or mortality due to entanglement in recreational fishing gear is *likely to adversely affect* green, Kemp's ridley, leatherback, and loggerhead sea turtles.

5.4.3.4.3 Fish

The effect of habitat conversion associated with cable protection for the Proposed Action on Atlantic sturgeon is expected to be similar to the effect of habitat loss associated with WTGs and OSSs (Section 5.4.3.1.3) and the effect of habitat conversion associated with scour protection (Section 5.4.3.3.3). Habitat conversion would result in a reduction in soft-bottom foraging habitat for this species. However, this reduction would be small relative to similar habitat in the action area, and the effects of loss of foraging habitat would be too small to be meaningfully measured or detected. Given the small scale of anticipated effects, the effects of habitat loss associated with the cable protection for the Proposed Action leading to reductions in foraging habitat is *not likely to adversely affect (insignificant*) Atlantic sturgeon.

5.4.4. Turbidity

Construction activities for the Proposed Action would include impact pile driving for WTG and OSS foundation installation, cable-laying activities for installation of inter-array and export cables, and dredging for bulkhead improvements at the South Brooklyn Marine Terminal and seabed preparation for cable installation, as described in Section 3.1.2. These activities would disturb bottom sediment, resulting in short-term increases in turbidity in the vicinity of the immediate Project area. The Project may also include HDD for export cable landfall and vibratory pile driving for installation of temporary cofferdams, which would likely have similar or lesser turbidity effects than impact pile driving, cable laying, and dredging and would occur in nearshore waters, potentially limiting which ESA-listed species are exposed to turbidity associated with these activities.

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

During cable installation, jet plowing is expected to produce maximum TSS concentrations of approximately 235.0 mg/L at 65 feet (20 meters) from the jet plow, with concentrations decreasing to 43.0 mg/L within 656 feet (200 meters) (NMFS 2020c citing ESS Group 2008). Sediment transport analysis conducted for the Project predicted that the sediment plume would extend between 328 and 1,640 feet (100 and 500 meters) along the majority of the cable routes but could extend as far as 3,280 feet (1,000 meters) in areas with strong currents (Empire 2022a). At this distance, maximum TSS concentrations were generally below 30 mg/L. Sediment plumes associated with cable installation would be present for up to six hours at a time until the activity is completed, and suspended sediment settles back to the seabed. The increases in suspended sediment associated with cable emplacement and maintenance would be localized to the cable corridors.

Measurements of suspended sediment concentrations associated with mechanical clamshell dredging indicate that TSS concentrations above background levels would be present in the lower water column for a distance of approximately 2,400 feet (732 meters) (NMFS 2020c citing USACE 2015). TSS concentrations associated with mechanical dredge sediment plumes typically range from 105 to 445 mg/L with the highest levels near the bottom of the water column (NMFS 2020c citing USACE 2001). The increases in suspended sediment associated with dredging for bulkhead improvements would be localized to the area around the South Brooklyn Marine Terminal. TSS levels associated with suction hopper dredging may reach 475 mg/L (NMFS 2020c citing Anchor Environmental 2003), and sediment plumes associated with suction hopper dredging may extend up to 3,937 feet (1,200 meters) (NMFS 2020c citing Wilbur and Clarke 2001).

During Project operation, routine maintenance activities, as described in Section 3.1.2, could result in short-term increases in turbidity in the vicinity of the immediate Project area. Any increases in TSS concentrations would occur in the immediate Project area and are not expected to exceed background levels associated with natural events (Empire 2022a).

Decommissioning activities would include removal and/or decommissioning of all Project infrastructure and clearance of the seabed of all obstructions at the end of the Project's 35-year designed service life, as described in Section 3.1.2.6. Some activities would result in bottom disturbance, resulting in short-term increase in turbidity in the vicinity of the immediate Project area. Impacts during decommissioning, including turbidity impacts, are expected to be similar or less than those experienced during construction (Empire 2022a).

5.4.4.1. Marine Mammals

As marine mammals may occur within portion of the action area affected by pile driving, cable laying, and dredging during construction, as well as O&M and decommissioning activities, increased turbidity associated with the Proposed Action could potentially affect these species. There are no data on the physiological effects of suspended sediment on whales. However, elevated suspended sediment may cause these species to alter their normal movements. Such alterations are expected to be too small to be meaningfully measured or detected (NMFS 2020c). No effects are anticipated if whales swim through the area of elevated suspended sediment. Suspended sediment is most likely to impact whales if the area of elevated concentrations acts as a barrier to normal behaviors. However, whales are expected to swim through sediment plumes or avoid the area of increased turbidity with no adverse effects (NMFS 2020c).

Sediment plumes associated with Project activities would be localized and short term. The plumes generated by pile driving, jet plowing, mechanical dredging, and suction hopper dredging are estimated to have radii of 300 feet (91 meters), 3,280 feet (1,000 meters), 2,400 feet (732 meters), and 3,937 feet (1,200 meters) respectively (Section 5.4.4). Given the limited spatial scale of the sediment plumes relative to the size of the action area, increased suspended sediment concentrations associated with Project activities are not expected to obstruct the movement of marine mammals in the action area.

Based on the anticipated non-detectable changes in marine mammal movements, the effects of elevated turbidity associated with the Proposed Action would be too small to be meaningfully measured, detected, or evaluated. Given the small scale of anticipated effects, the effects of increased turbidity associated with the Proposed Action leading to behavioral impacts is *not likely to adversely affect (insignificant*) fin whale, NARW, or sperm whale.

5.4.4.2. Sea Turtles

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

As described in Section 5.4.4, the suspended sediment plumes associated with Project activities would be localized and short term. The maximum sediment plume radius generated by the Proposed Action would be 3,937 feet (1,200 meters), associated with suction hopper dredging. Given the limited spatial scale of the sediment plumes relative to the size of the action area, increased suspended sediment concentrations associated with Project activities are not expected to obstruct the movement of sea turtles in the action area.

The maximum suspended sediment concentrations associated with pile driving (5 to 10 mg/L) and jet plowing (235 mg/L) are below the threshold that could have negative impacts on benthic communities (390 mg/L). However, maximum suspended sediment concentrations associated with the mechanical dredge (445 mg/L) and suction hopper dredge (475 mg/L) are above the concentration that could have negative impacts on benthic communities. It is anticipated that there would be a short-term impact on the availability of prey species within the area of direct impact; however, it is anticipated that this area would be recolonized within a short period of time after the completion dredging. Because the habitat disturbance would affect a relatively small amount of the action area and because of the short-term nature of the disturbance, the Project is expected to result in negligible reductions in benthic shellfish and infaunal organisms that serve as prey for ESA-listed species (NMFS 2020c), including sea turtles.

Based on the anticipated non-detectable changes in sea turtle movements and the negligible reductions in prey species, the effects of elevated turbidity associated with the Proposed Action would be too small to be meaningfully measured, detected, or evaluated. Given the small scale of anticipated effects, the effects of increased turbidity associated with the Proposed Action leading to behavioral impacts is *not likely to adversely affect (insignificant*) green, Kemp's ridley, leatherback, or loggerhead sea turtles.

5.4.4.3. Fish

As Atlantic sturgeon may occur within portions of the action area affected by pile driving, cable laying, and dredging during construction, as well as O&M and decommissioning activities, increased turbidity associated with Project activities could potentially affect this species. Studies of the effects of turbid water on fish suggest that concentrations of suspended sediment can reach thousands of milligrams per liter before an acute toxic reaction is expected (NMFS 2020c citing Burton 1993). TSS levels shown to have adverse effects on fish are typically above 1,000 mg/L (see summary of scientific literature in Burton 1993; Wilber and Clarke 2001). Potential physiological effects of suspended sediment on fish include gill clogging and increased stress (NMFS 2017). High TSS levels can cause a reduction in DO levels, and Atlantic sturgeon may become stressed when DO falls below certain levels (NMFS 2020c).

Increased turbidity can also result in behavioral effects in fish, such as foraging interference or inhibition of movement (NMFS 2017). However, increased turbidity is not expected to impact the ability of Atlantic sturgeon to forage as they are not visual foragers. Sturgeon rely on their barbels to detect prey and are known to forage during nighttime hours (NMFS 2017). Suspended sediment concentrations below those required for physiological impacts are not expected to inhabit sturgeon movement (NMFS 2017). While the increase in turbidity associated with the Proposed Action may cause Atlantic sturgeon to alter their normal movements, these minor movements would be too small to be meaningfully measured or detected. TSS is most likely to affect sturgeon if a plume causes a barrier to normal behaviors. However, Atlantic sturgeon are expected to swim through the plume and otherwise avoid the area with no adverse effects (NMFS 2020c). Increased suspended sediment concentrations could also affect Atlantic sturgeon indirectly by affecting benthic prey species. TSS levels are shown to have adverse effects on benthic communities when they exceed 390.0 mg/L (NMFS 2020c citing USEPA 1986).

As described in Section 5.4.4, the suspended sediment plumes associated with Project activities would be localized and short term. The maximum sediment plume radius generated by the Proposed Action would be 3,937 feet (1,200 meters), associated with suction hopper dredging. Given the limited spatial scale of the sediment plumes relative to the size of the action area, increased suspended sediment concentrations associated with Project activities are not expected to obstruct the movement of Atlantic sturgeon in the action area.

The maximum suspended sediment concentrations associated with pile driving (5 to 10 mg/L), jet plowing (230 mg/L), mechanical dredging (445 mg/L), and suction hopper dredging (475 mg/L) are below the threshold concentration for physiological effects on Atlantic sturgeon. The maximum expected suspended sediment concentrations associated with mechanical are above the level associated with negative impacts on benthic communities. It is anticipated that there will be a short-term impact on the availability of prey species within the area of direct impact; however, it is expected that this area will be recolonized within a short period of time after dredging is complete. Due to the small area in which benthic communities could be impacted relative the action area and the short-term nature of the impact, the Proposed Action is expected to result in negligible reductions in benthic shellfish and infaunal organisms that serve as prey for ESA-listed species (NMFS 2020c), including Atlantic sturgeon.

Given that suspended sediment concentrations associated with the Proposed Action would be below physiological thresholds for sturgeon and reductions in foraging opportunities for Atlantic sturgeon would be negligible, the effects of increased turbidity would be too small to be meaningfully measured, detected, or evaluated. Based on the small scale of anticipated effects, the effects of increased turbidity associated with the Proposed Action leading to behavioral impacts is *not likely to adversely affect (insignificant*) Atlantic sturgeon.

5.4.5. Physical Presence of Wind Turbine Generators on Atmospheric/Oceanographic Conditions

The presence of WTGs during operation of the Proposed Action could alter local hydrodynamic patterns at a fine scale. Water flows are reduced immediately downstream of foundations but return to ambient levels within a relatively short distance (Miles et al. 2017). The downstream area affected by reduced flows is dependent on pile diameter. For monopiles, effects are expected to dissipate within 300 to 400 feet. Individual foundations may increase vertical mixing and deepen the thermocline, potentially increasing pelagic productivity locally (English et al. 2017; Kellison and Sedberry 1998). Although effects from individual structures are highly localized, the presence of 147 WTG structures could result in impacts over a larger area within the turbine array. Modeling in the North Sea demonstrated that offshore wind farms have the potential to reduce wind speed at the water surface and in turn influence temperature and salinity distribution in the wind farm area (Christiansen et al. 2022). In comparison to long-term variation in temperature and salinity, wind farm effects were relatively small. However, impacts on stratification strength at a large scale and atypical mesoscale variations in current may occur (Christiansen et al. 2022). Conversely, infrastructure associated with offshore wind farms may increase mixing in stratified shelf seas (Dorrell et al. 2022). Stratification may influence the mixed layer depth, which in turn affects primary productivity. Alterations in primary productivity may alter typical distributions of fish and invertebrates on the OCS, which are normally driven by primary productivity associated with cold pool upwelling (Chen et al. 2018; Lentz 2017; Matte and Waldhauer 1984).

5.4.5.1. Marine Mammals

As described in Section 5.4.5, the alterations in atmospheric and oceanographic conditions due to the presence of WTGs may impact primary productivity, which is influenced by stratification of the water column. Changes in primary productivity could have localized impacts on prey species for ESA-listed marine mammals, particularly fin whale and NARW, which feed on plankton. Increased mixing of the water column may decrease concentrations of plankton, potentially reducing efficient foraging opportunities for these species in the vicinity of the Lease Area. However, the scale of these effects would be limited relative to foraging areas available in the region, and effects at this scale are expected to be too small to be meaningfully measured or detected. Based on the small scale of anticipated effects, the effects of alterations to atmospheric and oceanographic conditions associated with the physical presence of WTGs for the Proposed Action leading to reductions in prey density is *not likely to adversely affect (insignificant*) fin whale or NARW.

Though sperm whales do not forage on plankton, distributions of their prey may be affected by changes in primary productivity associated with changes in atmospheric and oceanographic conditions due to the physical presence of WTGs (Chen et al. 2018; Lentz 2017; Matte and Waldhauer 1984). Based on the scale of alterations in atmospheric and oceanographic conditions, any changes in prey distributions are expected to be small, and effects of these changes in distribution would be too small to be meaningfully measured or detected. Given the small scale of anticipated effects, the effects of alterations to atmospheric and oceanographic conditions associated with the physical presence of WTGs for the Proposed Action leading to changes in prey distribution is *not likely to adversely affect (insignificant*) sperm whale.

5.4.5.2. Sea Turtles

ESA-listed sea turtles do not consume plankton; however, distributions of prey may be affected by changes in primary productivity associated with changes in atmospheric and oceanographic conditions due to the physical presence of WTGs (Chen et al. 2018; Lentz 2017; Matte and Waldhauer 1984). Based on the scale of alterations in atmospheric and oceanographic conditions that would be required to alter ecosystems in such a manner that would impact sea turtles, the expected small changes in prey distributions would be too small to meaningfully measure or detect changes in prey distribution. Given the small scale of anticipated effects, the effects of alterations to atmospheric and oceanographic conditions associated with the physical presence of WTGs for the Proposed Action leading to changes in prey distribution is *not likely to adversely affect (insignificant*) green, Kemp's ridley, leatherback, or loggerhead sea turtles.

5.4.5.3. Fish

Changes in atmospheric and oceanographic conditions may affect distribution of prey species (Chen et al. 2018; Lentz 2017; Matte and Waldhauer 1984). However, Atlantic sturgeon forage on benthic prey, whose distribution is less influenced by primary productivity, the driver behind potential shifts in prey distribution associated with changes in atmospheric and oceanographic conditions. Therefore, effects on Atlantic sturgeon due to shifts in prey distribution are unlikely to occur. Given the low likelihood of effects, the effects of alterations to atmospheric and oceanographic conditions associated with the physical presence of WTGs for the Proposed Action leading to changes in prey distribution is *not likely to adversely affect (discountable)* Atlantic sturgeon.

5.4.6. Physical Presence of Wind Turbine Generators on Listed Species

In addition to effects on oceanographic conditions (Section 5.4.5), the physical presence of WTGs during operation of the Proposed Action may have direct effects on ESA-listed species in the vicinity of the Lease Area, including avoidance, displacement, or behavioral disruption.

5.4.6.1. Marine Mammals

The presence of structures associated with the Proposed Action could result in avoidance and displacement of marine mammals, which could potentially move them into areas with lower habitat value or with higher risk of vessel collision or fisheries interactions. Fisheries interactions are likely to have demographic effects on marine mammal species. Entanglement is a significant threat for NARW. Seventy-two percent of NARWs show evidence of past entanglements (Johnson et al. 2005), and entanglement in fishing gear is a leading cause of death for this species and may be limiting population recovery (Knowlton et al. 2012). Entanglement may also be a significant cause of death for other mysticete species (Read et al. 2006).

Disruption of normal behaviors could also occur due to the presence WTGs. Although spacing between the structures would be sufficient to allow marine mammals to utilize habitat between and around structures, information about large whale responses to offshore wind structures is lacking. The presence of structures could have long-term, intermittent impacts on foraging, migration, and other normal behaviors.

Given that displacement of marine mammals may increase risk of vessel strike or entanglement, the effects of displacement associated with the physical presence of WTGs for the Proposed Action leading to injury or mortality is *likely to adversely affect* fin whale, NARW, and sperm whale.

5.4.6.2. Sea Turtles

The presence of WTG structures could result in sea turtle avoidance and displacement, which could potentially move sea turtles into areas with lower habitat value or with a higher risk of vessel collision or fisheries interactions. However, the habitat quality for sea turtles does not greatly vary within and around the immediate Project area. Any avoidance or displacement is expected to be short term.

Disruption of normal behaviors, such as foraging and migration, could occur due to the presence of WTGs. Spacing between the Project WTGs would be sufficient to allow sea turtles to utilize habitat between and around structures for foraging, resting, and migrating. Although migrations could be temporarily interrupted as sea turtles stop to forage or rest around WTGs, the presence of structures is not expected to result in measurable changes in sea turtle migratory patterns.

Given that displacement of sea turtles may increase risk of vessel strike or entanglement, the effects of displacement associated with the physical presence of WTGs for the Proposed Action leading to injury or mortality is *likely to adversely affect* green, Kemp’s ridley, leatherback, and loggerhead sea turtles.

5.4.6.3. Fish

The effects of WTG structures on fish movements and migrations are not yet known (Sparling et al. 2020). However, there is some evidence that offshore wind structures may create stopover locations for migratory fishes (Rothermel et al. 2020), such as Atlantic sturgeon. Stopover locations may benefit migrating fish by providing feeding opportunities but may also disrupt or slow migrations (Rothermel et al. 2020). Behavioral effects may affect the migrations of individual fish, but they are not expected to have broad impacts on Atlantic sturgeon migration, and any effects on migratory deviations would be too small to be meaningfully measured or detected. Given the small scale of effects, the effects of the physical presence of WTGs for the Proposed Action leading to alterations in movements or migrations is *not likely to adversely affect (insignificant)* Atlantic sturgeon.

5.4.7. Electromagnetic Fields and Heat from Cables

The Proposed Action would include installation of up to 66 nautical miles (122 kilometers) of export cables and 260 nautical miles (481 kilometers) of inter-array cables, increasing the production of EMF and heat in the immediate Project area. EMF and heat effects would be reduced by cable burial to an appropriate depth and the use of shielding, if necessary.

5.4.7.1. Marine Mammals

Marine mammals are capable of detecting magnetic field gradients of 0.1 percent of the Earth's magnetic field (i.e., approximately 0.05 microtesla) (Kirschvink 1990). Based on this sensitivity, marine mammals are likely very sensitive to minor changes in magnetic fields (Walker et al. 2003) and may react to local variation in geomagnetic fields associated with cable EMFs. These variations could result in short-term effects on swimming direction or migration detours (Gill et al. 2005). However, no EMF impacts on marine mammals associated with underwater cables have been documented. Empire would bury cables to a minimum depth of 6 feet (1.8 meters) wherever possible (APM 101). In areas where sufficient cable burial is not feasible, surface cable protection would be utilized. Cable burial and surface protection, where necessary, would minimize EMF exposure for ESA-listed marine mammals. Any potential impacts on ESA-listed marine mammals from EMF associated with the Proposed Action are expected to be too small to be measured. Given the small scale of effects, the effects of EMF associated with the Proposed Action leading to alterations in movements or migrations is *not likely to adversely affect (insignificant)* fin whale, NARW, or sperm whale.

5.4.7.2. Sea Turtles

Sea turtles are capable of detecting magnetic fields, and behavioral responses to such fields have been documented. The threshold for behavioral responses varies somewhat among species. Loggerhead sea turtles have exhibited responses to field intensities ranging from 0.0047 to 4,000 microteslas, and green sea turtles have responded to field intensities ranging from 29.3 to 200 microteslas (Normandeau et al. 2011); other species are expected to have similar thresholds due to similar anatomical features, behaviors, and life history characteristics. Juvenile and adult sea turtles may detect EMFs when foraging on benthic prey or resting on the bottom in relatively close proximity to cables. There are no data on EMF impacts on sea turtles associated with underwater cables. Migratory disruptions have been documented in sea turtles with magnets attached to their heads (Luschi et al. 2007), but evidence that EMF associated with future offshore wind activities would likely result in some deviations from direct migration routes is lacking (Snoek et al. 2016). Any deviations are expected to be minor (Normandeau et al. 2011), and any increased energy expenditure due to these deviations would not be biologically significant. Empire would bury cables to a minimum depth of 6 feet (1.8 meters) wherever possible (APM 101). In areas where sufficient cable burial is not feasible, surface cable protection would be utilized. Any potential impacts on ESA-listed sea turtles from EMF associated with the Proposed Action are expected to be too small to be measured. Given the small scale of effects, the effects of EMF associated with the Proposed Action leading to alterations in movements or migrations is *not likely to adversely affect (insignificant)* green, Kemp's ridley, leatherback, or loggerhead sea turtles.

Buried submarine cables can warm the surrounding sediment in contact with the cables up to tens of centimeters (Taormina et al. 2018). There are no data on cable heat effects on sea turtles (Taormina et al.

2018). However, increased heat in the sediment could affect benthic organisms which serve as prey for sea turtles that forage in the benthos. Based on the narrowness of cable corridors and expected weakness of thermal radiation, impacts on benthic organisms are not expected to be significant (Taormina et al. 2018) and would be limited to a small area around the cable. Given the expected cable burial depths, thermal effects would not occur at the surface of the seabed where benthic-feeding sea turtles would forage. Therefore, any effects on sea turtle prey availability would be too small to be detected or meaningfully measured. Given the small scale of effects, the effects of heat associated with the Proposed Action leading to alterations in prey availability is *not likely to adversely affect (insignificant)* green, Kemp's ridley, leatherback, or loggerhead sea turtles.

5.4.7.3. Fish

Electromagnetic-sensitive species (e.g., sharks, rays) have been shown to respond to HVAC, but adverse consequences have not been established (Gill et al. 2012). EMF from alternating current cables is not expected to adversely affect commercially and recreationally important species in the southern New England area (CSA Ocean Sciences, Inc. and Exponent 2019), and studies have shown that EMF would not interfere with movement or migration of marine species (Kavet et al. 2016). Empire would bury cables to a minimum depth of 6 feet (1.8 meters) wherever possible (APM 101), which would minimize the strength of the EMF in the water column. Therefore, any potential impacts on Atlantic sturgeon from EMF associated with the Proposed Action are expected to be too small to be measured. Given the small scale of effects, the effects of EMF associated with the Proposed Action leading to alterations in movements or migrations is *not likely to adversely affect (insignificant)* Atlantic sturgeon.

As described in Section 5.4.7.2, buried submarine cables can warm the surrounding sediment in contact with the cables up to tens of centimeters, but impacts to benthic organisms are expected to be insignificant (Taormina et al. 2018) and would be limited to a small area around the cable. Given the expected cable burial depths, thermal effects would not occur at the surface of the seabed where Atlantic sturgeon forage. Therefore, any effects on sturgeon prey availability would be too small to be detected or meaningfully measured. Given the small scale of effects, the effects of heat associated with the Proposed Action leading to alterations in prey availability is *not likely to adversely affect (insignificant)* Atlantic sturgeon.

5.4.8. Lighting and Marking of Structures and Vessels

Vessels and offshore structures associated with future offshore wind activity would have deck and safety lighting, producing artificial light during the construction, O&M, and decommissioning phases of the Proposed Action. Offshore structures would have yellow flashing navigational lighting and red flashing FAA hazard lights, in accordance with BOEM's (2021a) lighting and marking guidelines. Following these guidelines, direct lighting would be avoided, and indirect lighting of the water surface would be minimized to the greatest extent practicable.

5.4.8.1. Marine Mammals

Lighting is not expected to have direct effects on marine mammals. However, artificial light may affect the distribution of zooplankton in the water column (Orr et al. 2013). A change in prey species distribution could affect ESA-listed marine mammals. Empire would light WTGs and OSSs in compliance with FAA and USCG standards and BOEM best practices (APM 168 and APM 219) and would avoid intentionally illuminating the water surface (APM 91). Empire has additionally proposed the use of an ADLS to minimize the time that FAA-required lighting is illuminated on the offshore structures associated with the Proposed Action (APM 88). Given the mitigation measures proposed, effects of lighting of vessels and offshore structures associated with the Proposed Action on ESA-listed marine mammals would be too small to be meaningfully measured or detected. Given the small scale of effects, the effects of lighting associated with the Proposed Action leading to alterations in prey distribution is *not likely to adversely affect (insignificant)* fin whale, NARW, or sperm whale.

5.4.8.2. Sea Turtles

The flashing lights on offshore structures associated with the Proposed Action are unlikely to disorient juvenile or adult sea turtles, as they do not present a continuous light source (Orr et al. 2013). However, lighting on vessels and offshore structures could elicit attraction, avoidance, or other behavioral responses in sea turtles. In laboratory experiments, juvenile loggerhead sea turtles consistently oriented toward lightsticks of various colors and types used by pelagic longline fisheries (Wang et al. 2019), indicating that hard-shelled sea turtle species expected to occur in the vicinity of the Projects (i.e., green, Kemp's ridley, and loggerhead) could be attracted to offshore light sources. In contrast, juvenile leatherback sea turtles failed to orient toward or oriented away from lights in laboratory experiments (Gless et al. 2008), indicating that this species may not be attracted to offshore lighting. There is no evidence that lighting on oil and gas platforms in the Gulf of Mexico, which may have considerably more lighting than offshore WTGs, has had any effect on sea turtles over decades of operation (BOEM 2019b). Any behavioral responses to offshore lighting are expected to be localized and temporary. Empire would light WTGs and OSSs in compliance with FAA and USCG standards and BOEM best practices (APM 168 and APM 219) and would avoid intentionally illuminating the water surface (APM 91). Empire has additionally proposed the use of an ADLS to minimize the time that FAA-required lighting is illuminated on the offshore structures associated with the Proposed Action (APM 88). With these mitigation measures, effects of lighting of vessels and offshore structures associated with the Proposed Action on ESA-listed sea turtles would be too small to be meaningfully measured or detected. Given the small scale of effects, the effects of light associated with the Proposed Action leading to behavioral response is *not likely to adversely affect (insignificant)* green, Kemp's ridley, leatherback, or loggerhead sea turtles.

5.4.8.3. Fish

Artificial lighting could elicit temporary attraction, avoidance, or other behavioral responses in some finfish, potentially affecting distributions near the light source. Atlantic sturgeon are demersal and forage on benthic prey. Therefore, neither the species nor its prey are likely to be exposed to artificial light associated with the Proposed Action. Empire would use lighting on the WTGs and OSS that complies with FAA and USCG standards and would follow BOEM best practices to minimize illumination of the water surface (APM 91). Furthermore, Empire has proposed the use of an ADLS to minimize the time that FAA-required lighting is illuminated on the offshore structures (APM 91). Based on the habitat used by Atlantic sturgeon and the measures in place to reduce artificial lighting of the water surface, lighting effects on Atlantic sturgeon are extremely unlikely to occur. Given the low likelihood of effects, the effects of light associated with the Proposed Action leading to behavioral response or alterations in prey distribution is *not likely to adversely affect (insignificant)* Atlantic sturgeon.

5.4.9. Offshore Substations

The Proposed Action includes the installation and operation of two OSSs in the Lease Area. Potential impacts associated with impact pile driving and vessel traffic during foundation installation, and with the presence of the structure are discussed in previous sections. The potential effects related to cooling water withdrawals and impacts to prey species are discussed in this section.

5.4.9.1. Water Withdrawals/Risk of Impingement and/or Entrainment

Operation and maintenance of the OSSs would not require water withdrawals. Therefore, there would be no risk of impingement or entrainment of ESA-listed species.

5.4.9.2. Impacts to Prey

As noted in Section 5.4.9.1, O&M of the OSSs would not require water withdrawals. Therefore, there would be no risk of impingement or entrainment prey for ESA-listed species.

5.4.10. Summary of Effects

5.4.10.1. Marine Mammals

Habitat disturbance or modifications associated with G&G surveys would have no effect on ESA-listed marine mammals. Habitat conversion and loss associated with WTGs, OSSs, scour protection, and cable protection is not expected to increase foraging opportunities for ESA-listed marine mammals and may increase entanglement risk due to increased recreational fishing activity. However, the effect of increased risk of entanglement in recreational fishing gear would be too small to be meaningfully measured or detected. Increased turbidity associated with the Proposed Action may result in short-term localized effects on ESA-listed marine mammals, but these effects would be too small to be meaningfully measured or detected. The physical presence of WTGs in the Lease Area could directly affect ESA-listed marine mammals through avoidance, displacement, or behavioral disruption or indirectly through localized hydrodynamic effects. Effects associated with any behavioral disruption or hydrodynamic changes are expected to be too small to be meaningfully measured or detected. Effects of EMF associated with submarine cables and lighting of vessels and offshore structures are also expected to be too small to be meaningfully measured or detected.

5.4.10.2. Sea Turtles

Habitat disturbance associated with G&G surveys would be short-term and localized to a small area. Therefore, effects of associated impacts on soft-bottom foraging habitat and prey resources for Kemp's ridley sea turtle would be too small to be meaningfully measured or detected. Other ESA-listed sea turtles do not forage in soft sediments and would therefore not be affected by G&G survey habitat disturbance. Habitat conversion and loss associated with WTGs, OSSs, scour protection, and cable protection may increase foraging opportunities for ESA-listed sea turtles but may also increase entanglement risk due to increased recreational fishing activity. Increased turbidity associated with the Proposed Action may result in short-term localized effects on ESA-listed sea turtles, but these effects would be short-term and minor and any impacts to sea turtles would be too small to be meaningfully measured or detected. The physical presence of WTGs in the Lease Area could directly affect ESA-listed sea turtles through avoidance, displacement, or behavioral disruption or indirectly through localized hydrodynamic effects. Any direct or indirect effects associated with the presence of WTGs too small to be meaningfully measured or detected. Effects of EMF and heat associated with submarine cables and lighting of vessels and offshore structures are also expected to be too small to be meaningfully measured or detected. Fisheries and habitat surveys are expected to potentially result in capture and minor injury of sea turtles.

5.4.10.3. Fish

Habitat disturbance associated with G&G surveys would be short-term and localized to a small area. Therefore, effects of associated impacts on Atlantic sturgeon would be too small to be meaningfully measured or detected. Habitat loss associated with WTGs, OSSs, scour protection, and cable protection may reduce foraging opportunities for Atlantic sturgeon. Increased turbidity associated with the Proposed Action may result in short-term localized effects on Atlantic sturgeon, but these effects would be too small to be meaningfully measured or detected. The physical presence of WTGs in the Lease Area could directly affect Atlantic sturgeon through disruptions of movements or migrations. Effects of EMF and heat associated with submarine cables and lighting of vessels and offshore structures are expected to be too small to be meaningfully measured or detected. Effects associated with lighting of vessels and offshore structures are extremely unlikely to occur given benthic habitat typically occupied by this species. Fisheries and habitat surveys are expected to potentially result in capture and minor injury of Atlantic sturgeon.

5.5. Air Emissions

Air emissions would be generated during the construction, O&M, and decommissioning phases of the Proposed Action. Emissions would primarily be generated by Project vessels (Section 5.5.1) and the installation equipment on board Project vessels (Section 5.5.2). Empire has conducted an air emissions inventory for the Proposed Action, provided in Appendix K, *Air Emissions Calculation and Methodology*, of the COP (Empire 2022a). Following the assessment of these potential sources of air emissions, a summary of overall effects to ESA-listed species is provided (Section 5.5.3).

5.5.1. Vessels

Operation of Project vessels during construction would result in short-term increases in Project-related air emissions. During O&M, operation of Project vessels would result in long-term increases in emissions related to the Proposed Action. However, estimated air emissions from O&M activities would generally be lower than emissions generated during construction activities and are not expected to have a significant effect on regional air quality. Air emissions during decommissioning are expected to be similar or less than emissions estimated for construction activities. Empire has proposed measures to avoid and minimize air emissions effects, including the use of low-sulfur fuels, the use of vessels that meet Best Available Control Technology and Lowest Achievable Emission Rate requirements, and minimization of engine idling time.

5.5.1.1. Marine Mammals

The effects of air pollution on marine mammals are not well-studied, and air emissions are not an IPF of concern for marine mammal species (BOEM 2019a). Given that long-term effects on regional air quality are expected to be insignificant and that the net benefits of replacing fossil-fuel burning power plants with offshore wind farms are expected to improve air quality, the air emissions produced by Project vessels are expected to have *no effect* on ESA-listed marine mammals.

5.5.1.2. Sea Turtles

The effects of air pollution on sea turtles are not well-studied, and air emissions are not an IPF of concern for these species (BOEM 2019a). Given that long-term effects on regional air quality are expected to be insignificant and that the net benefits of replacing fossil-fuel burning power plants with offshore wind farms are expected to improve air quality, the air emissions produced by Project vessels are expected to have *no effect* on ESA-listed sea turtles.

5.5.1.3. Fish

As Atlantic sturgeon do not breathe air, Project vessel air emissions would have *no effect* on this ESA-listed fish species.

5.5.2. Wind Turbine Generator Installation Equipment

Operation of WTG installation equipment during Project construction would result in short-term increases in air emissions during construction of the Proposed Action. Empire has proposed measures to avoid and minimize air emissions effects, including the use of low-sulfur fuels and minimization of engine idling time.

5.5.2.1. Marine Mammals

As described in Section 5.5.1.1, air emissions associated with the Proposed Action are expected to have *no effect* on ESA-listed marine mammals.

5.5.2.2. Sea Turtles

As described in Section 5.5.1.2, air emissions associated with the Proposed Action are expected to have *no effect* on ESA-listed sea turtles.

5.5.2.3. Fish

As Atlantic sturgeon do not breathe air, air emissions associated with installation equipment would have *no effect* on this ESA-listed fish species.

5.5.3. Summary of Effects

5.5.3.1. Marine Mammals

There is a lack of information on the effects of air emissions on marine mammals. However, based on the expected improvement in air quality and the net benefits of replacing fossil-fuel burning power plants with offshore wind farms, as well as the avoidance and minimization measures proposed by Empire, air emissions associated with the Proposed Action are expected to have no effect on ESA-listed marine mammals.

5.5.3.2. Sea Turtles

There is a lack of information on the effects of air emissions on sea turtles. However, based on the expected improvement in air quality and the net benefits of replacing fossil-fuel burning power plants with offshore wind farms, as well as the avoidance and minimization measures proposed by Empire, air emissions associated with the Proposed Action are expected to have no effect on ESA-listed sea turtles.

5.5.3.3. Fish

Air emissions would have no effect on ESA-listed Atlantic sturgeon.

5.6. Port Modifications

As described in Section 3.1.2, Empire would make improvements to the bulkhead at South Brooklyn Marine Terminal during the construction phase of the Proposed Action to utilize the onshore substation for the EW 1 Project and would conduct marina activities along inshore Long Island to utilize the area for the onshore substation for the EW 2 Project.

As noted in Section 3.1.2, the owner/operator of South Brooklyn Marine Terminal is proposing to conduct infrastructure improvements to provide the necessary structural capacity, berthing facilities, and water depths to operate as an offshore wind hub for several proposed offshore wind projects, including the Proposed Action. These improvements include in-water activities (i.e., dredging and dredged material management, replacement and strengthening of existing bulkheads, installation of new pile-supported and floating platforms, installation of new fenders) that could affect ESA-listed species. Some upland activities included in the improvements also have the potential to affect sea turtles. These improvements are not being undertaken by Empire but are considered a Connected Action for the Proposed Action and are therefore evaluated in this BA. The activities proposed for the Connected Action would occur prior to construction of the Proposed Action.

Port modifications for SBMT would involve dredging (Section 5.6.1), shoreside construction (Section 5.6.2), and pile driving (Section 5.6.4), which may affect habitat and prey for ESA-listed species (Section 5.6.3). Following the assessment of these potential effects of port modification, a summary of overall effects to ESA-listed species is provided (Section 5.6.5).

5.6.1. Dredging

Port modifications would include dredging. As described in Section 5.4.4, dredging would result in localized increases in TSS concentrations. Elevated TSS concentrations could reach 445 mg/L and would occur within a radius of up to 2,400 feet (732 meters). Dredging activities may also result in direct effects through physical interactions (i.e., entrainment, impingement, or capture) between the dredge and aquatic species and indirect effects through effects on benthic prey species.

The Connected Action would also include dredging. Dredging for the Connected Action would utilize a clamshell dredge with an environmental bucket. As described in Section 5.4.4, TSS concentrations associated with mechanical clamshell bucket dredging operations have been shown to range from 105 mg/L in the middle of the water column to 445 mg/L near the bottom (210 mg/L, depth-averaged) (NMFS 2020c citing USACE 2001). Additional studies indicate that elevated TSS concentrations at several hundreds of mg/L above background levels may be present in close proximity to the dredge bucket but would settle rapidly within a 2,400-foot (732-meter) radius of the dredge location (NMFS 2020c citing Burton 1993; NMFS 2020c citing USACE 2015).

5.6.1.1. Marine Mammals

As noted in Section 5.6.1, dredging effects associated with port modifications for the Proposed Action and Connected Action would be localized to the waters around South Brooklyn Marine Terminal. ESA-listed marine mammals are not expected to occur within the affected area. Therefore, dredging associated with port modifications would have *no effect* on ESA-listed marine mammals.

5.6.1.2. Sea Turtles

As described in Section 5.4.4.2, increased turbidity associated with dredging may result in behavioral effects on sea turtles and effects on benthic prey species. Turbidity effects associated with dredging for the Proposed Action were assessed in Section 5.4.4.2. Turbidity effects of dredging associated with the Connected Action would be similar to, or less than, the Proposed Action given the unlikely occurrence of sea turtles in the affected area. Turbidity curtains would be used for a large proportion of the dredge area for the Connected Action, minimizing water quality impacts and excluding sea turtles from most active dredging areas. Additionally, best management practices to reduce turbidity (e.g., slow bucket withdrawal) would be used. Therefore, turbidity effects associated with dredging for port modifications are not expected to obstruct sea turtle movements, and any reductions in benthic prey species would be negligible. Given the small scale of effects, the effects of increased turbidity associated with dredging for port modification leading to behavioral impacts or alterations in prey availability is *not likely to adversely affect (insignificant)* green, Kemp's ridley, leatherback, or loggerhead sea turtles.

Mechanical dredging, including the use of a clamshell dredge, is not expected to capture, injure, or kill sea turtles (USACE 2020). Additionally, turbidity curtains would be used for a large proportion of the dredge area, excluding sea turtles from most active dredging areas. Therefore, physical interactions with the dredge associated with the Proposed Action and Connected Action are extremely unlikely to occur. Given the low likelihood of effects, the effects of dredging associated with port modification for the Proposed Action leading to injury or mortality is *not likely to adversely affect (discountable)* green, Kemp's ridley, leatherback, or loggerhead sea turtles.

Habitat disturbance and modification associated with dredging could result in short-term reductions in foraging habitat or short-term effects on prey availability for some sea turtle species. Benthic communities would be expected to recover within one year of disturbance (NMFS 2017). Dredging for the Connected Action may increase water depths by up to 21 feet (6.4 meters), which is not expected to have a significant impact on benthic community composition. Dredging in the vicinity of South Brooklyn Marine Terminal is not expected to alter the sediment composition compared to the existing substrate in the dredge area. Given there would be no change in sediment composition, changes in benthic community composition would not be expected. However, the surface sediments following dredging are expected to contain increased concentrations of contaminants, which may affect recolonizing benthic invertebrates. Though habitat disturbance and modification associated with dredging for the Proposed Action and Connected Action may result in reductions in foraging habitat availability or prey availability, these reductions would be short-term, and there would be no changes in benthic community composition. Contaminants in the sediment could affect the recolonized benthic community. However, sea turtle foraging in the affected area is extremely unlikely. Given the low likelihood of effects, the effects of habitat disturbance associated with dredging for port modifications leading to alterations in prey availability is *not likely to adversely affect (discountable)* green, Kemp's ridley, leatherback, or loggerhead sea turtles.

5.6.1.3. Fish

As described in Section 5.4.4.3, increased turbidity associated with dredging may result in physiological or behavioral effects on Atlantic sturgeon and effects on benthic prey species. Turbidity effects associated with dredging for the Proposed Action were assessed in Section 5.4.4.3. Turbidity effects of dredging associated with the Connected Action would be similar to the Proposed Action as the TSS levels expected for mechanical dredging are below the physiological threshold for fish and sediment plume distances would be similar to those expected during dredging for the Proposed Action. Turbidity curtains would be used for a large proportion of the dredge area for the Connected Action, minimizing water quality impacts and excluding sturgeon from most areas of active dredging. Additionally, best management practices to reduce turbidity (e.g., slow bucket withdrawal) would be used. Therefore, turbidity effects associated with dredging for port modifications are not expected to obstruct the movement of Atlantic sturgeon and would result in negligible reductions in benthic prey species. Given the small scale of effects, the effects of increased turbidity associated with dredging for port modification leading to behavioral impacts or alterations in prey availability is *not likely to adversely affect (insignificant)* Atlantic sturgeon.

Atlantic sturgeon that could be present in the dredge area for the Proposed Action or Connected Action are expected to avoid mechanical dredge buckets. Since 1990, there has been only one verified record of a live Atlantic sturgeon entrained in a mechanical dredge along the U.S. East Coast (NMFS 2018c). Therefore, the risk of Atlantic sturgeon entrainment in mechanical dredges is low (NMFS 2018c). Further, turbidity curtains would be used for a large proportion of the dredge area for the Connected Action, excluding Atlantic sturgeon from most areas of active dredging. Based on the low risk of entrainment, physical interactions between dredging equipment and Atlantic sturgeon are extremely unlikely to occur. Given the low likelihood of effects, the effects of dredging associated with port modification for the Proposed Action leading to injury or mortality is *not likely to adversely affect (discountable)* Atlantic sturgeon.

Habitat disturbance and modification associated with dredging could result in short-term reductions in foraging habitat or short-term effects on prey availability for Atlantic sturgeon. As described in Section 5.6.1.2, dredging is not expected to alter benthic community composition, and the benthic community is expected to recover within one year of disturbance. Given that any reduction in foraging habitat or prey availability would be short-term and the affected area would be very small relative to available sturgeon foraging habitat, any effects on Atlantic sturgeon due to habitat disturbance and modification associated with dredging for port modifications would be too small to be meaningfully measured or detected. Given the small scale of effects, the effects of habitat disturbance associated with dredging for port modifications leading to alterations in prey availability is *not likely to adversely affect (insignificant)* Atlantic sturgeon.

5.6.2. Shoreside Construction

Runoff from shoreside construction has the potential to result in localized effects on water quality due to increased turbidity in the vicinity of South Brooklyn Marine Terminal. Turbidity effects associated with shoreside construction would be lower than turbidity effects associated with dredging (Section 5.6.1), and measures would be in place to minimize water quality impacts associated with shoreside construction.

5.6.2.1. Marine Mammals

Effects of shoreside construction associated with the Proposed Action and Connected Action would be localized to the waters around South Brooklyn Marine Terminal. ESA-listed marine mammals are not expected to occur within the affected area. Therefore, shoreside construction associated with port modifications would have *no effect* on ESA-listed marine mammals.

5.6.2.2. Sea Turtles

As turbidity effects associated with shoreside construction during port modifications would be lower than those associated with dredging (Section 5.6.1.2), shoreside construction is not expected to obstruct movements of ESA-listed sea turtle species; any effects of reductions in benthic prey species would be too small to be meaningfully measured or detected. Given the small scale of effects, the effects of turbidity associated with shoreside construction leading to alterations in prey availability is *not likely to adversely affect (insignificant)* green, Kemp’s ridley, leatherback, or loggerhead sea turtles.

5.6.2.3. Fish

As turbidity effects associated with shoreside construction during port modifications would be lower than those associated with dredging (Section 5.6.1.3), shoreside construction is not expected to obstruct movements of ESA-listed Atlantic sturgeon; any reductions in benthic prey species would be too small to be meaningfully measured or detected. Given the small scale of effects, the effects of turbidity associated with shoreside construction leading to alterations in prey availability is *not likely to adversely affect (insignificant)* Atlantic sturgeon.

5.6.3. Effects to Habitat and Prey

As described in Section 5.6.1, dredging for port modifications may result in short-term reductions in benthic habitat availability and prey availability for some aquatic species.

5.6.3.1. Marine Mammals

ESA-listed marine mammals are not expected to occur within the area affected by port modifications. Therefore, there would be *no effect* on habitat or prey for ESA-listed marine mammals.

5.6.3.2. Sea Turtles

As described in Section 5.6.1.2, port modifications may result in short-term reductions in prey availability. However, sea turtles are unlikely to forage in the affected area. Given the low likelihood of effects, the effects to habitat and prey associated with port modifications for the Proposed Action leading to alterations in prey availability is *not likely to adversely affect (discountable)* green, Kemp’s ridley, leatherback, or loggerhead sea turtles.

5.6.3.3. Fish

As described in Section 5.6.1.3, port modifications may result in short-term reductions in benthic foraging habitat and prey availability for Atlantic sturgeon. Any impacts on Atlantic sturgeon due to effects on habitat and prey associated with port modifications would be too small to be meaningfully measured or detected based on the relatively small area of lost foraging habitat relative to available foraging habitat and negligible reductions in prey availability. Given the small scale of effects, the effects to habitat and prey associated with port modifications for the Proposed Action leading to alterations in prey availability is *not likely to adversely affect (insignificant)* Atlantic sturgeon.

5.6.4. Pile Driving

The Connected Action would include installation of 36-inch (0.9-meter) steel pipe piles and steel sheet piles. Pipe piles would be installed using a vibratory hammer for the majority of installation. An impact hammer would be used to drive the pile during the final 10 to 15 feet (3 to 4.5 meters). Sheet piles will be installed entirely using a vibratory hammer. Mitigation measures for pile driving associated with the Connected Action include soft start and use of a bubble curtain, as well as a time of year restriction limiting in-water work to June 1 to December 15 (AECOM 2021). Pile driving impacts associated with port modifications for the Connected Action would be lower than pile driving impacts associated with impact and vibratory pile driving for construction of the Proposed Action (Section 5.1.1 and 5.1.2).

The Proposed Action would include installation of 24-inch (61-centimeter) z-type steel sheet piles and removal of 12-inch (30-centimeter) timber berthing piles using a vibratory pile driver. Underwater sound propagation modeling for vibratory pile driving was conducted in support of the COP (COP Appendix M-1; Empire 2022a).

5.6.4.1. Marine Mammals

ESA-listed marine mammals are not expected to occur within the area affected by pile driving for port modifications. Therefore, there would be *no effects* on ESA-listed marine mammals.

5.6.4.2. Sea Turtles

As described in Sections 5.1.1.2 and 5.1.2.2, pile driving can result in physiological and behavioral effects for sea turtles. To evaluate pile driving impacts for the Connected Action, the NMFS Multi-Species Pile Driving Calculator[10] was used to calculate distances to recommended regulatory thresholds for sea turtles. Assuming a strike rate of 60 strikes per minute (Matuschek and Betke 2009) and 5 decibels of attenuation due to use of a bubble curtain, noise levels associated with pile driving for the Connected Action could exceed recommended injury thresholds if sea turtles remain within up to approximately 457 feet (139 meters) of the pile driving for 24 hours.[11] Noise levels may exceed recommended behavioral thresholds for sea turtles up to approximately 241 feet (74 meters) from impact pile driving. For vibratory pile driving, sea turtles may experience PTS if they remain within up to 5 feet (1.4 meters) for an entire day of vibratory pile driving. Sea turtles may experience behavioral effects within up to approximately 15 feet (5 meters) of the pile. Given the relatively small distances to injury and behavioral thresholds and unlikely sea turtle presence in the project area for the Connected Action, impacts from pile driving noise associated with the Connected Action would be extremely unlikely to occur.

[10] Available at: https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-acoustic-technical-guidance

[11] Pile driving durations provided in the BA for the Connected Action (AECOM 2021) were used to estimate injury isopleths

To evaluate pile driving impacts for marina activities, the NMFS Greater Atlantic Regional Fisheries Office Acoustics Tool[12] was used to calculate distances to recommended regulatory thresholds for sea turtles. Without noise mitigation, ESA-listed sea turtles would have to be within 3.3 feet (1.0 meter) of sheet pile installation or 6.2 feet (1.9 meters) of berthing pile removal to experience behavioral effects. Given the small isopleth distances, behavioral effects are extremely unlikely to occur. Given the low likelihood of effects, the effects vibratory pile driving associated with port modifications for the Proposed Action leading to behavioral effects is *not likely to adversely affect (discountable)* green, Kemp's ridley, leatherback, or loggerhead sea turtle.

5.6.4.3. Fish

As described in Sections 5.1.1.3 and 5.1.2.3, pile driving can result in physiological and behavioral effects for Atlantic sturgeon. To evaluate pile driving impacts for the Connected Action, the NMFS Multi-Species Pile Driving Calculator was used to calculate distances to recommended regulatory thresholds for fish. Assuming a strike rate of 60 strikes per minute (Matuschek and Betke 2009) and 5 decibels of attenuation due to use of a bubble curtain, noise levels associated with impact pile driving for the Connected Action could exceed recommended injury thresholds for fish up to approximately 2,414 feet (736 meters) from the pile, assuming the sturgeon remain within that radius for an entire day of pile driving, and may exceed recommended behavioral thresholds up to approximately 2.1 miles (3.4 kilometers) from impact pile driving. For vibratory pile driving, fish may experience behavioral effects within up to 707 feet (215 meters) of the pile. Given the use of soft starts during impact pile driving, anticipated avoidance of disturbing sound levels, and the in-water work window, exposure to cumulative noise that could result in injury is extremely unlikely to occur. Though noise levels exceeding behavioral thresholds would extend several kilometers from the area of active pile driving, Atlantic sturgeon are unlikely to be present in the area affected by the Connected Action during the in-water work window. Given anticipated avoidance of disturbing levels of sound, any exposure to disturbing sound levels is expected to be temporary, as fish are expected to resume normal behaviors following the completion of pile driving (Jones et al. 2020; Shelledy et al. 2018). Any effects of this exposure would be too small to be meaningfully measured, detected, or evaluated. Based on the unlikely occurrence of effects and small scale of anticipated effects should they occur, the effects of underwater noise associated with pile driving for the Connected Action leading to behavioral disturbance is *not likely to adversely affect (insignificant*) Atlantic sturgeon.

5.6.5. Summary of Effects

5.6.5.1. Marine Mammals

Fin whales and NARWs are not expected to occur in the area affected by port modifications. Therefore, port modifications would have no effect on ESA-listed marine mammals.

5.6.5.2. Sea Turtles

Activities associated with port modifications, including dredging, shoreside construction, and pile driving, could result in turbidity effects, physical interactions with the dredge, habitat disturbance and modification, and noise impacts on sea turtles. Turbidity effects are not expected to obstruct sea turtle movements, and any reductions in benthic prey species would be negligible. Physical interactions with the dredge are extremely unlikely to occur. Any effects on sea turtles or their prey due to habitat disturbance and modification would be unlikely to occur given that sea turtle foraging in the expected area is extremely unlikely. Pile driving noise levels associated with port modifications could exceed

[12] Available at: https://www.fisheries.noaa.gov/new-england-mid-atlantic/consultations/section-7-consultation-technical-guidance-greater-atlantic

recommended injury thresholds for sea turtles and may result in behavioral effects within relatively close proximity (i.e., 241 feet [74 meters]). Given the small distances to injury and behavioral thresholds and unlikely sea turtle presence in affected area, pile driving noise impacts associated with port modifications would be extremely unlikely to occur.

5.6.5.3. Fish

Activities associated with port modifications, including dredging, shoreside construction, and pile driving, could result in turbidity effects, physical interactions with the dredge, habitat disturbance and modification, and noise impacts on Atlantic sturgeon. Turbidity effects are not expected to obstruct movement of Atlantic sturgeon, and any reductions in benthic prey would be negligible. Physical interactions with the dredge are extremely unlikely to occur. Any effects on Atlantic sturgeon or their prey due to habitat disturbance and modification would be too small to be meaningfully measured or detected given that effects on prey availability would be short-term and that the affected area would be very small relative to available sturgeon foraging habitat. Pile driving noise levels associated with port modifications could exceed injury and behavioral thresholds for fish. Given the in-water work window and likely sturgeon avoidance of disturbing sound levels, pile driving noise impacts would be too small to be meaningfully measured, detected, or evaluated.

5.7. Repair and Maintenance Activities

As described in Section 3.1.2, repair and maintenance activities during O&M of the Proposed Action would include inspections and any necessary repairs and replacements identified during inspections. Some inspections (e.g., surveys of submarine export cables) may generate noise which could affect ESA-listed species. Effects of these types of surveys on ESA-listed species were previously addressed in Section 5.1.3 and were determined to be *not likely to adversely affect (insignificant)* fin whale, NARW, sperm whale, green sea turtle, Kemp's ridley sea turtle, leatherback sea turtle, loggerhead sea turtle, and Atlantic sturgeon. Though not anticipated, repairs to faulty submarine cables may require additional cable laying activities that could result in noise and turbidity impacts to ESA-listed species in the vicinity of the immediate Project area. These impacts were previously assessed in Sections 5.1.4 and 5.4.4, respectively, and the effects on ESA-listed species were determined to be and were determined to be *not likely to adversely affect (insignificant)* fin whale, NARW, sperm whale, green sea turtle, Kemp's ridley sea turtle, leatherback sea turtle, loggerhead sea turtle, and Atlantic sturgeon.

5.8. Other Effects

5.8.1. Potential Shifts or Displacement of Ocean Users

The presence of offshore structures associated with the Proposed Action could displace commercial or recreational fishing vessels to areas outside of the Lease Area or potentially lead to a shift in gear types due to displacement. Though not anticipated, if displacement leads to an overall shift from mobile to fixed gear types, there could be an increased number of vertical lines in the water, increasing the risk of interactions between ESA-listed species and fixed fishing gear.

5.8.1.1. Marine Mammals

Assuming fishing vessels are displaced to areas adjacent to the Lease Area, risk of interaction with fishing vessels would not be greater than current risk given that marine mammal densities are expected to be similar in areas adjacent to the Lease Area and distribution is expected to be patchy both within and adjacent to the Lease Area. Therefore, there would not be a measurable increase in risk of interaction between fishing vessels and ESA-listed marine mammals. Given the small scale of effects, the effects displacement of fishing vessels associated with the presence of structures for the Proposed Action leading to vessel strike is *not likely to adversely affect (insignificant)* fin whale, NARW, or sperm whale.

If displacement were to lead to an overall shift from mobile to fixed gear types, the risk of marine mammal interactions with fishing gear would increase. As noted in Section 4.2.2, entanglement is a significant threat for large whales, including fin whale and NARW. Entanglement has been documented as a significant cause of death for mysticetes (Read et al. 2006). Entanglement is a particular concern for NARW, and 72% percent of NARWs observed show evidence of past entanglements (Johnson et al. 2005). Entanglement in fishing gear is a leading cause of death for this species and may be a potential factor in limiting the population's recovery (Knowlton et al. 2012). Though it is unknown how fishers will respond to the presence of large offshore wind farms on the Atlantic OCS, gear shifts due to fisheries displacement associated with the Proposed Action are not anticipated. Therefore, an increased risk of fisheries interactions for ESA-listed marine mammals due to shifts or displacement of ocean users is unlikely to occur. Given the low likelihood of effects, the effects displacement of fishing vessels associated with the presence of structures for the Proposed Action leading to increased fisheries interactions is *not likely to adversely affect (discountable)* fin whale, NARW, or sperm whale.

5.8.1.2. Sea Turtles

Assuming fishing vessels are displaced to areas adjacent to the Lease Area, risk of interaction with fishing vessels would not be greater than current risk given that sea turtle densities are expected to be similar in areas adjacent to the Lease Area and distribution is expected to be patchy both within and adjacent to the Lease Area. Therefore, there would not be a measurable increase in risk of interaction between fishing vessels and ESA-listed sea turtles. Given the small scale of effects, the effects displacement of fishing vessels associated with the presence of structures for the Proposed Action leading to vessel strike is *not likely to adversely affect (insignificant)* green, Kemp's ridley, leatherback, or loggerhead sea turtles.

If displacement were to lead to an overall shift from mobile to fixed gear types, the risk of sea turtle interactions with fishing gear would increase. However, such a shift is not anticipated in response to the presence of structures associated with the Proposed Action. Therefore, increased risk of fisheries interactions for ESA-listed sea turtles due to shifts or displacement of ocean users are unlikely to occur. Given the low likelihood of effects, the effects displacement of fishing vessels associated with the presence of structures for the Proposed Action leading to increased fisheries interactions is *not likely to adversely affect (discountable)* green, Kemp's ridley, leatherback, or loggerhead sea turtles.

5.8.1.3. Fish

Assuming fishing vessels are displaced to adjacent areas, risk of interaction with fishing vessels would not be greater than current risk given that sturgeon densities are expected to be similar in areas adjacent to the Lease Area and distribution is expected to be patchy both within and adjacent to the Lease Area. Therefore, there would not be a measurable increase in risk of interaction between fishing vessels and Atlantic sturgeon. Given the small scale of effects, the effects displacement of fishing vessels associated with the presence of structures for the Proposed Action leading to vessel strike is *not likely to adversely affect (insignificant)* Atlantic sturgeon.

A potential shift from mobile to fixed gear types is not expected to result in increased risk of capture for Atlantic sturgeon as this species is vulnerable to mobile gear types.

5.8.2. Physical Interactions with Dredges

As noted in Section 5.6.1, dredging activities associated with the Proposed Action also result in entrainment, impingement, or capture of ESA-listed species in dredge equipment, which can cause injury or mortality. Dredging may also affect ESA-listed species indirectly through effects on benthic prey species. As described in Section 3.1.2, dredging methods for the Proposed Action may include suction hopper, clamshell, or hydraulic dredging to support submarine cable installation.

5.8.2.1. Marine Mammals

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

5.8.2.2. Sea Turtles

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

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

Prey entrainment or benthic disturbance associated with dredging for the Proposed Action has the potential to reduce prey availability for ESA-listed sea turtle species that forage in soft bottom habitats (i.e., Kemp's ridley sea turtle). These effects would be localized and short-term. Recolonization and recovery of prey species is expected to occur within 2 to 4 years (Van Dalfsen and Essink 2001) but could occur in as little time as 100 days (Dernie et al. 2003). Based on the short-term and localized nature of effects, the relatively small area affected, and the availability of similar foraging habitat throughout the action area, the effect of benthic habitat disturbance associated with dredging for the Proposed Action on Kemp's ridley sea turtles would be too small to be meaningfully measured or detected. Given the small scale of anticipated effects, the effects of prey entrainment and benthic disturbance associated with dredging for the Proposed Action leading to reduced prey availability is *not likely to adversely affect (insignificant*) Kemp's ridley sea turtle. As green, leatherback, and loggerhead sea turtles do not forage in soft bottom habitats, the effects of prey entrainment and benthic disturbance associated with dredging for the Proposed Action leading to reduced prey availability would have *no effect* on these species.

5.8.2.3. Fish

The risk of Atlantic sturgeon entrainment in mechanical dredges is low given the small area affected by the clamshell and the slow lowering speed of the bucket (NMFS 2018c). Studies of sturgeon vulnerability to hydraulic dredges have demonstrated that fish would have to be within 3.3 to 6.6 feet (1 to 2 meters) of the dredge head to be at risk of entrainment (Boysen and Hoover 2009; Clarke 2011; Hoover et al. 2011). Therefore, the overall risk of Atlantic sturgeon entrainment in a hydraulic cutterhead dredge is low.

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

Prey entrainment or benthic disturbance associated with dredging for the Proposed Action has the potential to reduce prey availability for Atlantic sturgeon. These effects would be localized and short-term (Dernie et al. 2003; Van Dalfsen and Essink 2001). Based on the short-term and localized nature of effects, the relatively small area affected, and the availability of similar foraging habitat throughout the action area, the effect of benthic habitat disturbance associated with dredging for the Proposed Action on Atlantic sturgeon would be too small to be meaningfully measured or detected. Given the small scale of anticipated effects, the effects of prey entrainment and benthic disturbance associated with dredging for the Proposed Action leading to reduced prey availability is *not likely to adversely affect (insignificant*) Atlantic sturgeon.

5.9. Unexpected/Unanticipated Events

Unexpected or unanticipated events with the potential to affect ESA-listed species could occur during the construction, O&M, or decommissioning phases of the Proposed Action. Such events would include vessel collisions or allisions (i.e., collisions with stationary structures) (Section 5.9.1), severe weather events resulting in equipment failure (Section 5.9.2), oil spills (Section 5.9.3), or encounters with unexploded ordinance (Section 5.9.4). Following the assessment of these unexpected/unanticipated events, a summary of overall effects to ESA-listed species is provided (Section 5.9.5).

5.9.1. Vessel Collision/Allision with Foundation

Vessel collisions or allisions may result in oil spills, which are addressed in Sections 5.3.2 and 5.9.3. Such events are considered unlikely given the lighting requirements for Project vessels and offshore structures, vessel speed restrictions, proposed spacing of Project structures, inclusion of Project structures on navigational charts, and Notices to Mariners issued by the U.S. Coast Guard. Therefore, effects on ESA-listed species due to vessel collisions or allisions are extremely unlikely to occur. Given the low likelihood of effects, the effects of oil spills associated with collisions or allisions leading to injury or mortality is *not likely to adversely affect (discountable)* fin whale, NARW, sperm whale, green sea turtle, Kemp’s ridley sea turtle, leatherback sea turtle, loggerhead sea turtle, or Atlantic sturgeon.

5.9.2. Failure of Wind Turbine Generators due to Weather Events

The Lease Area may be affected by extratropical storms, which are common in the area between October and April, or hurricanes. The high winds associated with these events have the potential to result in the failure of WTGs. However, such a failure is highly unlikely, as these structures are designed to withstand significant storms, and effects on ESA-listed species associated with WTG failure are extremely unlikely to occur. Given the low likelihood of effects, the effects of catastrophic WTG failure leading to injury or mortality is *not likely to adversely affect (discountable)* fin whale, NARW, sperm whale, green sea turtle, Kemp’s ridley sea turtle, leatherback sea turtle, loggerhead sea turtle, or Atlantic sturgeon.

5.9.3. Oil Spill/Chemical Response

Vessel traffic associated with the Proposed Action would increase the risk of accidental releases of fuels, fluids, and hazardous materials (Section 5.3.2). There would also be a low risk of leaks of fuel, fluid, or hazardous materials from any of the 147 WTGs anticipated for the Project. The total volume of WTG fuels, fluids, and hazardous materials associated with the Proposed Action is estimated at 862,866 gallons (3.27 million liters) (**Table 1**). The two OSSs are expected to hold an additional 278,701 gallons of fuels, fluids, and hazardous materials (1.05 million liters) (**Table 1**). BOEM has modeled the risk of spills associated with WTGs and determined that a release of 128,000 gallons is likely to occur no more frequently than once every 1,000 years and a release of 2,000 gallons or less is likely to occur every 5 to 20 years (Bejarano et al. 2013).

5.9.3.1. Marine Mammals

Effects of oil spills from vessels was addressed in Section 5.3.2.1. Effects of oil spills from WTGs or OSSs would be similar. As noted in Section 5.3.2.1, Empire has developed an OSRP (see COP Appendix F; Empire 2022a) with measures to avoid accidental releases and a protocol to respond to such a release if one occurs. Given the low likelihood of occurrence, effects of oil spills on ESA-listed marine mammals are extremely unlikely to occur. Given the low likelihood of effects, the effects of oil spills associated with the Proposed Action leading to injury or mortality is *not likely to adversely affect (discountable)* fin whale, NARW, or sperm whale.

5.9.3.2. Sea Turtles

Effects of oil spills from vessels was addressed in Section 5.3.2.2. Effects of oil spills from WTGs or OSSs would be similar. As noted in Section 5.3.2.1, Empire has developed an OSRP (see COP Appendix F; Empire 2022a) with measures to avoid accidental releases and a protocol to respond to such a release if one occurs. Given the low likelihood of occurrence, effects of oil spills on ESA-listed sea turtles are extremely unlikely to occur. Given the low likelihood of effects, the effects of oil spills associated with the Proposed Action leading to injury or mortality is *not likely to adversely affect (discountable)* green, Kemp’s ridley, leatherback, or loggerhead sea turtles.

5.9.3.3. Fish

Effects of oil spills from vessels was addressed in Section 5.3.2.3. Effects of oil spills from WTGs or OSSs would be similar. As noted in Section 5.3.2.1, Empire has developed an OSRP (see COP Appendix F; Empire 2022a) with measures to avoid accidental releases and a protocol to respond to such a release if one occurs. Given the low likelihood of occurrence, effects of oil spills on ESA-listed Atlantic sturgeon are extremely unlikely to occur. Given the low likelihood of effects, the effects of oil spills associated with the Proposed Action leading to injury or mortality is *not likely to adversely affect (discountable)* Atlantic sturgeon.

5.9.4. UXO Encounters/Response

Empire conducted a UXO risk assessment and determined that the risk level for UXO is relatively low for most installation activities in the Lease Area. Risk level for UXO is medium along a portion of the EW 1 export cable route. Empire continues to evaluate the potential for UXO presence in the immediate Project area. It is anticipated that portions of the export cable route(s) would be surveyed and potentially cleared for UXO. Avoidance is the preferred approach for UXO mitigation. When avoidance is not possible, UXO may be relocated to another safe location on the seafloor or to a designated disposal area using a lift and shift technique.

If a lift and shift technique were used to relocate any UXO encountered along the export cable routes, benthic effects, including disturbance and habitat loss, could occur. However, these effects would be limited to a very small area. Benthic disturbance may occur in the UXO's original position, its relocated position, and within a very small radius surrounding these two positions. Habitat loss would occur within the sediment occupied by the relocated UXO. However, this habitat loss would likely be balanced by the new habitat available where the UXO was originally located, provided cable protection is not required in the original location. Benthic effects have the potential to impact ESA-listed species that utilize soft bottom habitats found along the export cable routes (i.e., Kemp's ridley sea turtle and Atlantic sturgeon). However, based on the small scale of potential habitat disturbance or loss, any impacts on Kemp's ridley sea turtle or Atlantic sturgeon prey or foraging habitat would be too small to be meaningfully measured.

Given that avoidance is the primary strategy under the Proposed Action and no UXO removal is proposed for any identified targets, effects of encountering UXOs under the Proposed Action would likely be avoided. If UXO cannot be avoided, effects on prey and foraging habitat would be limited to a very small area and associated impacts on Kemp's ridley sea turtle and Atlantic sturgeon would be too small to be meaningfully measured. Therefore, benthic disturbance and habitat loss due to UXO response associated with the Proposed Action are *not likely to adversely affect (insignificant)* Kemp's ridley sea turtle or Atlantic sturgeon. As fin whale, NARW, sperm whale, green sea turtle, leatherback sea turtle, and loggerhead sea turtle do not utilize soft bottom habitats found along the export cable routes, UXO response associated with the Proposed Action would have *no effect* on these species.

5.9.5. Summary of Effects

Unexpected or unanticipated events, including vessel collisions and allisions, WTG failures, oil spills, and UXO encounters or responses are all very unlikely to occur. Additionally, Empire has proposed measures to avoid or minimize many of these risks. Therefore, effects on ESA-listed marine mammals, sea turtles, or Atlantic sturgeon are extremely unlikely to occur.

6. Cumulative Effects

Cumulative effects are defined as those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area (50 CFR 402.02). Those activities involving Federal activities are excluded from consideration as they would require separate consultation under Section 7 of the ESA. The majority of activities which may occur within the action area for the Proposed Action would involve Federal activities, thereby requiring future consultation under the ESA. Potential future activities without Federal involvement that could occur in the action area include recreational fishing, state-regulated fisheries, marine transportation, recreational boat traffic, discharge of wastewater, and state or locally authorized coastal development. Effects of such activities are not expected to differ from the current environmental baseline (Section 4).

7. Conclusion

7.1. Marine Mammals

Six ESA-listed marine mammal species under NMFS jurisdiction may occur in the action area for the Proposed Action. However, three of these species (blue whale, Rice's whale, and sei whale) are unlikely to occur in the immediate Project area or their occurrence would be limited to only a portion of the action area (e.g., Rice's whale in the Gulf of Mexico). Potential effects on these species would be limited to vessel traffic effects (i.e., vessel strike, vessel noise, and vessel discharges). Given the patchy distribution of marine mammals, the low volume of vessel traffic where these species are likely to occur, mitigation measures in place to avoid effects of vessel traffic, such effects would be extremely unlikely to occur. Therefore, the Proposed Action may affect but is *not likely to adversely affect (discountable)* blue whale, Rice's whale, or sei whale (**Table 31**).

Fin whales, NARWs, and sperm whales are likely to occur in the action area, though sperm whales would occur in relatively low densities and would be subject to effects associated with the Proposed Action, including effects of noise, vessel traffic, habitat disturbance/modifications, repair and maintenance activities, and unexpected/unanticipated events and other effects (i.e., shifts or displacement of ocean users and physical interactions with dredges) (**Table 31**). Noise associated with the Proposed Action has the potential to result in injury or behavioral effects in these species. Project vessel traffic could increase vessel strike risk; however, vessel strikes would be unlikely to occur given the measures in place to avoid or minimize vessel strikes, including speed restrictions, minimum separation distances, and strike avoidance procedures (e.g., shifting to neutral or reducing speed and changing course). Habitat disturbance or modification could result in increased entanglement risk in recreational fishing gear, turbidity effects, behavioral disruption, or EMF effects. However, effects of these impacts would be too small to be measured or detected. Habitat disturbance or modification could also increase risk of fisheries interactions or vessel strike due to displacement of marine mammals into higher risk areas. Repair and maintenance activities would be similar to activities evaluated for noise and habitat disturbance/modifications. Other effects could result in displacement of fishing activity outside the Lease Area and may result in increased entanglement risk for fin whale and NARW if shifts to fixed gear from mobile gear were to occur. However, such a gear shift is not expected due to the potential need to acquire new fishing gear, a new fishing vessel, or a new fishing permit, and effects of displacement are not expected to increase collision risk for marine mammals. Unexpected/unanticipated events, including vessel collisions or allisions, WTG failure, oil spills, and UXO encounters, would be extremely unlikely to occur, making their effects extremely unlikely to occur. Given that underwater noise has the potential to result in injury or behavioral effects and the presence of structures may displace marine mammals into areas with higher risk of fisheries interactions or vessel strike, the Proposed Action may affect and is *likely to adversely affect* fin whale, NARW, and sperm whale.

7.2. Sea Turtles

Five ESA-listed sea turtle species may occur in the action area for the Proposed Action. However, hawksbill sea turtle occurrence would be limited to a portion of the action area that includes vessel transits from Corpus Christi. Since the potential effects on this species would be limited to small amount of vessel transits, any adverse effects would be extremely unlikely to occur. Therefore, the Proposed Action may affect but is *not likely to adversely affect (discountable)* hawksbill sea turtle (**Table 31**).

Green, Kemp's ridley, leatherback, and loggerhead sea turtles are likely to occur in the action area and would be subject to effects associated with the Proposed Action, including effects of noise, vessel traffic, habitat disturbance/modifications (including effects of fisheries and benthic surveys), port modifications, repair and maintenance activities, and unexpected/unanticipated events and other effects (i.e., shifts or displacement of ocean users and physical interactions with dredges) (**Table 31**). Noise associated with the Proposed Action has the potential to result in injury or behavioral effects in these species. Project vessel traffic could increase vessel strike risk for sea turtles, but vessel strikes are considered unlikely given sea turtles' patchy distribution and the measures in place to avoid or minimize vessel strikes. Habitat disturbance or modification could result in decreased foraging habitat for Kemp's ridley sea turtle and increased foraging opportunities, turbidity effects, species avoidance or displacement, behavioral disruption, EMF and heat effects, or lighting effects in all ESA-listed sea turtles. However, effects of such impacts would be too small to be meaningfully measured or detected. Habitat disturbance or modification could also increase risk of entanglement in recreational fishing gear due to concentration of recreational fishing effort around WTG and OSS foundations and increase risk of fisheries interactions or vessel strike due to displacement of marine mammals into higher risk areas. Additionally, fisheries and habitat surveys may result in capture or entanglement of ESA-listed sea turtles. Repair and maintenance activities would be similar to activities evaluated for noise and habitat disturbance/modifications. Other effects could result in displacement of fishing activity outside the Lease Area and may result in increased entanglement risk for ESA-listed sea turtles if shifts to fixed gear from mobile gear were to occur. However, such a gear shift is not expected due to the potential need to acquire new fishing gear, a new fishing vessel, or a new fishing permit, and effects of displacement are not expected to increase collision risk for sea turtles. Unexpected/unanticipated events, including vessel collisions or allisions, WTG failure, oil spills, and UXO encounters, would be extremely unlikely to occur, making their effects extremely unlikely to occur. Given that underwater noise has the potential to result in injury or behavioral effects; the presence of structures may attract recreational fishermen, increasing risk of entanglement, or displace sea turtles into areas with higher risk of fisheries interactions or vessel strike; and fisheries and habitat surveys may result in capture and minor injury, the Proposed Action may affect and is *likely to adversely affect* green sea turtle, Kemp's ridley sea turtle, leatherback sea turtle, and loggerhead sea turtle.

7.3. Fish

Five ESA-listed fish species may occur in the action area for the Proposed Action. However, giant manta ray and oceanic whitetip shark would be limited to a portion of the action area. Potential effects on these species would be limited to those related to vessel traffic, and such effects would be extremely unlikely to occur. Shortnose sturgeon and Atlantic salmon are unlikely to occur in the action area, making potential effects on this species extremely unlikely to occur. Therefore, the Proposed Action may affect but is *not likely to adversely affect (discountable)* Atlantic salmon, giant manta ray, oceanic whitetip shark, or shortnose sturgeon (**Table 31**).

Atlantic sturgeon is likely to occur in the action area and would be subject to effects associated with the Proposed Action, including effects of noise, vessel traffic, habitat disturbance/modifications (including effects of fisheries and benthic surveys), port modifications, repair and maintenance activities, and unexpected/unanticipated events and other effects (i.e., shifts or displacement of ocean users and physical interactions with dredges) (**Table 31**). Noise associated with the Proposed Action has the potential to result in injury or behavioral effects in Atlantic sturgeon , but mitigation measures are expected to minimize noise effects on Atlantic sturgeon. Project vessel traffic could increase vessel strike risk for Atlantic sturgeon, though strike risk in oceanic habitats is not well understood. Any increase in strike risk would be insignificant given their patchy distribution on the OCS and the limited trips anticipated by Project vessel in the Hudson River. Habitat disturbance or modification could result in decreased foraging habitat, turbidity effects, behavioral disruption, and EMF and heat effects. However, effects of such impacts are expected to be too small to be meaningfully measured or detected. Fisheries and habitat surveys are expected to result in capture or entanglement of Atlantic sturgeon. Repair and maintenance activities would be similar to activities evaluated for noise and habitat disturbance/modifications. Other effects could result in displacement of fishing activity outside the Lease Area or shifts from mobile to fixed gear. However, fishing displacement or gear shift would not increase risk for Atlantic sturgeon. Unexpected/unanticipated events, including vessel collisions or allisions, WTG failure, oil spills, and UXO encounters, would be extremely unlikely to occur, making their effects extremely unlikely to occur. Given that fisheries and habitat surveys are expected to result in capture of Atlantic sturgeon, the Proposed Action is *likely to adversely affect* Atlantic sturgeon.

7.4. Climate Change Considerations

As described in Section 4.3, climate change could affect ESA-listed species in the action area. Warming water temperatures associated with climate change could affect distribution of ESA-listed species or their prey, for species whose distribution is largely governed by water temperatures. Water temperature is generally not the most significant determinant of habitat usage for marine mammals. However, prey species distribution for some marine mammal species is affected by water temperatures. Recent changes in NARW distribution may be attributed to changes in the distribution of copepod prey in response to changing climate (Record et al. 2019). Warming may negatively impact the abundance of *Calanus* copepods, primary prey for NARW, on the Northeast U.S. shelf in the coming decades (Grieve et al. 2017), which could potentially reduce NARW foraging in the action area. Climate change is not expected to affect NARW use of the action area for other critical functions and is not expected to reduce the overall effects on NARWs associated with the Proposed Action. Climate change is not expected to have a measurable effect on usage of the action area by other ESA-listed marine mammal species and is therefore not expected to change the effects of the Proposed Action on these species.

Seasonal usage of the immediate Project area by ESA-listed sea turtle species is largely governed by water temperatures. Warmer water temperatures could increase the period of time in which sea turtles are likely to occur in the immediate Project area. However, any increase in the likely period of habitat use is expected to be small. Therefore, climate change is not expected to change the effects of the Proposed Action on ESA-listed sea turtle species.

Atlantic sturgeon exhibit seasonal migrations that are influenced by water temperatures, among other environmental and biological cues. Based on the large geographic distribution for Atlantic sturgeon, anticipated changes in water temperatures over the life of the Proposed Action are not expected to result in changes in use of the action area by Atlantic sturgeon. Habitat use by other ESA-listed fish species in the action area is largely governed by factors other than temperature. Therefore, climate change is not expected to change the effects of the Proposed Action on ESA-listed fish species.

Table 31 Summary of Effects of Proposed Action on ESA-Listed Species in the Action Area

Species	Noise	Vessel Traffic	Habitat Disturbance/ Modifications	Air Emissions	Port Modifications	Repair and Maintenance Activities	Other Effects	Unexpected/ Unanticipated Events
Blue whale	NLAA - Discountable	NLAA - Discountable	No effect	No effect	No effect	No effect	No effect	No effect
Fin whale	LAA	NLAA - Discountable	LAA	No effect	No effect	NLAA - Insignificant	Insignificant	NLAA - Discountable
North Atlantic right whale	LAA	NLAA - Discountable	LAA	No effect	No effect	NLAA - Insignificant	Insignificant	NLAA - Discountable
Rice's whale	NLAA - Discountable	NLAA - Discountable	No effect	No effect	No effect	No effect	No effect	No effect
Sei whale	NLAA - Discountable	NLAA - Discountable	No effect	No effect	No effect	No effect	No effect	No effect
Sperm whale	LAA	NLAA - Discountable	LAA	No effect	No effect	NLAA - Insignificant	No effect	NLAA - Discountable
Green sea turtle (North Atlantic DPS)	LAA	NLAA - Discountable	LAA	No effect	NLAA - Insignificant	NLAA - Insignificant	NLAA - Discountable	NLAA - Discountable
Hawksbill sea turtle	NLAA - Discountable	NLAA - Discountable	No effect	No effect	No effect	No effect	No effect	No effect
Kemp's ridley sea turtle	LAA	NLAA - Discountable	LAA	No effect	NLAA - Insignificant	NLAA - Insignificant	NLAA - Discountable	NLAA - Discountable
Leatherback sea turtle	LAA	NLAA - Discountable	LAA	No effect	NLAA - Insignificant	NLAA - Insignificant	NLAA - Discountable	NLAA - Discountable
Loggerhead sea turtle (Northwest Atlantic Ocean DPS)	LAA	NLAA - Discountable	LAA	No effect	NLAA - Insignificant	NLAA - Insignificant	NLAA - Discountable	NLAA – Discountable
Atlantic salmon (Gulf of Maine DPS)	NLAA - Discountable	NLAA - Discountable	NLAA - Discountable	No effect	NLAA - Discountable	NLAA - Discountable	NLAA - Discountable	NLAA - Discountable
Atlantic sturgeon (Gulf of Maine, New York Bight, Chesapeake Bay, Carolina, and South Atlantic DPSs)	NLAA - Insignificant	NLAA - Insignificant	LAA	No effect	NLAA - Insignificant	NLAA - Insignificant	NLAA - Insignificant	NLAA - Discountable
Giant manta ray	NLAA - Discountable	NLAA - Discountable	No effect	No effect	No effect	No effect	No effect	No effect
Oceanic whitetip shark	NLAA - Discountable	NLAA - Discountable	No effect	No effect	No effect	No effect	No effect	No effect
Shortnose sturgeon	NLAA - Discountable	NLAA - Discountable	NLAA - Discountable	No effect	NLAA - Discountable	NLAA - Discountable	NLAA - Discountable	NLAA - Discountable

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